Developing and Testing an Accountability-Centered e-Procurement Implementation Assessment Model: A Case Study of the Roads and Highways Division in Bangladesh

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Abstract

The Government of Bangladesh has implemented statutory instructions outlined in the Public Procurement Act (PPA) 2006 and Public Procurement Rules (PPR) 2008 to enhance its public procurement system. Despite these efforts, manual tendering processes by public procurement agencies have faced persistent challenges. To address these issues, the Ministry of Planning introduced an electronic procurement (e-GP) system in 2011, guided by the e-Government Procurement (e-GP) Guideline 2011, as part of a transformative vision for public procurement. However, limited research has been conducted to evaluate the effectiveness of the e-GP system since its implementation. This study aims to identify critical factors influencing the successful implementation of e-procurement in Bangladesh, examine challenges associated with the system, and develop an efficient e-procurement implementation assessment model. Data were collected through survey questionnaires administered to 206 Public Entity (PE) officers across eleven zones of the Roads and Highways Division (RHD). The data were analyzed using SPSS software to construct a multiple linear regression (MLR) model and test eight hypotheses related to e-procurement implementation. Accountability emerged as one of the key factors, with its corresponding hypothesis (Ha) being accepted. The findings of this research provide valuable insights for academics, practitioners, policymakers, and researchers, contributing to the theoretical and practical understanding of e-procurement in public procurement systems. The study's novel contribution lies in the development of a theoretical framework for an e-procurement implementation assessment model, which can guide future advancements and policy-making in public procurement in Bangladesh.

Keywords: e-GP guideline 2011, e-Procurement assessment model, Hypothesis test, e-Procurement, Accountability

I. INTRODUCTION

The Central Procurement Technical Unit (CPTU) established the Public Procurement Act (2006) and Public Procurement Rules (2008) to provide a legal framework for public procurement in Bangladesh. These regulations were initially implemented through a manual tendering procedure. However, this traditional method has been criticized for its susceptibility to manipulation by vested interest groups, undermining the efficiency, transparency, and competitiveness of the procurement process. Recognizing these challenges, Bangladesh introduced the electronic government procurement (e-GP) system in 2011 under the leadership of CPTU, following recommendations from the World Bank to enhance the effectiveness and credibility of public procurement processes [1], [2]. The e-GP system is a web-based platform designed to streamline procurement processes, eliminate paper-based practices, and reduce delays, thereby creating a more transparent and secure environment [3]. Despite its widespread adoption, public procurement entities (PEs) and bidders continue to face various complications, and comprehensive evaluations of the system's impact remain limited [4], [5].

This study focuses on developing a conceptual framework for assessing the performance of the e-GP system implemented by the Roads and Highways Department (RHD). Unlike prior studies, such as Akando's investigation into the challenges and prospects of e-procurement in RHD [4], this research introduces an e-procurement implementation assessment model and examines its validity through hypothesis testing. Specifically, the study explores the relationship between accountability, as a dependent variable, and four associated independent variables. The findings aim to address the gaps in secondary data and provide actionable insights for improving the e-GP system. The primary objective of this research is to evaluate the factors influencing the adoption and performance of e-procurement systems within the RHD. By leveraging a key performance indicator (KPI)-based evaluation approach, the study seeks to identify critical obstacles and provide recommendations to improve e-tendering processes [6]. The outcomes of this study are expected to benefit policymakers, practitioners,

researchers, and other stakeholders involved in public procurement by offering a robust assessment framework for future policy enhancements.

Furthermore, this research contributes to the development of a sustainable e-procurement system by addressing gaps in existing frameworks and proposing a novel conceptual model tailored to the RHD context. This model represents a theoretical advancement, as it is the first of its kind to be developed for Bangladesh's public procurement domain. The proposed assessment framework is grounded in critical success factors (CSFs) identified through a comprehensive literature review, which highlights the importance of specific variables in achieving competitive advantages and organizational goals [7]. By integrating these CSFs into the conceptual framework, the study ensures a systematic approach to evaluating e-procurement systems and aligns its findings with global best practices in procurement management. Indeed, this research offers significant contributions to the academic and practical understanding of e-procurement systems, particularly in Bangladesh. The insights gained will support the continuous improvement of the e-GP system and ensure its alignment with international standards for efficiency, transparency, and accountability in public procurement.

II. METHOD

The study employed a survey research design to collect data on the adoption of the e-Procurement implementation model in the Roads and Highways Department (RHD) of Bangladesh. The respondents for this study were officials from the Procurement Entities (PE) within RHD. Data were gathered through visits to various RHD zone-wise PE offices, which provided substantial insights into the current practices. A total of 206 PE officials were selected as the sample size, with a stratified sampling technique used to ensure that the selection was representative of different zones within RHD. This approach was crucial in obtaining a comprehensive understanding of the perspectives of e-Procurement-related officials across the organization. To measure their responses, a structured questionnaire was designed, based on the study's objectives, incorporating a 5-point Likert scale for the quantitative data collection.

The scope of the study covered four administrative wings of the RHD, which included 11 zones, 31 circles, and 70 divisions, offering a broad view of the department's organizational structure. The population consisted of all the PE officers working in the RHD. For sampling, a multistage technique was applied, beginning with stratified sampling to ensure proper representation across the different zones of the department. From each stratum, a simple random sampling technique was then used to select the individual respondents. The data collection tool was specifically designed to meet the objectives of the study. A structured questionnaire with a 5-point Likert scale was employed to collect data on the factors influencing the adoption of the e-Procurement system. The study aimed to assess how various independent factors affected the implementation of e-Procurement models within RHD's procurement process.

For data analysis, multivariate regression was employed to examine the linear relationships between multiple independent variables and the dependent variables. This technique, widely used to predict the behavior of response variables based on changes in predictor variables, was appropriate for establishing the degree of connection between the variables. A linear equation was used to combine specific input values and predict the anticipated output for each set of inputs. The hypotheses tested in the study involved four independent variables and one dependent variable, and field data were used to validate these hypotheses. The null hypotheses were rejected, confirming that the proposed conceptual model fit the data and provided an effective framework for evaluating the success of e-Procurement implementation in RHD. Through this systematic approach, the study aimed to draw conclusions about the factors that influence the successful adoption and implementation of e-Procurement in RHD, contributing to the overall effectiveness of procurement processes within the department.

III. RESULTS AND DISCUSSION
A. Factors Influencing the Successful Implementation of e-Procurement

The following table presents a detailed overview of the dependent and independent variables explored in this study to assess the factors influencing the successful implementation of e-Procurement within the Roads and Highways Department (RHD) of Bangladesh. These variables were carefully selected based on their relevance to the procurement process, particularly with respect to enhancing accountability and achieving value for money. The dependent variables, which are the outcomes being measured, include accountability and value for money in the procurement process. These outcomes are critical to evaluating the effectiveness of e-Procurement adoption. The independent variables, on the other hand, represent factors that are hypothesized to influence these outcomes. They include the level of collaboration between procurement entities (PE) and bidders, the behavioral changes in PE officers, and the behavioral changes observed in bidders. The survey was designed to capture data from PE officers, who are directly involved in the procurement process and play a crucial role in influencing these variables. This table serves to clarify the relationship between the variables and their application in the context of the survey.

Table 1 Proposed Conceptual Assessment Model Framework

SL No	Dependent Variables	Independent Variables	Applicable for Survey
1	Accountability	1. Collaboration increased between pe and bidders 2. Pe officer's behavioural change 3. Bidders behavioural change 4. Value for money	PE Officers

Data Source: Field Survey, 2020

The Table 1 presents a detailed breakdown of the variables examined in the study, focusing on factors influencing the successful implementation of e-Procurement within the Roads and Highways Department (RHD) of Bangladesh. The study distinguishes between dependent and independent variables, which are key to understanding the impact of e-Procurement on procurement processes. The dependent variables represent the outcomes the study aims to assess and measure. These include accountability and value for money in the procurement process. Accountability is a crucial aspect of procurement, as it ensures transparency and fairness in the management of public resources, while value for money reflects the effectiveness of procurement practices in achieving cost efficiency and quality. Both variables are essential indicators of the success of the e-Procurement system in improving procurement practices within RHD.

The independent variables, on the other hand, are the factors that are hypothesized to influence these dependent variables. These include four specific elements that are thought to shape the outcomes of e-Procurement implementation. First, increased collaboration between procurement entities (PE) and bidders is a key factor. The nature of this collaboration is expected to improve communication and coordination, which could lead to more efficient procurement processes and better outcomes for all stakeholders involved. Second, the behavioral change among PE officers is an important variable. As the individuals responsible for managing procurement processes, any shifts in their attitudes, decision-making processes, or approaches to procurement, especially in response to the e-Procurement system, could significantly affect accountability and value for money.

Third, the study also considers behavioral changes among bidders. Since bidders are essential participants in the procurement process, their adaptation to the e-Procurement system is critical. Changes in their behavior, such as how they submit bids, interact with the procurement system, or adjust to new regulations and processes, could impact the overall efficiency and effectiveness of the procurement system. Finally, value for money is evaluated as both a dependent and independent variable, reflecting the ongoing concern with ensuring that public funds are used effectively and efficiently in the procurement process. This variable is particularly important because it is directly related to the economic impact of e-Procurement systems, assessing whether they help achieve cost-effective solutions without compromising quality.

The survey targeted PE officers as the respondents, as they are the primary decision-makers and implementers of procurement policies within RHD. These officers are best positioned to provide insights into the influence of the aforementioned factors on the procurement process. By gathering data from PE officers, the study aimed to understand how various elements—such as collaboration, behavioral changes, and the focus on value for money—interact and contribute to the broader goals of accountability and cost efficiency in the procurement system. The results from this survey would thus provide valuable information on the effectiveness of the e-Procurement system and offer potential recommendations for further improvement in procurement practices.

B. Challenges and Development of an Efficient E-Procurement Model
1. Test on Accountability

Table 2 presents the statistical summary of the responses provided by the PE officers surveyed in the study. The table includes the mean scores, standard deviations, and sample size (N = 206) for each of the key variables examined. These variables include accountability ensured, collaboration between PE and bidders, behavioral changes in PE officers, observed behavioral changes in bidders, and value for money. The mean scores reflect the overall level of agreement or perception regarding each variable, while the standard deviations indicate the variability in responses among the respondents. This data, collected through a field survey conducted in 2020, provides a quantitative basis for analyzing the impact of various factors on the effectiveness of e-Procurement in the Roads and Highways Department.

Table 2 PE Officers' Respondents' Statistics

	Mean	Std. Deviation	N
Accountability Ensured	4.02	.677	206
Collaboration Between PE and Bidders	3.86	.585	206
PE Officers Behavioral Changes	4.10	.532	206
Observed of Bidders Behave Changes	3.94	.585	206
Value for Money	3.65	.709	206

Data Source: Field Survey, 2020

The data in Table 2 presents the results of a field survey conducted in 2020, focusing on the perspectives of Public Procurement Officers (PE Officers) regarding key elements of procurement activities. The table includes statistics such as means, standard deviations, and sample sizes for five critical factors: accountability ensured, collaboration between PE and bidders, PE officers' behavioral changes, observed changes in bidders' behavior, and value for money. Each of these factors was measured using a Likert scale, which helps in quantifying respondents' attitudes and perceptions. The first factor, "Accountability Ensured," had a mean score of 4.02 with a standard deviation of 0.677, indicating that respondents generally agreed that accountability was maintained during procurement processes. This suggests that most PE Officers believe the mechanisms in place are effective in holding stakeholders accountable for their actions. The relatively low standard deviation suggests that responses were fairly consistent among the 206 respondents, reflecting a shared understanding or experience regarding accountability in public procurement. Previous studies have underscored the importance of accountability in ensuring transparency and trust in procurement systems [8].

The second factor, "Collaboration Between PE and Bidders," recorded a mean of 3.86 and a standard deviation of 0.585, indicating a slightly lower level of agreement than accountability. This finding suggests that while collaboration between procurement officers and bidders is generally seen as positive, it might not be as robust or consistent. Effective collaboration is crucial for ensuring fair competition and preventing corruption [9], and the result may reflect varying levels of cooperation based on different procurement contexts or the complexity of the bidding process [10]. In terms of "PE Officers' Behavioral Changes," the mean score of 4.10 with a standard deviation of 0.532 indicates a positive shift in attitudes or practices among procurement officers. This suggests that PE Officers have adapted to new procurement processes or policies, with the low standard deviation reflecting a relatively uniform response among the officers. Behavioral changes among procurement officers are often linked to training, policy reforms, and increased awareness of ethical standards [11]. Such changes can enhance the efficiency and integrity of procurement practices, contributing to better outcomes in public procurement [12].

The "Observed Changes in Bidders' Behavior" recorded a mean of 3.94 with a standard deviation of 0.585, which aligns with the previous findings, suggesting that bidders' behaviors have also been influenced by changes in procurement practices. This might indicate that bidders are adapting to new expectations or becoming more transparent and ethical in their dealings with public procurement entities. These findings are in line with research suggesting that procurement reforms can lead to improvements in bidder conduct, including increased compliance and competition [13]. Lastly, the factor "Value for Money" had the lowest mean score of 3.65, with a standard deviation of 0.709, suggesting that while there is general agreement about the importance of value for money, it may not always be fully realized in practice. This could be due to the challenges of balancing cost efficiency with quality and service delivery [14].

2. Model Summary of Correlation by Accountability

The following table 3 presents the model summary of the correlation by accountability, providing a statistical overview of how accountability relates to other variables in the study. The summary includes key metrics such as the correlation coefficient (R), R square value, adjusted R square value, and standard error of the estimate. Additionally, the table outlines change statistics, including the R square change, F change, degrees of freedom (df1 and df2), and the significance of the F change (Sig. F Change). These values collectively demonstrate the strength and significance of the correlation between accountability and the factors under consideration, offering insights into how well accountability explains the variations in the observed outcomes. The results will inform the understanding of the role accountability plays in shaping the dynamics of procurement processes.

Table 3 Model Summary of Correlation by Accountability

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.556[a]	.309	.295	.568	.309	22.454	4	201	.000

Predictors: (Constant), Value for Money, Collaboration Between PE and Bidders, Observed of Bidders Behave Changes, PE Officers Behavioral Changes

Data Source: Field Survey, 2020

The data in Table 3 presents a model summary of the correlation analysis regarding accountability in a certain context, based on a field survey conducted in 2020. The model includes four predictors: Value for Money, Collaboration Between Public Entities (PE) and Bidders, Observed Changes in Bidder Behavior, and Changes in the Behavior of PE Officers. The table shows the relationship between these predictors and the dependent variable, represented by the correlation coefficient (R), R Square, Adjusted R Square, and the Standard Error of the Estimate. The model aims to predict the variance in accountability and explain how these predictors contribute to it. First, the correlation coefficient (R) is 0.556, which indicates a moderate positive correlation between the predictors and the outcome variable. This suggests that the selected predictors explain a significant portion of the variability in accountability, with a moderate strength of relationship. The R Square value of 0.309 indicates that approximately 31% of the variation in accountability can be explained by the predictors included in the model. This level of explanatory power is significant, as it shows a meaningful connection between the identified predictors and accountability. In practical terms, this means that the variables considered in the study contribute to a third of the outcome [15].

The Adjusted R Square value of 0.295 is slightly lower than the R Square value, which is expected due to the inclusion of multiple predictors. The Adjusted R Square accounts for the number of predictors in the model, providing a more accurate measure of the model's fit to the data. It adjusts the R Square value to reflect the degree to which the predictors are genuinely contributing to explaining the variance in the dependent variable. This indicates that while the model accounts for nearly 30% of the variance, the contribution of each predictor is carefully balanced to avoid overfitting [16]. Additionally, the Standard Error of the Estimate is 0.568, which provides an indication of the average distance between the observed values and the predicted values. A lower standard error suggests that the model's predictions are relatively close to the actual data, increasing the model's reliability. The significance of the model is confirmed by the F-change statistic of 22.454 with an associated p-value (Sig. F Change) of 0.000, which is less than the typical alpha level of 0.05. This shows that the model is statistically significant and that the predictors have a meaningful impact on the outcome, providing a robust basis for further analysis and interpretation [17], [18], [19].

3. ANOVA Results for Accountability Ensured Model

Table 4 presents the results of a regression fit test (ANOVA) used to assess the relationship between various predictors and the dependent variable "Accountability Ensured." The predictors in this model include Value for Money, Collaboration Between Public Entities (PE) and Bidders, Observed Changes in Bidder Behavior, and Changes in the Behavior of PE Officers. The data, collected from a field survey conducted in 2020, highlights the overall fit of the regression model and examines how much of the variation in accountability is explained by these predictors. The results show a statistically significant relationship between the predictors and accountability, as indicated by the F-statistic of 22.454 and a p-value of 0.000.

Table 4 Regression Fit Test (ANOVA) by Accountability

	Model	Sum of Squares	df	Mean Square	F	Sig.
	Regression	29.007	4	7.252	22.454	.000[b]
1	Residual	64.915	201	.323		
	Total	**93.922**	**205**			

a. Dependent Variable: Accountability Ensured

b. Predictors: (Constant), Value for Money, Collaboration Between PE and Bidders, Observed of Bidders Behave Changes, PE Officers Behavioral Changes

Data Source: Field Survey, 2020

The data in Table 4 presents the results of a regression fit test (ANOVA) to assess the factors influencing accountability, specifically the variable Accountability Ensured. The regression model includes four predictors: Value for Money, Collaboration Between PE (Procurement Entities) and Bidders, Observed Bidders' Behavior Changes, and PE Officers' Behavioral Changes. The total sum of squares (SS) is 93.922, with the regression component explaining 29.007 and the residual component accounting for the remaining 64.915. This suggests that the model effectively captures a portion of the variability in the dependent variable, Accountability Ensured.

The degrees of freedom (df) for the regression are 4, corresponding to the number of predictors in the model, and the residual degrees of freedom are 201, based on the total sample size of 206. The mean square values are calculated by dividing the sum of squares by their respective degrees of freedom. For the regression, the mean square is 7.252 (29.007/4), while for the residuals, it is 0.323 (64.915/201). These values serve as inputs for the F-statistic calculation, which is 22.454. This F-value is an indicator of how well the predictors explain the variability in the dependent variable relative to unexplained variability.

The F-statistic is compared to a critical value, and in this case, the result is highly significant ($p = 0.000$), as indicated by the significance level (Sig.) of 0.000, which is below the standard threshold of 0.05. This suggests that the model as a whole is statistically significant and that the predictors have a meaningful relationship with Accountability Ensured. The significance of the predictors indicates that changes in the observed behaviors of bidders and procurement officers, as well as collaboration between public entities and bidders, contribute significantly to accountability outcomes in procurement practices.

This regression model provides valuable insight into the factors that influence accountability in public procurement processes. The significant F-test supports the notion that the predictors, namely Value for Money, Collaboration Between PE and Bidders, Observed Bidders' Behavior Changes, and PE Officers' Behavioral Changes, explain a substantial proportion of the variation in accountability. This finding aligns with existing literature on the importance of stakeholder engagement and behavioral changes in ensuring transparency and accountability in procurement processes. Studies have shown that fostering collaboration between procurement entities and bidders can improve both the efficiency and accountability of procurement practices (e.g., [20], [21], [22], [23], [24]). Additionally, the behavioral changes of officers and bidders, such as adherence to ethical standards, play a crucial role in strengthening accountability mechanisms (e.g., [25], [26], [27], [28]). Indeed, by observing the regression row and Sig value 0.000, the regression model predicts the dependent variable *accountability* significantly well. Here, sig=.000, which is less than the p-value. So, overall, the regression model is significant and statistically fit. Considering ANOVA Table 4 for the F test and sig value- F=22.454 and sig=.000, i.e. p<.05 hence H_o is rejected.

The correlation analysis yielded a value of 55.6% (R), indicating a moderate correlation coefficient, as classified by Evans (1996). This suggests a moderate relationship between the variables under investigation. The R² value further reveals that the dependent variable, 'accountability,' is explained by 30.9% of the variance in the four independent variables. To assess the fit of the regression model, an ANOVA test was conducted, and the significance (sig) value was found to be 0.00, which is less than the standard p-value threshold. As a result, the alternative hypothesis (Ha) is accepted, confirming that the regression model is statistically significant and appropriate for the data. The test results underscore the importance of accountability as a critical component in the effective evaluation of e-Procurement implementation. The findings provide strong evidence supporting the proposed conceptual framework for assessing accountability within the e-Procurement model. This confirms that the framework is both viable and acceptable for use in evaluating e-Procurement processes.

IV. CONCLUSION

This study provides valuable insights into the successful implementation of e-Procurement within the Roads and Highways Department (RHD) of Bangladesh. Key factors influencing procurement outcomes, such as accountability and value for money, are identified, with a focus on the importance of collaboration between procurement entities (PE) and bidders, along with behavioral changes among both PE officers and bidders. These elements contribute significantly to improving accountability and ensuring transparency in procurement processes. The survey data reveals strong agreement on accountability's importance, while highlighting the need for enhanced collaboration and behavioral adjustments. The regression analysis and ANOVA tests confirm the statistical significance of the proposed model for assessing accountability in e-Procurement. The predictors— value for money, collaboration, and behavioral changes—account for a significant portion of accountability variance, with a strong correlation between these factors and procurement effectiveness. The model's F-statistic of 22.454 and p-value of 0.000 further validate the conceptual framework, underscoring the need for continuous development of e-Procurement systems to enhance efficiency, transparency, and value for money in public procurement.study's conceptual model and underscore the need for continuous development in e-Procurement systems to achieve higher efficiency, transparency, and value for money in public procurement.

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