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Relationships Between Cost Estimates, Scheduling and Project Success in the Construction Sector

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2020

Abstract

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

Project failure results in adverse productivity and viability of construction organizations. Construction leaders are concerned with project failure because it disrupts construction organizations' ability to be more profitable and sustainable. Grounded in the theory of constraints, the purpose of this quantitative correlational study was to examine the relationship between project cost estimates, project scheduling, and project success. Archival data were collected from 110 construction companies in Liberia. The results of the standard multiple linear regression analysis indicated the full model was statistically significant, $F(2,110) = 40.85$, $p < .001$, $R^2 = .433$. The project cost was statistically significant, $p < .001$; project scheduling was not significant, $p = .286$. A key recommendation is for project managers to exploit relevant project management training and other capacity development efforts to effectively manage project costs and schedules for success. The implication for positive social change includes the potential to utilize saving from cost and schedule overruns for meaningful programs that will lift the poor and vulnerable by restoring their dignity and enhance their standard of living.

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Dedication

I dedicate this work to my family in Liberia and the United States for the support and encouragement. My special dedication to my late mother, the Late Beatrice Sonpon, who guided me throughout my educational sojourn and my dearest friend, the Late Emmanuel Barthen Nyeswa who died few days to receiving final approval. I am grateful to my children, Teakon Williams, Jr., Tealine Williams, Tearina Williams, and Tommy Williams as well as my siblings Emmanuel Williams, Joshua Williams, Dickson Doe, Erica Doe-Miller and all other family members for been there for me in the midst of all the trials and tribulation. Finally, I will like to thank the Almighty God for his merciful blessings in allowing me to reach this stage of my life.

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Section 1: Foundation of the Study

Liberia is challenged by serious infrastructure gaps as a result of 13 years of civil unrest from 1990 to 2013 (World Bank Group, 2018). A study conducted in Liberia by Foster and Pushak (2011) revealed that productivity by 1Liberian firms is reduced by 40% due to infrastructure constraints. To bridge this infrastructure gap, the Government of Liberia and its international partners such as the World Bank (WB), the African Development Bank (AfDB), the European Union (EU), the United Nations and the United States Agency for International Development (USAID), have contributed substantially to Liberia's infrastructure initiatives (World Bank Group, 2018). The implementation of these infrastructures, mainly construction projects, by contractors is plagued with excessive cost overruns and schedule delays (World Bank, 2017). The purpose of this research was to examine the relationship between the predictor variables of cost and schedule and the dependent variable, project success.

Background of the Problem

The construction industry is considered a key driver of economic growth (Renuka & Umarani, 2018). Researchers such as Amoatey et al. (2015) asserted that the construction industry accounts for about 10% of the Gross Domestic Product (GDP) of countries across the globe because of its dominant presence throughout private and public economic activity and development. For example, construction projects throughout Africa between 2013 and 2016 accounted for 5 to 10% of GDP and 10 to 40% of household expenditure (Deloitte, 2016). Over the past 10 years, infrastructure and other

development projects in developing countries experienced major growth given the need for huge investment in construction (Emam et al., 2016).

Globally, the construction environment experienced frequent delays of projects compared to other labor enforced industries (Emam et al., 2016). Cost and schedule overruns represent two of the key project management concerns prevalent in construction projects that contribute to project delays. In many developing countries, including West Africa, construction projects are plagued with mounting cost overruns and schedule delays by contractors (Hatamleh et al., 2018). For example, in Liberia cost overruns can be as high as 100%, while schedule delays are as high as 30% or more (Collier et al., 2015). The *World Governance Indicators* found a correlation between post-conflict countries and corruption regarding infrastructure projects (Collier et al., 2015). In this research, the aim was to analyze two significant project management elements – project cost estimates and project schedule, and their effect on project success.

Problem Statement

Adverse profitability in the construction industry is associated with the organizational leaders ’inability to accurately estimate project costs and manage project schedules (Geetam & Samanta, 2017). Construction costs in post-conflict countries, including Liberia, increased by two times its original value, while schedule delay is 30% higher than the required project completion date (Collier et al., 2015). The general business problem was that some organizational leaders do not understand that unsuccessful construction project completion disrupts organizational productivity and profitability. The specific business problem was that some project managers do not

understand the relationships between project cost estimates, project scheduling, and project success.

Purpose Statement

The purpose of this quantitative correlational study was to examine the relationship between project cost estimates, project scheduling, and project success. The independent variables were project cost estimates and project scheduling. The dependent variable was project success. The targeted research population consisted of three ministries of the Government of Liberia (GoL) including the Ministries of Public Works, Agriculture and Education. This population was suitable for this study because the Ministry of Public Works is the statutory government agency responsible for all infrastructure works in Liberia (World Bank, 2017). Besides, the Ministries and Agriculture and Education work closely with the Ministry of Public Works in implement agricultural and educational-related projects. The implication for positive social change included the potential to utilize savings from overruns and profits from the timely construction of projects for meaningful programs that will lift the poor and vulnerable by restoring their dignity and enhance their standard of living.

Nature of the Study

A quantitative research methodology was employed for this study to explore the relationships between project cost estimates, project scheduling, and project success. Apuke (2017) mentioned that the utilization of the quantitative methodology allows researchers to test hypotheses, look at cause and effect, and make predictions. Researchers tend to use either qualitative, quantitative or mixed methods when carrying

out different types of research (see Rahi, 2017). Quantitative methods involve the use of numerical data to analyze and determine relationships between variables and generalize its findings to a larger population (Albers, 2017). The quantitative approach, therefore, was appropriate because the purpose of this research study is to examine the relationship between cost estimates, project scheduling, and construction project success to generalize to the Liberian construction industry.

A qualitative research methodology was also considered for this research. This methodology, however, is useful for an in-depth exploration of non-quantifiable subjective experiences and interpretation of phenomena (Rahi, 2017). There was due consideration for using the mixed methodology. Mixed-methods research methodology, however, involves the integration of both quantitative and qualitative methods to answer a research question (Thomas et al., 2015). Because this research does not require qualitative inputs, neither qualitative nor mixed methods were appropriate for this research.

To confirm or deny the relationship between project cost estimates, project scheduling, and project success, a correlation design was selected for this study. Researchers use the correlational design to examine the non-causal correctional relationship among variables (Thomas et al., 2015). Besides, A correlational design, therefore, was appropriate for this research study because the main objective of this study was to examine the non-causal correlational relationship among variables.

A descriptive design was also considered for this research. This design, however, does not allow causal or correlative relationships; instead, descriptive designs involve the

identification of a particular phenomenon's attributes using an observational approach (Bacon-Shone, 2015). Experimental and quasi-experimental designs were also under consideration for use in this study. Experimental and quasi-experimental designs, however, are only appropriate when seeking to establish cause-and-effect relationships (Thomas et al., 2015). Besides, experimental designs focus on the investigation of the treatment of an intervention and the subsequent measures of the outcomes of the treatment (Apuke, 2017). Consequently, descriptive, experimental, and quasi-experimental research designs were not appropriate for this study because the focus of this research is to establish a non-causal relationship among variables.

Research Question

What is the relationship between project cost estimates, project scheduling, and project success?

Hypotheses

$H1_0$: There is no significant relationship between project cost estimates, project scheduling, and project success.

$H1_1$: There is a statistically significant relationship between project cost estimates, project scheduling, and project success.

Theoretical Framework

The theoretical framework for this study was the theory of constraints (TOC), developed by Goldratt (1984). Goldratt (1984) developed the TOC as a framework for identifying the most important limiting factor that hinders the achievement of organizational goals. There are four constraints including *physical*, *policy*, *paradigm*, and

market, underlying this theory that may serve as limiting factors for project implementation (Goldratt, 1984). As applied to this study, costs are physical constraints and scheduling issues are policy constraints. Physical and policy constraints were applied for their efficacy in predicting project success. Costs and schedules are part of the triangular or triple constraints where tradeoffs are required among cost, schedule, and scope to achieve project goals.

Goldratt (1990) defined physical constraints as something rigid, and its current state limits the ability to complete work. Project cost, as a physical constraint, serves as a bottleneck for achieving project completion due to project managers ’inability to calculate properly the total cost required for completing a project. Underestimation of cost leads to cost deficit thereby requiring additional funds for its completion. Goldratt (1990) revealed that the total cost concept includes not only material costs but also the cost required for subcontracting, sales commission, customs duties, transportation, and overhead expenses.

Goldratt (1994) asserted that policy constraint is the most commonly occurring constraints that appear among organizational responsibilities, regulations, and purchasing regulations. Project scheduling is policy constraints involving regulatory policy that requires assessing activity duration and critical path analysis to reduce project duration (AlNasseri & Aulin, 2015). TOC in PM includes single project scheduling to reduce project duration, improving control and resource allocation, project risk management, and project cost management as well as monitoring and controlling of resources (Aziz et al., 2019).

Operational Definitions

Cost Overrun: Cost overrun is when the actual cost of a project exceeds the planned cost leading to a deficit (Amoatey et al., 2015).

Cost Variance (CV): Cost Variance refers to the difference between the actual budget and estimated cost. A positive value denotes that the project is operating at a surplus with high-cost performance, while a negative value implies that the project is operating at a deficit. (Wei et al., 2016).

Cost Performance Index (CPI): is the ratio of the planned cost and the actual cost while SPI is the ratio of the planned schedule and the actual schedule for completing the project (Ramasamy, 2015; Wei et al., 2016).

Earned Value Management (EVM): Earned Value Management is a management technique that integrates cost control, resources planning, and management expertise for achieving schedule and technical performance (Wei at al., 2016).

Gantt Chart: Gantt chart is a scheduling technique, frequently used in project management for helping to plan, coordinator, and tracks various tasks identified during the planning stage of the project (Ong et al., 2016).

Network Diagram: Network diagram is a model designed showing activities paths, durations, and critical and non-critical paths of the project (Doskocil, 2016).

Planned Value (PV): Planned value is the budgeted cost of work scheduled (Ong et al., 2016).

Schedule Performance Index: Schedule performance index is the ratio of the planned schedule and the actual schedule for completing the project. An index greater than 1 indicates success, while an index less than 1 indicates failure (Ramasamy, 2015)

Schedule/Time Overrun: Schedule or time overrun is the length of time that a project extends beyond the expected completion date (Adam et al., 2017).

Schedule Variance (SV): Schedule variance refers to the difference between estimated completion time and actual completion time (Wei et al., 2016).

Assumptions, Limitations, and Delimitations

In the process of developing this research study, there were two assumptions, three limitations, and four delimitations. The assumptions were related to the sample size and data collection method while one limitation was associated with the sample size and the other two were to the research design and research method. Three of the delimitations were related to the sample size while the other two to the research design. Most research carries assumptions, limitations, and delimitations regarding underlying theories, designs, data collection shortcoming, and statistical analyses (Theofanidis & Fountouki, 2018).

Assumptions

Assumptions are thoughts that are considered to be true before obtaining the actual evidence from the research (Wargo, 2015). This study was contingent on two primary assumptions. The first assumption was that the organizations sampled for this study represent a broader spectrum of the construction industry in Liberia. This sample population, however, was suitable for this study because the key ministries and agencies of the GoL and the United Nations organizations listed are involved in the

implementation of the majority of the construction projects in Liberia (World Bank, 2017).

The second assumption was that organizations sampled will cooperate in providing needed access to their various databases. This assumption was mitigated by the need to invoke the 2010 Liberian Freedom of Information Act (FOIA) in which every citizen in Liberia has the right to access to public information (Embassy of Liberia, 2010). The final assumption was that databases for organizations sampled will be accurate and reliable. This assumption was mitigated by the fact that most of the databases utilized by government agencies and ministries were financed and vetted by the United Nations organizations and other international partners (Independent Evaluation Group, 2017).

Limitations

Limitations are potential weaknesses or constraints that are beyond the control of the researcher (Wargo, 2015). Every study has limitations specific to methodology and design due to limited access to people, organizations, documents or locations (Wargo, 2015). This study was contingent on two primary limitations. The first limitation was that construction companies in Liberia, a developing country, which may not be representative of the larger construction community in Africa or across the globe. Still, project management practices during the construction or implementation phase of the project remain uniform with a focus on effective utilization of project management strategies that include managing contractors ’performance, controlling costs, and managing project schedules (de Carvalho et al., 2015).

The second limitation was the potential for invalidated databases of selected organizations that may contain unreliable or inaccurate data. This threat was mitigated by the fact that over the years, the Government of Liberia and its international partners have provided support to database development for the reliability of data. Moreover, the organizations involved in this research were either government entities supported by international bodies with the requisite reliable database or the international organization themselves provided the tools and technology to preserve data that are reliable and accurate (Independent Evaluation Group, 2017).

The final and last limitation was the use of the correlational research design which can only establish relationships between the dependent and independent variables, without establishing causal relationships. Therefore, for this study, the analyses was only able to show a positive, negative, or no relationship without providing that change in one variable can lead to the change in the other variable (Thomas et al., 2015).

Delimitations

Delimitations are the boundaries researchers set for the study (Leedy & Ormrod, 2013). The delimitations flow from the implicit characteristics of the design or research method requiring the researcher to make specific choices (Theofanidis & Fountouki, 2018). This study was contingent on four primary delimitations.

The first delimitation was the use of the cost performance index (CPI) and schedule performance index (SPI) as a means of measuring project success. There were other performance indicators for measuring project success including efficiency, the effectiveness of project implementation, sustainability, productivity, impact on the

customer, and relevance of work to society, not considered in this study. The adaption of the CPI performance metrics, unlike the others, is based on its extensive use by the Project Management Institute (PMI) and the United States 'Department of Defense (DOD) as the premier project evaluation tool, using EVM (Kranz, 2015).

The second delimitation was that data collection is restricted to three organizations among the many organizations in Liberia and may not represent the broader construction industry in Liberia. The selected organizations, however, are the major organizations that are involved in construction and other forms of infrastructure in Liberia. For example, the Ministry of Public Works (PMW) selected for data collection is the primary agency for awarding or supervising all construction contracts in Liberia (US Commercial Services, 2017).

The third delimitation was restricting the contract value to $25,000 or above. This approach was necessary for selecting contractors with a broader scope of work. Due to a 14-year civil conflict in Liberia, there existed many micro construction projects below $25,000 mainly for quick-fix intervention for Water, Sanitation, and Health (WASH) and other smaller construction for markets, youth centers, community health clinics, and community schools (Independent Evaluation Group, 2017). The focus of this research was on more substantial interventions including roads, agriculture, education, and health infrastructures.

The fourth and final delimitation was the selection of construction projects within the last five years, from 2015-2019. Since the completion of the civil crisis in Liberia in 2003, there was a sprout of many construction companies to cater to the many post-war

developmental initiatives (Independent Evaluation Group, 2017). In 2010, the Government of Liberia (GoL), with support from the international partners, formulated the revised and validated Public Procurement and Concessions Commission (PPCC) Act, intending to improve procurement processes in line with international standards. Selecting construction companies beyond the production of the new procurement Act is based on the assumption that that the PPCC vetted those contractors within the delimitated timeframe adequately utilizing all the relevant procurement and contract administration measures.

Significance of the Study

Findings associated with this study could add value to businesses in Liberia by allowing organizational leaders to properly understand the relationship between project cost estimates, project scheduling, and project success. Issues relating to project cost estimates are the accuracy of pre-tender estimation and the significant deviation the planned cost and the actual cost (Adafin et al., 2015). Therefore, reliable and accurate cost estimates and adequate planning during the inception stage of the construction projects are vital to all of the project stakeholders including the clients, consultants, and contractors (Lim et al., 2015).

Contribution to Business Practice

Findings from this study could contribute to the existing body of knowledge in the project management area. The study is relevant to business practice because findings will serve as a guide and direction of how project managers can effectively utilize project management concepts to manage cost and schedule. The most relevant aspect of effective

cost and schedule management is the use of quantity surveyors and project management tools including the Gantt chart, work breakdown structure (WBS) for better estimation and schedule planning.

Project management practitioners have pointed to many deficiencies in estimating referred to as suicide tendering is a primary cause for cost overrun in projects (Hatamleh et al., 2018). Without reliable estimates, there is often a gap between the amount available to implement the project and the actual cost of the project referred to as cost overrun (Hatamleh et al., 2018). Moreover, insufficient planning and scheduling of project activities and resources often lead to an adverse effect on project performance (Aziz et al., 2019).

Implications for Social Change (Heading Optional)

The implication for positive social change includes the potential empowerment of Liberian construction companies through knowledge sharing and training to improve cost estimation and schedule for meeting project outcomes. Construction companies achieving project success could realize increased profitability. Savings from overruns could be utilized for implementing meaningful programs that will lift the poor and vulnerable by restoring their dignity and improving their social status.

Moreover, profits from some Liberian first would be essential for fulfilling some Corporate Social Responsibilities (CSR) obligations by companies. CSR is a self-regulating business model that encourages businesses or companies to be socially accountable to the general public and stakeholders concerning economics, social and environmental support (Chen, 2019). Among the CSR obligations, companies might

provide basic social services to residents of local communities. Increased profits could also enhance employment opportunities for many Liberians using the additional income to support their families in facilitating their basic social needs which will enhance their social status and maintain their human dignity.

A Review of the Professional and Academic Literature

This literature review was a synthesis and critical analysis of peer-review articles, journals, government reports, and scholarly seminal books relating to the research variables – project cost estimates, project scheduling, and project success. During the review, there were critical analyses, arguments, and discussions of essential elements of the constructs such as the effect of cost estimates, critical project success and failure factors, and basic project management concepts. A lack of understanding of these two critical project elements - cost estimates and project scheduling - may lead to cost and schedule overruns which often lead to project delays or failure. The entire literature review focused on exploring all of the issues and constraints of the project variables that often affect project implementation and an assessment of other project management concepts and strategies that have to bear on project success or failure.

Organization of the Review

The review was organized into an analysis of the research variables, detailed scrutiny of the research variables, and a synthesis of the other factors that support or influence the research. The research variables consisted of project cost estimates, project schedules, and project success while the research variables supporting features consisted of factors that influence these constructs including project delays and failures, managing

quality, risks and change, and project management and its applications. The research variables supporting features were included to strengthen the research variables' argument and show linkages and relationships. During the review of the research variable supporting features, there was an in-depth analysis of the theoretical framework and its relevance to the research problem.

Strategy for Searching the Literature

There were many alternative searches carried out to find articles, journals, reports, and scholarly seminar books relevant to this research. Overall, there were 231 references from mainly peer-reviewed articles, seminal literature, book, reports, and scholarly literature. 196 of the 231 (85%) of the references were peer-reviewed and fell within the statutory five-year reference period. Most of the references beyond the five-year period were mainly country-related data specific to the research, theoretical framework information and instruments, and other statutory references.

The databases utilized in the literature search included: the Walden Library with searches from ABI/INFORM Complete, Academic Search Complete, Business Source Complete, dissertations, and theses EBSCO eBooks, Emerald Management, Google Scholar, ProQuest Central, SAGE, Premier, Project Management Institute Online, ResearchGate, and ScienceDirect. Many of the journal articles, reports, and scholarly seminar books were peer-reviewed the content focus was on infrastructure or construction projects, their implementations, and factors contributing to their successes and failures.

This literature review is alignd with the problem statement, the purpose statement, and the theoretical framework which were key components of this research. The purpose of this research study was to examine the relationship between project cost estimates, project scheduling, and project success with the aim of generalizing to the Liberian construction industry. The independent variables were project cost estimates and project scheduling while the dependent variable was project success. The key construct of this research was how project cost estimates and project scheduling correlate construction project success.

Overall, this study will add to the body of knowledge regarding the impact of cost estimates and project planning on the success of construction projects globally. The following research question guided the study: What is the relationship between project cost estimates, project scheduling, and project success? The hypotheses were as follows:

$H1_0$: There is no significant relationship between project cost estimates, project scheduling, and project success.

$H1_1$: There is a statistically significant relationship between project cost estimates, project scheduling, and project success.

Theory of Constraints

The theoretical framework for this study was the theory of constraints (TOC), developed by Dr. Eliyahu M. Goldratt in 1984. Goldratt (1984) developed the TOC as a framework for identifying the most important limiting factor that hinders the achievement of organizational goals. There were similar theories considered during this research

including Barnes (1956) *theory of iron triangle,* the Edward (1984) *stakeholders* ’*theory* or the Lidow (1999) *duck alignment theory.*

Barnes (1956) proposed the *iron triangle* as cost, schedule, and scope as inter-rational forces requiring tradeoffs among these variables for success (Pollack et al., 2018). However, project management has evolved due to considerable change from when it emerged as an independent field of research and professional practices to a new paradigm for implementing multi-dimensional and multi-cultural projects (Pollack et al., 2018). Hence, the inapplicability of this theory to this research which focuses on utilizing these three key constraints.

The stakeholder’s theory focused on an effective, efficient, ethical, and more practical way of managing project stakeholders (Harrison et al., 2015). The crux of this theory is fairness, honesty, and generosity to all stakeholders for the purpose of receiving reciprocal services in the interest of the project (Harrison et. al., 2015). This theory, however, does not directly address the key variables included in this research, therefore, was not considered for this study.

Finally, Lidow’s *duck alignment theory* focuses on the sequential implementation of different project actions that a necessary for achieving project success (Lilow, 1999). These sequential actions are initial comprehension, self-motivation, skills, resource management, and communications utilizing the duck alignment approach for success (Onyali, 2017). Oyewobi, et al. (2016) underscored, however, that project complexities, uncertainties and the fragmented nature of construction projects make it almost impossible to implement contemporary projects using this theory.

Given these analyses, Goldratt's *theory of constraints (TOC)* was considered the most appropriate theoretical framework given its direct link to the variables under study. For the TOC, the project manager identifies the most important limiting factor that hinders the achievement of organizational goals and focuses more on the non-restrictive factors for success. Key constraints underlying the theory are physical, policy, paradigm, and market. As applied to this study, costs are physical constraints and scheduling issues are policy constraints.

Goldratt (1990) defined physical constraints as something that is rigid, and its current state limits the ability to complete work. Project cost, as a physical constraint, serves as a bottleneck for achieving project completion due to project managers 'inability to calculate correctly the total cost required for completing a project. Underestimation of cost leads to cost deficit thereby requiring additional funds for its completion.

Goldratt (1994) asserted that policy constraint is the most commonly occurring constraints that appear among organizational responsibilities, regulations, and purchasing regulations. Project scheduling is policy constraints involving a regulatory policy that requires assessing activity duration and critical path analysis to reduce project duration (Aziz, 2019). TOC in PM focuses on linkages of all of the project inputs and activities in a coordinated way to minimize project implementation delays (Bhagdewani, Kanase, & Shinde, 2017). To avoid these delays, Bhagdewani et. al. (2017) stressed that, schedule for project implementation activities should be designed in a way that will ensure regular monitoring, meetings, and stakeholder consultation.

Identifying and analyzing the effects of these constraints at earlier stages of the project provide an opportunity for intervention and decision-making on which constraints to elevate and those to subordinate. Zivaljevic (2015) asserted that the goal of the project manager, using the TOC framework, should be identifying parts of the system or constraints that are relevant to improving performance and system utility. Project managers should ignore or subordinate those constraints that serve as a barrier to system completion, without contributing to the overall project success.

The TOC focuses on the full utilization of two of the three critical elements of project management – schedule, time; and resources, cost (Elhaniash & Stevovic, 2016). Parsons and Isharyanto (2015) highlighted the availability of essential resources to meet project schedules and the ability to maximize resources as two important features in relation to the TOC. Meeting project schedule involves assigning dates and duration to various tasks in a realistic way to meet tight deadlines (Harvard Business Review, 2016). Meeting project timelines, however, is a major constraint in project execution because formulating project schedule requires the knowledge, skills, and technical ability to include estimated duration of activities, sequencing of the various tasks, and establishing effective relationships among the various tasks and activities (Aziz et al., 2019).

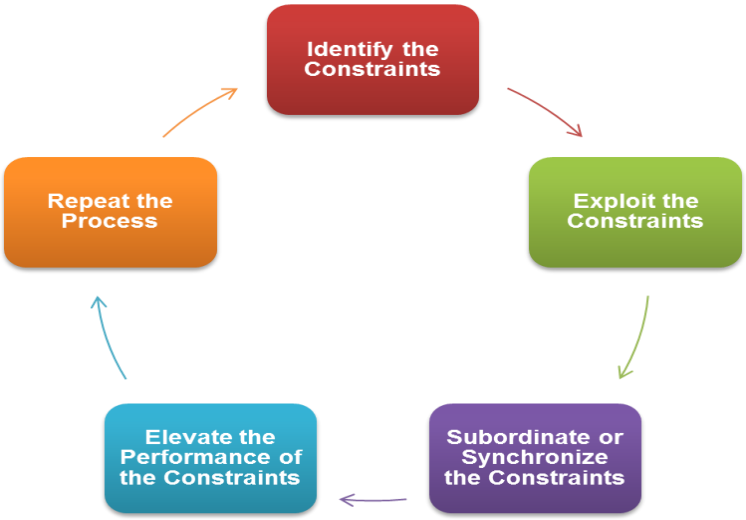
Maximizing resources involves gathering and utilizing all of the people, space, time, tools, and money for the benefit of meeting the project outputs or outcomes (Harvard Business Review, 2016). Górecki (2015) argued, however, that given resource diversities and project uncertainties, resource allocation may lead to conflict between owners and contractors. The two arguments on schedule and resource maximization

necessitate making critical decisions regarding tradeoff or choices between the essential project management components referred to as the *iron trian*gle, *triple constraints* or *triangular constraints* - scope, cost, and schedule (Górecki, 2015).

A basic understanding of various project constraints is essential in reducing the effect that may occur later during project execution. Parker et al. (2015) elaborated that the TOC is essential in identifying the weakest link in the project, exploit the constraints, and provide a strategy that can help mitigate its effect on the project. To this end, Goldratt et al. (2004) provided a 5-step approach referred to as *the process of ongoing improvement* described as a continuous and repeated process in dealing with project constraints and as an impetus of achieving project success.

Figure 1

TOC Five-Step Approach to Dealing with Project Constraints



The first step of the TOC framework, *identify the constraints*, begins with an identification of the various constraints, which include cost, schedule, scope, risks,

resources, quality, and stakeholders. For the second step, *exploiting the constraints*, Goldratt et al. (2004) asserted that project managers (PMs) could subordinate those constraints that are noncritical and elevate those that are critical. For example, in applying the TOC to project scheduling, Goldratt (1997) used Critical Chain Scheduling (CCS) to reduce project duration by focusing on critical project areas and resources, avoiding non-critical constraints.

The third step, *subordinating the constraints*, means that project managers can subordinate or set aside non-relevant or non-critical constraint resources, while they elevate critical or constrained resources, which is the fourth step, referred to in the framework as *elevating the performance of the constraint*. The fifth constraint, *repeat the process*, involves repeating this process if the PMs discover new constraints or bottlenecks. Addressing each of these steps is essential for mitigating critical constraints of this study – cost estimates and scheduling, which usually delay project implementation and result in construction companies ’failure.

Research Variables – Cost, Schedule and Project Success

The three research variables for this study were project cost estimates, project scheduling, and project success. Project cost estimates are all of the resources – materials and human – required to complete the project work (Project Management Institute, 2017). Project scheduling involves displaying all of the tasks/activities relating to the project, resources required to complete these tasks/activities and the timeline for each of the tasks or activities (Atef et al., 2015). Project success relates to the ability of organizations or

firms to achieve their goal based on effective project cost estimates, budget compliance, and adequate project scheduling (Project Management Institute, 2017).

Estimating project costs and schedules are extremely difficult because large projects contain a complex web of cost-influencing factors including material cost, possible design and scope changes, ground conditions, duration, the size of the project, type of client, tendering method, and other technical requirements (Ali & Chew, 2017). A well-controlled project schedule and good estimates are critical for project success in this highly competitive global market because it leads to performance improvement (Colin et al., 2015). However, modern day projects are complex and have many uncertainties, thereby requiring essential cost estimation and schedule management tools including Microsoft Project.

Project Cost Estimates

Reliable cost estimates are essential for completing projects in budget and on time. Some essential elements of reliable cost estimates are bidding strategy, quality of information, estimation method, level of involvement of the project management and risk sharing between the various parties (Hatamleh et al., 2018) Without reliable estimates, there is often a gap between amount available to implement the project and actual cost of the project referred to as cost overrun (Hatamleh et al., 2018).

Cost overrun is the process whereby Actual Cost (AC) exceeds Planned Value (PV) or estimated cost leading to a Cost Variance (CV) requiring an additional amount to complete an infrastructure project. Wei et al. (2016) defined cost overrun as the negative cost variance that exists because the final cost exceeds contract sum leading to conflict,

litigation, or abandonment. Other experts attribute cost overrun in construction projects to factors ranging from technical designs to a deliberate error on the part of the estimators or project managers.

Cost estimates occur in many construction projects because they are often complex and require experienced professionals to manage them. Edwards and Kaeding (2015) asserted that estimating final cost are extremely difficult because of variety of factors ranging from unexpected changes in the costs of materials, labor and other inputs; technical errors; honest mistakes; and other inadequate methods of developing cost estimates.

Globally, there are other exogenous and endogenous factors prevalent in many infrastructure or construction projects that cause cost overruns. Boateng et al. (2015) referred to those factors like inflation, cash flow issues, material price hikes, change in government policies and corruption are all factors that contribute to this global phenomenon. Collier et al. (2015) supported this assertion stating that allegations of fraud, corruption, or collusion in one-fourth of the 500 approved World Bank-financed projects with a road component between 2000 and 2010.

The nature and effect of this phenomenon gave rise to extensive research in different parts of the world to ascertain cost factors and mitigation methods. Overruns are attributed to either poor contract planning and supervision, multiple change order requests or lack of effective communication and coordination among project stakeholders (Asiedu & Adaku, 2019). In Nigeria, for example, overruns in construction projects have an average cost overrun runs of 44.46% and can be as high as 222 percent in Norway

with overruns reaching as high as 91.4% (Saidu & Shakantu, 2017; Olsson, 2015). In Liberia, overruns are as high as 100% due to allegations of fraud, corruption, and collusion (Collier et al., 2015).

The effects of these overruns in monetary terms are staggering. For example, the 2012 London Olympic contract was awarded at £2.4 billion in 2005 but ended up costing £8.9 billion in 2010 (National Audit Office, 2012). Another case of enormous cost value regarding infrastructure projects is the cost of the 32-mile Channel Tunnel Project in the United Kingdom increased from $2.6 billion to $4.7 billion, an 80% increase in the initial cost (Aljohani et al., 2017).

Aljohani et al. (2017) provided additional examples of massive cost variance declaring an overrun of 54% for the construction of the Great Belt Link in Denmark. The Humber Bridge in the United Kingdom had a cost overrun of 175%. The Paris Nord TGV in France showed a 25% overrun while the average price of seven mega-projects in Korea increased by 122.4% of its original budget. In the United States, eight rail projects accrued a cost overrun 61% while the cost overrun for 78 Dutch projects that included roads, rail, tunnels, and bridges experienced a 17% overrun (Aljohani et. al., 2017). This amount in dollar value for infrastructure projects is about $280 million additional amount required for every billion spent (Aljohani et. al., 2017).

Ben Flyvbjerg, a key proponent of issues relating to cost overrun, provided an in-depth analysis using different factors. Flyvbjerg (2008) looked at this phenomenon from three general perspectives – technical, psychological and political-economic. The technical issues related to cost estimation from a perspective of inaccurate and unreliable

data or other technical complications during project implementation that could increase costs. The psychological issues centered on egos, behavioral and social problems that affect judgment regarding conduct and perception of work. The political-economic issues involved the deliberate overestimation of benefits and underestimation of costs to get a contract by all means. Among the three perspectives, it seems that the technical view has gained prominence among many researchers.

Flyvbjerb (2006) assertion on the technical aspects relates to inherent risks and complexities given long planning horizon and complex interfaces. Aljohani et al. (2017) bolstered this statement saying that cost overruns in construction projects are due to lack of technical management resulting from inadequate resource management systems. Amoatey et al. (2015) linked cost overrun to technical issues relating to design changes by consultant or owner, variation orders, inappropriate construction methods and out of date technologies. Eliufoo (2017) supported this assertion stating that the most significant factor contributing to overruns of a budget is an inaccurate estimation of the original or initial cost of the project due to technical problems on how to estimate project cost.

Ephrem et al. (2019) heralded further appraisal of technical difficulties by indicating that cost overrun is a result of technical errors in design or estimation, managerial incompetence, risk and uncertainty, unstable environment condition, and delusion, and project manager incompetence. Oyewobi, et al. (2016) supported this assertion stating that project complexities, uncertainties and the fragmented nature of construction projects make it difficult to track costs and schedule. Additionally, Edwards and Kaeding (2015) emphasized technical problems in projects citing materials, labor and

optimism bias referring to project planner eagerness for positive results by overlooking possible problems.

Researchers in different parts of the world attributed cost overruns in construction projects to almost everything with some of those factors already listed. In a detailed study, it was revealed that there exists 35 different factors such as (a) premature tender documents resulting in ambiguities in different areas including scope of works, and technical designs; (b) too many changes in owner's requirements or definitions resulting in many variation/change orders that increases costs; and (c) Suicide tendering relating to unrealistic low tender-winning pricing (Ephrem et al., 2019).

Some of the remedies for reducing cost overruns in projects suggested by research are the need for project engineers and other project management practitioners to handle designs of technical documents more carefully to reduce the likelihood of added cost and project delays and minimize design errors and other technical irregularities which can help increase project costs. Love et al. (2015) emphasized that cost increases arise from errors in the designs or Bill of Quantities (BoQ) resulting in request change orders. Too many change orders can lead to an increase in actual cost leading to cost overrun.

Other researchers attributed cost overruns in construction projects to low-cost estimates by construction project managers or quantity surveyors. For example, Svejvig and Andersen (2015) asserted that underestimation of contracts during pre-implementation poses a serious challenge to the completion of the project due to cost overrun. Underestimation of project cost leads to a cost variance requiring additional funding to complete the project (Svejvig & Andersen, 2015). This scenario played out in

many construction projects where organizations use low-cost bid as a basis for awarding contracts. The bidders, to win the contract at all cost, often bid lower at their peril. For example, Andersen (2016) reported that the behavior of bidders in the bidding process that would cause systematic bias in final costs is the leading cause of cost overruns.

Project Schedule

Project schedule is a critical aspect of project management for achieving results. It is a schedule that displays all of the tasks/activities relating to the project, resources required to complete these tasks/activities and the timeline for each of the tasks or activities (Atef et al., 2015). Atef et al. revealed that project schedule is the differentiation and clearly defined tasks, responsibilities and due dates of all of the activities required to complete the project on time. The *Gantt Chart* and *Network Diagram* are two important project management tools for effectively estimating activity timelines, critical paths, non-critical paths, and project completion date (Project Management Institute, 2017).

A well-controlled project schedule is critical for project success in this highly competitive global market because it leads to performance improvement (Colin et al., 2015). Effective scheduling would require coordination of the various activities in a manner that required no deviation from the original plan (Colin et al., 2015). Persistent departure from existing plans often leads to rework which further results in schedule overrun (Amoatey et al., 2015). Schedule overrun is considered as the second most important factor (cost overrun as the first) that hamper project success (Amoatey et al., 2015).

Proper scheduling would require long-term and accurate planning by experts knowledgeable in managing simple and complex projects. Amoatey et al. (2015) stressed that inadequate planning by contractors, inappropriate site supervision, and contractors ' experience are leading causes of schedule overruns. Project Managers need to put in place a scheduling framework that will assign a duration to each activity of the project, monitor workflow, and provide feedback loop can help to reduce the probability of schedule overrun.

Schedule overrun is common in construction projects globally. Alade et al. (2016) asserted that consistency in schedule delays in various construction projects is a global problem prompting serious research regarding this phenomenon for decades. Construction schedule delays are mostly identical across developing countries and relate mainly to lack of technology, management, skills and project managers competencies (Zidane et al., 2015). Additionally, Zidane et al. (2015) listed factors such as management style, lack of stakeholder's participation, government policies, resource availability, political situation, working culture, and cash flow availability as key delay factors hampering project execution.

Effective cash flow management is essential for project success. Contractors ' survival in this competitive construction industry hinges on effective cash flow management (Theogene & Claude, 2017). Alao and Godwin (2017) further intimated that poor financial management and ineffective planning can lead to cash flow problems causing bankruptcy and delays in implementation. Therefore, project managers are

encouraged to put in place adequate cash flow plans to predict possible trends in cash utilization and management to avert cash deficits (Alao & Godwin, 2017).

Repeated change order or rework is another key attribute of *schedule overrun* (Andersen, 2015). Project scope change or change order negatively impacts project cash flow and the overall project delivery (Oyewobi et al., 2016). Additionally, it might cause a shift to the original specifications thereby requiring additional funds to offset the cost deficit (Andersen et al., 2016). Oyewobi et al. (2016) recommended new technologies in formulating designs, improvement in contractual procedures and effective review of contract documents as some of the ways of minimizing multiple change order request.

Delayed payment to contractors is another factor for project delays and schedule overrun (Akinsiku & Ajayi, 2016). Most construction companies finance their projects through bank loans with payment terms and therefore, delays in payment can lead to additional interest and cash deficits. Akinsiku and Ajayi (2016) stressed that construction companies' ability to make projects hinges on their ability to service their debts through revenue generation capacity and other fundamental investment decisions.

Planning and scheduling are deemed the hardest aspect of the construction process in dealing with uncertainty at project inception (Aziz et al., 2019). Adequate project planning and scheduling are essential for minimizing schedule overruns. Given the interrelationship between these factors, any mistake in utilizing them can lead to serious project delays (Aziz et al., 2019). Thus, thorough planning and scheduling are required to ensure the success of the project.

Inadequate planning by contractors often leads to uncoordinated workflow resulting in schedule overrun (Ephrem et al., 2019). Lind and Brunes (2015) intimated that planning and scheduling deficiencies during the initiation and planning phases have the highest impact on cost performance from the clients, consultants, and contractors ' perspectives. Therefore, adequate planning of project resources and its utilizations are paramount to the success of the project.

Some methods proposed by project management experts for proper schedule control are the use of Project Management Software (Microsoft Project) using *Gantt Chart* or *Network Diagram*, and Earned Value Management (EVM). Henry Gantt, a consultant hired by the United States Army in 1917 developed the *Gantt Chart* to help the Army prepare for entry in World War One (Doskocil, 2016) while the United States (US) Department of Defense (DoD) developed the Earned Value Management (EVM) in the 1960s (Project Management Institute, 2017)

Gantt Chart is a scheduling technique, frequently used in project management for helping to plan, coordinator and tracks various tasks identified during the planning stage of the project (Ong et al. 2016). The network diagram is a model designed showing activities paths, durations and critical and non-critical paths of the project (Doskocil, 2016). The *Gantt Chart* and *Network Diagram* are two important project management tools for effectively estimating activity timelines, critical paths, non-critical paths, and project completion date (Project Management Institute, 2017). The critical paths is the most relevant for estimating the actual time required to complete a project (Doskocil, 2016)

Project Success

Project success relates to the ability of organizations or firms to achieve their goal based on a given strategic framework or some basic outcomes. It is measured using project quality, timelines, budget compliance, and the degree of customer satisfaction (Project Management Institute, 2017). Project success variable for this research was *cost performance index* (CPI). Cost control and schedule management are essential indicators for achieving project success. Oyewobi et al. (2016) underscored that cost and schedule performance on construction projects remain the primary measures of the success of construction projects.

Construction organizations ’survival hinges heavy on their ability to manage project costs at the planning stage of the project. Geetam and Samanta (2017) averred that adverse profitability in the construction industry is associated with the organizational leaders ’inability to accurately estimate project costs and manage project schedules. Managing project costs, however, is a huge challenge for many project managers given project complexities and uncertainties. To effectively control project costs and resources, Project Management should develop effective project plan that include other subsidiaries plans like procurement plan, monitoring plan, risks plan, and change plan. Yang and Chen (2015) asserted that controlling project expenses within approved budgets is a major challenge to project managers and even to a firm’s management. Effective cost management is an incentive for organizational success and profitability.

Despite the focus on cost management as a measure of success, many project management professionals, however, advised that project owners should look at project

success from different dimensions. For example, de Carvalho et al. (2015) reported a correlation between organizational efforts in improving project management (PM) practices and project success. Systematic PM toolkits and models and the sequential application of structured processes and standardized practices are essential for achieving project success (De Carvalho et al., 2015).

Renuka and Umarani (2018) highlighted additional attributes in the form of social and political contextualization of performance in project management. Social and political context of performance relates to external influences by clients, project manager and scope, and schedule and budget which are critical to project success and failure (Serrador & Turner, 2015). In summary, project success incorporates all attributes that produce business-oriented results, sustainability, and customer satisfaction (Serrador & Turner, 2015). Project managers' inability to adequately manage these variables often lead to project failure.

Construction Delays and Project Failure

Delays in construction projects are global phenomena becoming a norm rather than an exception (Theogene & Claude, 2017). Hammadi and Nawab (2016) grouped delays in construction projects into two major categories – internal and external. Internal categories involve the major stakeholders associated with the project – clients, consultants, and contractors, while external categories relate to those conditions beyond the control of the projects including external factors like earthquakes and global inflation (Hammadi & Nawab, 2016).

Researchers attributed construction delays to many factors ranging from low estimates to poor site management. McCord et al. (2015) attributed these delays mainly to deficiencies in site management, ineffective communication strategies, and lack of communication between the key stakeholders - clients, contractors, and consultants. Hammadi and Nawab (2016) revealed that many reasons including designer changes or errors, economic conditions, unavailability of resources, are some of the many reasons for delays in construction projects in both developed and underdeveloped countries.

Islam and Trigunarsyah (2017) named improper planning and scheduling as the most dominant in developing countries. In 28 developing countries from Southeast Asia, Middle East, and Africa, project delays are attributed to factors such as ineffective site management, poor communication among stakeholders, inadequate contract management, cash flow issues, and numerous change request (Islam & Trigunarsyah, 2017). Overall, delay factors are similar in various parts of the world including developed, developing, and underdeveloped countries.

In the United Kingdom, a vastly developed country, for example, delays are attributed to poor site management and supervision and poor project management. Similarly, in Vietnam, an underdeveloped country, delay factors are attributed to the same attributes as the United Kingdom (McCord, 2015). In Liberia, project delays are commonplace because most of the contracts lack penalty clauses and other inputs that can deter contractors or consultants from minimizing delays. For example, Collier et al. (2015) emphasized that in South Saharan Africa, including Liberia, 62-65% of local contractors perform worse and experience long levels of delays.

To put in proper perspective, McCord (2015) listed country-based construction issues causing delays in construction projects taking into consideration both developing and developed countries.

Table 1

Delay Factors in Construction Projects per Country

Country	Source	Construction Type	Attributes Affecting Delays
United States	Bordoli and Baldwin (1998)	Construction Project	• Weather, labor supply, and sub-contractors,
Thailand	Ogunlana et al. (1996)	Construction Project	• Materials procurement, waiting for information, laborers/tradesmen shortages, poor contractor management and planning and scheduling deficiencies.
Indonesia	Kaming et al. (1997)	High-rise Project	• Design changes, poor labor productivity, inadequate planning, materials shortage and inaccuracy of materials estimate.
Lebanon	Mezher and Tawil (1998)	Construction Project	• Cash problems during construction, design change by owner, preparation of shop drawings, and • Preparation of scheduling work and lack of personnel training and management support
Saudi Arabia	Al-Khalil and Al-Ghafly (1999); Assaf and Al-Hejji (2006)	Public Utility and Construction Projects	• Delay in progress payments by the owner, • Difficulties in obtaining work permits, • Delay in the settlement of contractor claims by the owner, • Effects of subsurface conditions (type of soil, utility • lines and water table), and

			• Cash flow problems faced by the contractor
Australia	Walker and Vines (2000); Love et al. (2005)	Residential and Building Construction	• Construction management effectiveness, • Team communication effectiveness and teamwork, • Design team's management style, • Intra-team working relationships and procurement method and • Design, change orders
Jordan	Ayman (2000) & Al-Momani (2000); Sweis et al. (2008)	Construction Projects	• Poor design and negligence of the owner, change orders, weather conditions, site conditions, late delivery, economic conditions and increases in quantities • Poor planning and scheduling of the project by the contractor, financial difficulties faced by the contractor, too many change orders from owner.
Ghana	Frimpong et al. (2003)	Construction Projects	• Monthly payment difficulties, poor contract management, material procurement, inflation, and contractor's financial difficulties
Kuwait	Koushki et al. (2005)	Residential Projects	• Change orders, financial constraints, owner's lack of experience, materials and weather

Malaysia	Abdul-Kadir et al. (2005); Sambasivan and Soon (2007), Shehu et al. (2014) & Alaghbari et al. (2007)	Residential and Construction Projects	• Material shortage at project site, non-payment (financial problem) to suppliers causing the stoppage of material delivery to site, • Change order by consultants causing project delay, • Late issuance of construction drawing by consultants and incapability of contractor's site management to organize site activities
Hong Kong	Lo et al (2006)	Civil Engineering Construction	• Inadequate resources due to lack of capital, unforeseen ground conditions, exceptionally low bids, and • Inexperienced contractor and works in conflict with existing utilities.
India	Iyar and Jha (2005)	Construction Project	• Commitment of project participants, owner's competence and conflicts amongst project participants
United Arab Emirates	Faridi and El-Sayegh (2006)	Construction Project	• Shortage of labors, delay in progress payments by owner, type of project bidding and award, and • Unqualified workforce and late in reviewing and approving design documents by owner
Nigeria	Aibinu and Odeyinka (2006)	Construction Project	• Contractors' financial difficulties, clients' cash flow problem, architects' incomplete drawing, and • subcontractor's slow mobilization and equipment breakdown and maintenance problem
Vietnam	Long et al (2008)	Construction Project	• Poor site management and supervision, poor project management assistance, financial difficulties of owners, financial difficulties of contractor and design changes

Egypt	El-Razek et al. (2008)	Housing Construction	• Financing by contractor during construction, delays in contractor's payment by owner, • Design changes by owner or his agent during construction, partial payments during construction, and • Non-utilization of professional construction/contractual management
Pakistan	Azhar et al. (2008)	Construction Project	• Macroeconomic factors, management factors and business and regulatory environment
Gaza Strip	Enshassi et al. (2009)	Construction Project	• Strikes, external or internal military action and border closures; lack of materials in markets; • Shortage of construction materials on site; delay of material delivery to site; and cash problems during construction
Zambia	Kaliba et al. (2009)	Road Construction	• Delay payment, finance process, financial difficulties, contract modification, economic problems, material procurement, changes drawings, staffing problems, equipment unavailability, • Poor supervision, poor coordination on site, changes in specifications and labor disputes and strikes.
United Kingdom	Olaware and Sun (2010)	Construction Project	• Poor site management and supervision, poor project management assistance, financial difficulties of owners, financial difficulties of contractor and design changes
West Bank	Mahamid et al. (2011)	Construction Project	• Political situation, segmentation of the West Bank and limited movement between areas, award project to lowest bid price, and • Progress payments delay by owner and shortage in equipment

Turkey	Kazaz et al. (2012)	Construction Project	• Delay causes, design and material changes, and • Delay of payments and cash flow
Singapore	Hwang et al. (2013)	Public Housing	• Site management coordination amongst various parties, design changes by owner during construction, and
Liberia	(Collier, et al., 2015).		• Unit costs are higher in conflict countries thereby causing large disparities in unit cost for comparable road work activities and schedule delays; • Costs are higher in countries with high levels of corruption which often lead to delays.

Note: Summary of Research Evidence. Adapted from "Understanding delays in housing construction: Evidence from Northern Ireland," by J. McCord (2015) *Journal of Financial Management of Property and Construction, 20*, 289-291.

Table 1 is a display of reasons and conditions for project delays in different parts of the world. It is further revealed that there is global attention placed on construction delays resulting from factors such as cost estimation, inadequate schedule, technical designs, excessive use of variation orders, and unavailability of labor. Mpofu et al. (2015) placed specific reference on the three main stakeholders of the project – clients, consultants, and contractors – revealing that they need to change their business practices to ensure timely delivery of projects. McCord (2015) placed the most blame on the client

stating that owners or clients make frequent design changes due to economic conditions and customer requirements. These changes affect the scheduling and plan of contractors often leading to construction delays (McCord, 2015). Mpofu et al. (2017) provided additional factors for construction delays as unrealistic contract durations, poor labor productivity, and complexity of project designs.

Construction delays can be averted when project managers follow basic project management guidelines and techniques. McCord (2017) listed some of these guidelines as to proper site management, effective communications, and coordination of key stakeholders involved in the construction process. Moreover, effective project management, resource availability, adequate cash flow, and improved designs are essential elements for minimizing project delays (Alade et al., 2016).

Construction delays often lead to project failure. Project failure is the inability to deliver the required product or service based on the required cost, scope, or timeline (Aziz, 2019). Construction projects ’failures are as a result of many factors ranging from lack of planning, poor scope, poor stakeholder management, under-estimation of project cost, among others (Tillman et al., 2018). Other factors necessitating project failure are poor quality contract documentation, poor and unbridged communications gap, lack of proper monitoring and evaluation, and ineffective coordination and integration of project component (Oyewobi et al., 2015) For example, political pressure, production methods and lack of collaboration between the client and contractors were considered attributing causes of the 1986 *Space Shuttle Challenger*’*s* failure (Pflugfelder, 2018).

Project management practitioners summarized all the different construction failures factors into cost control and project scheduling. Hwang et al. (2015) asserted that regardless of management competence and financial strength of the contractor, project success hinges on accurate cost estimation at the earliest stage of the project is essential in minimizing cost overrun. Besides, effective planning, controlling and managing of risks, and controlling change requests are essential to achieving project success (Laufer et al., 2015). The utilization of lessons learned and experience is also critical to the success of the project (Pflugfelder, 2018).

Project failures are prevalent in organizations where top management is disengaged from the initial aspects of the project. Huemann et al. (2016) intimated that project failure in many organizations can be attributed to lack of engagement by top management and lack of attention from the organization during the formative stages of the project implementation. Top management involvement at the inception stages of the project is critical in minimizing defects associated with cost estimation, technical designs, and scheduling (Huemann et. al., 2016). Early detection of defects can lead to save costs and enhance project schedule, two key requirements for achieving project success (Wei et al., 2016).

Huemann, et. al. (2016) proposed good coordination and communications, sufficient funding availability, and implementers ’ability to utilize existing project management techniques and methodologies as key to project success. For example, in Liberia, inadequate planning and programming, low institutional capacity to deliver, and limited communications and networks are key factors that hamper infrastructure project

implementation (Hearn, 2016). Technical and capacity building supports for infrastructure personnel, capacity development for assessing life cycle cost, and effective coordination committees are essential in increasing project success rates (Hearn, 2016).

Climate and weather conditions are reported to be one of the main causes of project delays and failures (Ballesteros-Perez et al., 2015). This situation is because weather conditions are difficult to predict and can influence project schedule and cost (Ballesteros-Perez et al., 2015). In Liberia, for example, climate change has impacts on rainfall patterns leading to the unpredictability of project schedules thereby affecting project costs and duration (Ministry of Public Works, 2012). Extreme weather conditions can negatively influence construction activities causing delays for onsite activities (Wedawatta & Ingirige, 2016).

Two key attributes of climate change conditions or changes in weather patterns are productivity losses and schedule delays (Durdyev & Ismail, 2016). Productivity loss is the reduction in an organization's ability to perform (Assiri, 2016). Productivity losses due to weather conditions are influenced by the physical condition of the site -materials conditions, site conditions, snow, low temperature, and weather protection equipment for workers – along with the motivation of the workforce to operate under these extreme conditions (Durdyev & Ismail, 2016). To minimize this effect, project managers should exhibit flexible management practices and promote regular dialogue with site management, and construction laborers (Durdyev & Ismail, 2016).

Unexpected weather conditions or climate change can slow down or stop work which can affect the project schedule (Durdyev & Ismail, 2016). In Liberia, extreme

weather conditions, with persistent rains for up to seven months, affecting productivity and project schedule. For example, the Ministry of Public Works (2012) reported that inconsistent weather patterns are factual and possible threats to the success of construction projects with dramatic seasonal changes aggravated due to changing climate conditions. Heavy rains could become worse and the dry season altered from one year to another with road construction is heavily dependent on the favorable conditions of the dry season (Ministry of Public Works, 2012).

Cost Financing and Cash Flow

Success on any construction project strongly depends on the effective utilization of cash flow (Theogene & Claude, 2017). Cash flow is the balance of received and spent cash over a specific duration (Parnus & Bodea, 2016). Construction companies have the highest possibilities of folding up due to cash-flow problems than other industries (Liu, Zayed, & Li, 2017). In fact, over the past 25 years from 1991-2016, construction companies ’bankruptcy varied between 21% and 30% (Adjei et al., 2018). In good times, consultants ’insolvencies are on average 12.5% while it is up to 60% in bad times (Adjei et al., 2018).

Difficulties in getting extra cash to fill the funding gap created by the negative cost variance often lead to delays and in some cases abandonment or failure of project implementation. Zayed and Liu (2017) suggested updating the project plan to match the situation whenever there are huge discrepancies between actual and forecasted cash flow values. If the project scope is restricted, meaning that the client required no change in the

existing designs, the contractor will have to source the money through additional processes that include bank loans or private sources.

Construction project funding deficit is a common problem in Africa. Arewa (2016) asserted that construction deficits are commonplace in Africa given investment deficits in the form of poor infrastructure assets. Competition for scarce financial resources limits access to infrastructure financing (Arewa, 2016). This competing demand leads to some difficulties in accessing loans and other forms of lending (Arewa, 2016).

One of the difficulties in getting the extra cash to fill the cost gap is the lack of access to loans and other lending facilities. Access to financial services is the ability of individuals or organizations to obtain credits, deposits, payments, insurance, and other risk management (Theogene & Claude, 2017). Theogene and Claude (2017) further established that there exists a positive correlation between access to financial services and project success in the construction sector.

In Liberia, for example, the use of bank guarantee, as a means of acquiring initial funds to finance the initial portion of the project, is extremely restrictive to contractor's cash flow (USAID, 2008). The controls that the bank imposed on the contractor in terms of access to fund severally limited their cash flow. It also took a considerably longer time for the bank to review work done and provide further approval for funds to be released to close the funding gaps (USAID, 2008).

Access to credit in Liberia remains weak and limited to few borrowers (Oekinget al., 2016). In 2017, Liberia ranked 172 among 193 countries as a place to do business and

scored poorly in two *Doing Business* indicators including how courts resolve commercial and insolvency matters and debt recovery (World Bank, 2017). To improve access to credit, especially for small borrowers, the Central Bank of Liberia strengthened the commercial court, expanding the credit reference system and establishing a collateral registry (Oeking et al., 2016).

Bank institutions in Liberia complained that default in payments is the primary reason for limited access to several construction organizations (Oeking et al., 2016). In Liberia, non-performing loans (NPLs) are above 20% and low profitability by banks continues to be a challenge (African Development Bank Group, 2013). Liberian banks have a limited capacity to assess credit risk, property rights are weak, there are few legal means to enforce debt repayment, and no collateral registry exists (African Development Bank Group, 2013).

Project Management and Application

Project Management is a set of processes that encompasses the tools, techniques, and knowledge-based practices applied to projects, to achieve organizational goals and deliver products or services (Project Management Institute, 2018). Three key elements of project management are cost, scope, and schedule and formed what is known as the *triple constraints*, *triangular constraints*, or the *iron triangle*. Parker et al. (2015) attributed project success to the practical use and tradeoff of the *triple constraints*, *triangular constraints*, or *iron triangle* that include the management of scope, schedule, and cost.

Contemporary project management practices under the banner of “Rethinking Project Management” or “Second Order Project Management”, however, added risks,

resources, quality, and stakeholders to these constraints, thereby increasing these constraints to seven (Project Management Institute, 2018). Tinoco et al. (2016) asserted that project success goes beyond the triple constraints with consideration of the impact on customers, teams, business, new technologies, new market, and future competitiveness of the firm.

Project managers in the past adapted the *project management methodology* (PMM), a management concept designed to allow project managers to carry out a series of iterative steps for project success. Joslin and Muller (2015) asserted that the PMM is intended to provide project managers with the basic steps in achieving more predicable project success rates. Despite adherence to some of the key project management principles, projects still experience delays due to lack of interdisciplinary skills, data inaccuracy, and frequent changes in designs (Tillman et al., 2018).

Project management lifecycle iterative steps include inception, planning, execution, monitoring and control, and closing (Project Management Institute, 2018). Project success determination is utilizing the appropriate methodologies from the inception stage of the project, working closely with all stakeholders to achieve these tasks (Torrijos et al., 2015). Górecki (2015) emphasized the complexities and uncertainties of construction projects thereby requiring project managers to know about seven key project constrain variables – cost, schedule, quality, scope, risk, stakeholders and resources.

A greater understanding and guidance on basic project management concepts and principles can help significantly in dealing with some of the constraints and bottlenecks associated with construction projects. For example, a contractor can improve estimates by

utilizing estimation techniques using either *work breakdown structure* (WBS), where project managers break down work elements or activities to the lowest level known as *work package* for better estimation. (Torp & Klakegg, 2016). Contractors ’ability to use sophisticated methods and analytical tools for better estimation during project inception is essential to the success and viability of the organization (Torp & Klakegg, 2016). Additionally, a contractor can improve its schedule using project management software, Microsoft Project, using the Gantt chart used by many project management professionals for producing effective work schedules (Ong et al. 2016).

Contemporary project managers under the banner “Second Order Project Management” argued that the use of the traditional method is not sufficient to achieving project success but the utilization of contemporary methodologies called *agile project management* (Laufer et al., 2015). Agile project management is a new project management methodology of managing project with enormous levels of flexibility throughout the project’s lifecycle given various complexities (Laufer et al, 2015). Utilizing agile project management effectively reduces execution time and foster learning given the complex project environment (Hoa et al., 2018).

Managing Project Quality, Risks and Change

Project quality management is the process of ensuring that project activities conform to the scope, objectives, and expected performance of the project (Project Management Institute, 2017) Project quality management has become a serious concern of project management practitioners in the construction industry. Concerns regarding

project quality management spiked because small and middle-size firms neglect to include it at various levels of the project management cycle (Acikara et al., 2017).

Project quality management is essential to overall project success because of project complexities and uncertainties which makes project implementation risky. Planning and implementation of effective quality plans and implementation modalities can help prevent or control time and cost-related risks (Project Management Institute, 2017). Finishing a project with the needed quality will provide some advantage to a construction firm in a competitive industry (Mashwama et al., 2017).

Project quality management is a critical segment of ensuring project success. Allen et al. (2016) asserted that the maintenance and implementation of a quality plan that is reasonable, realistic, and meaningfully contribute to the ultimate success of the project. Two aspects of quality management that are very critical are *quality assurance* and *quality control* (Steinman, 2017). Quality assurance focuses on the process and preventing defects before they can even occur whereas quality control is geared towards identifying and fixing defects that occur (Steinman, 2017). Effective quality management including customers ’identification, requirements definitions and specifications, quality planning, assurance, and control are essential in increasing competitiveness and improving performance for a project (Steinman, 2017).

Project quality is becoming a contemporary measure of assessing project feasibility at the inception stage. For example, the European Union employs a preliminary evaluation of the project quantity to decide whether to finance a specific project (Staneva et al., 2015). Eliciting project quality preliminary information is costly

and sometimes cumbersome (Steneva et al, 2015). Knowing the quality of the project at the initial stage using assessment parameters can lead to cost-saving measures using optimizing of projects (Steneva et al, 2015).

The Cost of poor quality in the construction industry is a serious problem given failures in preventing wastage and defect during construction work (Mashwame et al, 2017). Studies showed that the cost of poor quality can eat up to 40% of the total revenue of the construction enterprise (Mashwame et al, 2017). Poor quality also impacts organizational sustainability requiring the rework of the poor-quality job (Steinman, 2017).

To improve project quality, researchers have adopted many success factors including providing effective leadership, team development, effective cash flow, defining quality objectives, and deploying an effective workforce (Mashwame et al, 2017). Additionally, project managers adopt *the total quality management* (TQM), a management process that ensures the involvement of all project participants and quality at every level of the project (Acikara et al, 2015). For example, Project managers usually assume that if the project is accomplished with good quality then the building will also have a good quality (Acikara et al, 2015). In TQM, both the design of the construction process and quality of the construction itself must meet the same quality.

Other methodologies adopted by businesses for project effectiveness are the *Six Sigma* and the *Lean Methodology*, with a combination known as *Lean Six Sigma.* Six Sigma is a disciplined and data-driven approach and methodology designed to minimize defects in project implementation (Thomas, 2018). With the Lean Methodology, the

project manager focuses on various cost-saving mechanisms for profitability (Thomas, 2018). Overall, the *Lean Six Sigma* methodology is an integrated approach designed to make business results more effective for project success (Thomas, 2018).

Risk management and mitigation are an integral part of project execution given its complexities and uncertainties. Risks are an inseparable part of the project given that all of its effective factors are unpredictable and risk management is inevitable (Asadi, 2015). Project managers' neglect of important risk management components often leads to delay in project delivery and an increase in project cost (Asadi, 2015). Project management practitioners recommend the utilization of risk mitigation strategies to avert project delays and possible failure (Renuka & Umarani, 2018).

The overall risk management process is more effective if project managers can identify possible risk factors at the initial stage of the process (Srinivas, 2018). Project Management Institute (2018) outlined the risks management steps as identifying project risks, analyzing project risks, defining and implementing risks response action, and monitoring project risks. Sequencing of these steps as outlined is essential in mitigating project risks.

Risks identification is the first step of the risks management process that involves the utilization of previous or similar projects to access some of the inherent risks associated with a construction project (Srinivas, 2018). Early identification of risks could limit the possibility of adverse outcomes and improve project performance (Biggins et al., 2016). The dynamic nature of the construction projects and the likelihood of risks at any

time during the projects' life cycle make it necessary for a project manager to carry out risk analysis at every stage of the project or contract (Biggins et al., 2016).

Risks analysis, the second step of risk management, focuses on understanding all of the risks identified and their potential effect on the construction industry (Gunduz & Maki, 2016). It is an essential component of the risk management process involving the assessment of all the key risks identified. In doing risk analysis, the project manager can distinguish between those risks that are threats to the project's survival and those that are not. Asadi (2015) asserted that risk analysis is essential in balancing between the loss of threats and the profits earned from opportunities. Inadequate risks assessment and analysis often lead to cost overrun in construction projects especially relating to variances in initial cost and actual cost (Gunduz & Maki, 2016).

A key component of risk analysis is a risk analysis framework that allows for systematic and professional risk evaluation (Ökmen & Öztaş, 2015). A survey of infrastructure practices showed that most investors do not use any risk assessment plan nor adhere to defined risk assessment procedures for analyzing risks threat (Borkowski, 2015). Understanding the relevant risks and uncertainties through a proactive risk management engage will minimize unexpected circumstances that can derail project success (Ökmen & Öztaş, 2015).

Defining and implementing risk response actions involves agreeing to the accepted and agreed risks threshold of the project for risk response (Osadchaya, & Torgayan, 2017). Risk response has to do with reviewing the results of risk analysis to determine how risks with high priority can be reduced (Srnivas, 2018). In so doing,

project managers should put in place a mechanism where some risks can be reduced through proactive measures; others can be transferred to a third party, whereas some risks situation can be accepted due to lack of control (Asadi, 2015).

Project risks monitoring is the process of identifying, analyzing and planning of newly emerging risks, tracking the identified risks, and verification and execution of risk response operation (Osadchaya, & Torgayan, 2017). The objective of risk monitoring is to assess current risks and emerging ones, and making sure that the accurate reaction occurrence, reviewing their effectiveness, and monitoring the risk changes in all stages of the project (Srnivas, 2018). During this process, project managers can eliminate certain risks, repair other risks, and escalate critical risks to the level of the project board (Osadchaya, & Torgayan, 2017).

Change Management (CM) is a very relevant aspect of managing changes in ensuring that projects remain within scope and budget through the regulation of the change process. Most projects experienced changes in designs or scope given the complexities of project designs, usually resulting in design errors. Change management is inevitable in projects given its complexities and uncertainties over time. Oyewobi et al. (2016) underscored that given the complex and fragmented nature of construction projects, it becomes almost impossible to have a completed project without changes to its original plan or the construction process.

Changes in projects emanate from the clients, consultants, or contractors. Fageha and Aibinu (2015) asserted that changes during the construction stage can arise from internal influences due to differences in stakeholders ’perspectives. Such change order

may be incomplete scope definition, or faulty technical designs provided by the client, while others can be external influences such as unpredictable economic cycles, price fluctuations, and project implementation delays affecting the consultants or contractors thereby inducing a change order (Fageha & Aibinu, 2015).

The continued application of change requests can result in scope creep, an uncontrolled change in the scope resulting in increased cost and time. Oyewobi et al. (2016) asserted that change orders have a significant effect on the cost and schedule performance or construction companies of up to 35.95% and 29.45% of original project cost and time respectively. Gobana and Thakur (2017) supported this assertion stating that change order effects on construction projects can increase project cost, induce additional payment for the contractors, extend project schedule, and lead to rework and demolition.

Change management is considered a standard way of managing changes and minimizing its impact (Alexandrova & Kuzmanova, 2017). Change management is not an optional process but a mechanism that would serve as preventive measures for potential changes (Alexandrova & Kuzmanova, 2017). This approach can ensure that change issues are resolved in a timely and systematic manner for the successful execution and good management of the project (Oyewobi et al., 2016).

Project management practitioners proposed the formulation of a *program governance board, change control board or change management board* to facilitate the process of change from inception to its final decision of accepting or rejecting (Project Management Institute, 2017). The role of the program governance or change control

board is to assist the approving authority in the review of change request consistent with projects ’baselines performance requirements, budgeted cost, and schedule (Pollack, 2017). Moreover, the board ensures that the prospective changes are clearly defined and fall within the approved cost, schedule and performance parameters (Pollack, 2017).

Stakeholder Coordination and Managing Project Teams

Stakeholder coordination is another significant aspect of project management requiring coordination and cooperation among the three important elements of the construction project - client, consultant, and contractor. All stakeholders have a very significant role in planning, monitoring, effective site management, communications, design efficiency and contractors' efficiency to reduce cost overruns and improve performance (Ling & Tan, 2015). Stakeholder coordination is also germane to minimizing disputes and unnecessary communications through face-to-face discussions on project issues and way forward. Effective stakeholder management is essential in the delivery of quality output and building rapport (Kelly, 2015).

Most construction projects suffer delays or failures due to a lack of communication and coordination among key stakeholders (Huemann et al., 2016). Continuous engagement among stakeholders in a more integrated and collaborative manner can minimize scope definition problem, design errors, and scheduling problems that are critical to project delivery (Badewi, 2016). The utilization of teamwork and coordination among stakeholders can lead to positive results which a traditional contracting arrangement involving a lack of coordination among stakeholders would not realize (Ling & Tan, 2015).

Construction project implementation at the local level must take into consideration local community members who are also relevant stakeholders. Construction projects at the local or community level do not involve local personnel who are conversant with local terrain, culture, and other socio-economic setups (Forsman, 2017). In many developing countries, contractors engaged in projects at the micro-level with little local inputs. Indeed, research shows that development occurs at the local level where local conditions are respected, funds are available and applicable management methods are communicated (Forsman, 2017).

A Project team is the assembly of individuals with different needs, diverse backgrounds, and expertise in a single group in a project intending to accelerate project activities during a project lifespan (Project Management Institute, 2017). Team building is not restricted to specific organizations but an approach that is essential for promoting coordination among a diverse group of professionals from different backgrounds and cultures (Matthews and McLee, 2015). The project team needs to work together collaboratively for the successful implementation of the project (Badewi, 2016). When forming a team, however, team members must possess not only technical skills but also interpersonal and organizational skills (Harvard Business Review, 2016).

Project Management Institute (2018) listed five stages of team development - *forming, storming, norming, performing,* and *adjourning*. The *forming stage* is the initial meeting of the project team members whereas the *storming stage* is when the team members begin to work together (Project Management.com, 2018). The *norming stage* is when the team members begin to work effectively as a team; the *performing stage* is

when team members are performing at a very high level, while the *adjourning stage* is when the project comes to an end and team members must disperse (Project Management.com, 2018). The *performing stage* is critical to project success because it ensures collaboration, teamwork, and productivity build towards the full utilization of the triple constraints (Whetten & Cameron, 2016).

A project team is essential and powerful because it provides an opportunity of finding unique, creative, and efficient ways to solve strategic business problems by harnessing skills, talents, and experiences from diverse backgrounds (Matthews & McLees, 2015). Leveraging the attributes of different professionals can provide more creative solutions involving brainstorming, problem-solving ability, and other technical efficiencies for achieving organizational outcomes (Matthews & McLees, 2015). A project team leader, responsible for coordinating and collaboration among team members, heads the project team (Project Management Institute, 2018).

A project team leader, head of the project team, is responsible for coordinating and collaboration among team members. The project team leader is responsible for developing credibility, influence, and motivating team members to aspire to the goals and vision of the organization (Whetten & Cameroon, 2016). The team leader also strives to have a balance between task-oriented and relationship-building roles for team effectiveness (Whetten & Cameroon, 2016).

The main responsibility of the project team is to work collectively in a coordinated fashion to minimize wastage of resources, ensure that the projects are delivered according to specification, quality, schedule, and budget requirements (Badewi,

2016). Specifically, the project team works to ensure that: (a) works are aligned with project strategic goals and objectives, (b) works are in line with clearly defined scope, budget, and schedule, (c) fostering an environment where members can openly communicate, build mutual respect, promote a culture of collaboration, teamwork, and productivity and, (d) learning diverse talent and background experience (Whetten & Cameroon, 2016).

Despite the importance of forming and managing project teams, there are several drawbacks and constraints. Ibrahim et al. (2014) provided some drawbacks such as self-interest by team members, unclear project objectives and competition over team leadership. Overcoming these barriers will require a strong and effective leader to help direct and lead the team throughout the project lifecycle (Matthew & McLee, 2015).

Procurement Management

Procurement is the acquisition of resources that include goods, services, and works (Project Management Institute, 2017). One of the main objectives of effective procurement is to reduce costs through competition, promoting transparency, safeguarding organizations funds and minimizing or eliminating corruption (Dzuke & Naude, 2017). There are many challenges in managing procurement in construction projects given its complexities and uncertainties. These challenges are evidenced by the size of the projects, the impact of changes to designs and other political and social considerations (Dyili et al., 2018).

Governments, organizations, and others involved in construction procurement mitigate this situation by putting in place an effective mechanism that can mitigate these

challenges. For example, the World Bank developed a detailed Project Procurement Strategy for Development (PPSD) which outlines the various steps and procedures in optimizing the entire procurement process relating to procurement approach, implementation and results. (World Bank, 2016). Similarly, the African Development Bank (AfDB) has in place *Rules and Procedures for Procurement of Goods and Works* outlining the procedures and processes for implementation AfDB projects (African Development Bank, 2015). In Liberia, the statutory body responsible for ensuring the fairness and value for money for procurement activities is the Public Procurement and Concession Commission (Mulbah, 2020).

World Bank (2016) premised procurement on five fundamental principles including value for money (VFM), ethics, competition, transparency, and accountability. Project management practitioners designed the VFM concept in procurement to achieve the best value for money for any goods, services or works purchased. For example, the United Kingdom (UK) Treasury Office in 2005 reported a saving of £20 billion, constituting 2.5% of the 2004 budget within three years (Bowles & Morgan, 2015). These savings were against the use of appropriate procurement methods that will ensure that organizations received optimal values for resources purchased.

Other issues of relevance for procurement are ethics, transparency, and accountability. Ethics in procurement is relevant in ensuring that procurement managers follow proper procurement guidelines and award contracts to deserving contractors or consultants. Dzuke et al. (2017) revealed that a lack of procurement ethics often results in poor procurement decisions which adversely affect the project outcome. Podsakoff et al.

(2009) established a correlation between ethical behavior and project success stating that unethical behavior such as stealing, fraud, and cheating reduces organizational productivity.

Transparency and accountability are also cardinal for ensuring visibility and liability of funds provided for specific reasons. Moreover, transparency and accountability in procurement are testimonies of visibility and openness that lend credibility to the entire procurement process. Agarchand and Laishram (2017) asserted that transparency and accountability are relevant for project viability and non-manipulation of data help reduce costs and lengthy negotiations.

Bribery and fraud are of major concern in the procurement sector. Fraud is considered a deliberate deception to secure unfair and unlawful gain (Smith, 2015) while bribery is considered an act of receiving, soliciting or offering items of value in return for a favor (Smith, 2015). The United States Government Accounting Office (GAO) observed that there are abuse and waste of resources, mismanagement, fraud, and bribery in government procurement processes (Rendon & Rendon, 2016). Accordingly, Smith (2015) stressed that the level of abuse and bribery in procurement have the propensity to thwart organizational progress and retard progress. However, sound procurement systems, policies, and applications have the propensity to foster good governance, corporate social responsibility, transparency, accountability (Rendon & Rendon, 2016).

Earned Value Management (EVM)

Earned Value Management (EVM) is a management technique that integrates cost control, resource planning and management expertise for achieving schedule and

technical performance (Wei at al. 2016). The United States Department of Defense (DoD) developed this tool in the 1960s for assessing cost, schedule and technical progress on programs and to support proactive decision-making as they navigate the day-to-day constraints and risks in infrastructure projects (Kranz, 2015). The Project Management Institute (PMI) adopted the EVM concept in 1999 as a project management technique for cost control and resource planning. (Project Management Institute, 2017).

The United States (US) Government Accountability Office (GAO) later adopted this instrument in June 2005 to establish a consistent methodology, based on best practices, for managing cost and schedule. Today, EVM is a mandatory requirement of the United States 'Government for performance-based management, managing software projects, and audits (McGregor, 2019). This tool is considered one of the DoD's and the infrastructure industry's most powerful program management tools for managing projects in this contemporary era (Kranz, 2015).

In EVM, the project manager integrates the project's scope, schedule, and cost, the three major project management constraints, into a unified set of prescribed metrics for monitoring and forecasting the project's performance (Najafi & Azimi, 2016). Moreover, this metrics is important in calculating cost, schedule and performance indices to predict final project cost and duration (Eirgish, 2019). Kerzner (2017) explained the key metrics of EVM as earned value (EV), planned value (PV), and actual cost (AC). These three matrices are data points used for assessing project performance from a perspective of the cost variance (CV), schedule variance (SV), cost performance index (CPI), and schedule performance index (SPI).

The CV is the difference between the EV and the AC, while SV is the difference between the EV and the PV (Najafi & Azimi, 2016). CV will represent the independent variable, project cost estimates, while SV will represent the independent variable, project scheduling. The CV and SV are essential in monitoring project performance during its lifespan to detect deviation from plans and take corrective measures (Kerzner, 2017). For tracking or performance purposes, the CV and SV help project managers to track project cost and schedule during the project lifespan. If the CV is less than one, then the project is over-budgeted, otherwise, it is under-budgeted. Moreover, if the SV is less than one, then the project is delayed, otherwise, it is ahead of schedule (Najafi & Azimi, 2016).

The CPI and SPI are important indices for monitoring project performance. The CPI is the ratio of the CV to the AC developed to assess whether the budget is over-utilized or under-utilized. If the CPI is less than one, then the project is over-budgeted, otherwise, it is underbudgeted (Wei et al., 2016). The SPI is the method used by project managers to assess whether the project is behind or ahead of schedule. If the SPI is less than one, then the project is delayed, otherwise, the project is ahead of schedule (Wei et al., 2016).

The relevance of these matrices to this study is that I use them to assess relevant quantitative variables for this research. In this research, the CV will represent the variable for assessing cost overrun, one independent variable; the SV will represent schedule overrun, another independent variable, and the SPI for assessing project success. I will attain the CV by subtracting the AC from the EV and attain the SV by subtracting the PV from the EV. I will calculate the SPI by dividing the EV by the PV (Kerzner, 2017).

EVM is considered a preeminent project management tool for performance evaluation and evaluating performance outputs. McGregor (2019) asserted that EVM is a global standard for performance management integrating scope, cost, and schedule to evaluate performance management and evaluation of construction projects. Ong et al. (2016) supported this assertion stating that many project management organizations (PMOs) adopt EVM because project managers use this tool to measure progress accurately and reduce the deviation in the cost and schedule forecast.

Utilizing EVM helps project managers (PMs) to assess early warnings relating to either overbudget, underbudget, schedule delays, or ahead of schedule. Wei et al. (2016) asserted that EVM has been successful in providing PMs with early project troubles and providing remedies to avert catastrophic effects relating to huge cost or schedule overruns. Moreover, EVM application can help PM to comprehensively review and evaluate the overall resource allocation and performance of the project (Wei et al., 2016).

Despite the successes associated with the use of EVM, it is still not widely used in the construction industry because most project managers are reluctant to change from the traditional way of project implementation and have limited knowledge in implementing EVM (Sunarti et al., 2018). Besides, project managers experience difficulties in forecasting the impact of variance and estimates at completion (Sunarti et al., 2018). Another issue of major concern regarding the EVM is that cost and schedule application are not uniform along the project lifecycle (Sunarti et al., 2018)

Key fundamentals of EVM involve the establishment of a *performance management baseline* (PMB) and measuring and analyzing the project performance

against the PMB (Wei et at., 2016). The performance baseline is the standard at which the project's actual cost and progress is compared from start to finish (Project Management Institute, 2017). It involves decomposing the scope of work (SoW) to a manageable level by assignment responsibilities and developing a time-phased budget for each task or activity (Aziz, 2019). It also requires recording resource usage during project execution, objectively measuring physical work progress, analyzing and forecasting cost and schedule performance, reporting performance problems and taking needed corrective action (Project Management Institute, 2017).

Transition

In Section 1, the focus was on issues and problems existing within the construction industry concerning managing costs and effective planning for project success. Key components of this section were the background of the problem, the problem statement, the purpose statement, nature of the study, research question and hypotheses, theoretical framework, operational definition, assumptions, limitations, and delimitations and significance of the study. More emphasis was on the review of the literature including a detailed examination of the theoretical framework. In the literature review, more emphasis was on the synthesis and analyses of the key constructs – project cost estimates, project scheduling, and project success - along with other relevant components of project management that support these constructs.

In Section 2, the focus was on expounding on the data collection method and approach and explaining the approach in ensuring data and study validities. Key areas of this section were the role of the researcher, research participants, research method and

design, population and sampling, ethical research, data collection, data analysis, and study validity. In Section 3, the highlights were the execution of the study to include the research steps, data collection process, the data analysis, and presentation of findings, conclusion and recommendations.

Section 2: The Project

The purpose of this quantitative correlational study was to examine the relationship between project cost estimates, project scheduling, and project success. The emphasis of this section was on restating the purpose statement, explaining the role of the researcher and specifying all of the participants in this research. There was an in-depth discussion on the research method and design, the population and sampling, and ethical considerations for this study. Finally, analyses on the data collection instrument and technique, the framework for data analyses, and a detailed explanation of the study validation was elaborated.

Purpose Statement

The purpose of this quantitative correlational study was to examine the relationship between project cost estimates, project scheduling, and project success. The independent variables were project cost estimates and project scheduling. The dependent variable was project success. The targeted research population consisted of three ministries of the Government of Liberia involved in construction in Liberia. This population was suitable for this study because these key ministries are involved in the implementation of the majority of the construction projects in Liberia (World Bank, 2017).The implication for positive social change includes the potential to utilize savings from overruns and profits from the timely construction of projects for meaningful programs that will lift the poor and vulnerable by restoring their dignity and enhance their standard of living.

Role of the Researcher

My role in this quantitative data collection process was to gather archival or secondary data, organize the data, carry on effective data analyses, verify the data collected, and interpret and report the research findings. After the research and the approval processes, all the research materials and records will be documented and preserved for up to the five years. Finally, the appropriate method, *a priori*, used to determine the right sample size for this research was prioritized.

As stated in the purpose statement, construction data for the two independent variables – cost estimates and project scheduling – was acquired from three key ministries of the Government of Liberia in which I have no linkage. Archival data collection was relevant for this research because its usage minimized the limitations associated with asking research participants to answer questions regarding sensitive data (Barnes et al., 2015).

Bias for this research was minimized because I had no relationship to the topic, research participants and the organizations where I gathered the samples. Researchers ' role is to acknowledge, reveal and minimize, in the best way possible, all possible biases that could affect the research outcomes (Råheim et al., 2016). Elements of the research topic are global phenomena explored by many researchers as evidenced in the literature. There was no direct research participants because the mode of data collection is archival. The data collection process focused on collecting existing secondary data belonging to other entities. Finally, the research area, like the research topic, is a vast area controlled by the Project Management Institute (PMI).

There were no human subjects directly involved in this research because the mode of the research was archival. There was no interaction with human participants because the data collection method was archival. This research did not submit to the Belmont protocol because it involved the collection of archival or secondary data and did not involve direct interaction with human participants.

Participants

Research participants determination are based on specific eligibility criteria and sampling method (Yin, 2018). Participants selected in this research were fully aligned with the research question and constructs. The eligibility criterial for this study was for three ministries of the Government of Liberia (GoL) including the Ministries of Public Works, Agriculture and Education. This population was suitable for this study because the Ministry of Public Works is the statutory government agency responsible for all infrastructure works in Liberia (World Bank, 2017). Besides, the Ministries and Agriculture and Education work closely with the Ministry of Public Works in implement agricultural and educational-related projects. Request for data access was after IRB approval.

Some strategies for accessing the participants were cultivating a relationship with participating organizations and project managers as well as assurance of adherence of ethical standard during the research (Salazar et al., 2015). Additional strategies were assurance of confidentially and anonymity and maintenance of good and cordial relationship with participating organizations throughout the data collection process (Salazer et al., 2015). Some specific safeguards in collecting these data were an

assessment of the integrity of the database and the durability of its use as well as assessing the reliability, and viability of the available data for content and construct validity (Wilms, 2019).

Research Method and Design

The purpose of this quantitative correlational study was to examine the relationship between project cost estimates, project scheduling, and project success. The most appropriate method for assessing relationship among variables was the quantitative methodology using a correlational design. In a correlational design, the researcher can only establish relationships between the dependent and independent variables, without establishing causal relationships (Thomas et al., 2015). This research contained two independent and one dependent, therefore the most effective correlational approach for determining relationships for multivariate was the *multiple linear regression* (MLR), utilizing secondary data.

Research Method

Quantitative research methodology was used for this study. Apuke (2017) mentioned that the utilization of the quantitative methodology allows researchers to test hypotheses, determine relations and make predictions. Researchers tend to use three distinct research methodologies - qualitative, quantitative, and mixed methods (Rahi, 2017). Quantitative methods involve the use of numerical data to analyze and determine relationships between variables and generalize its findings to a larger population (Albers, 2017). The quantitative approach, therefore, was suitable for this research because the purpose of this research study was to examine the relationship between cost estimates,

project scheduling, and construction project success to generalize to the Liberian construction industry.

A qualitative methodology was considered for this study. A qualitative research method is, however, useful for in-depth exploration of non-quantifiable subjective experiences and interpretation of phenomena (Rahi, 2017). Besides, qualitative research also focuses on understanding or interpreting social interaction preferably with smaller groupings (Apuke, 2017). The use of a mixed methodology was also considered for this research. Mixed-methods research methodology, however, involves the integration of both quantitative and qualitative methods to answer a research question (Thomas et al., 2015). Because this research does not require qualitative inputs, neither qualitative nor mixed methods was not appropriate for use in this study.

A quantitative approach was preferred to a qualitative approach because my research variables were numerical. In quantitative research, the researcher relies on collecting quantitative or numerical variables based on precise measurement using structural and validated data collection instruments (Bacon-Shone, 2015). For a qualitative study, the researcher, as the primary data collection instrument, uses an exploratory or "bottom-up" approach, collecting non-numerical data using open-ended in-depth interviews, participant observations and field notes from multiple sources (Apuke, 2017). This approach is unlike quantitative research, which involves using a confirmatory or top-down approach with stated hypotheses and theory based on distinct sets of variables or criteria (Apuke, 2017).

The research methodology for this study was implemented along a continuum from the perspective of a mature theory. Edmonson and McManus (2007) defined mature theory as well-developed constructs and models studied over time by variety of scholars, thereby presenting a united front on their authenticity. Researchers over the years used the quantitative research methodology, utilizing varieties of designs – descriptive, correlational, experimental, and causal comparative – considered as the best approach to social research for research involving the use of numerical data.

In qualitative study, the researcher utilizes words, images, and categories (Bacon-Shone, 2015). Mixed-method research involves the integration of both quantitative and qualitative elements in answering research questions (Thomas et al., 2015). This study contained variables that are quantitative or numerical, thereby making the qualitative or mixed method inappropriate for this study.

Research Design

To confirm or deny the relationship between project cost estimates, project scheduling, and project success, a correlation design was utilized for this study. Researchers use the correlational design to examine the non-causal correctional relationship among variables (Thomas et al., 2015). A correlational design is appropriate for this research study because the main objective of this study was to examine the non-causal correlational relationship among variables.

A descriptive design was considered for this research. Descriptive designs, however, do not allow causal or correlative relationships; instead, descriptive designs involve the identification of a particular phenomenon's attributes using an observational

approach (Bacon-Shone, 2015). Other designs for consideration were the experimental and quasi-experimental designs. Experimental and quasi-experimental designs, however, are only appropriate when seeking to establish cause-and-effect relationships (Thomas, et al., 2015). Besides, experimental designs focus on the investigation of the treatment of an intervention and the subsequent measures of the outcomes of the treatment (Apuke, 2017). Consequently, descriptive, experimental, and quasi-experimental research designs are not appropriate for this study because the focus of this research was to establish a non-causal relationship among variables.

Correlational designs involve the researcher exploring bivariate (two variables) or multivariate (more than two variables) relationships and making predictions among X and Y variables (Uraibi & Midi, 2019). The X (independent variable), is the *predictor variable*, while the Y (dependent variable) is the *criterion variable* (Bacon-Shone, 2015). The bivariate relationship, using a simple regression analysis, involves the prediction of dependent variables (Y) from independent variables (X) (Uraibi & Midi, 2019). My research consisted of the use of more than two variables; therefore, multivariate analysis was appropriate for this study.

There are four approaches to using a multivariate method including multiple linear regression (MLR), path analysis, canonical correlational analysis, and analysis of variance (ANOVA) (Bacon-Shone, 2015). The choice to use the MLR as opposed to the other three methods above was that MLR analysis involves determining a relationship between a dependent (criterion) variable and a combination of two or more independent

(predictor) variables. In MLR analysis, researchers can predict the outcomes of a response variables from several explanatory variables (Salleh et al., 2017)

Path analysis involves determining causal relationships among several variables represented by a graph, while the canonical analysis entails predicting a combination of several criterion variables from a combination of several predictor variables (Allen, 2017). For ANOVA, the researcher analyzes the effect of independent variables against the dependent variables (Clayton-Soh, 2016). This study involved determining the relationships between two independent variables and one dependent variable; hence, the MLR analysis was the more appropriate multivariate approach for this study.

Population and Sampling

The population and sampling were two essential elements jointly used in quantitative research. Population refers to the total quantity of things or cases which are the subject of the research whereas sampling refers to the part of the population from which the researcher attributes characteristics of the population (Etikan et al., 2015). Majid (2018) explained the ineffectiveness of using the entire population for a research study but recruit a sample that will be representative of the population. Therefore, researchers use a statistically representative samples of the population in which results from such sample can be attributable to the entire population (Majid, 2018).

Population

My sample population was based on a purposive sample of three ministries of the Government of Liberia (GoL) including the Ministries of Public Works, Agriculture and Education. This population was suitable for this study because the Ministry of Public

Works is the statutory government agency responsible for all infrastructure works in Liberia (World Bank, 2017). Besides, the Ministries of Agriculture and Education work closely with the Ministry of Public Works in implement agricultural and educational-related projects. Each of the government ministries outlined has multiple projects with funding provided by international organizations such as the World Bank, European Union, USAID, and the International Foundation for Agriculture Development (IFAD).

The research population aligned with the research question: "What is the relationship between project cost estimates, project scheduling, and project success?" To answer this question, I collected data from sample of this population to determine whether there exists or do not exist a relationship between the research constructs. Data collection emphasis was on collecting archival or secondary data relating to the two key independent variables – project cost estimates and project scheduling.

Sampling

Sampling techniques fall into two broad categories -probability or random, and non-probability or nonrandom (Taherdoost, 2016). A *non-probability* or *nonrandom* sampling method was essential for this research because in this method, each member of the population do not have equal chance of selection (Etikan et al., 2015). The *random sampling* method is not appropriate because it requires that each member of the population has an equal chance of been selected for the sample (Etikan et al, 2015).

To select samples aligned with the objective of the research and the population, a *purposive sampling* method was utilized for this study. The purposive sampling is a non-probability method in which the researcher can capture aspects of the population that is

aligned with the objective of the study (Etikan et al, 2015). The disadvantage, however, is that it is prone to high levels of bias and researcher's judgment (Sharma, 2017). This disadvantage was mitigated by the clear research criteria such as sample size selection and validities.

Sample Size Analysis

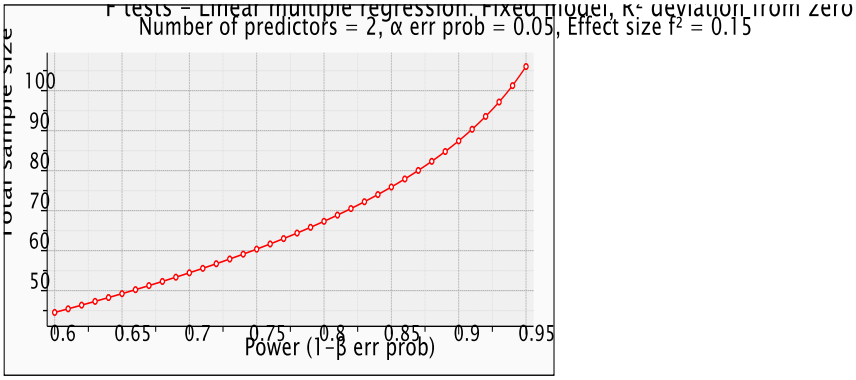
Determining the sample size is critical to quantitative research regarding statistical conclusion validity and data saturation. Data saturation refers to a situation where new data collected would yield the same results and conclusion (Weis & Willems, 2017). Large sample size reduces sampling errors but are often costly and time consuming while smaller sample size increases the chance of errors and bias (Taherdoost, 2017). G*Power software is essential for this research because of the need to strike a balance between using large samples, which are more costly and time consuming, and smaller samples which may not be representative of the entire population (Ahmad & Shafig, 2018). This approach is also essential for data saturation.

The G*Power3 software is the preferable method for performing a *priori power analysis* for determining sample size. To use the priori power analysis, researchers must first determine the effect size (f^2), the statistical power level, the significance level (α) and the predictor variables (Gayatri, 2017). The priori power analysis was selected over the other power analyses – *post how power, observed power, retrospective power, prospective power, and achieved power* – because of the need to determine the effect's presence instead of the precision of the estimates itself (Taherdoost, 2017).

The effect size (f^2) is one of the three elements needed when using the a priori power analysis. In a quantitative study, researchers use the effect size to measure the strength of the correlation coefficient, regression slope coefficient, and difference between means (Helwig, 2017). For this study, an f-test regression was utilized to determine the strength of the effect size denoted as 0.02 for small, 0.15 for medium, and 0.35 for large (Helwig, 2017). The Cohen's f^2 of effect size with formula $R^2/(1-R^2)$ was adopted to determine the strength of the effect size. Figure 2 displayed the graphical representation of the power levels based on a F-test. The graph portrays sample size value when using either small, medium or large effect size.

Figure 2

Power Analysis for F-test Linear Multiple Regression



The second element required for using a priori power analysis was the statistical power level. The statistical power level is the chance of rejecting null hypothesis when it is actually true (Yaseer et al., 2016). Historically, the power levels are between 0.8 and 0.95 with 0.8 predominantly used in the past and now 0.9 frequently used for power levels (Yaseer et al., 2016). For this research, a 0.9 power level was used to determine sample size.

The third element when using the a priori was the significance level (α) of .05. The significance level is the probability or chance of rejecting the null hypothesis when it is in fact true (Lepa, 2017). The significance level is derived from 1-0.95, with 0.95 representing the confidence level of 95% (Lepa, 2017). The last element when using a priori was the determination of the predictor variable. The predictor variable is the independent variable of the study. There were two predictor variables for this study – project cost estimates and project scheduling.

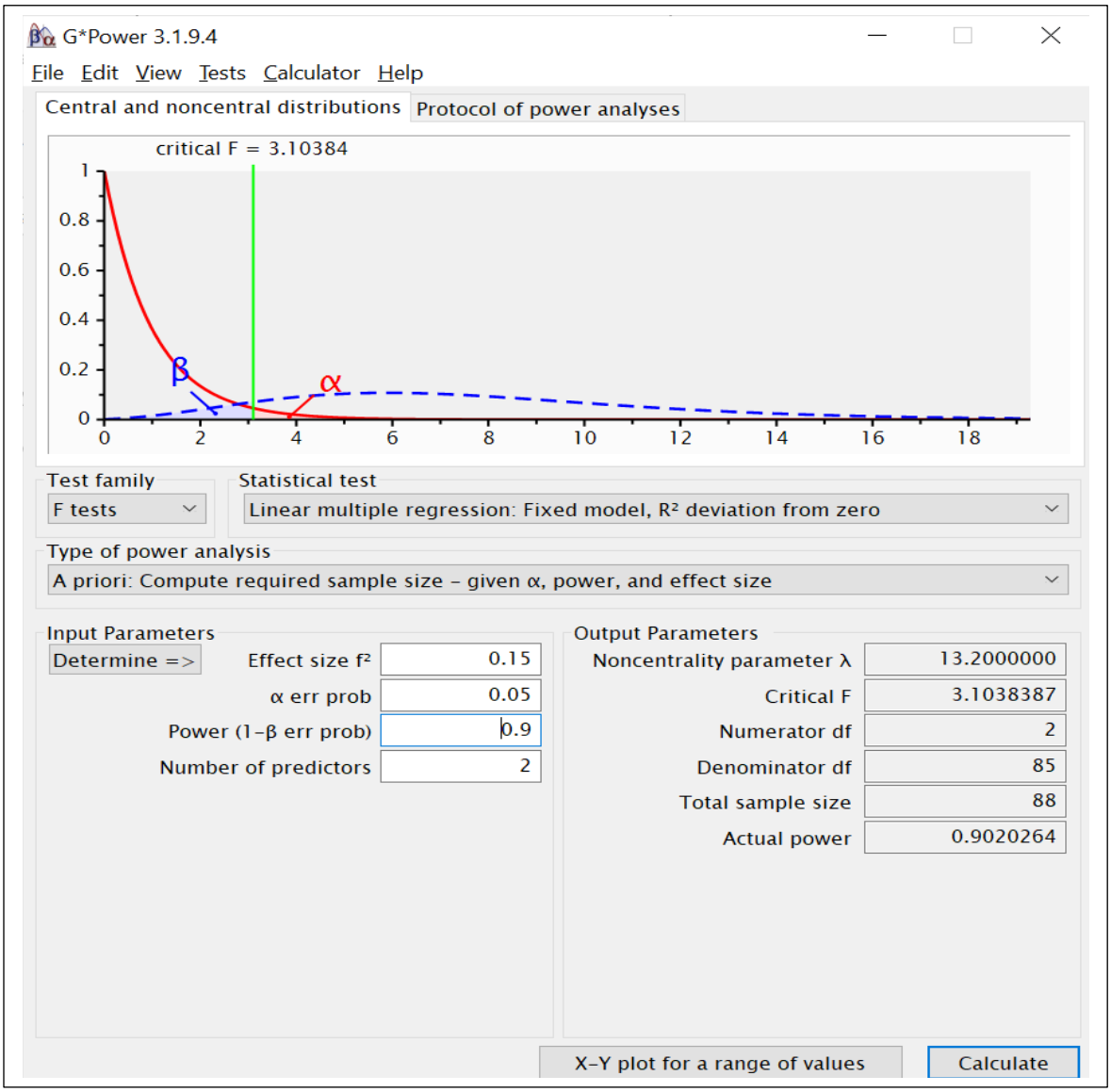
The G*Power3 software utilizing a *priori power analysis* was used to determine the sample size. To use the priori power analysis, researchers must first determine the effect size (f^2), the statistical power level, the significance level (α) and the predictor variables (Gayatri, 2017). The priori power analysis was selected over the other power analyses – *post how power, observed power, retrospective power, prospective power, and achieved power* – because of the need to determine the effect's presence instead of the precision of the estimates itself (Taherdoost, 2017).

The sample size was determined by applying the effect size (f^2), the power level, the significance level (α) and the predictor variable (Yaseer et al, 2016). The expected

minimal required sample size for this research provided by the G*Power software was 88 taking into consideration an anticipated effect size of 0.15 (medium), power level of 0.9, the significance level (α) of 0.05, and the predictor variables of 2. The sample was derived from a priori sample size calculator for multiple linear regression (MLR). Figure 3 displayed the output from the G*Power 3.1.9.4 using these parameters.

Figure 3

*A Priori Power Analysis for MLR using G*Power Software*



Ethical Research

Obtaining an Institutional Review Board (IRB) approval was cardinal to commencing the data collection process. I commenced the process by sending letters to organizations sampled in this study to request access to their databases. There was no interaction with human participants because the data collection method was archival. This research did not submit to the Belmont protocol because it involved the collection of archival or secondary data and did not involve directly interacting with human participants.

Data Collection Instruments

Data collection instruments relates to specific tool(s) utilized to obtain all of the necessary data (Yin, 2018). The data collection instrument for this research was archival data collection method. The archival data collection was relevant for this research because the focus of this study was to collect construction data and analyze correlations between the different variables. Moreover, using the archival data collection was cardinal in the retrieval of information relating to the two key independent variables – project cost estimates, and project scheduling.

The specific type of data for collection was secondary data relating to construction information. Data type was based on Earned Value Management (EVM) values used in project management for information relating to cost, schedule, and work performance (Wei at al. 2016). EVM, as a management tool, was developed by the United States Department of Defense in the 1960s and later adopted by the Project Management Institute (PMI) in 1999 (Project Management Institute, 2017). Today, EVM

is mandatory requirement of the United States ʾGovernment for performance-based management, managing software projects, and for audits (McGregor, 2019).

The ratio scale of measurement was essential for this research. The ratio scale is the highest among the four unique scale of measurement and was relevant for this study because researchers can use all of the arithmetic operations relating to nominal, ordinal, and interval measurement (Matthews, 2017). For this research, using the ratio provided flexibility in utilizing all of the various scales ʾattributes which include identity, magnitude, equal intervals and a minimum value of zero of the cost and schedule variances and the performance ratios. The ratio satisfies all four requirements inherent in the three previous measures – identity, magnitude, equal intervals and a minimum value of zero (Crossman, 2019).

The EVM metrices, as a project monitoring and evaluation tool, was the best instrument for measuring the research variables – project cost estimates, project scheduling and project success – because these variables form an integral part of project management inputs and constraints. Besides, EVM, in project management, is one of the few project management tools used for tracking performance and accessing variances of cost and schedule (Kranz, 2015). Organizations in the United States use EVM indicators such as baseline cost and schedule variance to assess performance (United States Government Accountability Office, 2009***)***.

To obtain needed metrices or values for measuring the research variables the EVM metrices of cost variance (CV), schedule variance (SV), cost performance index (CPI) and schedule performance index (SPI) was considered. The cost variance is the

difference between the initial cost and final cost while the schedule variance is the difference between the initial schedule and the final schedule (Mahdi et al., 2018). The cost and schedule variances were preferable metrics to measure the independent variables - project cost estimates and project scheduling.

The cost performance index (CPI) and the schedule performance index (SPI) are two key project management metrics for measuring project success. The CPI is the ratio of the planned cost and the actual cost while SPI is the ratio of the planned schedule and the actual schedule for completing the project (Ramasamy, 2015). The CPI and SPI are effective indices in assessing project success (Wei et al., 2016). Project success values was the *cost performance index* (CPI). CPI greater than one means favorable implying that work been performed more efficiently than planned while CPI less than one means unfavorable implying that work been performance less efficiently than planned (Ramasamy, 2015***).***

The United States Department of Defense (DoD) developed EVM in the 1960s for assessing cost, schedule and technical progress on programs and to support proactive decision-making (Kranz, 2015). In 1999, the Project Management Institute (PMI) adopted the EVM concept as a project management technique for cost control and resource planning. (Project Management Institute, 2017). Today, EVM is a mandatory requirement of the United States ’Government for performance-based management, managing software projects, and audits (McGregor, 2019). Moreover, the United States (US) Government Accountability Office (GAO) later adopted this instrument in June

2005 to establish a consistent methodology, based on best practices, for managing cost and schedule.

In quantitative research, reliability and validity are critical instruments used by researchers to ensure reliable measure of the variables of interest (Heale & Twycross, 2015). *Validity* is the extent to which the selected research instrument accurately measures and performs as expected whereas *reliability* refers to the extent to which a research instrument consistently produces the same results using the same situation or repeated occasions (Taherdoost, 2016). Reliability, however, is a sub-set of validity which implies that it must be attained before validity can be achieved (Haradhan, 2017).

The three most commonly used types of reliability for data collection are homogeneity (internal consistency), stability, and equivalence (Heale & Twycross, 2015). Homogeneity refers to the measurement of one construct whereas stability is the use of test-retest to the same participants to ensure reliability (Heale & Twycross, 2015). Equivalence is the process of ensuring that some level of consistency among multiple participants or observers (Heale & Twycross, 2015).

The Cronbach's alpha (α) coefficient is one of the essential reliability methods for determining the internal consistency of the instrument. The Cronbach α value is between 0 and 1 but the minimum acceptable reliability score, using this method is 0.7 (Arifin, 2018). Cronbach α, however, is recommended for verifying the reliability of scales for measuring perception (Taber, 2017). Therefore, Cronbach α was not applicable for use in this study because the nature of this research was the acquisition of archival

information. Stability and equivalence, two other reliability methods were also not applicable to this research given the use of the archival data collection method.

The three most common types of validity relating to data collection include content, construct, and criterion validity (Haradlan, 2017). *Content validity* is the extent to which a research instrument measures accurately all levels of the construct whereas *construct validity* is the extent to which the research instrument or tool measures the intended construct or variables (Haradhan, 2017). *Criterion validity* is the extent to which the research instrument concerning other instruments, measures the same variables (Rauta et al., 2017).

Content validity did not apply to this research because the data collection method used for this study was archival. In an archival research dealing with secondary data, justification of the validity of the instrument was not necessary because the researcher has no control of the method and test utilized to arrive at the final values of the constructs. Construct validity is also not applicable to this research because the data collection method is archival. In archival research, construct validity is a limitation because research tools are limited in measuring only a single item without an alternative item assessing the construct of interest (Barnes et al., 2015).

Criterion validity was essential for this research because in this method researchers use different instruments to measure the same variable (Heale & Twycross, 2015). To establish *criterion validity*, I will use the SPSS statistical software to analyze the *multilinear regression* (MLR) used in this study. SPSS statistics is one of the most

effective and widely used statistical software packages that can perform highly complex data manipulation and analysis (Green & Salkind, 2016).

All of the raw data and outputs from SPSS such as tests, assumptions and MLR analyses were placed in the appendices section. Other relevant information that were very detailed to be included in the text were also displayed into the appendices' section. Finally, other attachments including letters, and sample data were scanned and placed in the appendices.

Data Collection Technique

The focus of the research was to collect secondary construction data; therefore, the archival data collection method was preferred for this study. Archival data collection type was relevant for this research because the purpose of this study was to look at construction data and analyze correlations between two independent variables, cost estimates and project scheduling; and one dependent variable, construction project success. Barnes et al. (2015) mentioned that the use of the archival method provides a unique opportunity to explore phenomena is the pollical, social and cultural arena that are usually unsuitable for other forms of research.

Archival data collection type was relevant for this research because this study involved extracting archival or secondary data from sampled organizations elaborated in population and sampling section. The initial step in collecting archival data was the IRB approval authorizing the commencement of data collection. Once IRB approval was granted, communications were sent via email to the various organizations sampled to grant me access to their databases to extract construction data.

The archival data collection method was preferred over other data collection method because it saves time and money given that no new data collection is required (Wright et al., 2018). There are many advantages of using archival data compared to other data collection methods. One advantage is that the data may already be process by people with statistical expertise. A second advantage is that collecting the data save time and money compared to gathering primary data. The last and final advantage is that oversampling of low prevalence groups or entities allows for increased statistical precision when this method is utilized (Dooley, 2015).

Despite some of the advantages outlined, archival data also has many disadvantages including the fact that data collected may not facilitate the desired research, and data may potentially lack some depth thereby raising reliability or validity concerns. Another pitfall is that certain organizations or institutions may place less value on secondary thereby requiring reorganization of data (Dooley, 2015). The advantages of archival data offset the disadvantages because all construction data collected contained some cost and schedule values along with the performance indicator, CPI.

This archival method supported the research question and the purpose statement because data collection, using secondary sources was focused on retrieving data related to the two research variables – project cost estimates and project scheduling. Moreover, the population stated in the purpose statement was suitable for this study because the key ministries listed were involved in the implementation of the majority of the construction projects in Liberia (World Bank, 2017). The most important aspect of selecting a data collection method for a study was that such approach matched the research question and

the purpose of the research (Ivey, 2017). The various databases of the selected organizations listed in the population and sampling were utilized to collect relevant data.

Data Analysis

The research question for this study was: What is the relationship between project cost estimates, project scheduling, and project success? For this study, the independent variables were project cost estimates and project scheduling, while the dependent variable was project success. In order to test the research question, the following hypotheses were applied:

$H1_0$: There is no significant relationship between project cost estimates, project scheduling, and project success.

$H1_1$: There is a statistically significant relationship between project cost estimates, project scheduling, and project success.

To analyze the relationship between two independent and one dependent variables, a *multiple linear regression* (MLR) analysis was utilized. MLR is a multivariate correlational design tool used to find relationships between more than two variables (Salleh et al., 2017). A multivariate correlational design, specifically *multiple linear regression* (MLR) analysis is most suited for this study because the research involves a multivariate, more than two variables, and researchers can predict the outcomes of response variables from several explanatory variables (McQuitty, 2018).

There were other statistical correlational analyses considered for this study including *path analysis, canonical analysis* and *analysis of variance (ANOVA). Path analysis* involves determining causal relationships among several variables represented

by a graph, while the canonical analysis entails predicting a combination of several criterion variables from a combination of several predictor variables (Allen, 2017). For ANOVA, the focus is to analyzes the effect of independent variables against the dependent variables (Clayton-Soh, 2016). This study involved determining the relationships between two independent variables and one dependent variable; hence, the MLR analysis was the more appropriate multivariate approach for this study.

The use of a simple regression analysis (SRA) requiring examining bivariate relationships between *predictor* (X) and *criterion variables* (Y) are less effective because a researcher can technically conduct bivariate analysis repeatedly and have several null and alternative hypotheses (Mertler & Reinhart, 2017). Multivariate analyses, using MLR, are more effective for research involving more than two variables because researchers can cross-reference the results across variables by correlating each variable against the main outcome (Mertler & Reinhart, 2017). Because my research involved three variables, two independent and one dependent, multivariate analysis, using MLR, was appropriate for this study.

Screening and cleaning of data were essential for data integrity as a precursor to data analysis. *Data screening* is the process of identifying real or potential data entry error, whereas *data cleaning* is a process of correcting the errors identified before performing data analysis (DeSimone et al., 2018). Data cleaning is critical to the validity of quantitative method regarding accurate estimation of parameters (Azeroual et al., 2019)).

Data screening and cleaning are effective for research using archival data when the researcher follow a pre-defined protocol or procedures (Azeroual et al., 2019). Minimize data screening and cleaning required tracing the collection and having access to the data collected. Moreover, expert advised the need for quality assurance of the data and cross-referencing and cross-checking (Das et al., 2018).

Missing data in greater number affect data results and validity (Bannoh, 2015). In the case of a missing data due to data entry error, data points were discarded and data analyses was restricted to only fully developed available data (Curley et al., 2017). To account for missing or deleted data, more data than the required sample size was collected to account for missing or deleted data and, thus, ensure this study meets sample-size demands. During the data collection process, I collected about 130 datasets but utilized 110 because after analysis, the 20 were outliers.

Multiple linear regression data analysis involves testing the assumptions and addressing any violations as well as computing the regression using SPSS (Naghdi et al., 2016). When using the MLR, researchers test for four assumptions that include linearity, normality, multicollinearity, and homoscedasticity (Naghdi et al., 2016). Linearity test refers to ensuring a linear relationship between the dependent and independent variable, while for normality, researchers assess whether the residuals are normally distributed (Naghdi et al., 2016). For multicollinearity, the test is to guarantee that independent variables are not correlated with each other while for homoscedasticity, the researcher tests to confirm that the error terms are uniform across the values of the independent variables (Naghdi et al., 2016).

To test for linearity, a scatter plot was utilized while a descriptive data analysis of skewness of data and kurtosis was employed for normality (Vatcheva et al., 2016; Eftimov, 2018) To test for collinearity, the *collinearity tolerance* or *variance inflation factor* (VIF) distribution was employed, while the Levene's Test of Equality of Error Variance was used to test homoscedasticity (Vatcheva et al., 2016; Eftimov, 2018).

Unvalidated assumptions could lead to inaccurate results and possibly wrong conclusions (Knief & Forstmeier, 2018). To fix linearity test a scatter plot analysis using SPSS was utilized. In the scatter plot, the plots were inspected and outliers were removed. Thereafter, the samples were sampled. To remedy normality, a descriptive statistic analysis involving skewness and kurtosis were assessed. To remedy this problem, the samples were resampled to consider a smaller sample of the sample data for analysis (Field, 2013).

To fix multicollinearity, highly correlated predictors were removed from the model especially the model with the highest r-square value or coefficient of determination (Vatcheva et al., 2016). To fix homoscedasticity, the Levene's Test of Equality of Error Variance was assessed to ensure that one of more of the independent variables are not normality distributed (Vatcheva et al., 2016; Eftimov, 2018).

The value of the coefficient of determination (r^2) was relevant in determining what percentage of the dependent variable the researchers can predict from the independent variable (Field, 2013). However, for this study, the *coefficient of correlation* or *regression coefficient* method was applied to analyze the strength of the relationship between the predictors and the dependent variable. After careful data cleaning, screening,

verification, and validation, the Statistical Package for Social Sciences (SPSS) version 25 was utilized for conducting multiple linear regression (MLR) analysis. SPSS statistics is one of the most effective and widely used statistical software packages that can perform highly complex data manipulation and analysis (Green & Salkind, 2016). This software is effective when dealing with a structural numerical dataset but limited with extremely large dataset (Biju & Mathew, 2017).

Regression analysis is based on determining descriptive statistics, multiple linear regression data analysis and, hypothesis testing (Dhakal, 2018). Descriptive analysis involves the running the data into SPSS to evaluate the mean, mode, range, standard deviation, kurtosis, and skewness of the data (Dhakal, 2018). The output from the descriptive analysis is relevant to present the data in the more meaningful way by looking at data patterns such as central location, spreads, and skewness (Dhakal, 2018).

Multiple linear regression data analysis involves testing the assumptions and addressing any violations as well as computing the regression using SPSS (Naghdi et al., 2016). When using the MLR, researchers test for four assumptions that include linearity, normality, multicollinearity, and homoscedasticity (Naghdi et al., 2016). Linearity test refers to ensuring a linear relationship between the dependent and independent variable, while for normality, researchers assess whether the residuals are normally distributed (Naghdi et al., 2016). For multicollinearity, the test is to guarantee that independent variables are not correlated with each other while for homoscedasticity, the researcher tests to confirm that the error terms are uniform across the values of the independent variables (Naghdi et al., 2016).

To test for linearity, researcher uses the scatter plot to spot outliers. Outliers are data points that are different or far from the rest of the other data and can skew the results (Thirumalai et al., 2017). For normality, a descriptive data analysis of skewness of data and kurtosis was utilized. The recommended tolerance level for skewness are values between -1 and 1, while kurtosis values values are recommended to be between -3 and +3. (Shanmugam & Chattamvelli, 2015). To test for collinearity, researcher uses *collinearity tolerance* or *variance inflation factor* (VIF) distribution, while the Levene's Test of Equality of Error Variance is used to test homoscedasticity (Vatcheva et al., 2016; Eftimov, 2018).

Once the tests of assumptions are carried out, the next step is to compute the MLR using the IBM SPSS software. The SPSS' outputs from running the MLR will tables display tables such as model summary, Analysis of Variance (ANOVA), and Coefficient table. The MLR equation is denoted by: $yi=\beta 0+\beta 1xi1+\beta 2xi2+...+\beta pxip+\epsilon$. In this equation, x_i is the independent variable, yi is the dependent variable, $\beta 0$ is the y-intercept, βp is slope coefficient and ϵ is the model's error term (Dhakal, 2018).

The final step is hypothesis testing, where MLR data analysis outputs are analyzed to determine whether to accept or reject the null hypothesis. The null and alternative hypothesis for this research are:

$H1_0$: There is no significant relationship between project cost estimates, project scheduling, and project success.

$H1_1$: There is a statistically significant relationship between project cost estimates, project scheduling, and project success.

Accepting or rejecting the null hypothesis requires and understanding of the significance level (p-value) and determining the coefficient of coefficient (*r*) to determine the strength of the relationship (Travers, 2017). Significance level is determined based on the alpha (α) value. If the p-value for the F-test, ($p<0.05$), reject the null hypothesis, otherwise if ($p>0.05$) accept the null hypothesis. To test the strength of the relation a coefficient of correlation or regression coefficient (*r*) is utilized. The r is the value between 0 and 1 indicating the strength of the relationship. If r^2 value of 0.1, indicates 10%; 0.2, indicates, 20%; 0.3, indicates 30% and so on. An r-value of 0.7 and above implies strong correlation bolstering the strength of the relationship, if correlated (Travers, 2017).

Study Validity

Study validity refers to actions taken to ensure that the instruments, processes, and analyses are trustworthy and reliable for wider acceptance (N Gopi, 2018). Two categories of validity exist - internal and external (Whelan & DuVernet, 2015). *Internal validity* refers to steps or standards that enable researchers to obtain accurate results whereas *external validity* refers to the extent to which the results can be effectively generalized to other a larger population (N Gopi, 2018).

Internal validity is applicable to experimental and quasi-experimental where there exists a possibility of manipulating the independent variables relating to different types of treatments. Internal validity is not applicable to this study because this research is neither experimental or quasi-experimental. However, external validity was of paramount concern for this research.

External validity is more applicable to correlational research to establish the validity and reliability of the instrument and measurements (Heale & Twycross, 2015). External validity refers to the extent to which the results can be effectively generalized to other a larger population (N Gopi, 2018). External validity was applicable to this research because results from the sample was applied to the general construction population in the conclusion.

The major threat to external validity is statistical conclusion validity. Statistical conclusion validity is the process of carrying on data analysis, using appropriate tools and processes, by ensuring that no statistical assumption is violated (Venkatesh et al., 2016). The most common type of statistical conclusion validity is the type I error in which the researcher rejects the null hypothesis when it is actually true (Venkatesh et al., 2016). Three factors that are useful in ensuring statistical conclusion validity are reliability of the instrument, assumptions for statistical tests, and sample size

Reliability refers to the extent to which a research instrument consistently produces the same results using the same situation or repeated occasions (Taherdoost, 2016). The data collection instrument, archival research, is very reliable because integrity of the various databases for extraction were satisfied by the United Nations organizations and other international partners. Besides, database users are trained with the needed technology and tools to preserve data that are reliable and accurate. The data analysis instrument, SPSS version 25 is one of the most effective reliable, and widely used statistical software packages that can perform highly complex data manipulation and analysis (Green & Salkind, 2016).

Assumptions for statistical test are various types assumptions – normality, linearity, collinearity, and homoscedasticity – which are essential for minimizing Type 1 error. (Vatcheva et al., 2016). To ensure that these assumptions are not violated, researchers use (a) scatter plot, for linearity; (b) skewness of data and kurtosis, for normality; (c) *collinearity tolerance* or *variance inflation factor* (VIF) distribution, for multicollinearity; and (d) Levene's Test of Equality of Error Variance, homoscedasticity (Vatcheva et al., 2016; Eftimov, 2018). All of the assumptions and tests were conducted using the Statistical Package for the Social Sciences (SPSS), version 25.

Unvalidated assumptions could lead to inaccurate results and possibly wrong conclusions (Knief & Forstmeier, 2018). To fix linearity, I ran a scatter plot via SPSS to eliminate outliers (Thirumalai et al., 2017). To remedy normality, a descriptive statistics analysis was carried out via SPSS to assess the *skewness and kurtosis* values. To fix multicollinearity, a *variance inflation factor* (VIF) was employed to remove highly correlated predictors from the model especially the model with the highest r-square value or coefficient of determination (Vatcheva et al., 2016). To fix homoscedasticity, a *Levene's test of equality of error variances* was assessed to ascertain whether one or more of the independent variables were not normality distributed.

Determining the sample size was critical to quantitative research regarding statistical conclusion validity and data saturation. Data saturation refers to a situation where new data collected would yield the same results and conclusion (Weis & Willems, 2017). Large sample size reduces sampling errors but are often costly and time consuming while smaller sample size increases the chance of errors and bias (Taherdoost,

2017). G*Power software was essential for this research because of the need to strike a balance between using large samples, which are more costly and time consuming, and smaller samples which may not be representative of the entire population (Ahmad & Shafig, 2018). This approach was also essential for obtaining data saturation.

The G*Power3 software was the preferable method for performing a *priori power analysis* for determining sample size. To use the priori power analysis, researchers must first determine the effect size (f^2), the statistical power level, the significance level (α) and the predictor variables (Gayatri, 2017). The priori power analysis was selected over the other power analyses – *post hoc power, observed power, retrospective power, prospective power, and achieved power* – because of the need to determine the effect's presence instead of the precision of the estimates itself (Taherdoost, 2017).

The effect size (f^2) was one of the three elements needed when using the a priori power analysis. In a quantitative study, researchers use the effect size to measure the strength of the correlation coefficient, regression slope coefficient, and difference between means (Helwig, 2017). For this study, an f-test regression was utilized to determine the strength of the effect size denoted as 0.02 for small, 0.15 for medium, and 0.35 for large (Helwig, 2017). The Cohen's f^2 of effect size with formula $R^2/(1-R^2)$ was adopted to determine the strength of the effect size.

The second element required for using a priori power analysis was the statistical power level. The statistical power level is the chance of rejecting null hypothesis when it is actually true (Yaseer et al., 2016). Historically, the power levels are between 0.8 and 0.95 with 0.8 predominantly used in the past and now 0.9 frequently used for power

levels (Yaseer et al., 2016). A 0.9 power series was used in this research given the most recent historical trend.

The third element when using the a priori was the significance level (α) of .05. The significance level is the probability or chance of rejecting the null hypothesis when it is in fact true (Lepa, 2017). The significance level is derived from 1-0.95, with 0.95 representing the confidence level of 95% (Lepa, 2017). The last element when using a priori was the determination of the predictor variable. The predictor variable was the independent variable of the study. There were two predictor variables for this study – project cost estimates and project scheduling.

The sample size was determined by applying the effect size (f^2), the power level, the significance level (α) and the predictor variable. The expected minimal required sample size for this research was 88 taking into consideration an anticipated effect size of 0.15 (medium), power level of 0.9, the significance level (α) of 0.05, and the predictor variables of 2. The sample was derived from G*Power analysis output for multiple linear regression (MLR) displayed in Figure 3.

External validity also focuses on the extent to which results for the research can be applied to the greater population. In the case of this research, the results of the sampled construct companies were attributable to the larger construction organizations globally. A *non-probability* or *nonrandom* sampling method using purposive sampling for this research enhanced the chance of external validity because this method focused on the breadth and depth of information from smaller number of carefully selected participants (Etikan & Bala, 2017).

The population for this research comprises of three ministries of the Government of Liberia – Education, Public Works and Agriculture, that are involved in construction and other forms of infrastructure in Liberia (US Commercial Services, 2017). Besides, project management practices for construction projects remain uniform with a focus on effective utilization of project management strategies that include managing contractors ' performance, controlling costs, and managing project schedules (de Carvalho et al., 2015). Therefore, the research conclusion for Liberia could be attributable to various construction organizations globally.

Transition and Summary

In Section 2, the concentration was on the validation of the use of the quantitative methodology and correlational designs using multilinear regression for data analysis. Additionally, there was a detailed analysis of role of the researcher, research participants, research method and design, population and sampling, ethical research, data collection, data analysis and study validity. The highlights of Section 3 was the execution of the study to include the research steps and data collection process, the data analysis and presentation of findings, conclusion and recommendations.

Section 3: Application to Professional Practice and Implications for Change

Introduction

The purpose of this quantitative correlational study was to examine the relationship between project cost estimates, project scheduling, and project success. The independent variables were project cost estimates and project scheduling. The dependent variable was project success. The research question was: What is the relationship between project cost estimates, project scheduling, and project success? The null hypothesis ($H1_o$) was there is no significant relationship between project cost estimates, project scheduling, and project success. The alternative hypothesis ($H1_1$) was there is a statistically significant relationship between project cost estimates, project scheduling, and project success.

To collect data, archival data collection method was employed. The minimum sample size was calculated using the G*Power software and determined that at least 88 datasets were required. The data collected focused on construction data from three ministries of the government of Liberia. During the two weeks of collection, I extracted 130 datasets which were reduced to 110 datasets after running the regression test for eliminating outliers. After data analysis, the null hypothesis was rejected, thereby accepting the alternative hypothesis.

Presentation of the Findings

For this section, the focus was on discussing the test of assumption, the descriptive statistics, inferential statistical values, linkages of the study to the theoretical framework, and present a full summary of the study. In cases of violations of assumptions, the samples

were either resampled by removing outliers or by removing highly-correlated independent variables from the sample. A 95% confidence level was presented during the analysis, where necessary.

Test of Assumption

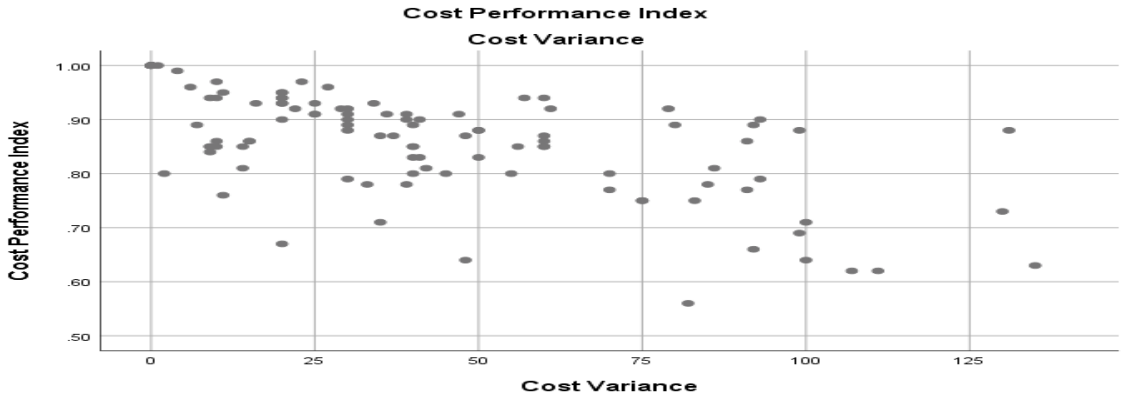
The statistical package for social sciences (SPSS) version 25 was utilized to test for linearity, normality, multicollinearity, and homoscedasticity. Statistics test of assumptions are relevant to eliminate Type 1 or Type II errors ((Vatcheva et al., 2016). To fix violated assumptions, the samples were either resampled by removing outliers or by removing highly-correlated independent variables from the sample.

Linearity

The test of linearity was designed was to ascertain whether the values are along the straight line. To test linearity, a scatter plot was utilized to spot and eliminate the outliers which can skew the results. Figure 4 and 5 display the scatter plot diagram for both the cost variance and schedule variance:

Figure 4

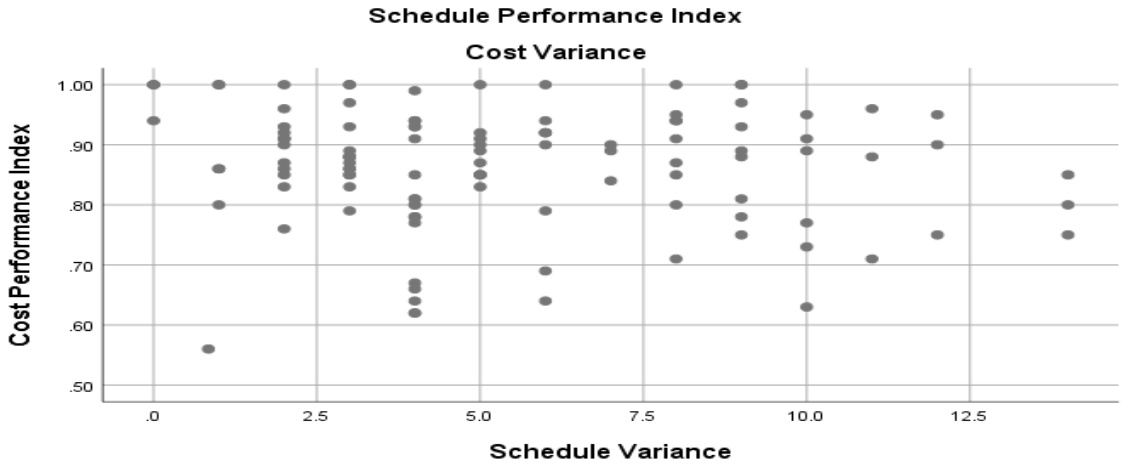
Scatter Plot to Test Linearity for Cost Variance



Figures 4 showed a scatterplot graph for relationships between cost variance and cost performance index. The cost values are in thousands of dollars between $0 and $150,000. To arrive at this interval, the total sample was resampled because initial analyses of data showed several outliers of up to 400,000 for costs. The majority of the cost variances are concentrated between 0 and 50,000. The initial value was n=130 which was resampled to n=110.

Figure 5

Scatter Plot to Test Linearity for Schedule Variance



Figures 5 displayed a scatterplot graph for relationships between schedule variance and cost performance index. The schedule values are in months; therefore, the values are between 0 to 12.5 months. To arrive at this interval, the total sample was resampled because initial analyses of data showed several outliers of up to 36 months for schedule. Unlike the cost variance, the majority of the schedule variances were equally distributed along the scatterplot. The initial value was n=130 which was resampled to n=110.

Normality

The test of normality is carried to assess whether the residuals are normally distributed (Naghdi et al., 2016). To test for normality, a descriptive statistical analysis involving skewness and kurtosis were assessed. The recommended tolerance level for skewness are values between -1 and 1, while kurtosis values are recommended to be between -3 and 3. (Shanmugam & Chattamvelli, 2015). If the values from the descriptive analysis exceeded the recommended tolerance level, the samples are resampled to consider a smaller sample of the sample data for analysis (Field, 2013).

After running the regression analysis, all of the skewness and kurtosis values for the three research variables, cost variance, schedule variance, and cost performance index fell within their tolerance range of -1 and 1 for skewness and -3 and 3 for kurtosis as displayed in Table 3.

Table 2

Statistical Test of Normality using Descriptive Statistics

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Cost Variance	110	135	0	135	41.59	33.978	.801	.230	-.127	.457
Schedule Variance	110	14	0	14	5.45	3.360	.629	.230	-.336	.457
Cost Performance Index	110	.44	.56	1.00	.8631	.09922	-.841	.230	.444	.457
Valid N (listwise)	110									

Multicollinearity

The test of multicollinearity is relevant for eliminating the repetition of the same kind of variables. The *variance inflation factor (VIF)* is the required test for analyzing multicollinearity. If the VIF>10, it means that the VIF has exceeded its tolerance level indicating poorly-estimated coefficients and questionable p-values (Daoud, 2017). The VIF values of 1.137 for both independent variables in Table 4 are within an acceptable tolerance level, therefore multicollinearity was not violated.

Table 3

Test of Multicollinearity using VIF

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	.925	.015		63.082	.000		
	Cost Variance	-.002	.000	-.693	-8.928	.000	.880	1.137
	Schedule Variance	.004	.002	.138	1.775	.079	.880	1.137

a. Dependent Variable: Cost Performance Index

Homoscedasticity

The test of homoscedasticity is carried out to confirm that the error terms are uniform across the values of the independent variables (Naghdi et al., 2016). It is relevant for ensuring that one or more of the independent variables is not normality distributed. The Levene's Test of Equality of Error Variance is used to test whether the variables across the sample have equal variance.

The Levene's Test is non-significant when the p-value is less 0.05, meaning that homogeneity is not present in the data set. Table 5 output showed that the Levene's Test is non-significant because P<0.05. The value of 0.025 meets the tolerance level for multicollinearity, therefore the data for this research did not violate the assumption of multicollinearity.

Table 4

Test of Homoscedasticity using Levene Test

Levene's Test of Equality of Error Variances[a,b]

		Levene Statistic	df1	df2	Sig.
Cost Performance Index	Based on Mean	3.105	11	14	.025
	Based on Median	.410	11	14	.928
	Based on Median and with adjusted df	.410	11	3.000	.881
	Based on trimmed mean	2.375	11	14	.065

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Dependent variable: Cost Performance Index

b. Design: Intercept + CostVar + ScheVar + CostVar * ScheVar

Descriptive Statistics

Before analyzing inferential data, a descriptive analysis of some of the study variables was assessed. Analysis of the descriptive statistics provides an opportunity for assessing the demographics, organization, and reliability of the values of key variables used in the research. The descriptive analysis showed a total of 110 data points. This total data point was arrived at after running the test of assumptions and eliminating

outliers. The total data collected was 130. Table 2 showed outputs of some of the vital descriptive statistics relevant for this study.

Table 5

Descriptive Statistics

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Cost Variance	110	135	0	135	41.59	33.978	.801	.230	-.127	.457
Schedule Variance	110	14	0	14	5.45	3.360	.629	.230	-.336	.457
Cost Performance Index	110	.44	.56	1.00	.8631	.09922	-.841	.230	.444	.457
Valid N (listwise)	110									

For (n=40), the descriptive statistics displayed the mean of the three research variables. The project cost estimates were represented by the cost variance (CV), project scheduling was represented by the schedule variance (SV) and project success represented by the cost performance index (CPI). The CV, SV, and CPI were 41.59, 5.45, and .86 respectively. The standard deviations of these three research variables were 33.98, 3.36, and .09 respectively.

Inferential Statistics

To answer the research question, what is the relationship between project cost estimates, project scheduling, and project success, I use a standard multiple linear

regression analysis to assess the p-value (test of significance) at α = .05 and Pearson correlation. The independent variables were cost variance (project cost estimates) and schedule variance (project schedule). The dependent variable was cost performance index (project success). A multiple linear regress was applied at α = .05, and found the model as a whole significantly predict project success, $F(2,110) = 40.85$, p=.000, $R^2 = .433$. The p-value is reflected in Table 6. The R^2(.433) displayed in Table 6 indicated that approximately 43% of the independent variables (project cost estimates and project scheduling) could predict the dependent variable (project success).

Table 6

Multiple Linear Regression Analysis for Test of Significance

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.465	2	.232	40.847	.000[b]
	Residual	.609	107	.006		
	Total	1.073	109			

a. Dependent Variable: Cost Performance Index

b. Predictors: (Constant), Schedule Variance, Cost Variance

Table 7

Correlational Analysis

Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.658[a]	.433	.422	.07541

a. Predictors: (Constant), Schedule Variance, Cost Variance

b. Dependent Variable: Cost Performance Index

Analysis Summary

The purpose of this research was to examine the efficacy of project cost estimates and project scheduling to project success. A standard multiple regression analysis was utilized to examine if project cost estimates and project scheduling can predict project success. I ran the scatterplot analysis to weed out outliers and no further violations were encountered during the statistical analysis. The model significantly predicts project success, $F(2,110) = 40.85$, $p=.000$, $R^2 = .433$. The conclusion from this analysis is that project cost estimates and project scheduling are significantly associated with project success.

Theoretical Discussion of the Findings

The theoretical framework for this study was the theory of constraints developed by Goldratt. Goldratt (1984) developed the TOC as a framework for identifying the most important limiting factor that hinders the achievement of organizational goals. The selection of project cost estimates and project scheduling as independent variables for this research to model the theory of constraints was essential to deal with tradeoff between key project constraints including cost and schedule. The findings from the study supported the theory of constraint which supported the use of enabling factors – efficient cost and estimates, for achieving project success.

There were few studies similar to this research that supported the theory of change. For example, Aggor (2017) found a positive relationship between project schedule and project budget as well as a relationship between site dispute and project budget. Windapo & Odediran (2015) found that there exists a positive relationship between project manager

skills and project performance. Aggor (2017) found a relationship between comprehension and project success as well as a relationship between resources and project success.

In summary, there existed a statistically significant relationship between project cost estimates, project scheduling, and project success which supports the theory of change. Other researchers with similar project management components supported a relationship between these attributes and project success. Further studies will be required to ascertain whether results from all of these studies can be attributable to the construction industry globally.

Applications to Professional Practice

The objective of the study was to determine if there exists a statistically significant relationship between project cost estimates, project scheduling, project success. The results of the analysis led to rejecting the null and accepting the alternative hypothesis which connotes that there exists a statistically significant relationship between the predictor and dependent variables. The results of the study showed that effective project planning and management (PPM) is critical to the survival and viability of any institution.

The viability and sustainability of any project are contingent upon detailed feasibility (planning) and the utilization of highly trained project manager to lead on the implementation of the project (Oyetunji et al., 2017). The project manager must be able to handle designs and technical documents judiciously to mitigate high cost, project delays, design errors, and other irregularities which can increase overruns and cause project delays or failure. For example, Love et al. (2015) emphasized that cost increases

leading to overruns are the results of errors in the designs of the bill of quantities (BoQ) due to many change or variation requests.

Some of the complexities and intricacies associated with management are due to the paradigm shift from the use of *critical path method* (CPM), which is managing along a straight path to *critical chain method* (CCM) which is based on this research's theoretical framework of theory of change. Therefore, project managers must be equipped with the tools, techniques, skills, and knowledge to ably handle these complexities.

In Liberia, the study location, most of those handling projects either lack the skills, knowledge, tools, and techniques to deliver on cost and schedule. The African Development Bank Group (2018) underscored that there exists a weak and inadequate capacity in project management in Liberia especially in the public sector. The lack of knowledge and preparedness of these project managers reduces the likelihood of profitability and sustainability because some of the firms become unsustainable and unprofitable leading to shutting down, in some cases. This vicious circle of lack of knowledge and preparedness often hamper the ability of construction companies to rise to the challenge of innovation, profitability, and sustainability.

Findings associated with this study will add value to construction companies' business processes and operations in Liberia by allowing project managers to properly understand the relationship between project cost estimates, project scheduling, and project success. Issues relating to project cost estimates are the accuracy of pre-tender estimation and the significant deviation of the planned cost and the actual cost (Adafin et

al., 2015). Therefore, reliable and accurate cost estimates and adequate planning during the inception stage of the construction projects are vital to all of the project stakeholders including the clients, consultants, and contractors (Lim et al., 2015).

The results of the study precipitate the need for more capacity development and knowledge management for project practitioners. Some of the key success factors associated with this capacity development efforts would be providing knowledge on understanding all of the project inception activities that serve as the foundation for project implementation. Some of these activities include developing a business case, carrying on a detailed feasibility study, and developing project charters that will lay the foundation for implementation. Additionally, an in-depth understanding of the theory of constraints relating to cost, schedule, and scope and all of its needed tradeoff for quality and success is essential for organizational growth and development.

Finally, insufficient planning and scheduling of project activities and resources often lead to an adverse effect on project performance (Aziz et al., 2019). Therefore, project managers, for successful project implementation, must carry out effective planning, management, and control. The lack thereof is attributed to the constant delays and failures of many construction projects in Liberia. These failures lead to a lack of profitability and sustainability of construction companies in Liberia.

Implications for Social Change

Social change implications may come from diverse perspectives relating to the direct benefit of profitability and sustainability to their communities. One practical social change approach would be the implementation of *corporate social responsibilities* (CSR)

by construction companies. CSR is a self-regulating business model that encourages businesses or companies to be socially accountable to the general public and stakeholders concerning economics, social and environmental support (Chen, 2019).

Among the CSR obligations, companies might provide basic social services to residents of local communities. Some CSR obligations include setting aside some percentage of the yearly net income of companies for community development. However, lack of profitability would stifle social change because some organizations may renege on their responsibilities citing loss of profit. Therefore, construction organizations should be empowered to effectively manage cost and schedule or profitability, and sustainability. In Liberia, for example, an exploration company contributes up to a million dollar per annum to three counti es where they carry out their operations. These contributions are vital for constructing schools, clinics, and other social development that can help the poor and other vulnerable groups.

Another area for positive social change will be stakeholder participation in all construction projects. Stakeholder participation and management are critical in ensuring that project deliverables are met and on time. Indications from some studies show the lack of stakeholder participation in the inception, implementation, and monitoring of project outcomes are cardinal to the failure of many projects. Magassouba et al. (2019) asserted that effective project planning and management involving the participation of all the stakeholders and can foster community development, improve cultural awareness, political accommodation, and regulation. Lack of effective communication and

coordination among project stakeholders are attributed to many overruns in construction projects ((Asiedu & Adaku, 2019)

Stakeholder effectiveness and participation in project activities often lead to project success and facilitate organizational profitability. Kelly (2015) stressed that effective stakeholder management is essential in the delivery of quality output and building rapport. Most construction projects suffer delays or failures due to a lack of communication and coordination among key stakeholders (Huemann et al., 2016). Continuous engagement among stakeholders in a more integrated and collaborative manner can minimize scope definition problem, design errors, and scheduling problems that are critical to project delivery (Badewi, 2016)

Organizational profitability through stakeholder participation can bring benefits to the larger community through community development, economic empowerment, and other social benefits including schools, hospitals, and personal well-being. Increased profitability could enhance employment opportunities for many Liberians using the additional income to support their families in facilitating their basic social needs. By so doing, the social status of community dwellers could be enhanced and their basic human dignity improved.

The final effort for positive social change would be the capacity development of relevant actors including project managers. Increased profitability can only be garnered through capacity development efforts that can help construction companies to estimate better and plan adequately. For example, effective and reliable cost estimates are the ability of projects to understand basic project management costing that includes *work*

breakdown structure (WBS) and effective cost, and parametric estimates. Adequate schedule management involves a basic understanding of Microsoft Project for developing Gantt Chart, PERT chart, and activity diagram utilizing the *critical path method* (CPM).

Profitability is also essential for the sustainability of construction organizations. Construction companies can attract more opportunities for economic growth and development when they are profitable. This situation can lead to the attainment of more contracts by construction companies that can keep the organization in business and key its employees economically empowered. Economic empowerment can foster socio-economic development through actionable activities that can lift the poor out of extreme poverty and get them engaged in meaningful ventures such as – small businesses, developmental activities, and self-help initiatives.

Recommendations for Action

The purpose of this quantitative correlational study was to examine the relationship between project cost estimates, project scheduling, project success. The results of the analysis led to rejecting the null and accepting the alternative hypothesis which connotes that there exists a statistically significant relationship between the predictor and dependent variables. Based on the finding of the research which established that there exists a statistically significant relationship between project cost estimates, project scheduling, and project success is it recommended that all construction project managers understand the basic guiding principles and strategies for effective cost management and scheduling.

For the timely completion of projects, construction project managers should be fully abreast of estimates' strategies that includes the use of *work breakdown structure* (WBS) for estimation of work elements, which is the bottom layer of the WBS' pyramid. An alternative approach would be to use a *parametric estimate* approach that require the use of previous estimates with modifications where necessary. To understand these approaches, it is recommended that construction project managers undergo fast-track or intensive project management training and be provided certification to be eligible to lead as a project manager.

For effective scheduling, it is recommended that construction project managers comprehend the use of MS-Project software. MS-Project is the premier software for project managers designed for developing *Gantt charts, activity diagrams, program evaluation review technique* (PERT) *char*t, *milestone charts,* and *critical path method* (CPM). An understanding of these various charts and techniques can help project managers to develop effective schedules and forecast project completion date effectively. Project management is becoming more complex and unpredictable; therefore, the use of effective planning and tracking mechanism can help greatly in meeting various project timelines and completion dates. Like project estimates, construction managers should be provided the needed capacity building and certification to construction project managers to be eligible to manage a project.

While it remains crucial to attaining good estimates and effective scheduling, it is also recommended that project planning and implementation should include stakeholders' involvement from inception to project completion. Stakeholders' participation in project

activities at every phase of the project lifecycle is essential for attaining project success because each stakeholder plays meaningful roles at various stages of the project lifecycle. Project managers should also work closely with other stakeholders to track the project periodically. The relevance of periodic tracking, referred to as *monitoring and control*, is to ensure that project stakeholders are abreast of project progress at various stages of the implementation. This approach is utilized in many project operations and contribute to the overall success of projects globally. Project success often engenders profitability and sustainability.

Recommendations for Further Research

Discoveries from this study could help future project managers in effectively managing project cost estimations and scheduling for profitability and sustainability. Finding from this study can add to the body of knowledge regarding cost and schedule overruns and effect on profitability and sustainability. For further research, it is recommended that future project managers should gain the relevant knowledge, skills, and strategies of how on developing effective project cost estimates and scheduling. Besides, project managers should also understand various project constraints and utilize the theory of constraints (TOC) in making use of the less-manageable constraints that will speed up project implementation.

Understanding stakeholder roles and responsibilities are also cardinal to achieving project success. An effective stakeholder management is essential in the delivery of quality output and building rapport (Kelly, 2015). Therefore, project

managers are encouraged to understand stakeholder coordination, involvement, and non-involvement in various aspects of the project from inception to closing.

Monitoring and control, one of the five phases of the project lifecycle, is cardinal to accelerating project activities and outputs. Monitoring and control are vital for tracking of project deliverable, costs, timeline, performance evaluation, and quality assurance. Most projects become successful when project managers put an effective mechanism for monitoring and control of project resources and timelines. To ensure that future projects in Liberia meet the cost and schedule requirements, future project managers should take advantage of monitoring and control literature and practical tools in their various project works.

This research is, however, limited by the lack of a national online database or web access for tracking of cost and schedule of various construction projects in Liberia. Researchers seeking to attain such information must send a letter of request and will only acquire the requisite information by sitting with the assigned personnel to extract the needed data. Future researchers desirous of carrying on similar research in Liberia should be cognizant of such procedure and may be better served by utilizing advanced databases in developed economies in the West African sub-region including Nigeria, Senegal, and Ghana.

Reflections

Overall the process was very challenging and rewarding because of the acquisition of additional knowledge in project management and related fields. Months of utilizing the Walden University databases and other research journals and articles have

deepened my understanding of some of the critical concepts of project constraints, managing teams, and effectively managing costs and schedule for project success. The University set up aided in getting all of the essential materials and supports for this research.

Regarding data collection, the conviction was that the Public Sector Investment Plan (PSIP) database located at the Ministry of Finance and Development Planning in Liberia was inadequate to provide all of the data for the research. Unfortunately, the data seemed inadequate and only contained planning (initial) variables, not including the final variables – cost and schedule, from all of the government's projects. This situation made the data collection process more difficult because there became a need to change strategy and to collect data from the three organizations listed in the population separately and in person.

Finally, given my experience in project management, I expected that the entire process would be easy. However, to my amazement, the process was more demanding, time-consuming, frustrating, and at one point even conceived the idea of quitting. It is important for those reading this research to be cognizant of the fact that it took almost three years for completion of the research paper alone and required time, money, and commitment. Overall, the experience was great because, with the review of literature, the knowledge attained was enormous and contributed to enhance my research skill.

Conclusion

The purpose of this research was to examine a relationship between project cost estimates, project scheduling, and project success. The results of the statistical test using

multiple linear regression (MLR) showed that there exists a statistically significant relationship between project cost estimates, project scheduling, and project success. Based on this result, project managers need to be cognizant of this relationship and focus on developing estimates and schedules using modern project management tools that would project accurate costs and schedules.

The cost performance index values which represented project success showed that almost all of the construction projects reflected in Appendix E were below the value of 1, indicating project failure. Project failure often results in a lack of profitability and sustainability; therefore, project managers are recommended to have the necessary skill, knowledge, and tools to achieve success. Attainment of these attributes is through capacity building and other project management training. With the requisite capacity development and varieties of training, project managers will understand the basic concept of reliable estimates using *work breakdown structur*e (WBS) and adequate project scheduling using the *Gantt chart* in Microsoft Project.

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Appendix A: Letter of Authorization – Ministry of Education

REPUBLIC OF LIBERIA
MINISTRY OF EDUCATION
P. O. BOX 10 - 9012
1000 MONROVIA 10, LIBERIA
WEST AFRICA

Office of the Deputy Minister
For Instruction

August 5, 2020

Ms. Libby Munson
Research Ethics Support Specialist
Office of Research Ethics and Compliance
Walden University
100 Washington Avenue South, Suite 900
Minneapolis, MN 55401

Dear Ms. Munson,

We present our compliments and confirms that Mr. Teakon J. Williams, a doctoral student of Walden University, will be granted access to our construction database for his doctoral research. Our acceptance to Mr. Williams' request for data access is based on his request for access accompanied by his draft dissertation and University Research Review (URR) and 1st Oral Presentation approvals.

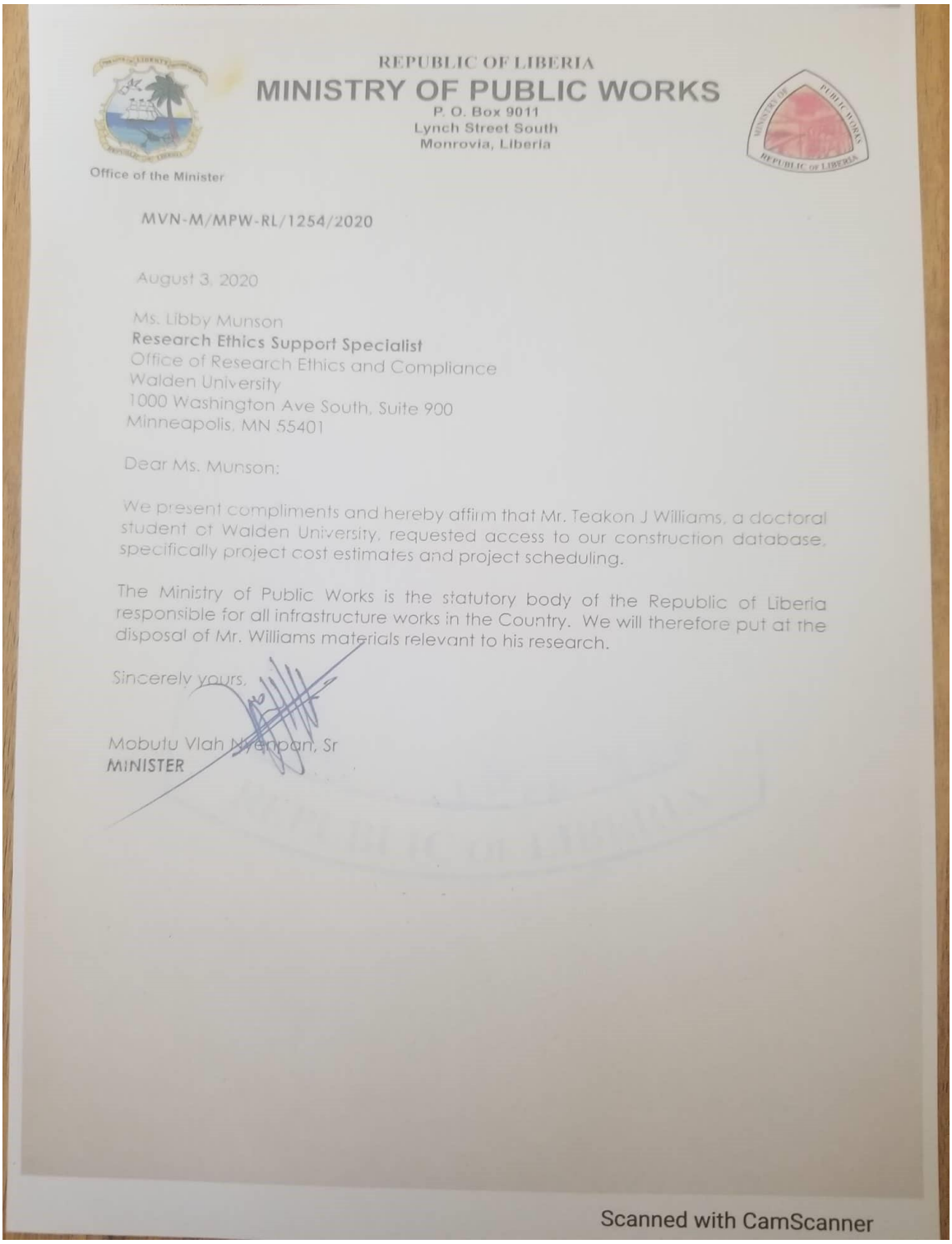
For your information, the Ministry of Education (MOE) of the Republic of Liberia, during the postwar period (since 2005) has been working with international development agencies including the World Bank, the Global Partnership for Education (GPE), the African Development Bank(AfDB), the United States Agency for International Development (USAID), among others on the construction of educational facilities and other infrastructure relating to education. I am confident that Mr. Williams will be able to fetch the relevant data for his research. For more information on the Ministry, kindly go to http://moe-liberia.org/

Best regards,

Yours truly,

Alexander N. Duopu
DEPUTY MINISTER FOR INSTRUCTION
MINISTRY OF EDUCATION, R.L.

Appendix B: Letter of Authorization – Ministry of Public Works



REPUBLIC OF LIBERIA
MINISTRY OF PUBLIC WORKS
P. O. Box 9011
Lynch Street South
Monrovia, Liberia

Office of the Minister

MVN-M/MPW-RL/1254/2020

August 3, 2020

Ms. Libby Munson
Research Ethics Support Specialist
Office of Research Ethics and Compliance
Walden University
1000 Washington Ave South, Suite 900
Minneapolis, MN 55401

Dear Ms. Munson:

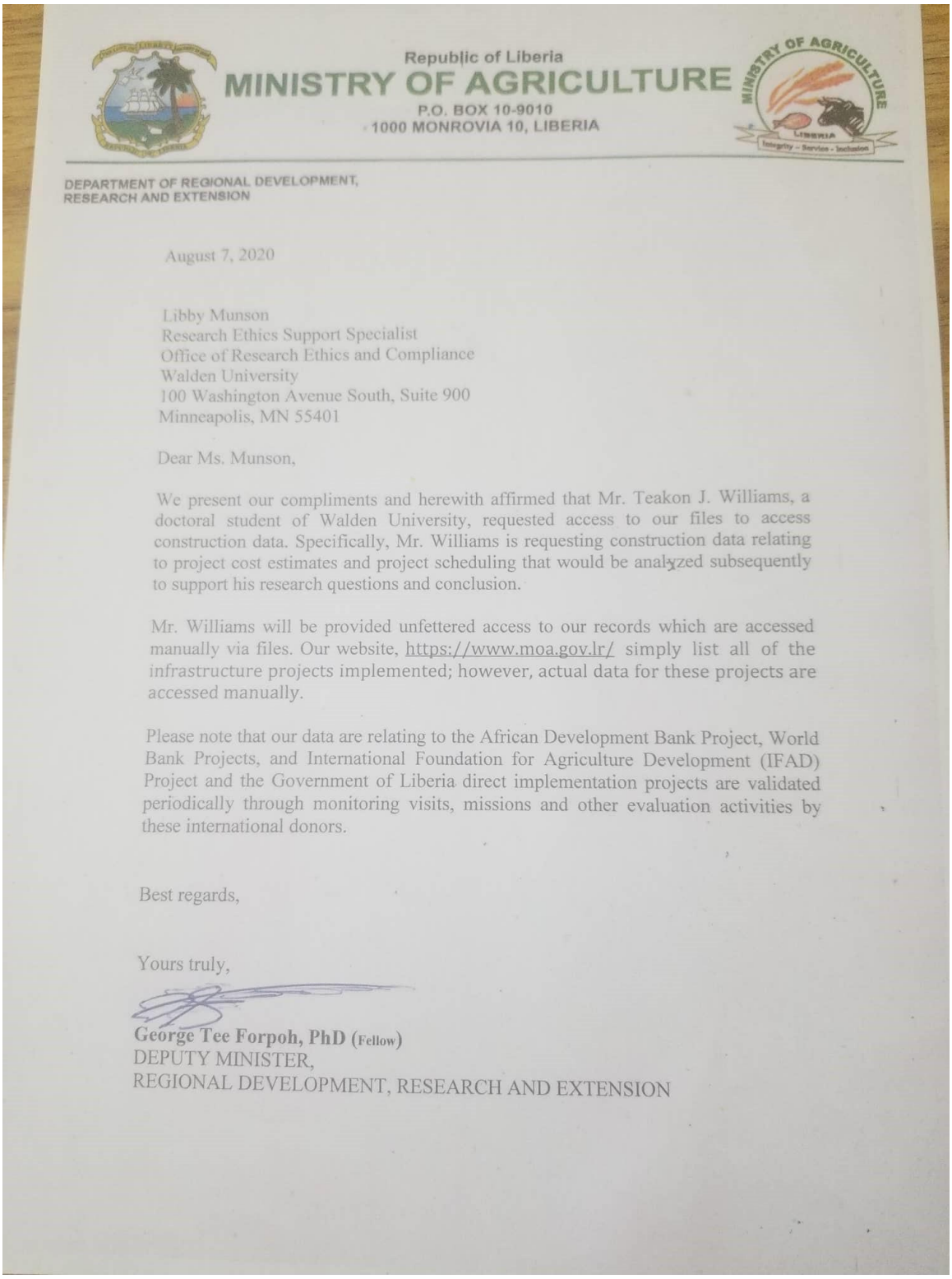
We present compliments and hereby affirm that Mr. Teakon J Williams, a doctoral student at Walden University, requested access to our construction database, specifically project cost estimates and project scheduling.

The Ministry of Public Works is the statutory body of the Republic of Liberia responsible for all infrastructure works in the Country. We will therefore put at the disposal of Mr. Williams materials relevant to his research.

Sincerely yours,

Mobutu Vlah Nyenpan, Sr
MINISTER

Appendix C: Letter of Authorization – Ministry of Agriculture



Republic of Liberia
MINISTRY OF AGRICULTURE
P.O. BOX 10-9010
1000 MONROVIA 10, LIBERIA

DEPARTMENT OF REGIONAL DEVELOPMENT,
RESEARCH AND EXTENSION

August 7, 2020

Libby Munson
Research Ethics Support Specialist
Office of Research Ethics and Compliance
Walden University
100 Washington Avenue South, Suite 900
Minneapolis, MN 55401

Dear Ms. Munson,

We present our compliments and herewith affirmed that Mr. Teakon J. Williams, a doctoral student of Walden University, requested access to our files to access construction data. Specifically, Mr. Williams is requesting construction data relating to project cost estimates and project scheduling that would be analyzed subsequently to support his research questions and conclusion.

Mr. Williams will be provided unfettered access to our records which are accessed manually via files. Our website, https://www.moa.gov.lr/ simply list all of the infrastructure projects implemented; however, actual data for these projects are accessed manually.

Please note that our data are relating to the African Development Bank Project, World Bank Projects, and International Foundation for Agriculture Development (IFAD) Project and the Government of Liberia direct implementation projects are validated periodically through monitoring visits, missions and other evaluation activities by these international donors.

Best regards,

Yours truly,

George Tee Forpoh, PhD (Fellow)
DEPUTY MINISTER,
REGIONAL DEVELOPMENT, RESEARCH AND EXTENSION

Appendix D: Reference Analysis

Source	Quantity	Percent of Total
Peer-Review Status		
Peer-Reviewed Publications	203	88%
Non-Peer-Review Publications	26	11%
Total	229	100%
Type of Sources		
Journal Articles	173	76%
Books	26	11%
Dissertations	3	1%
Government Websites	5	2%
Professional Association	17	7%
Conferences	5	2%
Total	229	100%
Publication Timelines		
Within 5 years (2015-2019)	213	93%
Below 5 years (2014 and below	16	7%
Total	229	100%

Appendix E: Raw Data

No.	Name of Contract	Initial Cost (PV) (in 000$)	Actual Cost (AC) (in 000$)	Initial Schedule (PV) (In Months)	Actual Schedule (EV) (In Months)	Cost Variance (CV) (in 000$)	Schedule Variance (SV) (In Months)	Cost Per Index (CPI)
MINISTRY OF AGRICULTURE								
1	Construction of Robertsport Market	180	317	11	15	137	4	0.57
2	Construction of Grand Bassa Technology Transfer Center	300	304	11	15	4	4	0.99
3	Construction of Compound 3 Market - Grand Bassa	180	487	11	15	307	4	0.37
4	Construction of Geekan	180	580	11	15	400	4	0.31

	Market - Grand Kru							
5	Renovation of Kakata Market - MarGibi	180	291	11	15	111	4	0.62
6	Renovation of Pleebo Market -- Maryland	180	430	11	15	250	4	0.42
7	Renovation of Philadelphia Tech Transfer Center - Maryland	300	385	11	15	85	4	0.78
8	Renovation of Karweaken Market - River Gee	180	472	11	15	292	4	0.38
9	Renovation of Karweaken Tech Transfer Center - River Gee	300	391	11	15	91	4	0.77
10	Refurbishment of Crop and Soil Labs - CARI	350	391	9	15	41	6	0.90
11	Refurbishment of University of Liberia Agric Lab	350	375	5	8	25	3	0.93
12	Refurbishment of Agric Lab at CARI	350	380	5	10	30	5	0.92
13	Construction of Offices and Warehouses for Nimba Cooperatives	270	300	6	11	30	5	0.90
14	Construction Chain Clinic Fence - Nimba Count	250	275	6	11	25	5	0.91
15	Construction of Warehouses in Grand Bassa	58	58	2	2	0	0	1.00
16	Construction of Warehouses in Grand Gedeh	91	91	10	15	0	5	1.00
17	Construction of Box	90	90	3	3	0	0	1.00

	Culverts in Philadelphia							
18	Construction of Philadelphia Dam	737	760	11	20	23	9	0.97
19	Construction of Fishtown Dam	643	670	11	22	27	11	0.96
20	Construction of Barclayville Dam	909	1100	14	22	191	8	0.83
21	Construction of Pleebo Dam, Maryland County	418	500	9	16	82	7	0.84
22	Construction of Milling House in Zwedru, Grand Gedeh	364	400	10	14	36	4	0.91
23	Construction of Milling House in Jarkaken - River Gee	344	364	9	17	20	8	0.95
24	Construction of Phenoneken Dam - River Gee County	341	370	11	17	29	6	0.92
25	Construction of CARI dam	728	820	8	18	92	10	0.89
26	Construction of Ziah Town Dam, Grand Gedeh County	739	800	12	18	61	6	0.92
27	Construction of MOA Offices in Fishtown, River Gee County	411	450	8	18	39	10	0.91
28	Construction of MOA Offices in Barclayville, Maryland County	441	475	11	20	34	9	0.93
29	Construction of Kaweaken Dam, River Gee County	214	230	7	9	16	2	0.93

30	Construction of Putuken Dam, River Gee County	701	800	11	20	99	9	0.88
31	Construction of Kaloken Dam, River Gee County	340	360	7	15	20	8	0.94
32	Construction of MOA Offices in Philadelphia, Maryland County	160	170	7	11	10	4	0.94
33	Construction of Glarro Swamp, River Gee Cojunty	503	550	8	16	47	8	0.91
34	Construction of Pennoken Dam, River Gee County	620	700	8	17	80	9	0.89
35	Construction of Box Culverts in CARI Bong County	50	59	4	6	9	2	0.85
36	Construction of Box Culverts in Bahn, Nimba County	82	96	4	7	14	3	0.85
37	Construction of Box Culverts in Grand Cess, Grand Kru County	90	105	4	5	15	1	0.86
38	Counstruction of Box Culverts in Zia, Grand Gedeh County	90	105	4	5	15	1	0.86
39	Construction of Box Culverts in Jarkaken	51	60	5	10	9	5	0.85
	MINISTRY OF PUBLIC WORKS							
40	Renovation of Grand Cess Bridge	141	180	9	18	39	9	0.78

41	Emergency Improvement of Road - New Georgia (Lot 1)	320	368	7	9	48	2	0.87
42	Emergency Improvement of Road - Barnersville (Lot 2)	315	371	7	11	56	4	0.85
43	Emergency Improvement of Road - Claratown (Lot 3)	220	260	8	11	40	3	0.85
44	Emergency Improvement of Road - Gardnersville (Lot 4)	260	280	6	10	20	4	0.93
45	Emergency Improvement of Road - Banjor (Lot 5)	220	250	6	9	30	3	0.88
46	Asphalt Patching and Shoulder Overlay - Somalia Drive	539	630	7	10	91	3	0.86
47	Asphalt Patching and Shoulder Overlay - Jamaica Road	320	350	7	9	30	2	0.91
48	Asphalt Patching and Shoulder Overlay - Logan Town	310	330	7	11	20	4	0.94
49	Asphalt Patching and Shoulder Overlay - Caldwell	340	400	7	12	60	5	0.85
50	Asphalt Patching and Shoulder Overlay - Claratown	325	350	8	12	25	4	0.93
51	Weasua Road Rehabilitation	320	360	7	10	40	3	0.89

52	Battle Field Road Rehabilitation	200	240	6	8	40	2	0.83
53	Asphalt Patching and Shoulder Overlay - Barnersville Kerbah	280	290	5	8	10	3	0.97
54	Asphalt Patching and Shoulder Overlay - Congo Town	280	300	5	9	20	4	0.93
55	Rigid Concrete Pavement of Redemption Road, Thinkers' Village	350	400	8	11	50	3	0.88
56	Boniken-Yebloken Clinic Road	240	400	10	20	160	10	0.60
57	Cherboken Clinic Road Rehabilitation	240	340	10	18	100	8	0.71
58	Ganta - Toe Town Rehabilitation	250	280	9	16	30	7	0.89
59	SKD Boulevard Road Conditioning	260	285	6	8	25	2	0.91
60	Rehabilitation of Clara Town Road	380	400	12	24	20	12	0.95
61	Rehabilitation of Louisina Road	220	260	36	50	40	14	0.85
62	Brewerville-Iron Gate Rehabilitation	243	280	36	44	37	8	0.87
63	Asphalt Patching and Shoulder Overlay - Sinkor to Capitol Bye-Pass	871	950	12	18	79	6	0.92
64	Asphalt Pavement Soul Clinic - Parker Paint	250	300	7	12	50	5	0.83

65	Logan Town - Bye Pass Extension Asphalt Patching	370	456	5	9	86	4	0.81
66	Logan Town - Duala Bye-pass	380	440	5	8	60	3	0.86
67	Tripple Box Culvert - Grand Cess	40	60	4	8	20	4	0.67
68	Gabriel Tucker Bridge Pavement Overlay	200	241	4	7	41	3	0.83
69	Gbargba Road Maintenance	250	272	6	8	22	2	0.92
70	Extension of Kolahun-Vahun Road	333	372	13	20	39	7	0.90
71	Rehabilitation of Sawmill Road	247	330	13	22	83	9	0.75
72	Rehabilitation of Karloken - Glofaken Road	284	354	14	28	70	14	0.80
73	Rehabilitation of Suaken to Glofaken Road	856	954	12	24	98	12	0.90
74	Rehabilitation of Kanweaken - Barclayville Road	360	490	12	30	130	18	0.73
75	Tripple Box Culvert - Zwedru	34	45	4	6	11	2	0.76
76	MVTC Renovation	348	441	12	18	93	6	0.79
77	Rehabilitation of Gbarnga to Zorzor Road	979	1110	13	24	131	11	0.88
78	Rehabilitation of Kesselly Blvd	400	460	6	9	60	3	0.87
79	Installation of Drainages and Kerbs	110	140	4	7	30	3	0.79
80	Asphalt Payment of Selected Sinkor Streets	350	400	6	9	50	3	0.88

81	Pavement Marking - RIA Highway	920	1110	12	18	190	6	0.83
82	Tripple Box Culverts - Barclayville	60	60	3	6	0	3	1.00
83	Rehabilitation of Clay Road	160	200	4	8	40	4	0.80
84	Rehabilitation of Bong Mines Road	180	200	5	7	20	2	0.90
85	Renovation of Health Center - Harper	8	10	1	2	2	1	0.80
86	Construction of 70 Durable Shelters - Bahn	271	271	3	11	-	8	1.00
87	Construction of Main Extension Bahn HC	58,830	#####	1	2	-	1	1.00
88	Construction of Office Building in Conto Town	210	221	12	22	11	10	0.95
89	Construction of 12 Durable Shelters, Bahn Camp	133	139	1	3	6	2	0.96
90	Construction of Maternal Waiting Home in Gbarpolu	57	64	5	10	7	5	0.89
91	Construction of Maternal Waiting Home in River Cess	57	67	5	13	10	8	0.85
92	Construction of Maternal Waiting Home in Cape Mount	48	57	5	12	9	7	0.84
93	Construction of Maternal Waiting Home in Grand Kru	60	74	5	12	14	7	0.81
94	Consturction of Maternal Waiting Home in Maryland	61	71	5	7	10	2	0.86
95	Refurbishment of JFK Main	117	150	10	14	33	4	0.78

	Medical Building							
96	Refurbishment of BSL3 Lab in Charlesville, Margibi County	87	135	12	18	48	6	0.64
	MINISTRY OF EDUCATION							
97	Construction of Fishtown Public School	152	161	10	10	9	0	0.94
98	Construction of Wropluken Public School (6 class rooms)	85	120	4	36	35	32	0.71
99	Construction of Murryville Public School (6 class rooms)	76	76	5	48	0	43	1.00
100	Renovation of Six Primary Public Schools	66	66	6	7	0	1	1.00
101	Construction of Deidala & Julijuah Tearcher's Quarter	46	46	6	9	0	3	1.00
102	Expansion of J. Milton Teahjay Elem. Sch.	29	29	5	16	0	11	1.00
103	Renovation of School of the Blind	57	57	3	12	0	9	1.00
104	Construction of Voinjama Learning Resource Center	167	167	10	12	0	2	1.00
105	Construction of Weintown Public School	225	260	8	13	35	5	0.87
106	Construction of Cherboken Public School	225	280	8	16	55	8	0.80

107	Construction of Glaro Public School	225	300	8	22	75	14	0.75
108	Construction of Jarkaken Public School	225	365	8	14	140	6	0.62
109	Construction of Pennoken Public School	225	300	8	20	75	12	0.75
110	Construction of Gbaepo Public School	225	360	8	18	135	10	0.63