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Assessing the Impact of Constraining Factors on Design-Bid-Build Project Delivery: A Relationship Strength Analysis

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Abstract: This study examines the strength of the relationship among constraining factors impacting Design-Bid-Build (DBB) project delivery. Data collection involved a structured questionnaire survey with 124 valid responses. Using Pearson correlation analysis revealed strong interdependencies among these factors, particularly between contractor-related factors (CRF) and project external-related factors (PERF) (0.855), design-related factors (DRF) and owner-related factors (ORF) (0.839), DRF and design documentation-related factors (DDRF) (0.821), CRF and project collaboration-related factors (PCRF) (0.815), DRF and PCRF (0.811), PCRF and PERF (0.808), DRF and CRF (0.803), PCRF and ORF (0.797), DDRF and ORF (0.793), DRF and PERF (0.759), CRF and DDRF (0.737), ORF and CRF (0.733), PCRF and DDRF (0.723).This suggests that effective collaboration is integral to managing these critical project components. All correlations are statistically significant with a p-value of <0.001, indicating robust linear relationships between these factors. The study underscores the importance of effective collaboration between project stakeholders to address challenges related to design documentation, contractor involvement, and external conditions. Furthermore, issues related to design documentation (DDRF) and consultant-related factors (DRF) significantly influence project outcomes by affecting owners and contractors' performance. The findings indicate that the interconnectedness of these constraining factors plays a critical role in DBB project success, emphasizing the need for proactive management, communication, and collaboration throughout the project lifecycle. The study recommends for improving design documentation quality, enhancing stakeholder collaboration, and implementing comprehensive risk management strategies.

Keywords: *Constraining Factors, DBB, Correlation, Scatter Plot.*

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I. INTRODUCTION

Governments around the world spend an estimated US$9.5 trillion in public contracts every year, which in many developing countries represents approximately 15-22 percent of GDP (WB, 2020). UNCITRAL Model Law on Public Procurement (2011) said that up to 50% or perhaps more of all government spending may be made up of procurement costs, which might account for 10% to 20% of GDP. From building roads and power stations to purchasing pharmaceuticals and construction of modern railways, efficient use of public resources contributes to better delivery of services.

The United Nations (2020) states that many developing countries still lack basic infrastructures such as roads, hence the need for the ninth sustainable development goal "build resilient infrastructure, promote sustainable industrialization and foster innovation". In achieving this goal, businesses and projects, particularly those using the Design-Bid-Build (DBB) approach, need to meet the objectives set.

The Tanzanian construction industry, using the Design-Bid-Build (DBB) approach, delivers various building and civil engineering projects that significantly contribute to socio-economic development. These projects provide shelter, create jobs, and boost GDP, which grew from 14.0% in 2021 to 14.1% in 2022 (NBS, 2023).

Although the construction industry offers many benefits, it often fails to meet project and business objectives, despite some improvements (Habibi et al., 2019; Kortenko et al., 2020; Sayidganiev et al., 2022). While underperformance is a global issue, it is particularly severe in developing countries, with nations like the UAE experiencing delays in half of their projects (Habibi et al., 2019; Kortenko et al., 2020b). Similar problems have been reported in Tanzania, Kenya, South Africa, Saudi Arabia, and Sri Lanka (Chileshe & Kikwasi, 2014; Mathonsi & Thwala, 2012; Alofi et al., 2015). Key

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challenges include inefficient procurement, delays, cost overruns, low productivity, poor quality, high accident rates, frequent disputes, and stakeholder dissatisfaction (Yu et al., 2024; Okereke et al., 2021). The widespread use of the Design-Bid-Build (DBB) system is often cited as a major cause of these issues (Ogunsanmi, 2013; Olanike et al., 2020).

The traditional Design-Bid-Build (DBB) delivery method consists of three main stages: Design, Bidding, and Construction. During the design stage, a designer creates the project plans. In the bidding stage, tender documents are prepared, and the project is tendered, often awarded to the lowest responsive bidder (Yu & Shen, 2024). The construction stage involves the contractor executing the building work. This method typically leads to a fixed-price contract with two separate agreements: one between the owner and the consultant and another between the owner and the contractor (Phoya, 2014). DBB is the most familiar approach for clients (Cooperative Research Centre, 2008; CIOB, 2010) and distinctly separates design from construction phases (Ntiyakunze, 2011; Phoya, 2014). The design team prepares contract documents and advises the client on meeting their needs with suitable solutions (Mathonsi & Thwala, 2012).

The execution and performance of the construction industry are not optimum due to some concerns associated with the procurement of construction contracts including the design-bid-build (DBB) (Owiti, 2022). Naoum and Egbu (2015) argue that the DBB is dominating the construction industry of nations all over the world such as the USA, UK, Germany, Malaysia, and Saudi Arabia. Mathonsi and Thwala (2012) found that the traditional procurement system is dominant in South Africa and a similar situation is reported in Nigeria by Oladirin et al. (2013).

Kortenko et al. (2020) examined the implications of the design-bid-build (DBB) procurement method and found that is still the most often employed, and it is likely to stay that way for a long time in many other nations. The DBB alone accounts for about 60% of usage in the construction industry globally (CMAA, 2012; Salla, 2020). A few other authors who have investigated the DBB procurement systems, include Heidemann and Gehbauer (2010); Shrestha et al. (2012) and Pishdad-Bozorgi and La Garza (2016) in the US; Clahorra-Jimenez (2020) in Chile; and Rahmani et al. (2017)) in Australia. Other researchers that looked at the elements impacting the development and path of procurement included Dada (2013), Jimoh et al. (2016), Kehinde and Atanda (2022) in Nigeria, and Buertey et al. (2016) and Buertey et al. (2018) in Ghana. In the UK, Kortenko et al. (2020), Malaysian scholars Jaafar and Mohd Radzi (2013), Suratkon et al. (2020), and Noor et al. (2022), Alofi et al. (2015), El Sawalhi and El Agha (2017) in Palestine, Mosley & Bubshait (2019) in Saudi Arabia, and Alofi et al. (2015) in Saudi Arabia all investigated the comparison, analysis, and selection criteria of DBB and DB procurement systems. However, there are situations in which using alternative procurement methods than DBB is not feasible due to financial, technological, behavioral, cultural, legal, and normative hurdles against the implementation of integrated project delivery (Dargham et al., 2019).

The literature indicates that the conventional project delivery method is the most commonly used approach in the global construction industry (Addy et al., 2018; Mesa et al., 2016; Nawi et al., 2011; Fish, 2011). This aligns with evidence revealing that over 90% of construction projects in Ghana, particularly in the public sector, are carried out using this method (Ameyaw & Oteng-Seifah, 2010).

Ntiyakunze (2011) and Phoya (2014) identified the Design-Bid-Build (DBB) system as the most widely used procurement method in Tanzania. In this system, design and construction are handled separately, with key participants including clients/employers, consultants (architects, structural, civil, and service engineers, and quantity surveyors), and main contractors. These parties typically form temporary collaborations to execute projects within a defined timeframe. Most construction projects in Tanzania follow established procurement processes, with the DBB method, which involves designing first and building afterward, accounting for over 95% of projects annually (Valerian, 2014).

The construction industry faces many problems, such as project cost overruns, time extensions, conflict among the parties, and quality not achieved. A significant number of projects have fallen short of their objectives as a result of the procurement method that was chosen. Despite the DBB approach frequently being criticized for its inadequate project performance in terms of time, cost, and quality standards (Julião, 2018; Okereke *et al.,* 2022; Shoar & Payan, 2021; Mesa et al., 2016). However, Rahmani (2021) singled out the separation of design responsibility from construction responsibility as the main source of poor construction industry performance.

According to the Indian Government's Status Report, 309 out of 951 government projects experienced cost overruns of nearly 55%. Additionally, 474 of the projects investigated faced delays, with time overruns ranging from 2 to 192 months (Buamah, 2021). These time and cost overruns have been linked to several design-related problems, such as geological surprises, underestimating initial costs, changes in project scope, and delays in the release and approval of designs.

Scholars have presented different views on the causes of delays in construction projects, including DBB (Design-Bid-Build) projects, in Tanzania. Konzo (2020) identified inadequate specifications, flawed designs, changes in project scope, and poor project management as contributing factors. Similarly, Kikwasi (2012) observed comparable delay-related issues in building projects. Simon (2017) further attributed delays in road construction to political interference, poor contractor performance, frequent amendments, resource shortages, weak contractual relations, and insufficient personnel. However, there is a notable gap in the comprehensive understanding of the dynamic nature of these constraints and their interrelationships throughout different project phases. While some studies focus on individual constraints, there is a lack of research examining how these factors interact and evolve over the project lifecycle. Understanding the dynamic nature of constraining factors is essential for developing proactive management strategies that

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can adapt to changing project conditions. These differing findings highlight ongoing debates about the causes of construction project delays.

This paper may serve as a useful reference document to the Government and its agencies, consultant firms and contractors on the matters pertaining to the constraining factors impacting DBB project delivery to enhance the performance of public construction projects in the country.

Therefore, the objective of this study is to examine the strength of the relationship among the constraining factors impacting DBB project delivery in the Tanzanian construction industry.

II. LITERATURE REVIEW

➢ *General Overview of Design Bid Build*

According to Hinton and Hamilton (2015), design-bid-build (DBB) is still the most often utilized procurement method, and many experts believe that this trend will continue for many years. Being commonly used in the construction industry in Tanzania, traditional contracts are design– bid – build contracts that involve the engagement of a design team to completely design the whole facility, prepare bills of quantities and tender them out for contractors to compete (Matto et al., 2021). Puri and Tiwari (2014) states that the client, guided by the design team, selects the contractor with the lowest bid that meets the owner's requirements, and the owner then signs a contract with the selected contractor to assemble the project's components. In essence, the client is bound by two contracts: one with the contractor and one with the design professional (Mathonsi & Thwala, 2012). The owner has a direct relationship with both the designer and contractor; however, there is no contractual relationship between consultant and contractor.

➢ *Theoretical Underpinning*

Research on DBB project delivery is shaped by different social science theories, depending on the research's objectives and focus. This study specifically relies on the Theory of Constraints (TOC) and Contingency Theory as key frameworks to examine these complexities.

The Theory of Constraints (TOC) is a management approach that was first proposed by Eliyahu Goldratt in his 1984 novel, "The Goal." The basic premise of the theory is to focuses on identifying and addressing the weakest link in a system to enhance overall performance (Naor et al., 2012). For businesses in both production and service sectors, understanding their internal processes is crucial to staying competitive globally. TOC serves as a key methodology for problem-solving and reshaping managerial thinking.

The very first contingency theory was developed by Austrian psychologist Fred E. Fiedler in the 1960s. Contingency theory, also known as the contingency approach, is a management theory that applies to various industries, including construction. In the context of construction, contingency theory suggests that there is no one-size-fits-all approach to managing projects. Instead, the most effective management style and strategies depend on various factors or contingencies. Contingency theory recognizes that the management of construction projects must be tailored to suit the unique circumstances and contingencies of each project (Donaldson *et al*., 2006). Flexibility, adaptability, and the ability to adjust management strategies based on changing circumstances are essential in effectively navigating the complexities of construction projects.

Practically speaking, DBB projects need to continually identify where bottlenecks are occurring and then take steps to correct them.

➢ *Empirical Review*

Despite multi-party contractual agreements acknowledged by the lean construction community as enablers of better communication and performance, design-bid-build (DBB) still dominates the construction industry in Germany, UK and other countries. The design-bid-build (DBB) is still the most commonly used procurement system (Hinton & Hamilton, 2015) and it can be argued that it will remain prevalent in many countries for many years.

In the UK and many other countries, design-bid-build (DBB) is still the most common way to deliver construction services (Morledge & Smith, 2013). Low-bid procurement is the most common way to choose construction companies (Hanák et al., 2021; Lines et al., 2022; Reta & Alyew, 2022).

Numerous studies have explored the causes of delays in construction projects under DBB project delivery. Chan et al. (1997) identified five main reasons for delays in Hong Kong's construction projects: inadequate site management and supervision, unexpected ground conditions, slow decision-making among project teams, client-initiated changes, and necessary modifications to the work.

In Malaysia under DBB project delivery, Sambasivan and Soon (2007) identified ten major causes of construction delays: poor planning by contractors, ineffective site management, lack of contractor experience, delays in client payments and insufficient funding, issues with subcontractors, material shortages, labour shortages, equipment unavailability or breakdowns, poor communication among stakeholders, and errors made during construction.

The traditional system of procurement, design-bid-build (DBB) has been the dominant method of procurement for building contracts in Ghana since the inception of architectural practices (Buertey et al., 2021). Buertey et al. (2018) state that, the system dominates the Ghanaian construction industry largely because it is well established with wide applicability and simple procedures. This popularity in the Ghanaian construction sector makes it difficult to introduce new and contemporary procurement systems. In the Nigerian construction industry, more project delivery problems have been reported on the projects delivered through the traditional system than others. Delays are a significant problem in Nigerian building execution, according to Olanike et al. (2020). In a similar vein, Anana (2021) claims that among other things, construction projects in Nigeria frequently

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experience budget slippage, productivity losses, revenue shortfalls, conflicts and litigation, contract cancellation, and delivery delays. The majority of the problems associated with this DBB method, especially during the construction phase develop from unseen and hidden problems and inefficiencies at the design stages (Okereke et al., 2022).

The traditional system of procurement "remains mainly because most contractors and clients are familiar with it and so it often becomes a default approach," according to Walker and Rowlinson (2008), who support this viewpoint. This argument is thought to be valid in Tanzania, where traditional procurement methods are frequently employed. Several African researchers, including Valerian (2014); Mchopa et al. (2021); Kihamba (2021); Matto et al. (2021); Mchopa et al. (2024), and Maagi and Mwakalobo (2023), have criticized the construction industry in Africa for its "detachment" from the extensive use of the traditional procurement method, despite its association with substandard projects, delays in project completion, cost overruns, and poor value for money. Despite the traditional procurement approach's theoretical assumption that design work should be fully completed before the commencement of construction, Valerian (2014) revealed that, in practice, this is not often the case in East Africa, including Tanzania. The research highlighted that design work is generally incomplete at the time of contractor selection, leading to potential challenges and adjustments during the construction phase.

Noulmanee et al. (1999) studied delays in highway construction projects in Thailand, including DBB projects, and concluded that delays can arise from all project parties. However, key causes were attributed to inadequate subcontractor performance, resource-deficient organizations, incomplete or unclear drawings, and poor coordination between consultants and contractors. Al-Momani (2000), analyzing 130 public projects in Jordan, identified delays caused by design issues, user changes, weather, site conditions, late deliveries, economic challenges, and increased project scope. These findings highlight the diverse and context-specific factors contributing to delays in construction projects.

Ahmed et al., (2002) identified the ten most critical causes of construction delays in Florida, including DBB projects. These causes include delays in building permit approvals, change orders, modifications to drawings, incomplete documentation, inspection delays, specification changes, decisions during the development stage, and delays in shop drawings and approvals.

Luvara's (2018) study examined and ranked the key causes of delays and cost overruns in the Dar-es-Salaam project, including DBB projects. The findings highlighted critical factors such as consultants' prior project experience, delayed decision-making, incomplete designs and estimates during the tender stage, revisions to standard drawings or designs during construction, and errors or omissions in the bill of quantities and drawings. Delays in processing payments from clients to designers and contractors can disrupt project cash flow and hinder progress. Research by Kikwasi and Escalante (2018) highlights the adverse effects of payment delays on project continuity and contractor motivation.

Incomplete designs are a common issue in DBB projects, often causing delays, rework, and cost overruns, which negatively affect project scheduling, cost estimation, and overall success (Li & Taylor, 2014; Rwakarehe & Mfinanga, 2014; Ramabodu & Verster, 2013). Additionally, financial difficulties faced by project owners further hinder project viability and execution (Dosumu & Aigbavboa, 2018).

Table 1 Summary of Constraining Factors Impacting DBB Project Delivery

Constraining factors impacting DBB project delivery	**References**
Incomplete designs.	Malekela et al, 2017; Rwakarehe & Mfinanga,2014; Ramabodu and Verster, 2013; Alarcón and Mardones, 1998
Client's delay in processing designer's and contractor payments.	Jarkas, 2014; Abolnour, 1994; Kiwasi, 2013; Mahamid, 2016 Issa, 2023
Negligence of the Professional.	Sunday and Afolarin, 2013;
Inadequate and insufficient documentation.	Akampurira and Windapo, 2018; Sunday and Afolarin, 2013
Change in project requirements by the client at later stages.	Love et al., 2019, Hwang et al., 2018, Jarkas & Bitar, 2012
Incorrect drawings.	Sunday and Afolarin, 2013; Alarcón and Mardones, 1998
Lack of experience on similar projects	Abdalaziz, 2009; ICE, 1996
Shortage of materials, plants and equipment	Kamaruddeen et al, 2020; Evarist *et al*, 2023; Ameh et al, 2010;
Owner's financial difficulties.	Dosumu and Aigbavboa, 2018; Le, 2018
Inadequate or frequent breakdowns of construction plant and equipment	Ling et al, 2004; Kamaruddeen et al, 2020
Adversarial weather	Kamaruddeen et al, 2020; Evarist *et al*, 2023; Al-Momani, 2000
Changes to specifications	Sunday and Afolarin, 2013; Malekela, 2018.
Inadequate or ineffective use of new technology	Malinda, 2017; Li and Love,1998

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Constraining factors impacting DBB project delivery	References
Designer's failure to clearly understand the client's brief.	Malinda, 2017; Andi and Minato, 2003
Client slow decision making	Faridi & El-Sayegh, 2006; Marzouk & El-Rasas,2014.
Mistake during construction	Kamaruddeen et al, 2020
Inadequate and poor communication between client, consultants and contractor	Malinda, 2017; Sunday and Afolarin, 2013; Malekela, 2018
Contractors financial difficulties	Ling et al, 2004; Kamaruddeen et al, 2020; Mohammad Saiful Islam et al., 2015
Provision of wrong or Insufficient information by the client.	(Abdalaziz, 2009; Andi and
Poor site management	Ling et al, 2004; Mahamid, 2016; Kamaruddeen et al, 2020; Baloyi and Bekker, 2010; Dixit, 2020
Poor communication among design team members	Malinda, 2017; Jarkas, 2014 ; Slater and Radford, 2012; Andi and Minato, 2003; Malekela et al, 2017
Shortage of workforce	Kamaruddeen et al, 2020; Evarist *et al*, 2023; Apolot et all, 2013
Frequent design and construction changes by the client.	Jarkas, 2014; Darwish, 2007; Andi and Minato, 2003; Al-Momani, 2000; Kiwasi, 2013
Limited time available for checking and coordinating all design documentation	Abdalaziz, 2009;
Unexpected/Fluctuation in price of raw materials	Kamaruddeen et al, 2020; Ameh et al, 2010; Baloyi and Bekker, 2010; Azhar et al, 2008; Evarist *et al*, 2023; Mahamid, 2016
Disparities between BOQ drawings and specifications.	Philips-Ryder et al.,2013;Ramabodu and Vester, 2013;Dosumu and Aigbavboa, 2018
Re use of design documents and details from previous project without effective review by the designer	Malinda, 2017; Andi and Minato, 2003; Philips-Ryder et al.,2013;Ramabodu and Vester, 2013
Shortage of skilled and unskilled labours.	Kikwasi, 2011; Luvara and chileshe, 2022; Malinda, 2017; Kamaruddeen et al, 2020
Transfer of knowledge and experience between designers.	Dosumu et al., 2017
Late delivery of materials and equipments.	Kamaruddeen et al, 2020; Ameh et al, 2010; Baloyi and Bekker, 2010; Azhar et al, 2008; Evarist *et al*, 2023; Mahamid, 2016
Lack of continuous and effective communication between parties.	Philips-Ryder et al.,2013; Malinda, 2017
Contractors design capability	Lappalainen et al, 2022;Plusquellec et al, 2017
Social and cultural impacts	Ameh et al, 2010; Kamaruddeen et al, 2020

Source: Adapted from Mwaipungu et al., (2025)

- ➢ *Correlation*

Correlation is a statistical method used to assess and evaluate the strength of the relationship between two variables. Correlation analysis focuses on the connections between two or more variables (Patil & Sarode, 2017). Several statistical tests are employed to gauge the relationships between various variables. The selection of a particular type of test statistic is contingent upon the nature of the variables to be assessed and the desired outcomes. The Spearman ranking correlation and Pearson correlation, which are both non-parametric and parametric statistical measures, are the most often employed metrics for assessing associations (Marshall, n.d.). A popular statistical tool for determining the link between two or more variables is the Pearson correlation.

The correlation coefficient, represented by the letter "r" and ranging from -1 to +1, signifies the degree of association between the variables; a value of zero implies no relationship (Akoglu, 2018). Table 2 provides a summary of how different researchers interpret the strength of correlations. A relationship between the variables is present if the correlation coefficient falls between +/- 0.2 and +/- 1.0. When a correlation coefficient is positive, it means that rising values of one variable are correlated with rising values of other variables, and falling values suggest the opposite.

The relationship between the constraining factors impacting the delivery of DBB projects in Tanzania's construction industry was studied using Pearson correlation. According to Schober *et al*. (2018), a parametric test statistic, Pearson correlation is based on a set of assumptions. These assumptions include the following: (1) data must be representative of the population and must be chosen at random; (2) both variables must be continuous and must pass the test of normality. Continuous data is the dependent variable in this study and independent variables have been transformed to conform to these assumptions.

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Table 2 Strength of Correlation Coefficient

Correlation Coefficient (r)		(Marshall, n.d)	**(Akoglu, 2018)**	(Dancey & Reidy, 2007)	(Chan, 2003)
0	Non	Zero	Zero	Non	Non
+0.1	Weak	Weak	Weak	Poor	Weak
+0.2	Weak	Weak	Weak	Poor	Weak
+0.3	Weak	Weak	Weak	Fair	Weak
+0.4	Moderate	Moderate	Moderate	Fair	Moderate
+0.5	Moderate	Moderate	Moderate	Fair	Moderate
+0.6	Strong	Moderate	Moderate	Moderate	Strong
+0.7	Strong	Strong	Strong	Moderate	Strong
+0.8	Strong	Strong	Strong	Very Strong	Strong
+0.9	Very Strong	Strong	Strong	Very Strong	Very Strong
+1	Very Strong	Perfect	Perfect	Perfect	Very Strong

III. METHODOLOGY

- *Research Design, Approach*

This study is a quantitative in nature; a questionnaire survey was administered to 156 contractors, civil consulting firms and project client in Dar es salaam part of Tanzania. The region comprises of 5 districts. A total of 124 questionnaires were returned and analyzed. This represented 79.49% response rate against researches of Odeyinka et al., (2008) with 52% and Yassamis et al., (2002) with 54%. The analysis, conducted with IBM SPSS Statistics for Windows, Version 27.0, includes descriptive and inferential statistics, starting with insights from a pilot study to ensure the robustness of the instrument.

- *Population*

The target population size studied for quantitative research is known, as established from the Contractor's Registration Board (2023) website by selecting civil contractors' class one "N" =75 and from the Engineers Registration Board (2023) website by selecting civil consultant's "N" =100 located in Dar es Salaam Region. The entities were selected using Kothari, (2004) formula.

$$\frac{Z^2 P.q.N}{e^2.(N-1)+Z^2.P.q} \qquad \text{………………… …………Equ 1}$$

Where N = size of population; n = size of sample; z = standard variate at a given confidence, level worked out from table under normal curve (1.96 at 95%); e = margin/sampling error or precision rate (5%); p = sample proportion (0.5) and q = 1-p, the formula also used by studies like (Luvara, 2020); (Malekela, 2018).

- *Questionnaire Survey Administration*

The data were collected through questionnaires and semi structured interviews. The mixed- method approach was preferred because it maximizes the benefits of both approaches while minimizing their drawbacks (Kavishe, 2017). The questionnaires were distributed by hand as well as online using Google Forms between January 2024 and April 2024. The questionnaire comprised close-ended questions and was in 4 sections. Section 1 comprised preliminaries information, section 2 demographic information, section 3 awareness and practice of DBB, and section 4 constraining factors impacting DBB project delivery, using a 5-point Likert scale were applied to increase response rate and response quality along with reducing respondents' frustration level (Luvara & Benjamin,2023). Where by 1 = No impact, 2 = Low Impact, 3 = Moderate impact, 4 = High impact, and 5 = Very high impact. Out of the 156 questionnaires dispersed, only 124 questionnaires were returned, and 124 were deemed legitimate, representing a 75% response rate. A total of 156 returned questionnaire survey participants may seem significant sample size. Saunders and Townsend (2018) state that a sample size of at least 10% of the intended population is sufficient.

- *Data Analysis*

Using the aid of IBM SPSS Statistics for Windows, Version 27.0 and Microsoft Excel software, the quantitative data acquired for this study were analysed using descriptive statistics from which measures of central tendency, specifically mean values and standard deviation. The mean scores were used to rank the constraining factors impacting DBB in ascending order. Meanwhile, the qualitative data was analysed using the content analysis technique, specifically the summative approach, which focuses on identifying key words and subject frequencies and recurrences. Moreover, this is a good approach when trying to find out the opinions, knowledge, and views of people from a set of variables, which is the case in this study. The data collected were coded, in the sense that the text or words from the interviewees were scrutinized to establish a single or a few words that represent the main point from the text. Then, frequencies were assigned based on the number of respondents to one point.

- *Factor Analysis*

Factor analysis is employed to either reduce the number of observed variables. This method condenses a large set of variables (refer table 1 above) into a smaller subset (six latent constructs, PCRF, DDRF, DRF, ORF,CRF, PERF) while preserving most of the original information. The Kaiser-Meyer-Olkin test was used to assess sample adequacy by examining the strength of partial correlations between variables. KMO values close to 1.0 are considered ideal, while values below 0.5 are unacceptable (Monko, 2015). In this study, the KMO value was 0.928, well above the minimum threshold, indicating sufficient sampling adequacy for further analysis. Bartlett's Test of Sphericity showed a Chi-Square value of 4114.901 with 595 degrees of freedom and a significance level (p = 0.00), confirming an adequate correlation among the variables and the suitability of the data for factor analysis.

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Each factor's impact was ranked based on its mean score (descriptive statistics) from the extracted components, with Owner Related Factors (4.4188) and Design Documentation Related Factors (4.2889) having the highest influence on DBB project delays and cost overruns.

- *Correlation Analysis*

Correlation is a statistical test used to measure the relationship or association between two or more variables in a dataset (George and Mallery, 2019; Morgan et al., 2019; Aldrich, 2018). This test is crucial for this research, as it aims to assess the relationships among the variables in the study. Various types of correlation exist, but the Pearson correlation was selected for this research, conducted using SPSS Statistics Version 27.0. In this research, the Pearson correlation was utilized to evaluate the strength of the relationships among the constraining factors affecting DBB project delivery.

- *Scatter Plots*

A scatter plot is a graphical tool used to display the relationship between two variables. Each point on the plot represents a pair of observations from the two variables, with one variable plotted on the x-axis and the other on the y-axis (Nguyen *et al*.,2020). A scatter plot can illustrate the type and strength of the relationship between variables. Positive Correlation**:** If the points show an upward trend from left to right, it indicates a positive correlation, meaning that as one variable increases, the other also tends to increase.

In this study, a scatter plot is a valuable graphical method for exploring and understanding the relationship between two variables, helping to identify correlations, patterns, and anomalies in the data.

- *Reliability in Quantitative Research*

Reliability refers to the stability and consistency of data over time. In this study, questionnaires were distributed to project professionals, including project managers, consultants (engineers and quantity surveyors), and contractors. To assess the reliability of the measurement scale, Cronbach's Alpha was utilized, which measures internal consistency. The alpha coefficient ranges from 0 to 1, where higher values indicate greater reliability. According to Kline (2000)**,** an alpha value above 0.7 is generally considered acceptable, while values between 0.90 and 0.95 are preferred for stronger reliability.

IV. FINDINGS AND DISCUSSION

- *Questionnaire Respondent's Profile*

Table 3 highlights the demographic characteristics of the study participants, revealing insights into their gender, experience, education, profession, and firm type. The gender distribution shows a male-dominated sample, with 89 males (71.8%) and 35 females (28.2%), reflecting broader trends in the construction sector. Participants' experience levels vary, with 26.6% having 16-20 years of experience, 23.4% with 11-15 years, and 25.0% having over 20 years, indicating a highly experienced group overall.

In terms of education, most participants hold a Bachelor's degree (63.7%), while 26.6% possess a Master's degree, suggesting a well-educated workforce with advanced qualifications. Professionally, Engineers form the largest group (45.2%), followed by Quantity Surveyors (37.9%) and Project Managers (10.5%). Participants are nearly evenly distributed between Contractor firms (46.0%) and Consultancy firms (44.4%), with a smaller representation from Client/Financier organizations (9.7%). These attributes underscore the qualifications, experience, and diverse professional backgrounds of the participants, ensuring their suitability to provide accurate and reliable data for the study.

Table 3 Participants Background Information's

Demographic characteristics	Frequency	Percent
Gender		
Male	89	71.8%
Female	35	28.2%
Experience		
Less than 5 years	11	8.9%
5-10 years	20	16.1%
11-15 years	29	23.4%
16-20 years	33	26.6%
Over 20 years	31	25.0%
Education level		
Advance Diploma	9	7.3%
Bachelor's degree	79	63.7%
Master's degree	33	26.6%
PhD degree	3	2.4%
Professions		
Project manager	13	10.5%
Engineer	56	45.2%
Quantity surveyor	47	37.9%
Architect	3	2.4%
Procurement manager	2	1.6%

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Demographic characteristics	Frequency	Percent
Others	3	2.4%
Firm		
Consultancy	57	46.0%
Contractor	57	43.5%
Client/Financier	13	10.5%

- *Understanding and Implementation of Design-Bid-Build (DBB) Project Delivery in Tanzania's Construction Industry*

Table 4. provides insights into stakeholders' perceptions of the constraining factors impacting the Design-Bid-Build (DBB) project delivery method in the Tanzanian construction industry.

Table 4 highlights the variation in stakeholder familiarity with the Design-Bid-Build (DBB) method, with only 9.7% of respondents being very familiar and 59.7% indicating familiarity. This suggests that most stakeholders have a general understanding of the method. Regarding usage frequency, a small proportion rarely (2.4%) or never (3.2%) utilizes the DBB method, while the majority use it occasionally (46.0%) or frequently (42.7%), indicating its predominance as a project delivery method in Tanzania's construction industry.

Stakeholders' involvement in DBB projects varies significantly. Those with experience in 11-15 projects account for 26.6%, while 16.9% have participated in 15-20 projects. Notably, 23.4% of respondents have been involved in more than 20 DBB projects, reflecting a highly experienced subset. Satisfaction with the DBB method's performance is mixed: only 3.2% are very satisfied, 38.7% are satisfied, and 43.5% are neutral. Dissatisfaction is relatively low at 14.5%. These findings indicate that while many stakeholders find the DBB method acceptable, a significant portion remains neutral or sees room for improvement in its performance.

Table 4 Understanding and Implementation of Design-Bid-Build (DBB) Project Delivery in Tanzania's Construction Industry

	Frequency	Percent
Familiar with the Design-Bid-Build (DBB) project delivery method		
Very Familiar	12	9.70%
Familiar	74	59.70%
Somewhat Familiar	37	29.80%
Not very Familiar	1	0.80%
Not Familiar at all	0	0%
Frequent utilization of the DBB project delivery method		
Always	7	5.60%
Frequently	53	42.70%
Occasionally	57	46.00%
Rarely	3	2.40%
Never	4	3.20%
DBB Project construction involvement		
Less than 5	21	16.90%
5 to 10	19	15.30%
15-20	33	26.60%
15-20	21	16.90%
Over 20	29	23.40%
Satisfaction of Performance of the DBB project delivery method		
Very Satisfied	4	3.20%
Satisfied	48	38.70%
Neutral	54	43.50%
Dissatisfied	18	14.50%
Very Dissatisfied	0	0%

- *The Mean Score and ranking of major groups affecting the DBB project delivery in the study area.*

- ✓ **Owner Related Factors (ORF) – Mean Score: 4.4188** Owners significantly influence project outcomes, with frequent design changes, financial difficulties, delayed decision-making, and slow payment processing causing disruptions in cost management and scheduling.
- ✓ **Design Documentation Related Factors (DDRF) – Mean Score: 4.2889** Issues such as incomplete designs, inconsistencies in bills of quantities and drawings, outdated specifications, and inadequate documentation contribute to errors, rework, and delays in project execution.
- ✓ **Project Collaboration-Related Factors (PCRF) – Mean Score: 4.2100** Poor communication among stakeholders, lack of coordination between clients, consultants, and contractors, and ineffective knowledge transfer lead to misunderstandings and inefficiencies in project execution.

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- ✓ **Designer Related Factors (DRF) – Mean Score: 4.1595** The expertise and decision-making of designers play a crucial role, with challenges including misunderstandings of client requirements, lack of experience, over-reliance on previous designs, and limited adoption of new technologies impacting project quality.
- ✓ **Contractor Related Factors (CRF) – Mean Score: 4.1077** Contractors face financial constraints, construction errors, poor site management, equipment breakdowns, and skilled labor shortages, all of which affect productivity and project timelines.
- ✓ **Project External Related Factors (PERF) – Mean Score: 3.9824** External factors beyond project control, such as material shortages, price fluctuations, workforce unavailability, adverse weather conditions, and socio-cultural influences, introduce risks that can lead to cost overruns and delays.

➢ *Reliability Test*

A Reliability test was performed using Cronbach's Alpha test where values ranging from 0.7 and above are considered reliable (Gadisa and Zhou, 2019; Bonett and Wright, 2015). The Cronbach's Alpha test for this study ranged from 0.867 to 0.918 (i.e. above the recommended threshold value of 0.7), indicating that the data obtained by the research instrument was internally consistent.

Table 5 Reliability Analysis

Variable	Cronbach's Alpha	No. of Items (Observed Variables)	Remark
Design documentation-related factors	0.871	6	Reliable
Designer related factors	0.867	6	Reliable
Owner related factors	0.907	6	Reliable
Contractor related factors	0.869	6	Reliable
Project collaboration-related factors	0.909	5	Reliable
Project external related factors	0.918	6	Reliable

Sources: Researcher Field Data (2024)

➢ *To Examine of the Strength of the Relationship among Constraining Factors Impacting DBB Project Delivery*

Table 6 shows the summary of the results obtained from inferential statistics on the six main grouped constraining factors impacting DBB project delivery. The Pearson correlation coefficients indicate the strength and direction of the linear relationships between these factors refer to Table 2 above. All correlations are statistically significant with a p-value of <0.001.

- *Project Collaboration-Related Factors (PCRF):*

- ✓ **PCRF and DRF** (r = 0.811): There is a very strong positive correlation between project collaboration and designers' factors, suggesting that effective collaboration is closely tied to the role of consultants and designers in DBB projects.
- ✓ **PCRF and CRF** (r = 0.815): Another very strong positive correlation shows that successful collaboration also depends significantly on contractors' involvement, reinforcing the importance of coordination between project teams and contractors.
- ✓ **PCRF and PERF** (r = 0.808): Project collaboration is similarly linked to external factors, highlighting how external constraints such as material shortages and market conditions can affect the overall project collaboration.
- ✓ **PCRF and ORF** (r = 0.797): Collaboration with owners is also crucial, as indicated by the strong positive relationship, showing the impact of owners' decisions on project outcomes.
- ✓ **PCRF and DDRF** (r = 0.723): Although slightly lower, this strong correlation indicates that design documentation quality is still closely tied to effective project collaboration.

- *Design Documentation-Related Factors (DDRF):*

- ✓ **DDRF and DRF** (r = 0.821): There is a strong positive correlation between design documentation and designers' related factors, indicating that the quality and accuracy of design documentation are highly dependent on the input of consultants.
- ✓ **DDRF and ORF** (r = 0.793): A strong relationship exists between design documentation and owners' roles, showing how owners influence the design process through approvals and decision-making.
- ✓ **DDRF and CRF** (r = 0.737): Design documentation also strongly impacts contractors' performance, indicating that clear and accurate design documentation is essential for contractors to execute tasks effectively.
- ✓ **DDRF and PERF** (r = 0.674): External factors have a moderate yet significant influence on design documentation, likely due to constraints such as material availability and environmental conditions.

- *Designers (Consultants)-Related Factors (DRF):*

- ✓ **DRF and ORF** (r = 0.839): Designers' work is highly dependent on owners' involvement, as indicated by the very strong correlation, emphasizing the need for clear communication between owners and designers.
- ✓ **DRF and CRF** (r = 0.803): Very strong relationship between designers and contractors is essential, as design decisions directly influence construction execution.
- ✓ **DRF and PERF** (r = 0.759): External factors moderately impact designers' performance, suggesting that factors such as material and labour availability can affect design decisions.

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- *Owners-Related Factors (ORF):*

✓ **ORF and DRF** (r = 0.839): There is a very strong correlation between factors. Owners significantly influence design-related factors, reinforcing the importance of owners' roles in providing clear requirements and approvals.
✓ **ORF and CRF** (r = 0.733): There is a strong correlation between owners' involvement and contractors' performance, indicating that decisions made by owners can impact the efficiency and effectiveness of contractors.
✓ **ORF and PERF** (r = 0.691): Owners must also be aware of external factors, as these can affect overall project progress and decision-making processes.

- *Contractors-Related Factors (CRF):*

✓ **CRF and PERF** (r = 0.855): There is a very strong positive correlation between contractors' factors and external factors, highlighting that contractors are particularly sensitive to external constraints, such as supply chain issues, shortage of labour forces, fluctuation of material prices or regulatory requirements.
✓ **CRF and DRF** (r = 0.803): Collaboration with designers is key for contractors, showing how design quality can directly impact construction execution.
✓ **CRF and DDRF** (r = 0.737): Contractors' performance is also strongly linked to the quality of design documentation, further underscoring the importance of clear and accurate design deliverables.

- *Project External-Related Factors (PERF):*

✓ **PERF and CRF** (r = 0.855): Contractors are most affected by external factors, reinforcing the need for contractors to effectively manage risks like fluctuating material prices and labour shortages.
✓ **PERF and DRF** (r = 0.759): External factors also impact designers' roles, particularly in terms of material availability and regulatory compliance.
✓ **PERF and ORF** (r = 0.691): Owners must also manage external factors, as they influence project timelines, costs, and overall success.

Therefore, the correlations in Table 6 demonstrates that all the constraining factors in DBB project delivery are highly interconnected. The strongest relationships are observed between CRF and PERF (0.855), DRF and ORF (0.839), DRF and DDRF (0.821), CRF and PCRF (0.815), DRF and PCRF (0.811), PCRF and PERF (0.808), DRF and CRF (0.803), PCRF and ORF (0.797), DDRF and ORF (0.793), DRF and PERF (0.759), CRF and DDRF (0.737), ORF and CRF (0.733), PCRF and DDRF (0.723). The correlation results indicate strong relationships among the factors studied, suggesting that they are closely interconnected and may collectively influence project outcomes.

Table 6 Correlations between Constraining Factors Impacting DBB Project Delivery

		PCRF (R)	DDRF	DRF	ORF	CRF	PERF
Pearson Correlation	PCRF (R)	1.000	0.723	0.811	0.797	0.815	0.808
	DDRF	0.723	1.000	0.821	0.793	0.737	0.674
	DRF	0.811	0.821	1.000	0.839	0.803	0.759
	ORF	0.797	0.793	0.839	1.000	0.733	0.691
	CRF	0.815	0.737	0.803	0.733	1.000	0.855
	PERF	0.808	0.674	0.759	0.691	0.855	1.000

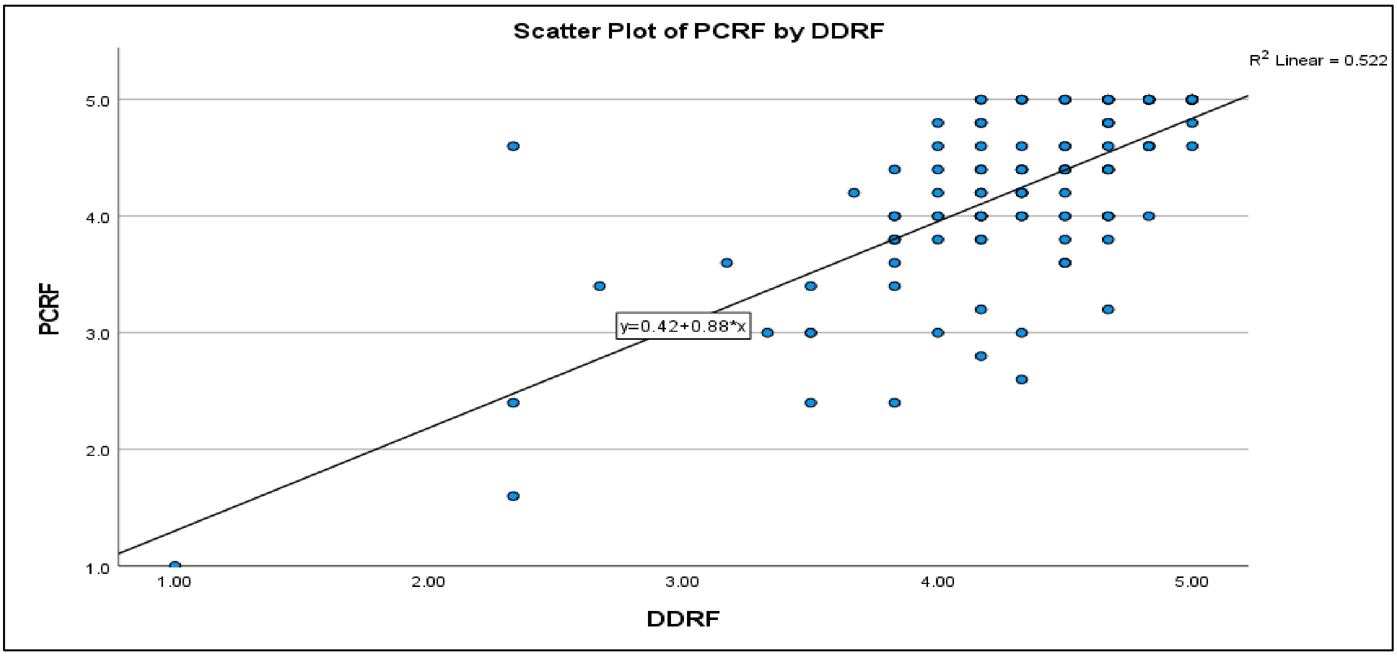

Fig 1 Scatter Plot “Project collaboration -Design Documentation related factor” Relationship

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Figure 1 illustrates a positive correlation between the variables, with data points clustering around an upward-sloping line of best fit, indicating a consistent variance (homoscedasticity). The analysis shows that 52.2% ($R^2 = 0.522$) of the variation in the dependent variable is explained by the independent variable. Table 7 further indicates a strong positive correlation (correlation coefficient = 0.723) between the dependent variable PCRF and the independent variable DDRF, with a p-value of <0.001, signifying statistical significance. This means that as DDRF increases, so does PCRF. The Design Documentation Related Factor (DDRF) ranks second in importance with a mean score of 4.2889. These findings are consistent with Agbaxode et al. (2021b) and Malinda (2017), who both highlighted the positive impact of collaboration, teamwork, and communication on improving design documentation quality

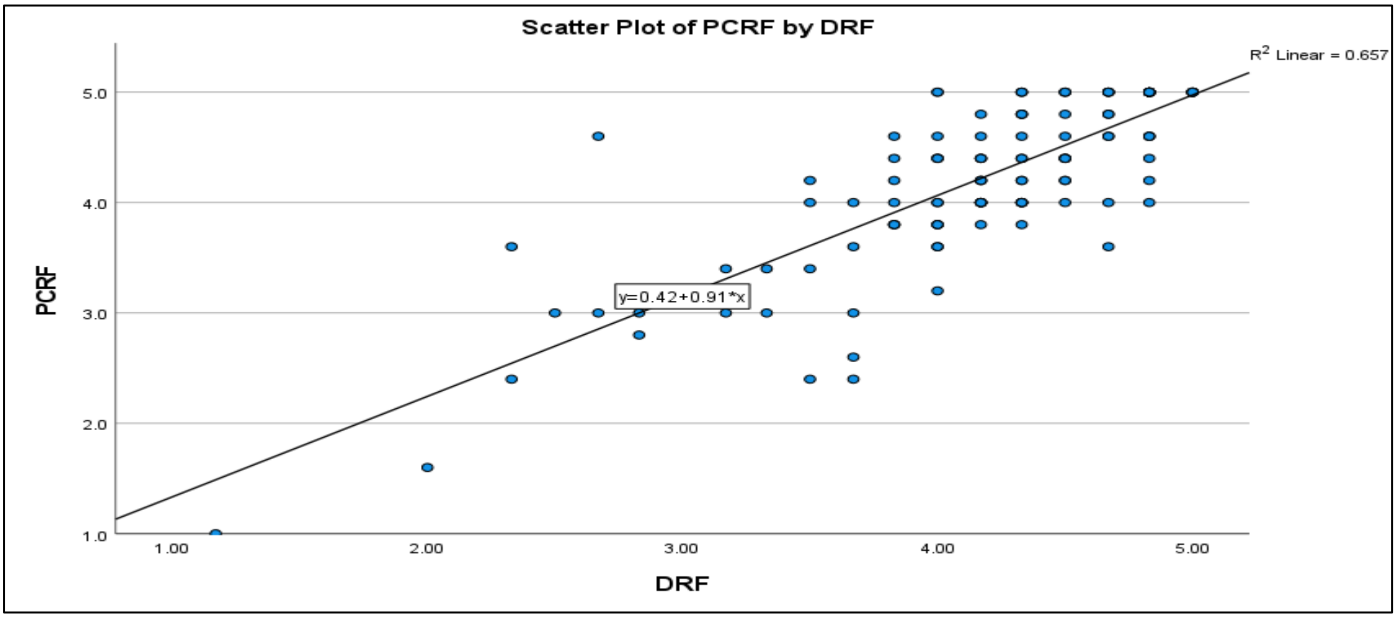

Fig 2 Scatter Plot "Project collaboration -Design related factor" Relationship.

Figure 2 shows a positive correlation between the variables, with homoscedasticity, meaning the variance remains constant along the regression line. The analysis reveals that 65.7% ($R^2 = 0.657$) of the variation in the dependent variable is explained by the independent variable, design-related factors. These factors show a strong positive relationship with project collaboration-related factors, with a correlation coefficient of 0.811 and a statistically significant p-value of <0.001, indicating that an increase in design-related factors leads to an increase in project collaboration-related factors. Ranked fourth in frequency of use, design-related factors have a mean score of 4.1595. This relationship is consistent with Fatawu's (2016) findings, which concluded that improved collaboration among stakeholders enhances design and contract documentation quality, positively impacting overall construction project performance.

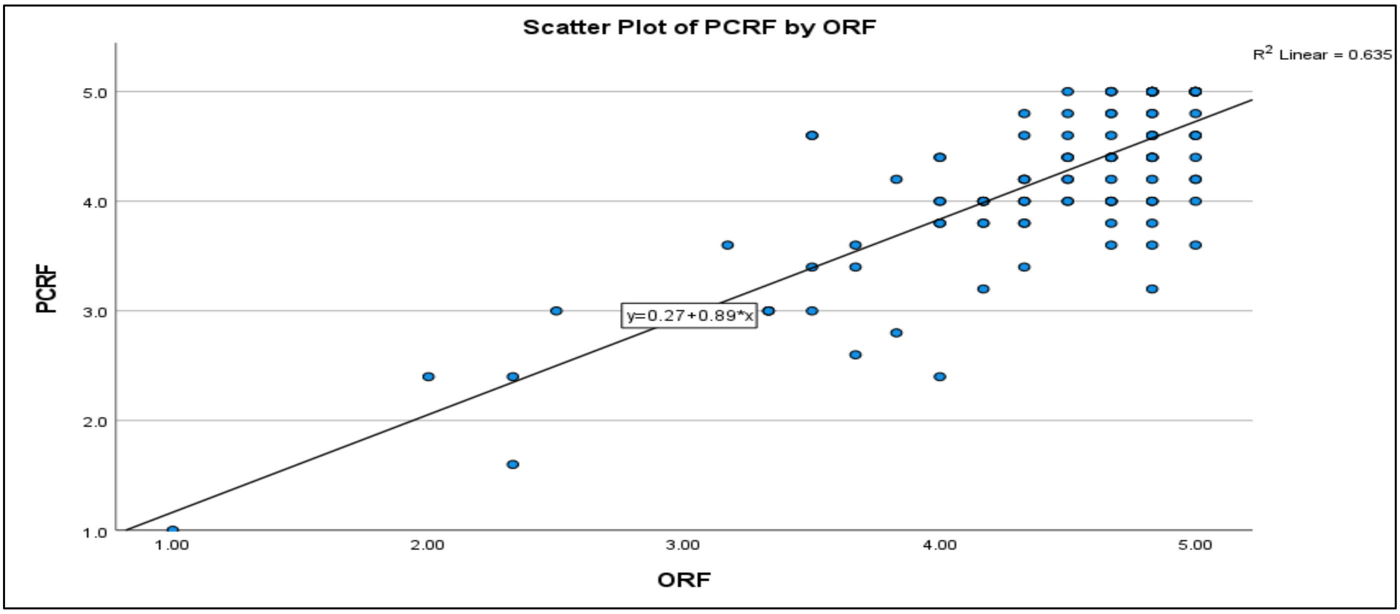

Fig 3 Scatter Plot "Project collaboration - Owner-related factors" Relationship

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Figure 3 shows a positive correlation, with data points clustering around the line of fit, which rises from the bottom left to the top right. It explains that 63.5% ($R^2 = 0.635$) of changes in the dependent variable are due to owner-related factors. These factors rank third as predictors with a strong positive relationship to project collaboration factors, showing a correlation coefficient of 0.797 and a p-value of <0.001. As owner-related factors increase, so does project collaboration. Interestingly, owner-related factors are ranked first in frequency of use with a mean score of 4.4188. Jarkas (2014) backs this, showing that better collaboration with project owners boosts overall DBB project performance.

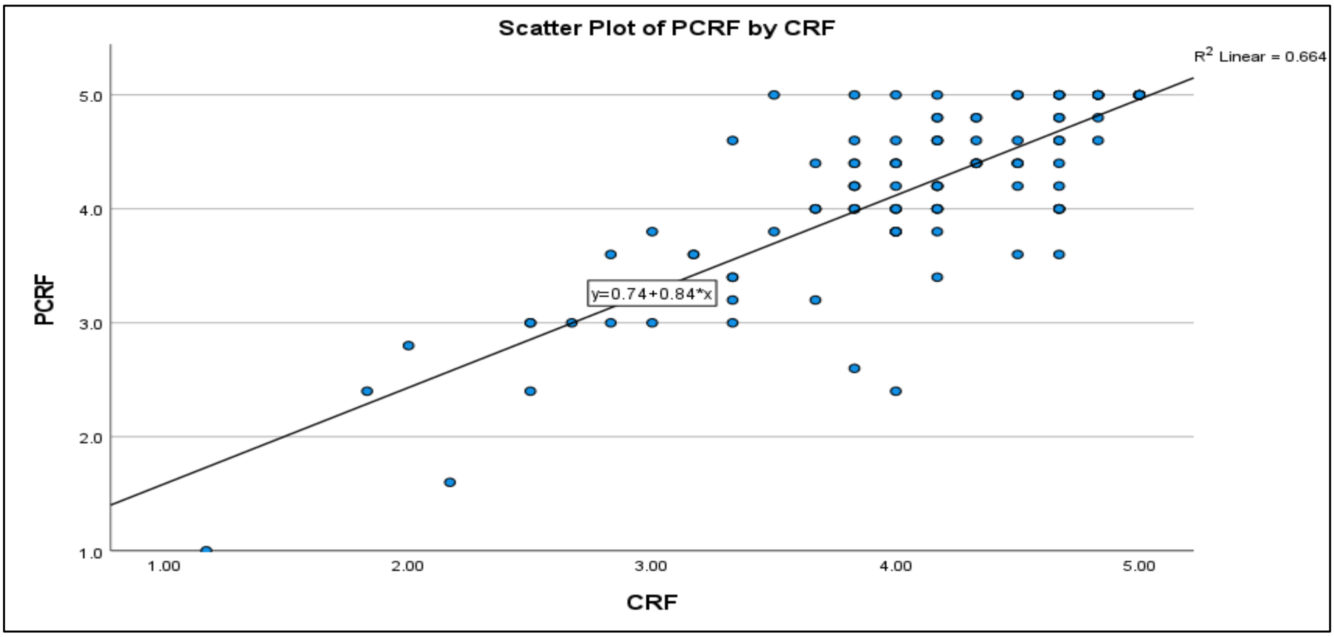

Fig 4 Scatter Plot "Project collaboration - Contractor related factors" Relationship

Figure 4 illustrates a positive correlation between contractor-related factors and the dependent variable, with data points clustered around an upward-sloping line of fit. Contractor-related factors explain 66.4% ($R^2 = 0.664$) of the changes in the dependent variable. Ranked as the fourth predictor, these factors have a strong positive relationship with project collaboration, with a correlation coefficient of 0.815 and a p-value of <0.001, indicating that an increase in contractor-related factors leads to an increase in project collaboration. Contractor-related factors are ranked fifth in frequency of use, with a mean score of 4.1077. These findings align with Lappalainen, et al. (2022) study, which highlighted that improved collaboration with contractors enhances design quality and overall DBB project performance.

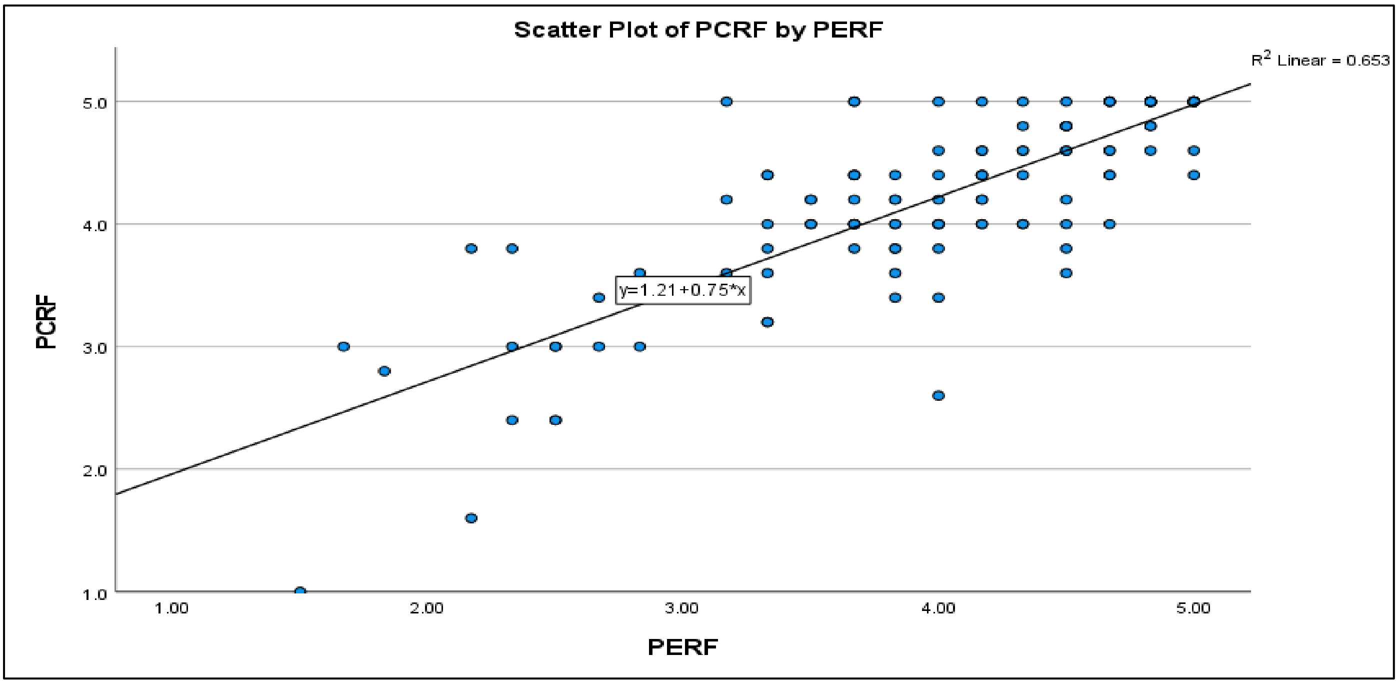

Fig 5 Scatter Plot "Project collaboration – Project external related factors" Relationship.

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Figure 5 illustrates a positive correlation between project external-related factors and the dependent variable, with data points clustering around an upward-sloping line of fit. These factors account for 65.3% ($R^2 = 0.653$) of the variation in the dependent variable. Ranked as the fifth predictor, project external-related factors have a strong positive relationship with project collaboration, with a correlation coefficient of 0.808 and a p-value of <0.001, indicating that as external-related factors increase, so does project collaboration. Despite their impact, external-related factors are ranked fifth in frequency of use, with a mean score of 4.1077. These findings are consistent with Kamaruddeen et al. (2020), who noted that external factors, such as material price fluctuations and workforce shortages, significantly affect DBB project outcomes despite being outside the project team's direct control.

V. CONCLUSIONS AND RECOMMENDATIONS

➢ *Conclusions*

The study highlights key constraining factors impacting DBB projects delivery in Tanzania and highlights their interrelationships, emphasizing the critical role of collaboration, accurate design documentation, and active consultant involvement in project success. External factors also significantly influence outcomes, underscoring the need for effective management of broader influences.

However, the research is limited by its focus on the Tanzanian context and reliance on professional perceptions, which may introduce bias. Future studies could extend these findings by exploring other regions, validating results with quantitative data, and developing predictive models to better understand the dynamic impact of these factors on DBB project performance.

➢ *Recommendations*

The strong correlation between Contractor-Related Factors (CRF) and Project External-Related Factors (PERF) highlights the significant impact of economic conditions, regulatory challenges, and supply chain disruptions on DBB project delivery. To address these risks, it is essential to enhance contractor selection and management. A strict prequalification process should be implemented, evaluating contractors based on past performance, financial stability, and their ability to handle external risks. Performance-based contracting, with incentive structures and Key Performance Indicators (KPIs), can help align contractor performance with project goals. Additionally, risk-sharing mechanisms, such as price adjustment clauses, should be included in contracts to prevent the unfair transfer of financial burdens due to external factors like inflation and regulatory delays.

The strong correlation between design-related factors (DRF) and design documentation-related factors (DDRF) indicates that poor-quality design documentation can lead to significant risks in DBB project delivery, including procurement challenges and construction delays. To strengthen design documentation quality, independent third-party reviews and peer audits should be conducted before finalizing procurement and construction contracts. Standardized design templates, aligned with national and international building codes, can help ensure consistency in drawings, specifications, and technical documentation, reducing errors and misinterpretations. Additionally, adopting digital documentation tools like Building Information Modeling (BIM) and Computer-Aided Design (CAD) can improve design accuracy, detect clashes early, and facilitate better coordination among project stakeholders. Digitizing design approvals and version control further ensures proper tracking of changes, minimizing disruptions during project execution.

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