Enablers and barriers of Adopting BI-tool for data analytics in Large Enterprises of Bangladesh

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Abstract. The objective of this research is to examine the factors that facilitate or hinder the incorporation of Business Intelligence (BI) tools for data analysis and decision-making in enterprises in Bangladesh, using an adapted TOE framework. A quantitative methodology was used, consisting of a purposive survey conducted on 290 individuals who had experience in BI-Applications for the purpose of analytics. 191 valid survey responses were collected and analyzed using PLS-SEM. A conceptual framework consisting of 8 first order reflective constructs and 3 second order constructs were developed to examine the hypotheses, which portrays the main reflective elements as a set of variables that serve as reflective indicators for second-order constructs, encompassing technical, organizational, and environmental factors. The reported data indicated that factors such as relative advantage, compatibility, simplicity, top management support, organizational fit, competitive pressure, and vendor support have a substantial effect on the adoption of BI tools

1 Introduction

Business Intelligence (BI) solutions are crucial for big firms since they allow organizations to convert extensive data into practical insights, enabling informed decision-making and strategic planning. By using BI solutions for data analytics, enterprises in Bangladesh can enhance their operational efficiency, uncover market trends, and eventually stimulate corporate development which result in enhanced performance metrics and a competitive edge [1]. Numerous academic studies have been undertaken on the utilization of business intelligence tools for tasks such as data integration and management, performance monitoring, decision support, reporting, and visualization [2]. However, there have been limited number of studies undertaken to comprehend the obstacles that hinder the adoption of business intelligence tools exclusively for data analytics purposes, both in the realm of regular data analytics and big data analytics, inside large organizations of digitally divided country such as Bangladesh [3]. This study aims to address the identified gap by examining the relationships between the dimensions of the TOE framework in the adoption of business intelligence (BI) tools for data analytics. It will evaluate both the factors that facilitate and hinder BI integration within the context of organizational readiness. This gap is particularly

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pronounced in understanding how organizations navigate the interplay between technology availability, organizational readiness, and external environmental pressures to integrate BI tools effectively. In pursuit of understanding the integration of dedicated BI-Applications within various organizational contexts for data analytics purpose, this study is designed to address a comprehensive question that encapsulates the multifaceted nature of technology adoption. The research question is formulated to reflect the overarching goal of the research, ensuring that it aligns with the specified objectives and expected outcomes.
RQ: What are the factors that influence the adoption of BI tools in major companies in Bangladesh, and how do these factors interact to either support or hinder the integration of BI tools for data analytics and decision-making?

2 Literature Review and Hypothesis development

TOE framework is frequently utilized to assess the adoption and integration of technology like BI tools for business analytics which considers three aspects - technological readiness, organizational alignment, and environmental factors, which collectively influence technology adoption decisions of organizations. According to prior qualitative research using the TOE framework, it was shown that perceived advantages, organizational data environment, technical assets, and competitive pressure are the primary variables influencing the adoption of business analytics in Indian organizations[4]. An empirical research conducted with Korean firms revealed that constructs from TOE framework are connected with various stages of business analytics adoption, including initialization, utilization, and integration [5]. A comprehensive literature analysis examined the variables influencing the adoption of business analytics in organizations operating in a data-driven business environment. The review analyzed 29 papers and identified key aspects that contribute to the adoption process [6].

Table 1. Significant BI-Tools for Data Analytics TOE factor

Construct	Measuring variable	Ref	Construct	Measuring variable	Ref
Relative Advantage	Perceived Benefit Assessment, Performance Metrics	[7,8]	Organizational fit	Alignment Assessment, Employee Feedback, Organizational structure	[4,5]
Simplicity	Ease of Use, Training Requirements, Complexity	[9,10]	Competitive Pressure	Peer group pressure, Industry pressure, Government pressure	[10,11]
Compatibility	System Integration, Cultural fit	[4,6]	Top management support	Leadership Engagement, Resource Allocation	[12,13]
Vendor support	Vendor Response Time, Vendor Knowledge Base, Training and Support, After-Sales Support, Vendor Customization, and Integration				[4,14]

BI-tools are increasingly pivotal in the strategic operations of organizations, providing crucial data insights and decision-making capabilities Prior studies, specifically look at the effects of technological characteristics like "complexity," "compatibility," and "relative advantage" because these are often emphasized in the tech-adoption models [15]. These features in the context of BI technologies have been extensively studied and believe they significantly influence adoption decisions [9]. Hence, the study proposes the hypothesis that,

Hypothesis 1. (H1): Technological dimensions have positive influence on the actual use of BI-Tools for data analytics.

The utilization of technology in the business sector in Bangladesh is primarily driven by the concept of relative advantage [7]. The concept of "relative advantage" is widely discussed in previous investigations on the implementation of BI-technologies in the business context. Multiple studies have found that the primary element influencing the effective implementation of BI- tools in decision-support systems for small, medium, and big organizations is the relative advantage [8]. This study proposes that the "Relative advantages" derived from a technological perspective are essential for the adoption of BI-tools. These advantages determine the benefits that BI provides compared to traditional analytics methods, influencing organizations' decisions to implement BI solutions. Therefore, the study proposes that:

Hypothesis 1a. (H1a): Relative advantages of BI-tools from technological dimensions have positive impact on the actual use of BI-Tools for data analytics.

The easiness of using technology, often referred to as simplicity, is typically assessed in relation to its complexity, which significantly influences how quickly an innovation is adopted. Under the technological dimension, perception of complexity plays crucial role in BI innovations' adoption [9], since the perception of simplicity effects adoption stages in a positive way [10]. Based on the aforementioned recommendations the hypothesis The study proposed is:

Hypothesis 1b. (H1b): Perception of simplicity of BI-tools from technological dimensions have positive impact on the actual use of BI-Tools for data analytics.

The extent to which consistency between organizational needs and business tools used for data analytics determines the degree of compatibility that significantly impacts organizations' decisions to adopt new technologies [4]. Successful BA adoption depends on the compatibility of business analytics tools with an organization's existing systems and infrastructure [6]. Hence, the study hypothesizes that:

Hypothesis 1c. (H1c): Compatibility of BI-tools from technological dimensions have positive impact on the actual use of BI-Tools for data analytics.

Previous research has shown that the organizational mechanisms are of utmost importance [9], as it could impede the adoption of business intelligence (BI) technologies for data analytics via unwillingness to change and a lack of a culture that prioritizes data-centric decision-making [16]. The study has considered two organizational factors that are important for BI adoption: top management support, organizational fit, and firm size. Hence, the study has proposed that:

Hypothesis 2. (H2): Organizational dimensions have a positive impact on the actual use of BI-Tools for data analytics.

Managers of business and technology who rely on BI technologies have recognized the organizational benefit of using BI tools [12] whereas some senior managers in the textile industry remain unaware of the indispensable role that modern BI solutions play in a competitive global market increasingly challenged by sustainability issues [13]. Based on these insights, this study hypothesizes that:

Hypothesis 2a. (H2a): Top management support from organizational dimensions has positive impact on the actual use of BI-Tools for data analytics.

The firm's characteristics and resources, including its size, level of centralization, degree of formalization, leadership framework, human resources, and employee connections, are encompassed by the organizational variable [4]. Once BI technologies for analytics are properly integrated with organization's processes need to facilitate analytics experts group to ensure impressive progression of adoption [5]. So, the proposed hypothesis is:

Hypothesis 2. (H2c): Organizational fit from organizational dimensions have positive impact on the actual use of BI-Tools for data analytics.

This study determines to examine two strategic factors within the environmental setting: competitive pressure and vendor support. They are recognized as essential factors that enable effective BA adoption [6]. Though competitive intensity generally effects BI adoption in initial stages, quality of vendor support can be handy to extrapolate the tenure of assimilation stage [5]. Therefore, the proposed hypothesis is:

Hypothesis 3. (H3): Environmental dimensions have a positive impact on the actual use of BI-Tools for data analytics.

Competitive pressure can act as an enabler for BI tool integration within organizations [11], since businesses are more likely to adopt BI systems when confronted with intense market competition [10]. Therefore, businesses are more inclined to use BI if they feel pressure from competitors and think their competitors are using BI tools [14]. Hence, the hypothesis the study proposed:

Hypothesis 3a. (H3a): Competitive Pressure from environmental dimensions has positive impact on the actual use of BI-Tools for data analytics.

The importance of vendor support which can come directly from the vendor or through consultants has been a well-established topic in technology adoption [14]. Several studies focusing on BI (BI) tools highlight a positive correlation between expertise of vendor and successful adoption [4,14]. Organizations recognize the need for ongoing assistance and feel more comfortable during the adoption process if they have positive rapport with the vendor. Hence, the hypothesis this study proposed:

Hypothesis 3b. (H3b): Vendor Support from environmental dimensions has positive impact on the actual use of BI-Tools for data analytics.

2.1 Presenting the conceptual model:

The study employed Structural Equation Modeling (SEM) rather than Structural Causal Models (SCM) to examine the variables that impact the adoption of business intelligence technologies in major companies in Bangladesh. SEM was chosen because it enables the simultaneous analysis of multiple relationships among latent variables, offering a thorough comprehension of the delicate connection between these components within the TOE-framework. On the other hand, SCM may need more stringent assumptions about causal links, which may be difficult to verify in complex organizational settings. This might restrict its ability to accurately capture the intricate dynamics of BI tool adoption. The literature review and qualitative research helped this study to suggest a structural model as well as a hierarchical one. The third-order reflective model represents the hierarchical model, while the third-order construct is the actual application of BI- tools. These three second-order notions reflect this framework: technical factors, organizational factors, and environmental variables. The proposed second-order structural model for studying BI tool adoption integrates various factors influencing this process. At the foundational level, specific attributes like Relative Advantage, Simplicity, and Compatibility (Technological Factors); Top Management Support and Organizational Fit (Organizational Factors); Competitive Pressure, and Vendor Support (Environmental Factors) are mapped to their respective second-order constructs. Technological Readiness, Organizational Alignment, and External Environment encapsulate the aggregated effects of the first-order factors, providing a more extensive perspective of their influence on the actual use of BI tools in organizations.

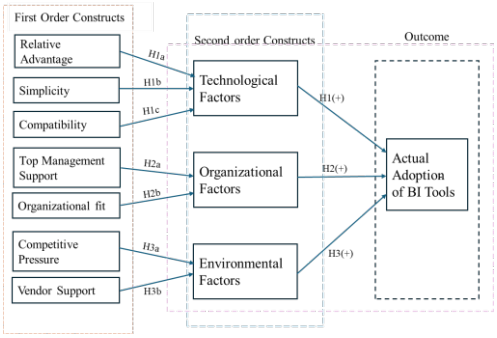

Fig. 1. Conceptual model with second order reflective Constructs (Authors' Creation).

3 Research Methodology

This study adopted a theoretical framework called TOE framework to hypothesize the relationships between the factors influencing BI tool integration and tests these hypotheses through empirical data collected via questionnaires. This approach allows for a structured investigation of pre-identified factors and the measurement of their impact on BI tool integration outcomes. The population for this study consists of professionals in business roles who have familiarity and involvement with BI tool implementation and use within their organizations. These professionals are ideally positioned to provide insights into both the technical and organizational dimensions of BI tool integration. The research specifically chose knowledge worker employees of different nationalities using "purposive sampling" from different departments and roles inside large enterprises in Bangladesh. The study only chooses personnel who have knowledge and understanding of data analytics, decision support systems, and BI concepts, tools, and technologies. Purposive sampling is the best approach as it enables researchers to intentionally choose participants who possess pertinent expertise and perspectives, guaranteeing the acquisition of comprehensive and enlightening data that directly pertains to the study goals. This focused approach improves the comprehensiveness of knowledge about the intricate interplay of variables in facilitating or impeding the integration of BI tools, a level of understanding that cannot be attained using random sampling techniques. We have emailed link of survey to 450 professionals, out of 290 responses were received, yielding a response rate of approximately 65.86%. After data cleaning and ensuring the completeness of responses, 191 valid responses from professionals who are working in ten different organizations were retained for analysis. Before full deployment, the questionnaire undergoes a content validation process with 5 expert interviews and a pilot test with 50 participants from a smaller subset of the target population. Partial Least Squares (PLS) route modelling is applied for data analysis which is an appropriate choice for this study due to its ability to effectively manage the intricate connections statistically between the higher-order constructs of the TOE framework. This allows researchers to investigate how TOE factors interact and impact the adoption of BI tools. Additionally, Smart-PLS can accommodate the study's anticipated small sample size and non-normal data distribution. A total of 24 indicators were used to measure the constructs, providing a comprehensive analysis of the factors influencing BI tool adoption. The fit of the model is assessed using goodness-of-fit indices, and adjustments are made based on the findings to refine the theoretical framework and enhance its applicability and accuracy in explaining the phenomenon under study. This methodology ensures a rigorous approach to understanding the dynamics of BI tool integration in organizations, providing a solid basis for drawing valid and reliable conclusions that can inform both theory and practice.

4 Result and Discussion

A model of a higher order [17] was developed to evaluate the hypotheses in this study. The study's model comprises lower-order reflecting elements that serve as indicators that shape higher-level variables—in this particular situation, the organizational, environmental, and technical settings. A discontinuous two-stage method examined higher-order constructs [18]. This study's indicator reliability (measured by outer loadings) denotes the relationship between measured variables and the underlying conceptions they reflect within the TOE framework. High outer loadings indicate strong relationships, confirming that the indicators reliably measure their respective constructs. Loadings above 0.70 are typically considered acceptable, indicating that the indicator reliably measures the construct [19]. Most of the outer loadings surpassed the optimal threshold of 0.70, demonstrating high indicator reliability. To assess the consistency of constructs, the study used Cronbach's alpha. Convergent validity and reliability of constructs were evaluated using composite reliability and AVE. These metrics are crucial in ensuring that measurement models accurately capture the underlying concepts related to technology adoption. According to the test findings, Cronbach's Alpha values (Table 2) for all variables exceeded the recommended threshold of 0.70 ($\alpha > 0.70$) [19]. This suggests that the factors examined in this research are reliable. Composite Reliability of all constructs were above 0.70, indicating adequate reliability. Results show that all the constructs have that are significantly higher AVE scores than the acceptance score of 0.50 (AVE > 0.50) [20][19].

Table 2. Construct reliability and validity.

Construct	Cronbach's alpha α	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)	Construct	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Actual Use	0.887	0.888	0.922	0.747	Org-Fit	0.825	0.826	0.896	0.741
CP	0.711	0.713	0.874	0.776	RA	0.753	0.753	0.858	0.669
Comp	0.814	0.814	0.877	0.642	SI	0.719	0.726	0.844	0.645
Env	0.821	0.825	0.882	0.652	TMS	0.772	0.780	0.869	0.689
Org	0.869	0.871	0.902	0.605	Tech	0.892	0.894	0.912	0.509
					VS	0.818	0.818	0.916	0.846

The discriminant validity of the measurement model was evaluated using the Fornell–Larcker criterion. In order to assure discriminant validity, researchers have shown that the square root of any construct's AVE value must always be greater than the correlation value it has with any other construct in the same model [21].

Structural Model: Once it has been proven that the lower-order and higher-order build values are reliable and valid, the subsequent stage entails assessing the results of the structural model. Figure 2 displays the structural model that was derived from the PLS-SEM analysis, in which the path coefficients (ß) and the explained variance of endogenous factors (R^2) are shown. When using PLS-SEM, the structural model is judged by its (R^2) values, its ability to predict (Stone-Geisser Q2), and the size of the effect of the path coefficients. This is different from covariance structure analysis modeling methods, which use goodness-of-fit measures. Figure 2 illustrates that each research hypothesis was validated and Table 3. Shows that with acceptable β and p values, Technological features, organizational features, and environmental features of BI actual use having a statistically significant positive effect on the rate at which BI is adopted. Also, the first-order variables under Technological context, relative advantage, Compatibility, Simplicity positively influence BI adoption intention. Concerning the organizational context and environmental context, top management support, Organization fit, competitive pressure, and Vendor

support have highly significant positive impact (with acceptable β and p values) on the acceptance rate of BI-Applications.

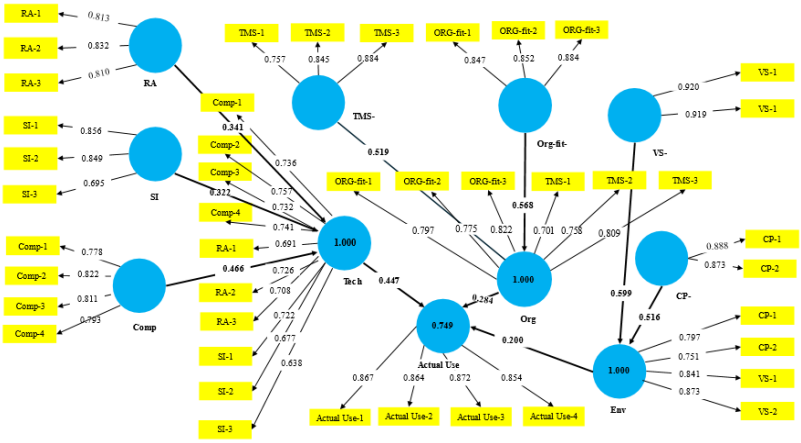

Fig. 2. Structural Model of the Research

Table 3. Partial Least Square-Structural Equation Modelling (PLS-SEM) results

Construct	Path coefficients β	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Decision
CP –> Env	0.516	0.514	0.017	29.562	0.000	Supported
Comp –> Tech	0.466	0.467	0.021	21.992	0.000	Supported
Env –> Actual Use	0.200	0.197	0.075	2.662	0.008	Supported
Org –> Actual Use	0.284	0.283	0.080	3.540	0.000	Supported
Org-Fit –> Org	0.568	0.568	0.022	25.850	0.000	Supported
RA –> Tech	0.341	0.340	0.016	20.967	0.000	Supported
SI –> Tech	0.322	0.323	0.019	17.262	0.000	Supported
TMS –> Org	0.519	0.519	0.017	30.370	0.000	Supported
Tech –> Actual Use	0.447	0.452	0.083	5.395	0.000	Supported
VS –> Env	0.599	0.602	0.028	21.436	0.000	Supported

Table 4. Coefficient of Determination

Construct	R-square	R-square adjusted
AU	0.429	0.420
Env_factor	0.980	0.980
ORG_factor	1.000	1.000
Tech_Factor	1.000	1.000

Table 5. Analysis that is oriented toward prediction (PLSpredict).

Construct	Q^2predict	Construct	Q^2predict	Construct	Q^2predict	Construct	Q^2predict
Actual Use-1	0.593	TMS-2	0.574	VS-1	0.699	RA-1	0.469
Actual Use-2	0.540	TMS-3	0.649	VS-2	0.700	RA-2	0.521
Actual Use-3	0.536	Comp-1	0.536	Org-Fit-1	0.633	RA-3	0.489
Actual Use-4	0.514	Comp-2	0.569	Org-Fit-2	0.590	SI-1	0.508
CP-1	0.633	Comp-3	0.526	Org-Fit-3	0.671	SI-2	0.451
CP-2	0.556	Comp-4	0.540	TMS-1	0.479	SI-3	0.403

R-squared (R^2) values were employed in study to assess the ability of the model to explain the endogenous constructs. The percentage of variance in a dependent construct that may be explained by its independent constructions is represented by the R^2 value. An R-Square score of more than 0.67 indicates a strong model. It is thus possible to classify the model as moderate if the R-Square value falls between 0.33 and 0.66. The results indicate that 98% of the environmental factors (R-squared = 0.980) have a significantly strong influence on the adoption of BI tools, followed by 100% of organizational factors (R-squared = 1.000) and 100% of technological factors (R-squared = 1.000). These findings suggest that organizations seeking to adopt BI tools should focus on creating an environment that supports the adoption process, as well as ensuring that their organizational structure and technological infrastructure are conducive to the adoption of these tools. The study confirms that technological features such as relative advantage, compatibility, and simplicity significantly influence BI tool adoption. The path coefficients for these factors were substantial, with relative advantage ($\beta = 0.341$), compatibility ($\beta = 0.466$), and simplicity ($\beta = 0.322$), all showing strong positive impacts on the adoption of BI tools. These findings align with previous studies, indicating that when BI tools are perceived as advantageous, easy to integrate with existing systems, and simple to use, their adoption is more likely to be successful. This suggests that organizations should enhance these technological aspects to facilitate BI tool adoption. Organizational factors, including organizational alignment and support from senior management, have a substantial impact on the adoption of BI tools. The path coefficients for top management support ($\beta = 0.519$) and organizational fit ($\beta = 0.568$) were both highly significant. This emphasizes the importance of leadership in driving BI initiatives and ensuring that the tools align well with the organization's existing processes and culture. Organizations should therefore ensure that their leadership is committed to BI adoption and that there is a strategic alignment between the BI tools and the organizational goals and processes. Competitive pressure ($\beta = 0.516$) and vendor support ($\beta = 0.599$) were found to have strong positive influences. This indicates that external pressures from the market and the support provided by BI vendors are critical in motivating organizations to adopt BI tools. Organizations should leverage competitive pressures as a catalyst for BI adoption and seek robust vendor support to ensure successful implementation and utilization of BI tools. The primary theoretical contribution of the study is in its use of the TOE framework within the specific context of Bangladesh, a region that has been relatively neglected in the field of BI research. The framework's adaptation to the local context enables a better understanding of the unique challenges and enablers faced by enterprises in Bangladesh while using BI technologies. The study's results on the positive influence of technological features on BI adoption are consistent with previous research, emphasizing the importance of relative advantage, simplicity, and compatibility of BI tools in driving adoption. The results also support the notion that organizational resources, particularly top management support and organizational fit, play crucial roles in facilitating BI adoption. Additionally, the study's results on the positive impact of environmental context, specifically competitive pressure, and vendor support, on BI adoption are consistent with prior study findings highlighting the importance of external factors in influencing organizational decisions. The study's theoretical contribution is further enhanced by its use of SMART-PLS analysis, which provides a robust method for testing the hypotheses and validating the model. The application of SMART-PLS also allows the estimation of the relationships between the variables, providing a more comprehensive understanding of the complex relationships between the factors influencing BI adoption. The Stone-Geisser value Q^2 is used to evaluate the predictive effectiveness of the inner model. When the Q2 values exceed zero, it becomes evident that the observed values have been accurately reconstructed; furthermore, this indicates that the model is effective for prediction [19]. The blindfolding process in the present model (Table 5) shows

that every construct exhibits a Q-Square value greater than zero, affirming the validity of the study model's predictive capabilities.

5 Conclusion

This study can be achieved by promoting decision-making based on solid evidence, fostering innovation, improving operational efficiency, and enhancing competitiveness in a rapidly digitizing economy. Ultimately, this would contribute to sustainable development (SDG) in the country, with the goal of reducing poverty and fostering economic growth. The study fills gaps in theoretical understanding using higher order constructs and practical implementation of BI systems by analyzing organizational dynamics. The research provides valuable insights for professionals in IT management, CIOs, and business strategists, helping them make informed decisions when choosing, implementing, and managing BI solutions. It also impacts policy and decision-making, providing valuable information for IT investments and training programs. The study adds to the body of current knowledge by filling the research gap concerning the comprehensive analysis of BI tool adoption in the context of developing countries, specifically Bangladesh. The research used a cross-sectional approach, which offers a static perspective of the variables impacting the adoption of BI tools for data analytics at a certain moment but fails to reflect the evolving nature of the adoption process as organizations accumulate more familiarity with BI technologies. Furthermore, the study specifically concentrated on the implementation of BI-tools but did not investigate the subsequent use and influence of these tools on decision-making and organizational performance. This aspect has significant importance for future research endeavors.

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