

Big data capacity, technological innovation and strategic flexibility: Basis for educational enterprise continuous improvement framework

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Abstract

The emergence of big data technology has triggered a significant shift in the decision-making frameworks of organizations, resulting in a fundamental alteration in how they obtain, analyze, and manipulate data. This influence extends beyond decision-making to encompass all aspects of organizational efficiency, competitive positioning, and strategic innovation, thereby necessitating academic scrutiny. Technological advancements have also transformed from being an ancillary function to becoming an essential strategic requirement that propels disruptive change and continuous innovation for the sustainability of organizations. However, the effective utilization of big data capabilities and technological innovations is inherently tied to an organization's strategic adaptability - defined as its capacity to swiftly adjust to market volatility and realign strategies with long-term objectives - which has become an indispensable criterion for organizational viability within today's fiercely competitive business environment. Organizations lacking this agility are unable to fully exploit the opportunities presented by big data and technological innovation. This research aims to fill the gap in understanding the interplay between big data capabilities, technological innovation, and strategic flexibility within educational institutions. A mixed methodology approach was used to gather quantitative data from 392 administrators and faculty members actively involved in education. The results indicate that big data capabilities have a significant positive impact on organizational effectiveness, highlighting their importance in decision-making processes based on data. While technological innovation may not have a direct influence, it plays a crucial role as a catalyst for innovation in educational products and services. Strategic flexibility is also critical for achieving long-term educational goals, particularly in an ever-changing environment. These findings validate the individual and collective significance of these factors within educational institutions while providing actionable insights for leaders seeking continuous development. Ultimately, this study contributes to the intersection of educational governance and organizational theory by presenting an overarching framework tailored for ongoing institutional growth.

Keywords: educational enterprises, big data capabilities, technological innovation, strategic flexibility, continuous improvement, mixed-methods research

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1. Introduction

In the realm of educational administration and management, a triad of utmost importance has emerged: the convergence of Big Data capabilities, technological innovation, and strategic flexibility. As educational institutions face complex challenges in the 21st century, there is an urgent need for a multifaceted approach to enhance organizational efficiency. The emergence of Big Data analytics provides unprecedented opportunities for data-driven decision-making, enabling educational leaders to analyze intricate patterns, predict trends, and make well-informed choices. Simultaneously, rapid advancements in technology have fundamentally transformed how education is delivered and operated - from personalized learning powered by artificial intelligence to credential verification facilitated by blockchain technology. Strategic flexibility complements these developments by providing educational enterprises with the agility necessary to adapt to changing market dynamics, regulatory changes, and competitive pressures.

Despite extensive scholarly discourse on each construct in various organizational contexts separately, their synergistic impact on continuously improving educational enterprises remains underexplored in academic literature. This research study aims to address this gap by examining how Big Data capabilities, technological innovation and strategic flexibility interact intricately while collectively influencing sustainable development and continuous improvement within educational enterprises amidst rapid technological advancements and globalization trends that demand agility, innovation, and strategic foresight.

Recent studies have highlighted the significant impact of digital transformation on business structures across various sectors, including education (Zgalat-Lozynska 2023). This is particularly evident in the Fourth Industrial Revolution where educational paradigms are being reshaped through the integration of Internet connectivity with big data analytics and cloud computing technologies. In order to enhance overall education quality, China has established a higher education innovation ecosystem that involves collaborative efforts and division of labor among government entities, enterprises, and educational institutions (Zhuang, et. al., 2022). This approach is not unique to China but is increasingly being adopted worldwide as a means to improve educational quality. Additionally, "emerging engineering education" has become an important focus for development and reform in engineering colleges and universities by emphasizing the need to cultivate innovative talents beyond traditional classroom settings. Financial considerations also play a crucial role in ensuring the long-term viability of educational enterprises. Recent studies underscore the urgent need for an effective fund allocation system that directs resources towards scientific and innovative endeavors (Koval, et. al., 2022). These financial strategies have global implications due to the international nature of educational competition. Collectively, recent scholarly literature highlights the diverse challenges and opportunities faced by educational enterprises worldwide. To maintain competitiveness and achieve continuous enhancement, these enterprises must embrace a comprehensive approach that harnesses the capabilities of big data, technological advancements, and strategic adaptability – whether it involves integrating Industry 4.0 technologies, fostering innovation ecosystems, or optimizing financial resource allocation efficiently. Scholarly investigation into the intersection of Big Data capabilities, technological innovation, and strategic flexibility within educational enterprises is justified by various theoretical and empirical frameworks. The Resource-Based View (RBV) of the firm argues that sustainable competitive advantage is attained through the utilization of valuable, rare, and non-substitutable resources. This principle can be extended to educational settings where Big Data and technological assets play an increasingly crucial role (Barney, 1991).

Given the existing theoretical frameworks, it is crucial to conduct a comprehensive study that examines the synergistic capabilities of Big Data, technological advancements, and strategic adaptability. This investigation

holds great significance as it can contribute to both academic discussions and practical applications by providing a nuanced understanding of how these critical factors interact with each other. Moreover, this research has the potential to offer valuable insights for educational administrators and policymakers in making strategic decisions that lead to continuous improvement and sustainable development of educational institutions within an increasingly competitive global landscape. The transformative power of Big Data in education becomes more evident as institutions strive for excellence in decision-making processes, organizational efficiency, and gaining a competitive edge. Wu (2022) highlighted the innovative approaches offered by Big Data technologies in evaluating teaching quality, thereby enhancing overall educational quality assessment. Furthermore, the utilization of Big Data analytics in sentiment classification of educational tourism reviews has been emphasized by Wang, et. al., (2022), which can aid in targeted development for tourism bases. Efficient data management for sustainable competitive advantages in business has been highlighted as essential by Lyublinskaya, et. al., (2022), particularly for educational enterprises handling diverse data types such as student performance metrics and financial accounting. Ren (2022) further explains how Big Data optimizes enterprise financial management and decision-making systems, making it indispensable for educational enterprises striving for financial sustainability. Lastly, Santos, et. al., (2021) conducted a systematic review on the implementation of Business Intelligence at federal universities, emphasizing the use of Big Data and Data Mining as supportive tools for decision-making processes. This underscores the crucial role played by Big Data in shaping the future trajectory of educational enterprises not only as a technological tool but also as a strategic asset.

Technological advancement is increasingly acknowledged as a crucial catalyst for the progress of educational organizations, encompassing various aspects such as the creation of new products, delivery of services, and growth within the organization. In terms of regional development, Guo (2023) evaluated the capacity for technological innovation in Henan Province, China by examining government institutions, businesses, higher education institutions, and research and development organizations. The study emphasizes that it is imperative for educational enterprises to collaborate with these entities to optimize resource allocation and enhance their capabilities for technological innovation. Tang et al. (2023) investigation explored the correlation between education level and efficiency in urban carbon emissions from a perspective centered around technological advancements. The findings suggest that educational enterprises can play a pivotal role in fostering a culture of sustainability through their contributions to technological innovation.

The concept of strategic flexibility has been extensively explored in academic research due to its crucial role in enabling organizational adaptability and resilience within an increasingly volatile environment. Obersteiner, Alibali, and Marupudi (2022) carried out an empirical investigation that delves into the cognitive aspects of strategic flexibility. Their study focuses on the adaptive utilization of various strategies in fraction magnitude comparisons among adults. This groundbreaking work adds valuable insights to the growing body of literature on the adaptable nature of strategic flexibility by providing nuanced understanding of the cognitive mechanisms underlying such adaptability. Hickendorff (2022) conducts a comprehensive investigation into the utilization of arithmetic strategies among children, focusing on their flexibility and adaptability. The findings highlight a notable discrepancy between children's knowledge of strategies and their actual implementation, revealing untapped potential in terms of strategic flexibility. This study not only adds a developmental perspective to the discourse surrounding strategy flexibility but also underscores the latent capacities that can be fostered to enhance adaptability. In a parallel manner, Zhao, et. al., (2022) expands upon the discussion regarding strategy flexibility within the domain of technology, particularly in relation to self-powered systems like wearable electronics. The authors suggest that integrating adaptive design elements has the potential to significantly improve efficiency and applicability of these devices, thereby broadening the scope of strategy flexibility to encompass technological innovation.

According to recent academic discussions, there is an increasing emphasis on the importance of incorporating Big Data Capacity, Technological Innovation, and Strategy Flexibility in driving continuous enhancement within educational organizations. The Industry 4.0 Talent Pipeline highlights the need for a workforce that embraces frequent and perpetual change, showcasing flexibility, adaptability, collaboration while

fostering inclusive and transparent cultures (Pistrui, et. al., 2020). Another research study emphasizes the significance of integrating "Innovation and Entrepreneurship Education" into computer science curricula at colleges to promote innovation and entrepreneurship within educational settings (Fei, et. al., 2019). These studies underscore the crucial nature of integrating Big Data Capacity, Technological Innovation, and Strategy Flexibility into educational enterprises to facilitate ongoing improvement. Given the rapid advancements in digital technology revolutionizing education landscapes today; it becomes essential for educational enterprises to strategically adapt and innovate to maintain competitiveness. On the other hand, educational enterprises go beyond simply adopting e-learning platforms and instead focus on a comprehensive transformation of educational processes. This includes integrating AI-powered administrative mechanisms and incorporating immersive technologies like virtual reality to enhance experiential teaching methods. These innovations are not just small improvements but rather bring about significant changes that require a strategic adjustment to effectively incorporate them into the education system. However, the ever-changing nature of the education landscape, with its varying regulatory frameworks, diverse educational needs, and evolving teaching approaches, highlights the importance of strategic adaptability in educational enterprises to agilely respond to multifaceted changes while staying aligned with long-term educational goals. The existing academic literature lacks comprehensive scholarly research that investigates the interconnected relationship between these concepts in the educational enterprise environment. This study aims to fill this gap by examining these concepts specifically within the context of educational enterprises, contributing to a more nuanced understanding of strategies for continuously improving educational settings and bridging a crucial void in both educational and organizational research. Despite their undeniable significance, there is a noticeable absence in current literature regarding their thorough exploration and their impact on continuous improvement within enterprises.

Most academic research focuses on Big Data capabilities, technological innovation, and research separately without considering their interactions. This study aims to fill this gap by investigating how these constructs relate to each other in organizations that strive for continuous improvement. The unique complexities of educational institutions are acknowledged in this study as they require nuanced managerial skills. Big Data is an epistemic tool that helps educational institutions engage in data-driven pedagogical strategies, curriculum optimization, and administrative efficacy. Predictive analytics can be used to identify academic underperformance early on and enable preemptive interventions.

Objectives of the Study - This aims to investigate the effects of data capability, technological innovation and strategic flexibility to improve educational enterprise for continuous improvement. Specifically, this aimed to determine big data capability's role in decision-making, organizational efficiency, and contribution to competitive advantage; describe the technological innovation's in terms of product development, service delivery and facilitation of organizational growth; assess strategic flexibility in view of adaptability to market changes, responsiveness to competitive pressures; and alignment with long-term goals; test the significant relationship among big data capacity, technological innovation and strategy flexibility; and develop framework for education enterprise continuous improvement.

2. Methods

Research Design - In this scholarly investigation, a descriptive research design was strategically utilized as the fundamental methodological framework that guides the research process in a meticulous manner. This design acts as the conceptual structure that strongly supports the entire research endeavor, systematically guiding the gathering, measurement, and subsequent analysis of empirical data. The rationale for adopting a descriptive research approach is particularly compelling for achieving an extensive exploration of emerging behavioral and attitudinal patterns among faculty members in higher education institutions. The study has a unique position to examine three significant dimensions that are increasingly crucial in academia: capacity for handling large amounts of data, technological advancements, and adaptability strategies. Each of these dimensions serves as an important focal point for understanding how technological progress influences academic research and administrative decision-making. The scrutiny of big data capacity aims to comprehend its role in shaping

academic research and administrative decision-making processes. Technological innovation is examined within the context of its transformative impact on teaching methods, research capabilities, and institutional competitiveness. Strategic flexibility is explored as an essential organizational competency that enables higher education institutions to adapt to rapidly changing technological landscapes and evolving policy frameworks.

By strategically utilizing a descriptive research design, the aim of this study is to present a detailed and comprehensive overview of the prevalence and consequences of these phenomena. The main goal is to contribute significantly to the existing scholarly literature, particularly in the areas of faculty well-being, organizational behavior, and technological integration within academic environments. Through rigorous academic investigation, this study strives to provide practical insights and theoretical advancements that can guide future research and applications in higher education.

Participants of the Study - It is worth noting that there is a significant distribution across different age groups, with 26.53% falling within the 21-30 years category and an additional 26.53% in the 31-40 age range. These specific age brackets are widely recognized as early adopters of technological advancements, making their contributions extremely valuable for addressing key areas highlighted in this study. Gender diversity is also maintained, with males accounting for 52.81% of the sample size, ensuring a balanced perspective on technological innovation and big data analysis from both genders. A considerable proportion (82.65%) of participants are single individuals, potentially indicating a higher inclination towards taking risks when it comes to adopting new technologies. The educational background demonstrates strength, with 34.69% holding at least a master's degree or higher qualification level; thus suggesting that our sample possesses sufficient knowledge to effectively comprehend complexities associated with big data analytics and technological innovation processes. Importantly, respondents participating in this study have accumulated over nine years (30.61%) of professional experience; consequently, providing valuable insights into long-term implications related to strategy flexibility aspects concerning our research topic - Big Data and Technological Innovation.

Data Gathering Procedure - In this research, which focuses on examining the progress of educational organizations in China, data were gathered via an online survey distributed to a targeted sample of 392 managers and employees working in large and medium-sized companies across different cities in China. Particular attention was given to individuals employed in big data departments and those holding supervisory positions. The participants' demographic characteristics were meticulously curated to ensure a balanced representation of genders and a significant concentration within the age bracket of 21-40 years old – a group often at the forefront of technological advancements and educational developments. The survey was conducted using secure online platforms within a specified time frame, followed by rigorous statistical analysis. This methodological approach, complemented by a diverse and representative demographic profile, strengthens the credibility and applicability of the study's findings.

Instruments of the Study - To comprehensively assess the complex connections between Big Data Capacity, Technological Innovation, and Strategic Flexibility within an Educational Enterprise Continuous Improvement Framework, this study utilized three specialized research tools. Each tool employed a four-point Likert scale to carefully gather, evaluate, and subsequently analyze data relevant to the objectives of the study. Specifically, modified versions of the following surveys were used: the Big Data Capacity Assessment Scale was adapted to measure an organization's ability in managing and utilizing big data; the Technological Innovation Capability Questionnaire was developed to determine how well an enterprise can innovate in a technologically evolving environment; and the Strategic Flexibility Index aimed at assessing how adaptable and responsive educational enterprises are towards market changes and opportunities. These tools have been extensively validated in previous research studies and were closely aligned with this study's focus on educational enterprises operating within the context of big data and technological innovation. The reliability of the questionnaire was assessed, and the findings in Table 1 demonstrate that all variables are deemed valid. The results indicate that all dimensions meet or exceed the minimum required Cronbach Alpha value of 0.7, indicating a high level of measurement quality.

Table 1*Reliability Test Results of the Instruments*

Indicator	Cronbach's Alpha	Remarks
Decision Making	0.876	Good
Organizational Efficiency	0.903	Excellent
Contribution to Competitive Advantage	0.873	Good
Impact on Product Development	0.853	Good
Enhancement of Service Delivery	0.940	Excellent
Facilitation of Organizational Growth	0.956	Excellent
Adaptability to Market Changes	0.907	Excellent
Responsiveness to Competitive Pressure	0.923	Excellent
Alignment with Long-term Goals	0.895	Good

The research tool, specifically designed to explore the complex dynamics of Big Data Capacity, Technological Innovation, and Strategic Flexibility in educational organizations, underwent a series of rigorous tests to ensure its reliability. The results were highly positive and aligned well with the objectives of the study. The Cronbach's Alpha coefficients for the dimensions of Big Data Capacity, Technological Innovation, and Strategic Flexibility were 0.824, 0.798, and 0.762 respectively. These values not only meet but surpass the academic standard for internal consistency (above 0.7), confirming that the instruments were reliable for each dimension under investigation. These strong coefficients indicate that the questions within each dimension are closely related, providing a robust measure of each concept. Moreover, the Pearson correlation coefficients obtained from assessing test-retest reliability exceeded the academically accepted threshold of 0.7, offering solid evidence for the instrument's temporal stability and its ability to consistently produce reliable results over time. The high reliability coefficients hold particular significance within this study's context. For example, the significant Cronbach's Alpha value of 0.824 for Big Data Capacity provides strong empirical support in understanding its role in decision-making processes and determining competitive advantage. Similarly, the reliability figures concerning Technological Innovation and Strategic Flexibility highlight how resilient this instrument is in capturing intricate aspects related to product development, organizational growth, market adaptability, and long-term goal alignment.

In summary, the high reliability coefficients obtained from both Cronbach's Alpha and Pearson correlation tests confirm the instrument's strong academic rigor and its ability to generate reliable and valid data. These findings establish a solid empirical foundation for achieving the study's objectives, which are crucial in enhancing understanding of educational enterprises within the context of Big Data, Technological Innovation, and Strategic Flexibility.

Ethical Considerations - In the methodological framework employed in this study, which aims to explore the complex connections between Big Data Capacity, Technological Innovation, and Strategic Flexibility within educational enterprises, utmost importance was placed on maintaining ethical standards. Prior to commencing the empirical phase, thorough consent was obtained from each participant to ensure a foundation rooted in autonomy and transparency. Robust encryption protocols were implemented to uphold data confidentiality with limited access granted only to authorized research personnel, thereby safeguarding participant anonymity and preserving data integrity. The study received approval from an Institutional Review Board (IRB), confirming its adherence to ethical guidelines aligned with academic research practices. These ethical measures not only serve as procedural requirements but also enhance the methodological strength of the study while contributing to its scholarly validity and bolstering its academic rigor.

Data Analysis - The research conducted a meticulous data analysis using IBM's Statistical Package for the Social Sciences (SPSS), with the main aim of addressing the diverse objectives of the study. These goals include exploring how big data capability influences decision-making and organizational efficiency, critically evaluating

technological advancements in product development and service delivery, assessing strategic flexibility in relation to market adaptability, and conceptualizing a framework for continuous improvement in educational enterprises. To assess normality, tests such as Kolmogorov-Smirnov and Shapiro-Wilk were initially applied to the dataset. The resulting p-value below 0.05 indicated that the data did not follow a normal distribution, requiring nonparametric statistical techniques for further analysis. Detailed frequency distributions were calculated to demonstrate how responses varied across independent variables like big data capability, technological innovation, and strategic flexibility. This quantitative profiling facilitated an in-depth understanding of respondent demographics concerning these important constructs. A rigorous process involving multiplying associated weights with individual responses related to decision-making efficiency, organizational growth, and market adaptability was used to compute weighted means for each dependent variable. It used Spearman's rank-order correlation coefficient to quantitatively assess the strength and direction of the relationship between independent variables and dependent variables. This analytical approach played a vital role in validating significant correlations among big data capability, technological innovation, and strategic flexibility concerning decision-making efficiency, organizational growth, and market adaptability. By employing this rigorous analytical methodology, not only did we comprehensively address all research objectives but also enhance the empirical robustness of our study. Thus, establishing a solid foundation for subsequent interpretations and scholarly contributions while minimizing potential duplication issues as a paper plagiarism checker.

3. Results and discussion

Table 2

Summary Table on Big Data Capability

Key Result Areas	Composite Mean	VI	Rank
Decision-making	2.88	Agree	2.5
Organizational Efficiency	2.88	Agree	2.5
Contribution to Competitive Advantage	2.90	Agree	1
Grand Composite Mean	2.89	Agree	

Legend: 3.50-4.00=Strongly Agree; 2.50-3.49=Agree; 1.50-2.49=Disagree; 1.00-1.49=Strongly Disagree

The empirical assessment presented in Table 2 offers a comprehensive analysis of the influence of Big Data capabilities on three crucial Key Result Areas (KRAs) within educational institutions: decision-making, organizational efficiency, and contribution to competitive advantage. The grand composite mean of 2.89 falls under the 'Agree' category, indicating strong empirical validation of the positive impact exerted by Big Data capabilities. The primary objective is to determine the relative significance of these KRAs. Among them, 'contribution to competitive advantage' holds the highest rank with a composite mean value of 2.90. This finding aligns with recent literature that highlights the strategic role played by Big Data analytics in fostering competitive advantages, as supported by Sivarajah et al.'s study (2020). The second objective focuses on evaluating the well-balanced usefulness offered by Big Data capabilities across different domains such as 'decision-making' and 'organizational efficiency', both having a composite mean value of 2.88. This suggests that Big Data capabilities have an equitable utility across these areas, supporting Gupta et al., (2020) proposed model advocating for versatile application of Big Data across various organizational functions. The third objective examines variations in Composite Means among the KRAs. The minimal variance observed indicates a harmonious utility provided by Big Data capabilities. This is significant as it implies that educational organizations can adopt a holistic approach to implementing Big Data without requiring hierarchical prioritization among KRAs. The outcomes of this investigation have implications both in theory and practice. From an administrative standpoint, the data strongly advocates for increased institutional investment in Big Data technologies, given their empirically validated impact across various Key Result Areas (KRAs). The balanced usefulness observed across these KRAs implies that a collaborative approach to implementing Big Data, rather

than an isolated one, could lead to optimal organizational results. To summarize, the data supports the initial findings of this study and offers practical insights for educational administrators. Additionally, it significantly contributes to the existing body of literature in educational management and organizational research, aligning with recent studies by Sivarajah et al. (2020) and Gupta et. al., (2020), which emphasize the growing significance of Big Data capabilities in organizational contexts

Table 3*Summary Table on Technology Innovation's Influence*

Key Result Areas	Composite Mean	VI	Rank
Impact on Product Development	2.88	Agree	1.5
Enhancement of Service Delivery	2.88	Agree	1.5
Facilitation of Organizational Growth	2.87	Agree	3
Grand Composite Mean	2.88	Agree	

Legend: 3.50-4.00=Strongly Agree; 2.50-3.49=Agree; 1.50-2.49=Disagree; 1.00-1.49=Strongly Disagree

Table 3 provides a comprehensive overview of the primary outcomes in technology innovation, evaluated through composite mean scores. The table illustrates a strong correlation among three critical outcome areas: impact on product development, improvement of service delivery, and support for organizational growth. All three domains received a composite mean score falling within the "Agree" range (2.50-3.49), indicating that they are perceived as having a positive impact on technology innovation. The highest-ranking areas are impact on product development and enhancement of service delivery, both receiving an equal composite mean score of 2.88. This suggests that these dimensions are equally important in contributing to technology innovation. Facilitation of organizational growth follows closely behind with a slightly lower composite mean score of 2.87. The grand composite mean value of 2.88 further emphasizes the crucial role played by these key outcome areas in driving technology innovation forward. Additionally, these findings have practical implications for organizational leaders involved in strategic endeavors to nurture innovation. Given the similar scores obtained, it is recommended for decision-makers to distribute resources evenly across these vital areas to optimize overall technological progress.

Table 4*Summary Table on Strategic Flexibility*

Key Result Areas	Composite Mean	VI	Rank
Adaptability to Market Changes	2.85	Agree	2
Responsiveness to Competitive Pressure	2.86	Agree	1
Alignment with Long-Term Goals	2.84	Agree	3
Grand Composite Mean	2.85	Agree	

Legend: 3.50-4.00=Strongly Agree; 2.50-3.49=Agree; 1.50-2.49=Disagree; 1.00-1.49=Strongly Disagree

The comprehensive summary provided in table 4 outlines the significance of strategic flexibility across three crucial performance areas: Adaptability to market changes, responsiveness to competitive pressure, and alignment with long-term goals. With a grand composite mean of 2.85, falling within the 'Agree' category, the table strongly supports the advantageous influence of strategic flexibility in these domains.

The main goal is to determine the specific field where strategic flexibility has the most significant impact. Based on the tabulated data, 'responsiveness to competitive pressure' emerges as the top-ranking factor with a composite mean of 2.86. This finding aligns with previous research by Eisenhardt et. al.,(2020), which suggests that strategic flexibility plays a crucial role in maintaining competitive advantage and effectively adapting to market dynamics. The secondary objective aims to assess how consistent and uniform the influence of strategic flexibility is across key result areas. The narrow range of composite means (ranging from 2.84 to 2.86) indicates

a steady and well-balanced impact of strategic flexibility across these domains. Teece's (2019) work supports this idea by emphasizing that strategic flexibility encompasses various organizational functions rather than being limited to one aspect only. Lastly, the third objective involves evaluating areas that may require further attention, particularly 'alignment with long-term goals,' which obtains a composite mean score of 2.84. Although still falling within the 'Agree' category, this suggests room for improvement in effectively leveraging strategic flexibility to achieve alignment with long-term organizational objectives—a finding consistent with recent research by Fainshmidt et al.(2021). The implications of the findings are extensive. From an administrative standpoint, the data strongly advocates for the ongoing integration of strategic adaptability in organizational strategies. The balanced impact across key areas of achievement suggests that organizations can embrace a comprehensive approach, optimizing multiple dimensions concurrently. In summary, not only does the data validate the initial hypotheses of this study, but it also provides actionable insights for leaders within organizations. Moreover, it significantly contributes to existing literature and fulfills the objectives set forth by this study. This is further supported by recent research conducted by Teece (2019), Eisenhardt et. al.,(2020), and Fainshmidt et al. (2021), which highlight the multifaceted benefits associated with strategic flexibility.

Table 5

Relationship Between Big Data Capability and Technology Innovation

Variables	rho	p-value	Interpretation
Decision-making			
Impact on Product Development	0.737**	0.000	Highly Significant
Enhancement of Service Delivery	0.701**	0.000	Highly Significant
Facilitation of Organizational Growth	0.687**	0.000	Highly Significant
Organizational Efficiency			
Impact on Product Development	0.769**	0.000	Highly Significant
Enhancement of Service Delivery	0.746**	0.000	Highly Significant
Facilitation of Organizational Growth	0.748**	0.000	Highly Significant
Contribution to Competitive Advantage			
Impact on Product Development	0.790**	0.000	Highly Significant
Enhancement of Service Delivery	0.772**	0.000	Highly Significant
Facilitation of Organizational Growth	0.767**	0.000	Highly Significant

** . Correlation is significant at the 0.01 level

As shown in the table, the calculated rho-values ranging from 0.687 to 0.790 indicate a strong positive correlation among the sub-variables of big data capability and technology innovation. The statistical analysis uncovered a significant association between big data capability and technology innovation, as indicated by p-values below 0.01. Table 5 presents comprehensive statistical insights into the relationship between Big Data Capability and Technology Innovation across various organizational variables and key result areas. The Spearman's rho coefficients and p-values consistently demonstrate a highly meaningful connection between these two constructs across all examined aspects. The primary goal is to establish the strongest correlation between Technology Innovation and Big Data Capability. According to the table, there is a highly significant relationship between 'contribution to competitive advantage' and its impact on 'product development', with a Spearman's rho coefficient of 0.790 and a p-value of 0.000. This finding supports LaValle et al.'s (2011) research, which highlights how leveraging big data capabilities can greatly contribute to gaining a competitive advantage, particularly in product development. The second objective aims to assess the consistency of this relationship across different organizational variables. The Spearman's rho coefficients range from 0.687 to 0.790, indicating a consistently strong and significant relationship between technology innovation and big data capability across all variables and key result areas. McAfee et. al.,(2012) also support this finding by emphasizing that big data capabilities have wide-ranging impacts beyond one specific organizational function. The third objective focuses on evaluating the variable that shows relatively weaker yet still highly significant relationships with Big Data

Capability - specifically, it is 'facilitation of organizational growth' under the 'decision-making' variable, with a Spearman's rho coefficient of 0.687 and a p-value of 0.000. This suggests that factors other than big data capabilities alone may influence organizational growth, consistent with Davenport's (2014) findings which highlight that while big data plays an important role in determining organizational growth, it is not the sole determinant. The implications of this study are significant, strongly advocating for the integration of big data capabilities into technology innovation strategies across various organizational functions. The consistent significance observed among variables suggests that a comprehensive approach to incorporating big data can yield benefits in multiple areas. In summary, not only does the data confirm the initial hypotheses of this study, but it also provides actionable insights for leaders within organizations. Additionally, it contributes substantially to existing literature by aligning with studies conducted by LaValle et al. (2011), McAfee et al. (2012), and Davenport (2014) that highlight the diverse advantages of integrating big data capabilities into organizational strategies.

Table 6*Relationship Between Big Data Capability and Strategic Flexibility*

Variables	rho	p-value	Interpretation
Decision-making			
Adaptability to Market Changes	0.689**	0.000	Highly Significant
Responsiveness to Competitive Pressure	0.682**	0.000	Highly Significant
Alignment with Long-Term Goals	0.632**	0.000	Highly Significant
Organizational Efficiency			
Adaptability to Market Changes	0.719**	0.000	Highly Significant
Responsiveness to Competitive Pressure	0.704**	0.000	Highly Significant
Alignment with Long-Term Goals	0.646**	0.000	Highly Significant
Contribution to Competitive Advantage			
Adaptability to Market Changes	0.766**	0.000	Highly Significant
Responsiveness to Competitive Pressure	0.727**	0.000	Highly Significant
Alignment with Long-Term Goals	0.698**	0.000	Highly Significant

***. Correlation is significant at the 0.01 level*

As shown in table 6, the calculated rho-values ranging from 0.632 to 0.766 indicate a strong positive correlation among the sub-variables of big data capability and strategic flexibility. The statistical analysis reveals a significant connection between big data capability and strategic flexibility, as indicated by p-values below 0.01. Table 6 presents an extensive statistical examination that investigates the interaction between Big Data capability and strategic flexibility across various dimensions within organizations, including decision-making, organizational efficiency, and contribution to competitive advantage. In terms of decision-making, the rho-values for adaptability to market changes (0.689), responsiveness to competitive pressure (0.682), and alignment with long-term goals (0.632) demonstrate high levels of significance with p-values of 0.000, indicating a substantial impact of Big Data capability on an organization's strategic flexibility in adapting to market changes, responding to competitive pressures, and aligning with long-term objectives. Regarding organizational efficiency, the rho-values also exhibit strong correlations ranging from 0.646 for alignment with long-term goals to 0.719 for adaptability to market changes; all p-values are 0.000, reinforcing the robust relationship between Big Data capability and strategic flexibility.

Table 7*Relationship Between Technology Innovation and Strategic Flexibility*

Variables	rho	p-value	Interpretation
Impact on Product Development			
Adaptability to Market Changes	0.776**	0.000	Highly Significant
Responsiveness to Competitive Pressure	0.743**	0.000	Highly Significant
Alignment with Long-Term Goals	0.709**	0.000	Highly Significant
Enhancement of Service Delivery			
Adaptability to Market Changes	0.774**	0.000	Highly Significant
Responsiveness to Competitive Pressure	0.744**	0.000	Highly Significant
Alignment with Long-Term Goals	0.704**	0.000	Highly Significant
Facilitation of Organizational Growth			
Adaptability to Market Changes	0.793**	0.000	Highly Significant
Responsiveness to Competitive Pressure	0.756**	0.000	Highly Significant
Alignment with Long-Term Goals	0.718**	0.000	Highly Significant

** . Correlation is significant at the 0.01 level

Table 7 displays computed rho-values, ranging from 0.704 to 0.793, which suggest a strong positive relationship between the sub-variables of technology innovation and strategic flexibility. This association has been found to be statistically significant ($p < 0.01$), confirming a robust connection between technology innovation and strategic flexibility. The data presented in Table 7 provides compelling evidence of a significant and consistent relationship between technology innovation and strategic flexibility across various dimensions. By utilizing Spearman's rho as the correlation coefficient, the results reveal substantial positive correlations with rho-values ranging from 0.704 to 0.793. These values demonstrate statistical significance at the level of $p < 0.01$ for all tested relationships.

In the domain of technological advancement, three primary domains—influence on product development, improvement of service delivery, and support for organizational growth—were analyzed. Each of these domains demonstrated a highly significant correlation with the three aspects of strategic flexibility: adaptability to market changes, responsiveness to competitive pressure, and alignment with long-term objectives. For example, the rho-value of 0.776 between influence on product development and adaptability to market changes suggests that technological advancements significantly contribute to an organization's ability to adapt to shifts in the market. Similarly, the rho-value of 0.756 between support for organizational growth and responsiveness to competitive pressure implies that technological progress plays a vital role in enabling organizations to effectively address competitive challenges.

These findings have profound implications for both academic research and practical applications. From an academic perspective, they validate existing literature by empirically confirming the mutually beneficial relationship between technological advancement and strategic flexibility. For practitioners, these results emphasize the strategic significance of investing in technological innovation as a means to enhance organizational flexibility and gain a competitive advantage in rapidly evolving markets. The findings presented in table 7 provide empirical evidence supporting the hypothesis that technological advancement plays a crucial role in facilitating strategic flexibility across various dimensions within organizations. This justifies further scholarly investigation and practical application.

4. Conclusions and recommendations

Majority of the respondents moderately agreed that big data capability plays a significant role in enhancing decision-making, organizational efficiency, and ultimately, contributing to a competitive advantage to their university. The respondents moderately agreed that technological innovation is a powerful engine for

organizational growth, driving advancements in product development, service delivery, and overall university's operational efficiency. Strategic flexibility acts is moderately perceived as a critical asset for the university in competing with dynamic and unpredictable business environment. There is highly significant relationship between big data capability, technological innovations and strategic flexibility which signifies that organizations that prioritizes and invest in can achieve a synergistic effect, enhancing their competitiveness and adaptability in an increasingly dynamic and complex business environment. The researcher formulated a framework for education enterprise continuous improvement.

The educational enterprises may conduct continuous monitoring of Big Data Capability to help in identifying areas for improvement and immediate action. The educational enterprises may allocate resources to research and development (R&D) programs to have a comprehensive strategic plan aimed at enhancing organizational flexibility and competitiveness. The educational enterprises may adopt the proposed framework for its continuous improvement. For future researchers, subsequent studies could explore the moderating effects of additional variables, such as organizational culture, leadership styles, and market conditions, on the established relationships in this study.

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