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Relationship Between Cost, Schedule Overruns, and Project Success in the Nuclear Construction Industry in the United Kingdom

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Abstract:-

- ***Purpose:***

Failure to achieve project success due to cost and schedule overruns may negatively affect an organization's financial strength, profitability, and competitive advantage. Grounded in the triple constraint model, we investigated the relationship between cost, schedule overruns, and project success in the nuclear construction industry in the United Kingdom.

- ***Design/methodology/approach:***

Data were collected from 66 project managers, project directors, project control, delivery integration managers, and construction project planners. The multiple linear regression analysis was carried out.

- ***Findings:***

The multiple linear regression analysis results were significant, F (2,63) = 19.002, $p < .05$, $R^2 = .38$. Schedule overruns provided the only statistically significant contribution to the model ($\beta = .462$, $p = .002$).

- ***Practical implications:***

A key recommendation is for organizational leaders to implement strategic trade-off plans by prioritizing project schedules over cost to improve project success, profitability, and competitive advantage.

- ***Social Implication:***

The implication for positive social change included the potential to empower the local community by creating jobs.

Keywords:- *Cost Overrun, Schedule Overrun, Project Success, Nuclear Industry, Triple Constraint Theory.*

- ***Paper type****: Research paper*

- ***Originality/Value:***

The study presents the relationship between cost, schedule overruns, and project success in the nuclear construction industry in the United Kingdom.

I. INTRODUCTION

With the growing concerns around the adverse effects of global warming, most countries are shifting toward affordable and eco-friendly sources of energy (Bayulgen & Benegal, 2019). The United Kingdom has identified nuclear power as a reliable source of energy to help the nation achieve a four-fold increase in the generation of environmentally friendly energy (Cox, 2018). Currently, the United Kingdom depends on nuclear power to meet approximately 16% of its electricity demands (Kirikkaleli et al., 2021). With the continued reliance on nuclear power, the country's existing fleet of nuclear reactors will soon reach the end of its operating life (Johnstone & Stirling, 2020). The U.K.government has begun the construction of eight new nuclear power plants to meet the expected demand for clean energy by 2050 (United Kingdom Department of Business and Industry, 2022). The implementation of these projects could be on hold because of schedule and cost overruns experienced on Hinkley Point C (HPC). Tshidavhu and Khatleli (2020) maintained that delayed implementation of these projects has adverse economic effects. For this reason, it is plausible to examine the relationship between cost, schedule overruns, and project success in the nuclear construction industry in the United Kingdom.

Energy is considered a key driver of economic growth. The findings of a study conducted by Ntanos et al. (2018) to determine the role of energy in promoting economic development indicated that the scarcity of energy imposed strong constraints on economic growth. Also, the findings indicated that the growth of the gross domestic product was significantly and positively related to the availability of energy. The findings of this study are consistent with the results of a study undertaken by Zafar et al. (2019) to determine the role of energy in economic development. Zafar et al. found a positive link between the availability of cheap energy and economic growth, especially in industries such as manufacturing and construction. These findings allude to the importance of investing in reliable and affordable energy.

Globally, nations have started to invest in renewable and eco-friendly energy sources such as solar energy, hydroelectric energy, and nuclear energy (Cox, 2018). The implementation of these projects continues to be delayed by schedule and cost overruns, which present two of the main project management concerns in a project life cycle. For example, in the United Kingdom, energy-related projects record approximately 30% delays and 70–80% cost overruns (Wealer et al., 2019). Since most of these projects are cost-intensive, the delays and the cost overruns translate into a significant economic loss (Tshidavhu & Khatleli, 2020).

Construction organizations often experience project failure due to cost and schedule overruns (Johnson & Babu, 2018). The cost overruns have been as high as 70%, and schedule overruns have been as high as 65% for power generation projects (Callegari et al., 2018). Ma and Fu (2020) concluded that schedule and cost overruns lead to a low project success rate, which impacts the ambitions of a construction company. The general business problem is that project failure weakens organizational financial strength, profitability, and competitive advantage. The specific business problem is that some construction project managers do not understand the relationship between cost, schedule overruns, and project success.

The purpose of this quantitative correlational study was to examine the relationship between cost, schedule overruns, and project success. Cost and schedule overruns were the independent variables for this study, and project success was the dependent variable. The target population was nuclear construction project managers in the United Kingdom who had successfully adapted processes for projects to reduce cost and schedule overruns, thereby improving project success. The implication for positive social change included the socio-economic benefits from the savings on timely project delivery for an education program to motivate young people to develop their skills in science, technology, engineering, and mathematics that could be helpful during the construction of Hinkley Point C (HPC) power station, and its future operations. The following sections are organized as follows. Chapter 2 discussed the existing literature on cost, schedule overruns, and project success. The methodology is then presented in chapter 3. The findings from the data collection and analysis are discussed in chapter 4.

II. LITERATURE REVIEW

A. Barnes' Iron Triangle Model

The iron triangle is also known as the project management triangle or the triple constraint (Pollack et al., 2018). Project managers use the iron triangle to measure project success because it helps to measure whether the project team completed projects within the agreed time, budget, and quality standard. Zid et al. (2020) claimed that the project team uses the iron triangle to communicate the expected cost and time. The triangle depicts the project success criteria on the vertices, and any movement on one criterion can put pressure on the two other criteria. Albert et al. (2017) affirmed that Barnes' iron triangle model is one of the most common approaches adopted to measure the success of projects in terms of performance, cost, and time. Albert et al. emphasize this triangle contains three interdependent aspects: (a) performance, (b) cost, and (c) time, all of which are determinants of project success.

B. Project Cost Overruns

Vu et al. (2020) defined project cost overruns as the excess of actual expenses over the approved budget. One of the critical criteria for an effectively completed project is accomplished within the contractually stipulated cost. Cost overruns in the construction sector are a significant issue for all stakeholders (Abusafiya & Suliman, 2017). International researchers and policymakers strive to determine the causes of project cost overruns (Durdyev, 2021; Herrera et al., 2020). For instance, Herrera et al. (2020) conducted a methodical assessment of stakeholders' views on the construction sector to determine the factors responsible for cost overruns in road construction. The findings indicated that cost overruns resulted from five key factors: (a) constant design modifications, (b) project scope alterations, (c) poor project planning, (d) changes in the price of building materials, and (e) failures in design (Herrera et al., 2020). The findings are consistent with the outcomes of a study conducted by Durdyev (2021) to explore the factors constraining on-site effectiveness in the construction sector. Durdyev and Herrera findings indicated that the most common causes of cost overruns in the construction sector were: (a) site conditions, (b) contract management concerns, (c) price fluctuations, (d) poor financial management, (e) competence and experience, (f) stakeholder's skills, (g) poor communication, (h) climatic conditions, (i) poor planning, (j) incorrect estimations, (k) incomplete designs, and (l) design problems (Durdyev, 2021). Based on these findings, the researchers concluded that cost overruns originate from various sources, particularly those connected to the project owner.

Because construction projects often experience cost overruns, project teams need to understand the causes of the overruns to deliver projects within the agreed cost. For instance, Subramani et al. (2014) undertook a study to determine the key causes of cost overruns in construction projects in the Indian building sector. The researchers examined the views of construction contractors and supervisors through a questionnaire survey and a desk study. The results indicated that the causes of project cost overruns in the construction sector included (a) long periods between design and the time of rendering or bidding, (b) an erroneous estimation approach, (c) challenges in land procurement, (d) rework because of faults, (e) interruption in delivering design, (f) poor design, (g) poor contract regulation, (h) increase in machine/material prices, (i) sub-standard plan management, and (j) slow decision making (Subramani et al., 2014). The findings are consistent with the results of studies conducted by Durdyev (2021) and Herrera et al. (2020). Based on these outcomes, Subramani et al. concluded that cost overruns in construction projects result from a combination of various factors.

Cost management performance has a significant influence on the overall success of a project (Abusafiya & Suliman, 2017). It is, therefore, a fundamental criterion for determining the success of construction projects (Johnson & Babu, 2018). Abusafiya and Suliman undertook a study to determine the key causes of cost overruns in the Bahraini construction industry and appraised the impact of the causes on overall project success. The researchers employed various research methodologies to collect the data, including expert opinions, historical building project records, and an extensive literature review. The study findings identified 45 broad causes of cost overruns in construction projects, including changes in project scope, poor project

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management practices, inadequate planning and scheduling, and fluctuations in the cost of construction materials.

➢ *Design and Cost Overruns*

Project design changes predict cost overruns (Aslam et al., 2019; Yap et al., 2019). Aslam et al. (2019) explored the influence of design alterations on project cost and the actions that led to these modifications. The researchers conducted an extensive literature review of past studies. The findings indicated that design modification was a key cause of cost overruns. At times, changes in design could increase the cost overruns to between 5% and 40% of the overall project cost (Aslam et al., 2019; Gharaibeh et al., 2020). The findings affirmed that design modification, which is a key cause of cost overruns, is related to clients' needs to alter the project scope.

By contrast, technical advice from contractors and consultants resulted in minimal design modifications (Aslam et al., 2019). Yap et al. (2019) found that factors leading to cost overruns included unanticipated site conditions, errors in design documents, addition or omission of scope, alterations of specification or project requirements, and lack of coordination among professional consultants working on a project. Yap et al. concluded that design changes have a significant impact on cost overruns.

Design changes are considered primary contributors to the disruption of cost and time performance in building projects (Liu et al., 2017; Muhamad & Mohammad, 2018). Liu et al. (2017) interviewed five knowledgeable construction professionals to determine the design risk factors of design-built projects and the impact on project success. The findings indicated the causes of design changes leading to project cost overruns included (a) incorrect design project, (b) risk of delay or inaccuracy of third-party details, (c) risk of inadequate experience among designers, (d) risk of lack of responsibility among designers, and (e) risk of an inappropriate design team (Liu et al., 2017). Such risks adversely impacted project costs and delivery periods. The results were similar to a study conducted by Muhamad and Mohammad (2018) to explore the effects of design modifications in building projects. The researchers demonstrated that design changes were primary contributors to the disruption of cost and time performance in building projects. The researchers concluded that design modifications are significant cost and schedule performance inhibitors in construction projects.

➢ *Poor Communication and Cost Overruns*

Evidence from the available literature suggests poor communication is one of the factors leading to cost and schedule overruns in construction projects (Gamil et al., 2019; Othman et al., 2018). For instance, Gamil et al. (2019) conducted a correlational study to investigate the impact of poor communication on schedule and cost overruns in the construction sector. The researchers achieved the goal by eliciting information from different stakeholders in the construction industry in developed nations. The results indicated that developed nations had adopted advanced communication systems and information communication technology, which substantially reduced the severity of cost and schedule overruns. The findings also suggested that poor communication had a considerable impact on schedule and cost overruns in the construction sector (Gamil et al., 2019).

Othman et al. (2018) extended this work by evaluating the causes of poor communication on cost and schedule overruns. The study findings showed that poor communication in construction projects occurred because construction stakeholders came from diverse professions and varied in values, cultures, skills, and objectives (Othman et al., 2018). Poor communication resulted from language barriers or a lack of respect for diversity (Othman et al., 2018). The researchers concluded that poor communication among stakeholders in the construction sector contributed strongly to cost and schedule overruns.

➢ *Project Complexity and Cost Overruns*

Project complexity is the measurement of project interfaces or a comparative appraisal of difficulty to what a construction firm has previously attained (Dao et al., 2020). Researchers suggested that different types of complexities linked with diverse kinds and sizes of projects have substantial effects on project cost overruns (Bohórquez-Castellanos & Mejía, 2019; Ma & Fu, 2020). For instance, Ma and Fu (2020) evaluated the effect of project complexity on the success of mega construction projects for project administration. The researchers defined a megaproject as a time-intensive undertaking that takes several years to complete, costs a minimum of $1 billion, and involves multiple private and public stakeholders. The researchers interviewed and scored 21 complexity cases concerning five project complexities and five components of project success. The outcomes indicated high organizational complications resulted in critical schedule delays in mega-building initiatives (Ma & Fu, 2020). The findings were consistent with the outcomes of research conducted by Bohórquez-Castellanos and Mejía (2019) to explore the association between cost overruns and complexity in engineering developments. The researchers concluded that the highly complex projects resulted in greater cost overruns while projects with low complexities exhibited relatively low-cost overruns. The researchers concluded that the mechanisms of project difficulty affecting the success of large building projects could assist project administrators in comprehending and evaluating the complexity of large building initiatives and correctly estimating their adverse effects.

Past literature has indicated that the type and nature of a project are predictors of cost overruns (Nguyen et al., 2019). For instance, Locatelli et al. (2014) undertook a study to determine the correlation between different characteristics of megaprojects. The researchers focused on various megaprojects, including cultural events, construction projects, and power plants. The findings indicated that for complex megaprojects, especially nuclear power plants, cost overruns positively and significantly correlated with delays by relevant authorities (Locatelli et al., 2014). To affirm this, Locatelli et al. referred to the case of the Moorburg power plant project. In this project, concerns over ecological requirements, particularly the discharge of warm water into the local river, led to massive conversations and disagreements in German politics that delayed the project's approval (Locatelli et al., 2014).

In another study conducted to determine the causes of project overruns in megaprojects, Nguyen et al. (2019) evaluated the correlation between the complexity of construction projects, project performance, and resource apportionment. The findings highlighted a significant and positive correlation between project complexity and schedule overruns but no significant association between project complexity and cost overruns. There was also a positive relationship between resource allocation and schedule overruns but no significant link between resource allocation and cost overruns. Resource allocation exhibited a buffering impact as increasing resources decreased the influence of project complexity on schedule overrun. Nguyen et al. concluded that highly complex projects might correlate with more cost overruns than less complex projects. Project dynamism and complexity can affect project duration because it involves different scope changes and valuable resources. The project management team needs to manage projects in phases to manage the project complexity. Project Schedule Overruns

Researchers have revealed the effects of schedule overruns on the performance of construction projects (Chen & Bien, 2019; Choi et al., 2016). For instance, Mukuka et al. (2015) explored the impacts of construction project schedule overruns. The researchers surveyed 200 construction stakeholders, including project managers, construction administrators, civil engineers, quantity surveyors, and architects. A statistical analysis of the data by researchers revealed that delayed customer compensation, reputation interaction with the contracting team, accelerated losses, poor work quality, disputes, loss of profit, cost overruns, and extension of project completion were the key effects of schedule overruns in construction projects (Mukuka et al., 2015). The findings were consistent with Chen and Bien (2019) study to evaluate the causes and effects of grain bin projects in China. The findings demonstrated that schedule overruns resulted in challenges with subcontractors, cost overruns, and project failure. Chen and Bien concluded that schedule overruns are undesirable for construction projects.

➢ *Design Changes and Schedule Overrun*

The complexity and uncertainties associated with construction projects cause a significant delay when making design changes. Researchers have shown that design flaws resulting in design modifications and reworks are key factors leading to schedule overruns in the construction sector (Han et al., 2013; Johnson & Babu, 2018; Yap et al., 2019). For instance, Han et al. (2013) used a dynamic system model to assess experts' perceptions of the effects of design flaws on building projects in the construction sector. The findings indicated that design faults substantially delayed project completion irrespective of the constant schedule recovery measures taken by project managers (Han et al., 2013). The researchers also found that schedule pressure amplified the adverse impact of design faults on many construction activities directly linked to those flaws. The findings were consistent with Yap et al. (2019), who found that design errors caused by design modifications resulted in schedule overruns in construction projects. The researchers concluded that design errors significantly delay construction work.

➢ *Funding and Schedule Overrun*

Projects require constant funding to ensure success. Project parties, such as individuals, corporations, and governments, fund projects based on nature, scope, and magnitude (Martin & Benson, 2021). Financial and other associated factors significantly impact the completion dates of projects (Amri & Marey-Pérez, 2020). For instance, Amri and Marey-Pérez (2020) explored the financial-related causes of construction project delays by evaluating stakeholders.

Financial literacy was the most critical factor leading to schedule overruns, followed by late payment, inadequate monetary resources, and, finally, instability in the financial market (Amri & Marey-Pérez, 2020). Other significant causes of project delays included inflation, problems in acquiring a loan from financiers, the poor business and financial management of clients, and the fluctuating financial background of contractors. The findings were identical to those of Martin and Benson (2021), who evaluated the effect of funding on schedule overruns. The timely compensation of contractors was significant in ensuring continuity of operations and accomplishing infrastructural projects within the stipulated quality, budget, and time (Martin & Benson, 2021). Researchers concluded that adequate financing and funding ensure the timely completion of construction projects.

C. Project Success

Achieving project success is a dimension of increasing importance in the project control literature (Osei-Kyei & Chan, 2017). A project is successful if it attains an attempted, planned, or desired initiative (Gemino et al., 2021). A major concern in the existing literature is determining project success (Müller & Turner, 2007; Santos et al., 2020). For instance, Santos et al. (2020) conducted a systematic and extensive literature review of previous studies to explore general success criteria and success factors in construction projects. The researchers' findings indicated that general project success criteria included standards adopted by all stakeholders to determine such success. The findings were consistent with Müller and Turner's (2007) study. The researchers found that the significance attached to project success rates and project success criteria varied according to the nationality and age of the project manager, the project complexity, and the sector (Müller & Turner, 2007). The researchers concluded that the adopted success criteria are based on both type and significance.

D. Nuclear Construction Projects

Construction and commissioning are commonly used in nuclear-related studies to refer to nuclear facilities built or renovated and whose components, structures, and systems are in certain working conditions (Grimston et al., 2014). Grimston et al. (2014) noted that the building phase of a new nuclear facility is critical for the safe operation of the plant throughout its stipulated lifespan. Various factors impact the successful construction of a nuclear plant, including the personnel, materials used, government approvals, facility design, and effective planning (Lovering et al., 2016). Only nine nations worldwide possess nuclear plants and weapons: the United Kingdom, North Korea, Israel, Pakistan, India, China, France, Russia, and the United States (Khattak et al., 2017). In the United Kingdom, Électricité de France is currently constructing the Hinkley Point C nuclear facility in Somerset and Essex, London. UK authorities in the regions monitor projects closely as nuclear power plants can be extremely dangerous to both human lives and the environment.

➢ *Sensitivity, Quality, and Safety Requirements of Nuclear Projects*

Researchers have identified various factors influencing the construction of nuclear plants (Madyaningarum et al., 2019; van Niekerk & Steyn, 2011). For instance, Madyaningarum et al. (2019) explored the main factors impacting project quality in construction projects involving radioactive minerals. The researchers focused on the rare earth metals thorium and uranium pilot plants and employed multiple linear regressions to analyze the data. The findings indicated that safety culture, project planning, leadership, and commitment impacted the quality of the construction projects. The results were consistent with van Niekerk and Steyn's (2011) study to examine a nuclear engineering project and determine the significant criteria for the success of complicated, high-tech programs. The researchers revealed that project effectiveness factors, including cost and timely delivery, were less significant for super high-technology projects. The researchers concluded that, unlike other projects, nuclear construction projects involve numerous factors due to their sensitivity and intense safety requirements. The safety requirements of the nuclear construction project during the planning phase make it sensitive. The decommissioning process needs to be incorporated into the planning phase to reduce reworks and remove complexity. Stable funding, availability of storage facilities, and communication with the governing bodies such as the Office for Nuclear Regulation can help reduce cost and schedule overruns in nuclear construction and decommissioning projects. The nuclear construction project location is important for its installation and operation as the site context should have an adequate supply of water to cool the reactors.

III. METHODOLOGY

A. Research Design and Sampling

This study employed a correlational research design. A correlational approach determines the degree to which a relationship exists between the set of paired variables (Curtis et al., 2016; Gaskin & Chapman, 2014; Hoe & Hoare, 2012). A correlational research design facilitated an evaluation of both the magnitude and behaviour of the relationships between variables (Leedy & Ormrod, 2010). Regression analysis is the best technique to determine the strength and direction of the variables and the best statistical technique to answer this study's research questions. Therefore, a correlational design was the most appropriate for this study.

The population of interest in this study was employees in the nuclear construction industry in the United Kingdom. The target population was project managers, project directors, project control managers, and project planners working on various nuclear construction projects in the United Kingdom. The Nuclear Industry Association (2019) reported that approximately 60,000 were employed in the civil nuclear sector in the United Kingdom. Employees in the civil nuclear industry are highly skilled people employed in power station construction and operations, manufacturing, decommissioning, research and development, waste management, and nuclear fuel (Nuclear Industry Association, 2019).

For this research, we used purposive and snowball sampling to recruit the participants. Purposive sampling is a sampling technique that involves the deliberate selection of participants such that only those who satisfy the inclusion criteria for the study are included (Campbell et al., 2020; Duan et al., 2015; Haas, 2012). The snowball sampling technique uses participant referrals and recommendations from the existing sample. Researchers typically employ this method when studying participants with unique attributes and beliefs who do not come from sites or pre-existing environments (Chambers et al., 2020). Thus, referrals from individuals in the same situations with similar characteristics are beneficial (O' Dwyer & Bernauer, 2014). The inclusion criteria for this study were as follows: participants (a) must currently be a project manager, project director, project control manager, or project planner of the HPC power station construction project; (b) must have at least one year of experience or exposure to nuclear construction projects; (c) must be currently employed in the civil nuclear industry in the United Kingdom, and (d) must be 18 years old or above. The exclusion criteria were as follows: participants must not be (a) associate employees with less than one year of working experience in the civil nuclear industry, (b) non-English-speaking individuals, and (c) individuals younger than 18 years old. Researchers use G*Power software power analysis to help select the required sample size (Faul et al., 2013).

B. Questionnaire Structure

We collected data via an administered survey. A self-developed survey was employed to obtain data consistent with quantitative research methodology. We used the survey (see Appendix) to measure the study variables (cost, schedule overruns, and project success) in two parts: a demographic section and a project details section. The demographic section of the survey was used to collect data on age, position, and years of working experience in the nuclear industry. The project details section gathered data on the cost, schedule overruns, and success of projects managed by the participants. A Likert-type questionnaire containing 36 questions was used to collect data. A Likert rating is a five-point scale system ranging from strongly agree (1) to strongly disagree (5) to test the different degrees of agreement and disagreement (Dourado et al., 2021). The survey was validated by establishing the validity, pilot testing the survey, and collecting pilot data. Conducting a pilot test helped ensure the reliability and validity of the self-developed survey. This pilot test consisted of two phases. The first phase involved showing the survey (see Appendix) to a panel of five experts to examine the feasibility and acceptability of the instrument for the study variables. Recommendations from the experts were meant to then facilitate appropriate revisions. All experts agreed that the survey instruments aligned with the research questions and hypothesis; hence there was no need to update the questionnaire. The second phase involved selecting a sample of 20 participants following the inclusion criteria previously described. The outcome of the pilot study showed no need for revisions to the survey (or any other documents).

C. Data Analysis

Data analysis in this quantitative study involved systematically applying a statistical test to answer research questions and test the null and alternative hypotheses. Researchers use data analysis to clean, transform and model collected data to help make decisions (Anda et al., 2017). The data analysis was conducted using SPSS for Windows to provide a range of descriptive and inferential statistics, including statistical correlations. Researchers in the educational, social, and behavioural sciences use SPSS software extensively (Hinton et al., 2014). The advantage of SPSS is that it is user-friendly and enables the researcher to import data from Microsoft Excel. Therefore, SPSS was used to analyze all the collected data.

Microsoft Excel facilitated all processing and ensured a clean set by excluding outliers, duplicated Ips, and missing data. Only those surveys with complete information were included in the data analysis. Once a completed, clean data set was prepared, we imported the data to SPSS for analysis.

A descriptive analysis was used to characterize the participants' demographic information and their responses to the survey. Descriptive statistics such as frequency, percentage, mean, and standard deviation were computed. Charts (i.e., pie charts and histograms) accompanied and illustrated the descriptive analysis.

The central part of the data analysis consisted of inferential analyses, specifically multiple linear regression analysis, to examine the relationship between cost, schedule overruns, and project success. Multiple regression analysis is a statistical technique that predicts the value of a dependent variable based on the value of two or more independent variables (Creswell, 2013). A multivariate correlation design was suitable for this study because there were two independent variables (cost and schedule overruns) and one dependent variable (project success). According to McQuitty (2017), researchers could predict the result of response variables from other multiple variables.

D. Results

➢ *Pilot Study*

Five experts completed Phase 1 of the pilot study survey hosted on SurveyMonkey. Their role was to examine the feasibility and acceptability of the instrument for the study variables. The participants in Phase 1 of the pilot study were academics, scholars, and peer-reviewed authors who had conducted quantitative studies. They all accepted the survey instruments. Phase 2 of the pilot study comprised 20 participants to ascertain the ease of completion, understanding, and reliability. Each participant spent an average of 3 minutes completing the questionnaire, which implies ease of completion and understanding of the details of the survey. The data for Phase 2 of the pilot study were analyzed using Cronbach's alpha, where a score of .60 was considered acceptable for this research (Jovanović & Lazić, 2018). The variable scores of cost, schedule overruns, and project success were .69, .62, and .76, respectively. According to the data, all variable scores are strongly consistent and reliable.

➢ *Main Study*

A total of 66 participants were used for the analysis of the main study. The observation for the cost overrun independent variable had a mean value of 3.99 (SD = .64, Min. = 2.33, Max.= 5.00). The observation for the schedule overrun independent variable had a mean value of 3.72 (SD = .69, Min. = 2.27, Max.= 5.00). Finally, the mean value of the observation for the project success dependent variable was 3.42 (SD = .64, Min. = 2.00, Max. = 4.54). These standard deviations (SD) values indicate a minimal variance of the data from the mean, which implies the reliability of the data sets. The assumption for normality, linearity, homoscedasticity, and multicollinearity is not violated.

E. Inferential Results

For the current study, I conducted a multiple regression analysis by using IBM SPSS 24. This was undertaken at $\alpha = .05$ (one-tailed) and bootstrapping of 1,000 samples at 95% bootstrap confidence intervals to examine the correlation between cost, schedule overruns, and the project success. The null hypothesis (H_0) exhibited no statistically significant relationship between cost overrun, schedule overrun, and project success. The alternative hypothesis (H_1) indicated a statistically significant relationship between cost overrun, schedule overrun, and project success. The research question involved how cost and schedule overrun affect project success.

The multiple regression results exhibited a linear combination significant relationship between cost, schedule overruns, and project success, $F(2,63) = 19.002$, $p < .05$. The sample multiple correlation coefficient $R = .613$, the $R^2 = .376$ and the adj. $R^2 = .356$ implied that approximately 36% of the variance of the dependent variable, and project success in the sample, could be predicted by the linear combination of the independent variables, cost, and schedule overruns. The null hypothesis of no statistically significant connection between cost overrun, schedule overrun, and project success was rejected. The alternative hypothesis of a statistically significant relationship between the above factors was accepted.

As indicated by the coefficients, no statistically significant relationship was apparent between cost overrun and project success because p = .256 exceeds .05. Nevertheless, a statistically significant relationship exists between schedule overrun and project success because p = *.002* (being less than .05). Tabachnick and Fidell (2018) claimed that a single unit change in the independent variable would result in a change in the corresponding value of β in the dependent variable. Therefore, the unstandardized coefficients β=.462 show that a unit change in the value of schedule overrun will lead to .462 units of project success. The unstandardized coefficients β=.165 value of the cost overruns indicates that a unit change in the value of cost overruns will result in .165 units of project success. Schedule overruns have a greater effect on project success, while cost overruns have little or no impact.

IV. THEORETICAL DISCUSSION OF THE FINDINGS

The triple constraint model, or iron triangle, which Barnes developed in 1969, was the theoretical framework for this study. This constraint is a central concept of traditional project management practices representing the key project success factors: cost, schedule, and quality (Pollack et al., 2018). The management team can measure the project's success by aligning the final project variables, cost, schedule, and quality to the agreed criteria, while the movement of one criterion on the triangle vertices will influence the other two variables. If the team fails to complete the project on time, this could affect the cost and the quality criteria. Project success can be measured by other critical criteria such as stakeholder satisfaction, sustainability, client satisfaction, health and safety, and profitability; the criteria of the triple constraint are most relevant (Ike et al., 2022).

Project managers are over-reliant on progress measurement as they adhere to cost, time, and quality. This means that they create an illusion of the project's progress because these criteria are insufficient to determine project success. Badewi (2016) argued that the triple constraint could limit the project management team in focusing on time, cost, and quality, while Ike et al. (2022) concluded that ignoring other critical success criteria such as client satisfaction and benefits realization highlighted may lead to project failure. Some construction project managers do not understand the relationship between cost, schedule overruns, and project success, thereby causing a problem. The study confirmed a statistically significant relationship between cost, schedule overruns, and project success.

We found that schedule overrun has a greater impact on project success when compared with cost overruns. This implies the possibility of a trade-off on the cost for the project schedule to achieve success. Lotfi et al. (2022) argued that project success requires scheduling, cost, resources, quality, and stakeholder management trade-offs to achieve project success in the construction industry. Also, Montenegro et al. (2021) argued that in addition to triple constraint components, project success criteria should include client satisfaction, benefits realization by the organizations, project management team, and stakeholders, end-user satisfaction, the strategic objective alignment, organizations, and business success.

Moghadam et al. (2019) contended that project execution encounters various uncertainties. Therefore, the project team should implement strategic trade-off plans concerning cost, time, and quality to attain success. Luong et al. (2018) stated that project cost, schedule, and quality are crucial in achieving project success. The project management team needs to implement trade-off optimization to gain the intended benefit and deliver on time. Managers can plan project construction effectively and implement control measures by adopting trade-off project success criteria (Tran et al., 2019).

V. RECOMMENDATIONS FOR FURTHER RESEARCH

This research was conducted in the United Kingdom, whose wealth and accelerated development may have influenced the orientation of project factors in order to favor costs and schedule overruns. Therefore, it is recommended to conduct research among a larger population in numerous different nations to justify the findings of this research in comparison with that of other nations. For future analysis, it is recommended to investigate the correlation between different variables such as stakeholder management, communication, project location, and culture by using project implementation datasets.

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