Analysis of Impacts of Geotechnical Investigation on Construction Projects Performance, Case Study: Rwanda

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Abstract: ***Construction industry is a huge area where many investments have been made so far and will still be so, but changes during the construction phase generate cost growth, quality changes, schedule delays, scope changes and claims in any project. However, one of the areas that causes variations related to the impact of geotechnical problems on construction costs, schedules, quality and claims in construction projects but still no deep analysis or investigation had been done. A survey conducted on 102 engineers from public, private, and contractor consultant's engineers has been completed within three months ended in March 2019. It has been found that the geotechnical investigation affects not only the quality of construction project but also cost, time and scope prior to the scale at which it is completed. The root causes of the impacts rely on misunderstanding and negligence related to initial investment required during predesign and implementation phases. The most affected aspects of project performance identified are quality, schedule, scope and project schedules, which result to project claims. The majority of the respondents stated that these geotechnical-related parameter like shear strength of soil, Soil Particle distribution, Compaction, Soil Permeability, Soil bearing capacity, SP and bore hall cause negative impacts on cost and schedule growth of projects during construction. When asked about geotechnical guide document that facilitate to predetermine the needful parameters and cost implication in predesign phases, only 15% have acquired otherwise 85% do not have any document nor guide hence resulting to bypassing the practice securing project fund that at the end of the day is spend will a lot of remedial works and cost implication. Respondents revealed that the designer having detailed knowledge about the project site's geotechnical information, such so predefine and predict ahead impacts related to soil and ground and underground conditions for construction project appraisal and fund raising that will cover all cost related otherwise unpredicted impact remain surprise to both clients and contractors***

Index Terms: Geotechnical Investigation, Construction Projects Performance, Quality, Cost, Schedule and Scope.

I. INTRODUCTION

Most construction projects are successfully implemented if meet planned cost, quality and time however, construction projects cannot be fully implemented without experiencing some variations that at the end of the day compromise the project performance. Variations may be raised from either scope changes. Apart from major issues that can results into construction project variation, inaccurate geotechnical investigation for construction project site has been set apart however it is a issue to be addressed to reduce project risks toward time, cost quality expectations. A part from liking the poor performance of construction project to either poor design or poor management there is no elaborated correlation defining or liking the construction project failures to geotechnical parameters as root cause of problem of construction projects so as to set a guideline usable the project development [1].

II. BACKGROUND

To some degree each construction project is unique no two jobs are the same. Each project in its specifications and structure is enrolled to suit the unique environment and should be arranged to perform its own particular function, and designed to reflect personal, client or institutional tastes and preferences [2]. The whimsies of the construction site and the possibilities for creative and utilitarian variation of even the most standardized building product combine to make each construction project a new and different experience. The research main objective was to evaluate impacts of geotechnical investigation toward the success and poor performance of construction projects in Rwanda and come up with the guideline to mitigate the related variations, cost and time overruns and quality mostly occurring to in construction projects. The specific objectives included to assess the extent to which geotechnical study affects construction project performance, to segregate of parameters of geotechnical nature that highly affect project quality, time cost and scope, to examine the effective usage of geotechnical information throughout the project lifecycle, and to evaluate the geotechnical risks associated to each parameter and scale at a which it affects construction project performance [3].

III. LITERATURE REVIEW

A. Cause of Project Failures

The Major Project Association (MPA, 2003) identifies the major reasons for project failure as poor project definition, unclear objectives, unrealistic targets, inadequate risk evaluation, client inexperience, poor forecasting on demand, lack of effective sponsor and strong leadership, poor communication and lack of openness, inadequate stakeholder management,

Revised Manuscript Received on May 15, 2019.

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management focus wrongly targeted at the back end rather than at the front-end of the project. On the other hand, poor design resulted from applying assumptions due to inaccurate geotechnical investigation can be a higher potential to result in project successfully executed with more variations that affect construction project quality, cost and time however smart and tough the project management applied. The construction process is subject to the influence of highly variable and sometimes unpredictable factors [2].

B. Project risks

Researchers have argued that there is no construction project without risk, implying that in some instances, construction projects are completely unpredictable. Risk can be managed, minimized, shared, transferred, or accepted but it cannot be ignored [3].

C. Factors Affecting Cost and Time Performance

[4] stated that a number of unexpected problems and changes from original design arise during the construction phase, leading to problems in cost and time performance. It is found that poor site management, unforeseen ground conditions and low speed of decision-making involving all project teams are the three most significant factors causing delays and problems of time performance in local building works. It has been so far discussed that cost and time performance has been identified as general problems in the construction industry worldwide.

D. Geotechnical investigation

Geotechnical investigation is performed to evaluate those geologic, seismologic, and soils conditions that affect the safety, cost effectiveness, design, and execution of a proposed engineering project. Insufficient geotechnical investigations, faulty interpretation of results, or failure to portray results in a clearly understandable manner may contribute to inappropriate designs; delays in construction schedules, costly construction modifications, and use of substandard borrow material, environmental damage to the site, post-construction remedial work, and even failure of a structure and subsequent litigation [5].

Geotechnical investigations for proposed sites should be generally divided into three separate phases to minimize costs and for developing the necessary data at each stage of the approval, design, and construction of a project including preliminary Investigations (Adequate information to justify site selection and preliminary cost estimates), initial Design Investigations (Information necessary to obtain regulatory approvals, refine cost estimates, and develop engineering and environmental data), and final Design Investigations (Information necessary for developing plans and specifications, obtaining bids, and constructing the project [5]).

E. Factors influencing the selection of methods of investigation

According to US Army Corps of Engineers (2001), there are factors influencing the investigation approach to such as nature of subsurface materials and groundwater conditions, size of structure to be built or investigated. scope of the investigation, e.g., feasibility study, formulation of plans and specifications, purpose of the investigation, e.g., evaluate stability of existing structure or design a new structure, complexity of site and structure, topographic constraints, difficulty of application, degree to which method disturbs the samples or surrounding grounds, budget constraints, time constraints, environment requirements/consequences, political constraints [5].

F. Construction and geotechnical investigating interrelationship

Geotechnical investigation in construction is necessary during preconstruction Engineering and Design Studies due to the following: Preconstruction engineering and design (PED) studies are typically initiated after a feasibility study has been completed. PED studies are developed to reaffirm the basic planning decisions made in the feasibility study, establish or reformulate the scope of the project based on current criteria and costs, and formulate the design memoranda which will provide the basis for the preparation of plans and specifications. Figure 2-3 schematically outlines the engineering tasks for the PED studies with the requirements for geotechnical information [6].

IV. RESEARCH METHODOLOGY

The methodology used included mainly a collection of necessary information relevant to the study and chiefly of literature review, design tool analysis, questionnaires and interviews, analysis of collected data, interpretation of results and drawing the conclusion and recommendation. This intended to explore possible impacts and limitations of geotechnical study to construction projects in Rwanda more particular in the City of Kigali on important construction project.

This study consisted of two variables; “Geotechnical study” as independent and “Construction Project Performance” as dependent. In the meantime, in this research, construction projects depend highly on soil condition and geological condition of with in the study are encompassed in geotechnical study, thus, applying geotechnical study and assimilation model can influence construction projects success in Rwanda towards the infrastructure sector sustainable development. The targeted study population consisted of ongoing and/or completed construction site in Kigali City that demonstrated tremendous impact on infrastructure sector development in Kigali city. Companies, client or owner and laboratories involved in testing, design and execution and project handover of such mega projects was part of population of the research project.

The sample size was estimated based on a proportion where it will be calculated with an approximate 90% confidence level, the following formula will be used:

$n_{ir}=(z^2\ p(1-p))/d^2$

Where z=1.645 at 90% of confidence, nir = initial required sample size, p = proportion of the population having the characteristic, and d = the degree of precision. The proportion of the population (p) is unknown from prior research or other sources; using p = 0.5 which assumes maximum heterogeneity.

The degree of precision (d) is the margin of error that is acceptable. Setting d = 0.08, for example, would give a margin of error of plus or minus 8%. Thus, n_ir was calculated to 106.

Questionnaires have been key tools to undertake the data collection process of this research and has been designed based on a feature of geotechnical studies and project performance indicators recommended in construction Project in Rwanda especially in Kigali and will particularly tend to acquire the main objective of this research by answering of the related questions. Few questionnaires have been distributed to some respondents and corrected back to fortune it; whereas data entry and analysis was compiled in the office. We chose to evaluate questionnaire pretesting techniques that are commonly used following initial questionnaire drafting. Expert review and cognitive interviewing are very frequently applied in Federal cognitive laboratories, and we decided to also include the forms appraisal method, which is more systematic than an expert review, but less labor intensive than cognitive interviewing.

V. RESEARCH RESULTS AND FINDINGS

This study has been undertaken to access the extent to which geotechnical study affects construction project performance and findings indicated that geotechnical parameters such Soil Shear Strength which has been found impacting all quality, cost, time and scope of construction project and ranked 1, while soil bearing capacity has been found affecting much time, cost and quality. In additional to that organic matter has been ranked number 2 to affect time and quality performance. Otherwise SP and Bore hall their impacts has been identified important on quality and time performance and scope.

Since the targeted parameter has been found be significantly affecting quality, cost, schedule and project scope at different scale and stage, attention must be made to them at early age to ensure sustainable mitigation measures have been take at project pre-mature age Segregation of parameters of geotechnical nature that highly affect project quality, time cost and scope must be done vis à vis to weight of effect it has on above construction project performance factors.

Through examining the effective usage of geotechnical information throughout the project lifecycle. It has been observed that most of people do geotechnical investigation for project as part of project document but not as quality, cost, schedule and scope control tools hence the reason why risks associated to geotechnical investigation remain vital.

VI. CONCLUSION

While evaluating the geotechnical risks associated to each parameter and scale, at which it affects construction project performance it is concluded that geotechnical parameters are associated by how they contribute to geotechnical risk where by ranking of risks associated to geotechnical parameters have noticed.

Through this research, the following recommendation has been drawn to address the issue related to construction project performance. To consultant: All geotechnical parameters related that impact project performance here we mean quality, cost schedule and scope must be clearly done before any decision for implementation is done otherwise challenges related to cost, time, schedule and scope overrun will remain. To Developer: Documentation related the size, quality and quantity of geotechnical investigation must be look at and financed for clear information on which decision related to successful construction project implementation. To Client: Clients are recommended to think on project investment covering all cost related to deep geotechnical investigation where at least parameters discussed here which are likely to impact project implementation should be invested in to control any cost, time, scope and quality overrun. It is recommended to future studies to assess correlation with other underground conditions in additional to all parameters here investigated to come up with guiding tools and system of geotechnical nature that control quality of project in initialization phase, and to conduct study related to effects of geotechnical investigation vis à vis to post-occupancy phases of construction projects.

ACKNOWLEDGEMENT

I would like to first and foremost thank my All Might God for his work towards regarding me and my Country Rwanda, all professors who took part in my master program studies. I am grateful to my supervisors Dr. Abednego Oswald Gwaya, for the guidance and coaching provided all along the journey, Mr Sylvie UWERA, my brothers and Sister in law. My special thanks go to to Dr Abednego Oswald Gwaya, Dr Stephen O. Dianga's, Dr Titus Kivaa and Dr Githae Wanyona for their contribution towards the successfully completion of the program.

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