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Ameliorating Performance of UAE Projects by Technological Collaboration of Construction Entities

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ABSTRACT

The construction industry is comprised of various entities that are a collection of different teams with varying expertise. These entities are supposed to work together on a particular project to achieve a common goal. This research investigates the association of Information Technology and the Degree of Functional Integration with the performance of Construction Projects. The United Arab Emirates is known for its Construction wonders and mega structures supported by massive investments. Therefore, the construction industry of the United Arab Emirates is selected to study the role Information Technology application in the Performance of the Construction firms when studied together with prevailing function integration norms within the organizations. The collected data is then analyzed through SPSS. It is revealed based on the regression results that Information Technology Capability and Degree of Functional Integration of including entities i.e., Owner, Contractor, and Supplier have positive effects on the performance of Construction projects. In the end findings are supported by a conceptual model that explicitly explains the Procedural levels of Concept implementation.

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1. Introduction

The construction industry is one of the largest sectors globally, especially in investments, and is considered an important sector due to its contribution to the country's development (Wilkinson, 2001). However, all this significance is accompanied by the issues of low productivity, cost overruns, time delays, and political and governmental influences (Mbachu & Taylor, 2014). Sharing information and improved decision-making in the construction industry is a fundamental need due to the fragmentation and disjointedness of project activities (Boamah et al., 2021). The accomplishments of the projects are delayed because failure to do one project activity may cause a delay in later activities of construction projects. The involvement of multiple entities, including Clients, Contractors, and Supply chain partners, put another pressure on construction communication channels with efficient transfer sharing needs. All these concerning entities need to access and validate the information regarding costs, time, and capital for effective planning.

Researchers are trying to explore ways to enhance construction productivity and find out that the integration of Information Technology tools can improve the performance of the Construction Industry by 30 % (Jelodar, Yiu, & Wilkinson, 2015). Without the use of Information Technology drawings and designs has been saved in the format of paper yet with the inclusion of IT value has been added in the areas of production, design, communication and operations of Construction Projects (Dutta, 2022). Information Technology is used for accessing, sorting, processing, and then using the information for enhanced decision-making. In the past, the use of Information Technology was majorly done for information processing. But over time, Information Technology usage was found in coordination and cooperation, thus improving the projects' performance. Yet the incorporation of Information Technology within the firms operating in the construction industry will not solve the whole problem as the adoption of Information Technology is characterized by various barriers (Chouki, Talea, Okar, & Chroqui, 2022). The varying nature of the construction industry due to the high interdependence of supply chain partners makes it more complex to manage as compared to other sectors, which leads to an increased need for better communication among organizations both within and outside the organization's boundaries. The inclusion of Functional Integration increases the flow of information and enhances the positive impacts on the performance of the firms. The objectives served by the collective use of Information Technology and Functional Integration will result in more coordinated operations of the firms. With the advancements in digitalization and global sourcing, firm’s performance is getting more sensitive about communication and collaborative operations. This enlightens the need to investigate the significant role of coordination and communication within the vibrant nature of Construction Industry.

2. Literature Review

Performance is the threshold criteria for standardizing and measuring the results of any business activity. The performance of the business or any specific project gives the foundations for decision-makers about plans and analyzes the current strategy. The performance judges the decision to continue the strategy or the need for any alteration (Green, Welsh, & Dehler, 2003). The concept of performance in the Construction industry is a topic of high significance because Construction industry performance is based on its projects' performance. These projects are vulnerable and subject to more uncertainties due to their complications (Mills, 2001). These project complications and uncertainties lead to a rise in the budget by up to 80%. It is higher than planned and requires about 20% more time to complete than the scheduled (Akintoye, 2000). It is estimated that only 2.5% of companies can complete their projects with 100% standards (Betz, 2018). Therefore, it is crucial to equip the construction industry with helpful dynamics that could help Project managers manage and improve the performance of projects they are responsible for. This paper aims to explore how Information Technology Capability coordinates with a Degree of Functional Integration of all parties, including the Owner, Contractor, and Supplier, affects the performance of the construction project.

2.1. Information Technology Capability

The current research on Information Technology renders it as a primary source of knowledge integration and Project coordination (Mehta, Jack, Bradley, & Chauhan, 2022) and controlling Construction schedules (Zhang, 2022). Yet the concept of Information Technology to improve economic developments first emerged in the 1960s by Japanese academicians. Nevertheless, the application of Information Technology capability in engineering started in the 1970s in the form of Computer-aided designs that ease the process of engineering drawings. However, this technological advancement was accessed by large engineering projects only, and medium-sized firms used this facility after the invention of Personal computers (Peansupap & Walker, 2005). Thus, the integration of Information Technology in Construction is not free from complications. These complications are caused by barriers to superseding the business strategy over the Infrastructure of Information Technology within the organization (Henderson, Venkatraman, & Oldach, 1996). Thus, it leads to the need for strategic alignment of Information Technology Capability with business processes and strategy (Luftman, 1996). This alignment aims to provide solutions to the construction fields by creating a competitive advantage. To obtain better results after implementing Information Technology infrastructure within the organization, firms need to focus on Functional Integration that will move the requirements of business process and Information Technology objectives in the same direction.

2.2. Degree of Function Integration

Functional Integration is the Degree to which different functions within the organizational boundaries coordinate and communicate with each other (Gatignon & Xuereb, 1997). This coordination and communication can include the extent of information sharing and the limit of mutual interaction among departments to achieve a common goal with the aim of reducing uncertainties (de Vries, van der Vegt, Scholten, & van Donk, 2022). This Functional Integration benefits organization by sharing information from different departments requires for robust decision making (da Silva Poberschnigg, Pimenta, & Hilletofth, 2020). The extent of Functional Integration requires for efficient operations varies from one industry to another. It is the most significant in sectors subject to more rapid changes in business processes and requires an immediate response. As the Construction industry varies highly in its patterns of project prerequisites, this makes it an area of immense Functional Integration obligation.

Furthermore, it is a domineering need of firms to be more aware of the customer's changing demands and fluctuations on towards Supplier's side so that the schedules of production and sales can be aligned (Siemieniuch, Waddell, & Sinclair, 1999). This Degree of Functional Integration is supported by establishing an Information Technology infrastructure within the organization that will facilitate and accelerate the communication and information flow between different departments (Clemons & Row, 1992).

2.3. Performance

As per the complexities of Construction, a sophisticated approach is required to deal with all phases of planning, finances, execution, and project handing over (Wang & Huang, 1994). The standard criteria for accessing the performance of construction projects are on-time delivery, cost management, establishing technical standards, and conforming to Client satisfaction criteria (Slevin & Pinto, 1986). However, the list of these performance standards is not exhaustive and can also include stakeholders' performance while understanding their involvement and expectations fulfillment (Wateridge, 1998). However, these performance indicators vary from one organization to another. Some organizations are strict in maintaining high standards and do not allow any negligence in fulfilling the preset return standards. In contrast, others may show some flexibility in project performance decisions.

The construction industry's performance is measured by a multi-dimensional approach due to the involvement of more than parties in the development of construction projects. Similarly, this multidimensionality is backed by the inclusion of different supplies and inputs for different phases of the construction projects. The performance of all stakeholders in terms of their technical and managerial achievements describes the overall performance of the construction project. While studying performance of construction terms there are often confusion about performance indicators, measures and measurement. Table 1 describes the concept of these terms that are often used alternatively.

Table 1
Scope of Performance evaluation Terms

Terms	Scope
Performance Indicators	Criteria of project success that can be measured
Performance Measure	Performance measuring indicators that can give accurate and clear results
Performance Measurement	Numerical and quantitative values of project's performance

In this paper performance of construction project is evaluated by examining the effects of Information Technology capability and Degree of Functional Integration. As point of investigation, we studied these indicators of Information Technology Capability, Degree of Functional Integration with their impact on Performance of construction projects within the boundaries of all involving parties i.e. Owner, Contractor and Supplier while Figure 1 displays the research framework.

Hypothesis H_1: Owner's Information Technology Capability and Owner's Degree of Functional Integration is associated with the Performance of Construction Project.
Hypothesis H_2: Client's Information Technology Capability and Client's Degree of Functional Integration is associated with the Performance of Construction Project.
Hypothesis H_3: Supplier's Information Technology Capability and Supplier's Degree of Functional Integration is associated with the Performance of Construction Project.

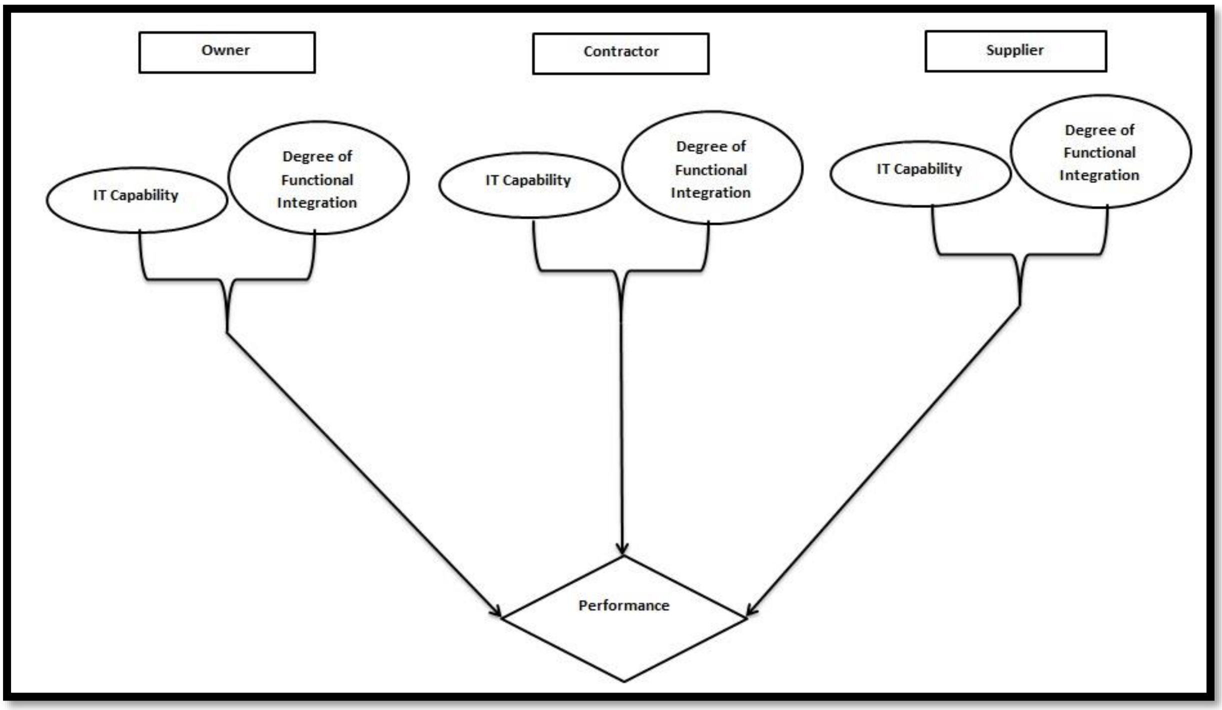

Figure 1: ***Research Framework***

3. Methodology

In order to answer questions about whether Information Technology Capability and Degree of Functional Integration have any effect on all the concerning organizations including Owner, Client, and Supplier. A multidimensional questionnaire based on 5- Point Liker scales ranging from "Strongly Disagree" to "Strongly Agree" is used to collect data.

Multiple linear regression analysis in SPSS determines the relationship between dependent and independent variables. In this research paper, Information Technology capability and Degree of Functional Integration are considered independent variables, while Performance is tested as a dependent variable. This justifies the use of multiple linear regression analysis to understand the relationship between two independent and one dependent variable.

Most of the responses are collected from professionals working on the middle and higher hierarchical levels thus naming as Expert Sampling technique. This selective approach of getting responses from individuals on a specific managerial level increases the chance of having feedback from people who have more opportunities to have a holistic view of the firm's operations. The data collected from the quantitative survey research method is then used to test the hypothesis. After carefully segregating the answers, 18 responses from the Owner, 20 from the Contractor, and 18 from the Supplier are considered final for data analysis.

4. Data Analysis

The value of R is used to represent the ability of the model to predict the dependent variable by using the values of independent variables. If the value of R=0 shows the lack of linear relation between investigative variables, and R=1 shows that the model possesses a perfect prediction of the dependent variable. The regression test for the Owner's firm represents the value of R = 0.780 in Table 2, and this is the prediction of a solid correlation between dependent and independent variables. Similar, the value of R for the Contractor's data is 0.719 shown in Table 3, and R = 0.773 in Table 4 also represents a strong positive relationship between independent (Information Technology Capability, Degree of Functional Integration) with Dependent variable (Performance) as all these values are closer to 1.

Table 2
Model summary of Owner's Firms

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.780	0.608	0.555	0.03783

Table 3
Model summary of Contractor's Firms

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.719	0.516	0.460	0.03911

Table 4
Model summary of Supplier's Firms

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.773	0.597	0.543	0.02884

The value of R^2 represents the model's goodness of fit. The value of R^2 ranges from 0% to 100%. Suppose there is a slight difference between the actual values of the dependent variable from its predicted value using the model. This case indicates that the model fits the data more accurately. If the value of R^2 tends to be below, it indicates the model's low ability to predict a specific variable. However, the value of the minimum threshold R^2 depends on the field of study, as the field of pure science requires the value of $R^2 \geq 0.60$, while for the field of Social sciences, Arts, and Humanities, $R^2 \geq 0.10$ is also acceptable. As a point of reference, we will consider the Low effect as $R^2 \leq 0.12$, the Medium effect as $0.13 \leq R^2 \leq 0.25$, and the High effect as $R^2 \geq 0.26$ (Cohen, 1992). Referring to Table 2, the value of R^2 for the Owner is 0.608. It indicates that 60.8% of performance can be predicted by Information Technology Capability and Degree of Functional Integration. Similarly, Table 3 and Table 4 indicate $R^2 = 0.516$, i.e., 51.6% for the Contractor, and $R^2 = 0.597$, i.e., 59.7 % for Supplier's firms, and all these values lie within the acceptable R^2 values for social sciences research.

Nevertheless, for the model that involves more than one independent variable Adjusted R^2 is considered a more accurate predictor for the model's fitness of data as adjusted R^2 calculates the value of R^2 by adjusting the values of those variables that are significant to the model. The value of R^2 and adjusted R^2 will remain precisely the same for the model with only one independent variable. However increase in the number of variables will ultimately increase the value of R^2, but adjusted R^2 reduces this effect of variable addition. So the Adjusted $R^2 = 0.555$ in Table 2 for the Owner, Adjusted $R^2 = 0.460$ for the Contractor firm in Table 3, and Adjusted $R^2 = 0.543$ in Table 4 for Supplier's firms indicates high effects of independent variables on the dependent variable.

Table 5
ANOVA – Owner's Firm

	Sum of Squares	df	Mean Square	F	Sig.
Regression	0.033	2	0.017	11.616	.001^b
Residual	0.021	15	0.001		
Total	0.055	17			

Furthermore, the statistical significance of regression analysis for the involved firms is presented in Table 5 for Owner's Firms, Table 6 for Contractor's Firm and Table 7 for Supplier's Firm. The value of F > 0 rejects the acceptance of the Null Hypothesis as it compares the model containing the independent variables with the model without any predicting variables. The addition of more predicting variables increases the value of F. The value of F needs to relate to the Significance p-value with a threshold value of $p \leq 0.05$ for a complete assessment of the model. Referring to Table 5 for Owner's Firms - F = 11.616 with p = 0.001, Table 6 for Contractor's Firms – F = 9.079 with p = 0.02 and Table 7 for Supplier's Firms – F = 11.115 with p = 0.01 signaled the notion that a considerable relationship exists between Information Technology Capability, Degree of Functional Integration and Performance of all respective firms.

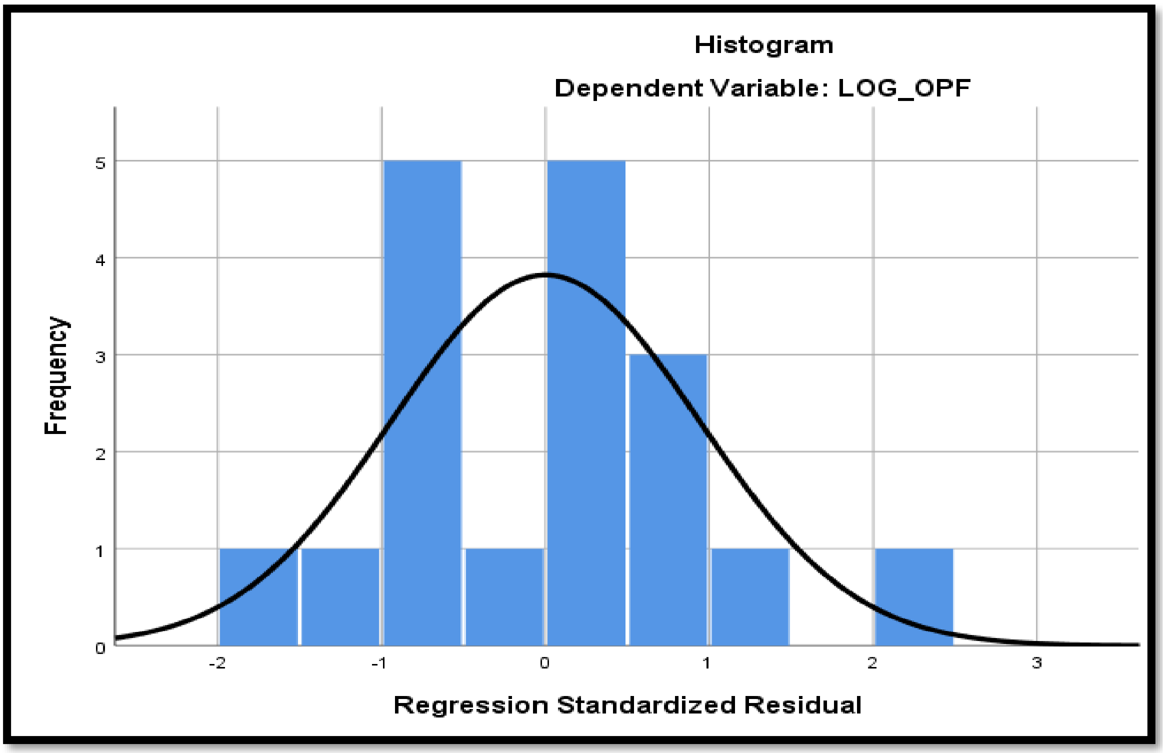

Figure 2: ***Owner's Firms data Standardized Residual Plot***

Table 6
ANOVA – Contractor's Firm

	Sum of Squares	df	Mean Square	F	Sig.
Regression	0.028	2	0.014	9.079	.002[b]
Residual	0.026	17	0.002		
Total	0.054	19			

Table 7
ANOVA – Supplier's Firm

	Sum of Squares	df	Mean Square	F	Sig.
Regression	0.018	2	0.009	11.115	.001[b]
Residual	0.012	15	0.001		
Total	0.031	17			

To get more linear regression testing, we also tested the normal probability plot of residuals. As per the assumption of the linear regression model, the error terms should be normally distributed. This assumption works on the idea that if the mean and variance of the data are normally distributed, then the plot of data of the observed percentile versus expected or theoretical percentile should be linear approximately. Based on this notion, if the average probability of the residuals is expected, we can also expect a normal distribution of error terms. Figures 2 and 3 shows the standardized residual plots for Owner firms, while Figures 4 and 5 represent Contractor Firms' data. Figures 6 and 7 show standardized residual plots for Supplier firms.

Figure 2 depicts a normal distribution of variance for Owner's firms as bell shaped histogram is evenly distributed around zero. Thus, verifying the assumptions of the model.

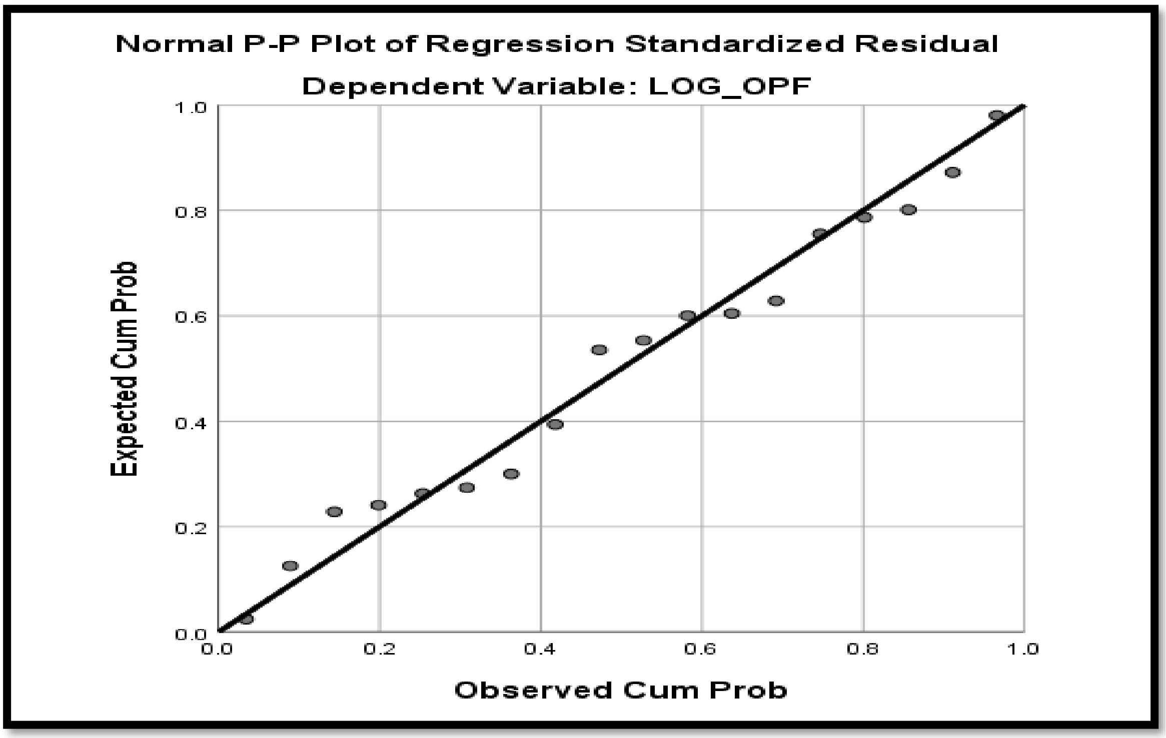

Figure 3: ***Owner's Firms data Normal P-P Plot of Standardized Residual***

This notion is supported by normal P-P Plot of standardized residuals in Figure 3 for the owner's firms data.

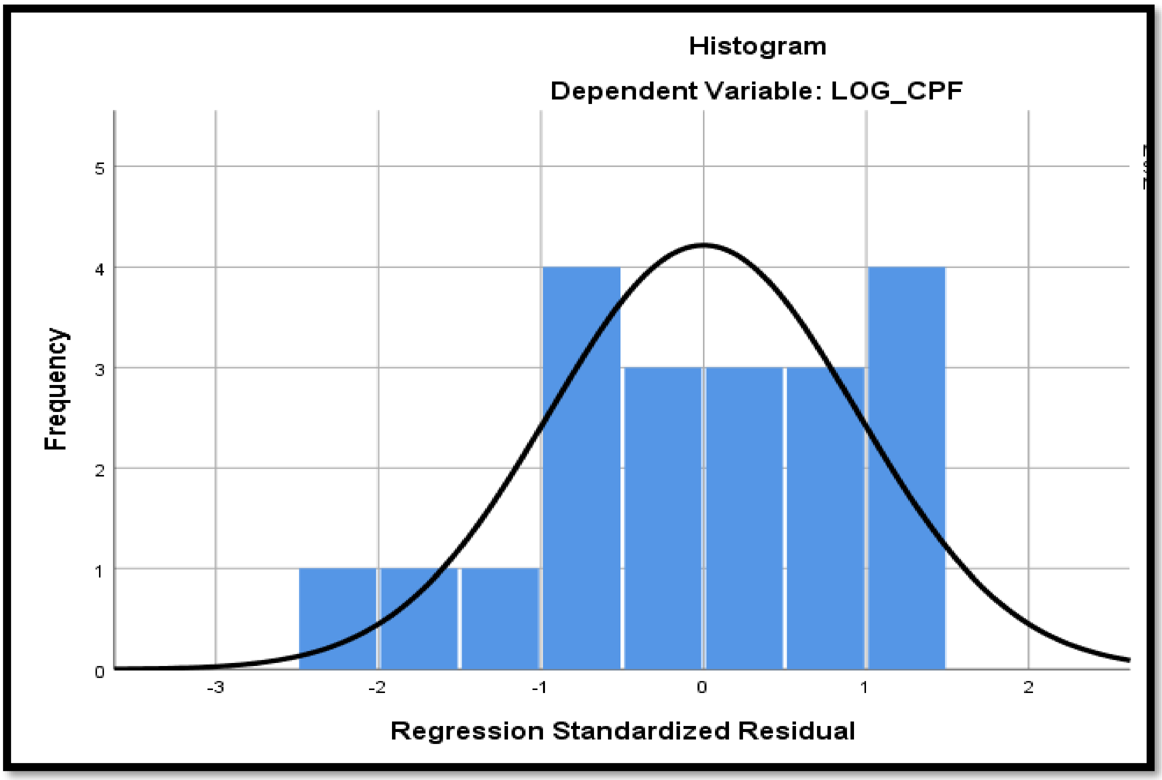

Figure 4: ***Contractor's Firms data Standardized Residual Plot***

Figure 4 for Contractor's firms' data also indicated that data is normally distributed around zero thus creating a normal bell shape around zero.

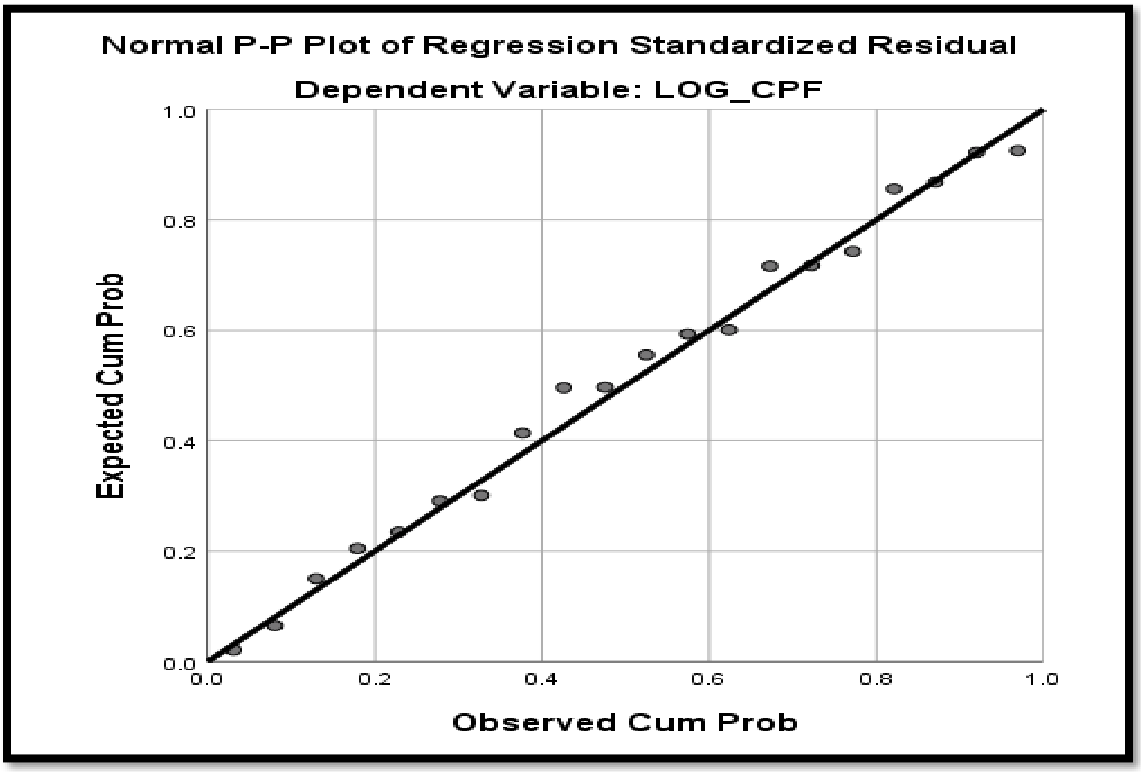

Figure 5: ***Contractor's Firms data Normal P-P Plot of Standardized Residual***

However, the data for Supplier's firms shows bit of variance that is explained below

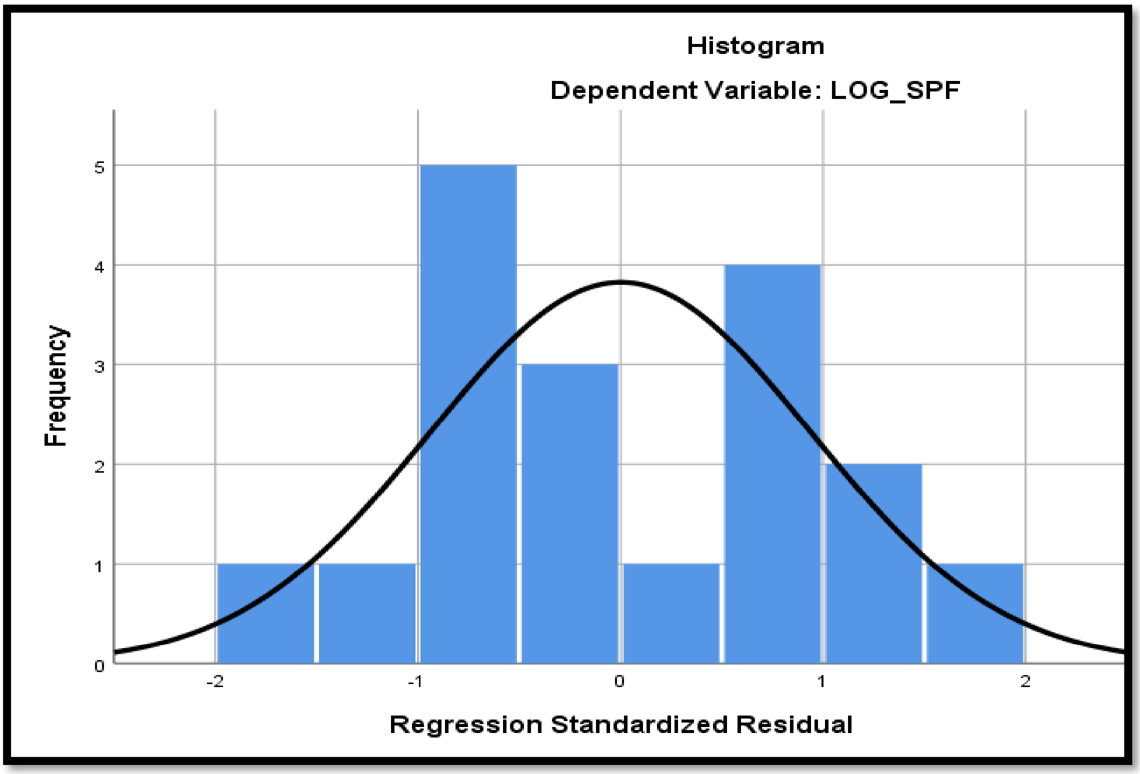

Figure 6: ***Supplier's Firms data Standardized Residual Plot***

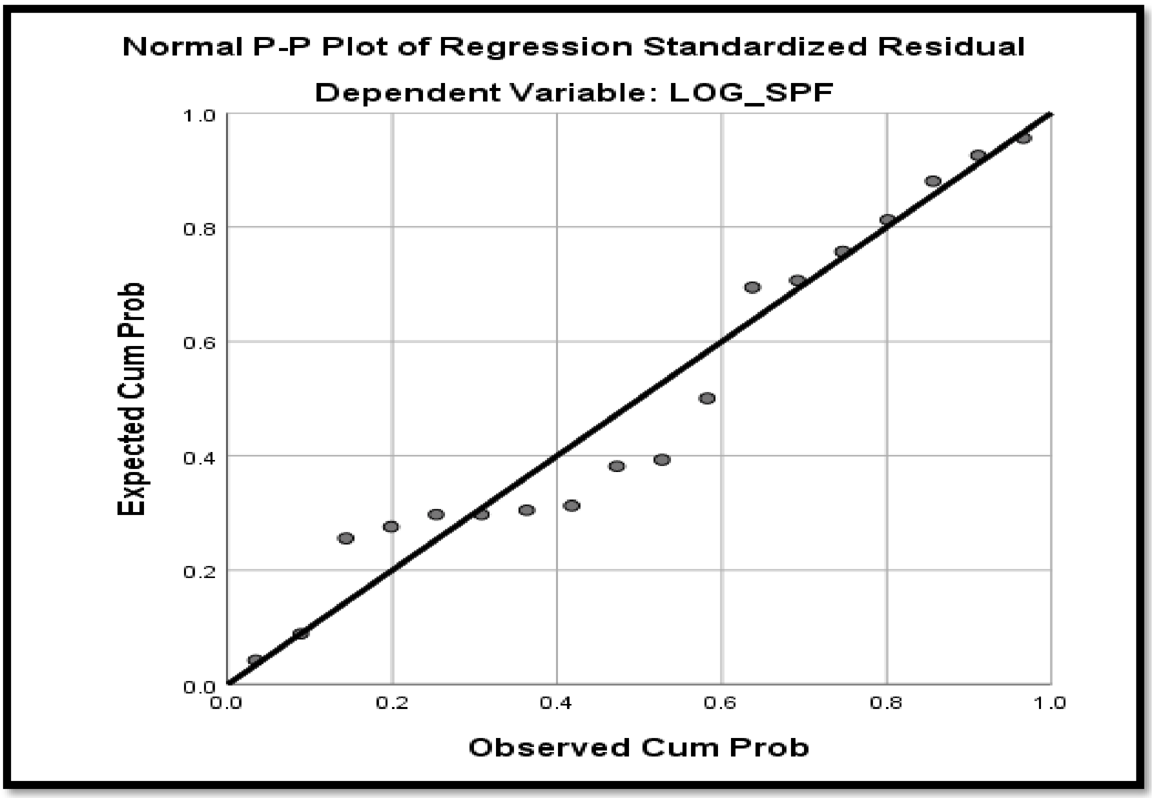

Figure 7: Supplier's Firms data Normal P-P Plot of Standardized Residual

The data for Owner's and Contractor's firms shows an approximately linear probability plot of the residuals that supports the condition that error terms are normally distributed. While the Supplier's Firms data Normal P-P Plot of Standardized Residuals is somehow skewed. It is supported by the Histogram in Figure 7, representing that the data is not perfectly regular. Nevertheless, the data skewness is not very enormous and does not support the notion of the presence of an outlier in the data. The overall presence of the data is around the linear regression line. Tables 8 summarize the results of Hypothesis testing.

Table 8:
Hypothesis testing results

Hyp.	Statement	Results
H_1	Owner's Information Technology Capability and Owner's Degree of Functional Integration is associated with the Performance of Construction Project.	Supported
H_2	Client's Information Technology Capability and Client's Degree of Functional Integration is associated with the Performance of Construction Project.	Supported
H_3	Supplier's Information Technology Capability and Supplier's Degree of Functional Integration is associated with the Performance of Construction Project.	Supported

5. Conclusion

The flow of information within the boundaries of firms and also with its outside partners is a continuous process. This flow of information is supported by the Information Technology infrastructure provided by firm's management. The more sophisticated the Information Technology applications within the firms the more accurate and timely flow of information can be made. However this communication needs to be reinforced by the extent of Functional Integration prevailing within the departments of firm. Our research indicates that establishing of Information Technology infrastructure along with the impacts of Functional Integration has positive impacts on the performance of the construction project. As various parties are involved during the Construction Project execution so we also studied these impacts in terms of Client/ Owner, Contractor and Supplier's firms. All these results indicate a positive impact on the Construction Project performance.

However, this commination and flow of information is an all-time process and keeps on rotating starting from the Project's planning, execution and delivery phase and operates on all levels of organization following conceptual model Figure 8 elaborates the roles of these variables within the construction industry.

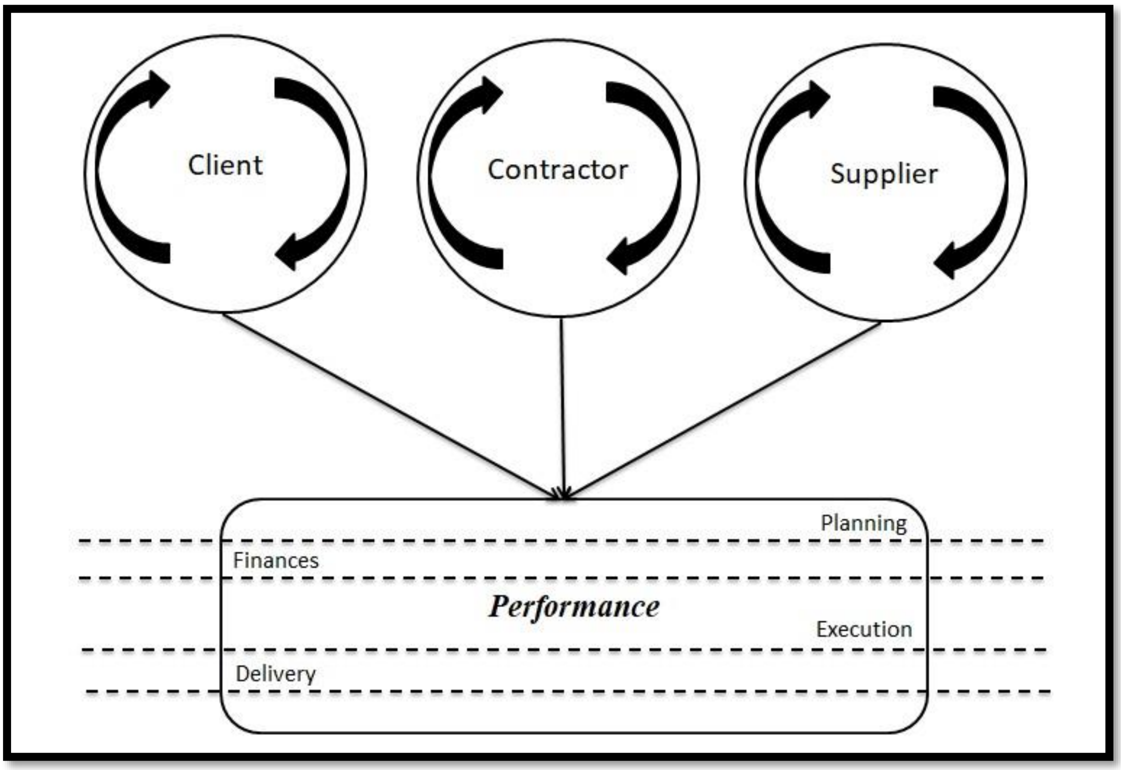

Figure 8: ***Conceptual Model of coordination for improved Project's Performance***

However, the coordination among involving parties is also essential for letting the project team know of the exact project's standards. This coordination will also help project managers to respond timely and effectively during times of crisis. Furthermore, the installation of Information Technology as per the requirements of business and projects will enable project managers to improve their performance by increasing the performance of their projects in terms of their finances, timely schedules, and technical specifications.

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