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Managing Chaos: Leadership in Uncertain Environments

Ghayur Ahmad *,1 **and Bassem E. Maamari** *,2
*College of Business Administration, Prince Mohammad Bin Fahd University, Al-Khobar, Saudi Arabia.

ABSTRACT The present study explores the effectiveness of various leadership approaches to improve institutional robustness and flexibility in higher education institutions in Khyber Pakhtunkhwa. This cross-sectional study is based on multiple regression analysis to examine how traditional leadership methods impact chaos management and institutional change readiness in educational organizations. This study examined adaptive, transformational, communicative, empowering, and integrative technological leadership methods. This survey involved 250 faculty members in the region's major universities and used structured questionnaires to quantify the leadership impacts. The findings indicate that the traditional methods of leadership do not enhance institutional robustness on their own. However, the integration of technological innovations into these methods strongly improves their explanatory power, suggesting positive effects on the dependent measures. This demonstrates the significance of technology in the management of leadership in complex learning organizations, particularly in social, political, and economic instability. Moreover, the technological integration of traditional leadership methods in leadership tasks would enhance its potential to provide the basis for reinforcing leadership roles in an institution. The findings revealed that educational administrators should consider technological advancements as a key component in strategic development to promote progress and robustness in educational institutions.

KEYWORDS
Stability
Randomness
Adaptability
Complex system
Chaos

INTRODUCTION

Organizations are able to succeed and flourish when they acquire some fundamental factors of success. One of these pillars for success is efficient management. Despite the widespread belief that financial resources and production facilities are at the core of the success of a firm, corporate history shows evidence that many well sources organizations, with abundant resources and access to financing, have faltered (Adobor *et al.* 2021). The events lead the business community to look into the effect of managing the multiple functional areas of an organization properly, on its success. This concept involves not only tangible assets, but also human talent, as managing is at its core, about leadership and human decision-making activities (Gelgör and Can 2025). This opens the door for analyzing the role of leadership on organizational success. Within this framework, the challenge confronted by organizations revolves around understanding the human ways and processes of thinking and decision-making, both of which are complex and diverse in nature. With such a diverse and complex subject for analysis, it is difficult to properly define human nature's understanding how a person thinks. As a result of these multi-facets, researchers have failed after decades to put forth the best practice framework for managing humans. To date, scientists are still investigating the field of organizational behavior to find answers to these challenges, reporting various new findings, proposing concepts, models and framework that attempt to improve our understanding on people's behavior in workplace (Shufutinsky *et al.* 2020).

The extant literature on leadership and organizational behavior present numerous potential answers to the fundamental challenge in organizations, that is, what are the ideal leadership style and best human behavior at work in a stable work-environment. Knowing that organizations today operate in a more volatile and continuously evolving environment, with change being the only constant at hand. This environment prescribed as chaotic, a situation that ensues at an unexpected turn in time and takes the world by surprise, such as a pandemic. In such an unexpected environment, known as chaos management, the managerial dilemma shifts to a new level, trying to investigate whether chaos can be managed (Uhl-Bien 2021).

The theoretical framework of chaos theory, which posits that within the apparent randomness of complex systems, there are underlying patterns that can be identified and leveraged, underpins this paper. In the dynamic realm of higher education, universities often encounter rapid changes in technology, policy, economic conditions, and societal demands (Bishwas and Sushil 2020). These fluctuations introduce a complexity that can seem chaotic, with Khyber Pakhtunkhwa's unique socio-political environment and educational challenges providing a prime setting for such phenomena. This area, characterized by diverse educational needs and resource variability, serves as an ideal backdrop for exploring how leadership within universities navigates these turbulent conditions.

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[1]gahmad@pmu.edu.sa (**Corresponding author**)
[2]bmaamari@pmu.edu.sa

The study titled "Harnessing Chaos: Evaluating Adaptive Leadership Strategies in Government Sector Higher Education Institutions of Khyber Pakhtunkhwa," i.e., the University of Peshawar and Islamia College University Peshawar, focuses on uncovering the leadership methodologies that enable these institutions not just to cope but to excel amid such uncertainty. This study provides a lens through which the study examines the strategic manoeuvres of university leaders in the study area as they respond to continuous shifts in their operational landscapes.

The application of chaos theory to the management practices of these institutions offers a unique perspective on how adaptive strategies can transform potential disorder into a structured pathway for institutional development and progress. This research investigates the existence, direction and magnitude of the relationship between chaos theory and chaos management on organizational success. It attempts to uncover the needed leadership characteristics and the type of leadership required in times of chaos. The manuscript lays first the foundation of chaos theory and its roots in social sciences, then highlights the relationship between leadership, management science, and the chaos theory, in the attempt to present the most important leadership characteristics in managing chaotic situations or environments.

BASICS OF CHAOS THEORY

Chaos theory, rooted in mathematics and physics, examines complex systems that exhibit sensitive dependence on initial conditions, commonly known as the "butterfly effect." Small changes can lead to significant and unpredictable outcomes, making it relevant to organizational behavior (Lemoine and Richardson 2020). Chaos theory, a fascinating branch of mathematics and physics, deals with the behavior of certain dynamical systems that are highly sensitive to initial conditions, a phenomenon popularly referred to as the "butterfly effect" (Sinha and Sinha 2020). This theory posits that small differences in initial conditions can lead to vastly different outcomes, making long-term predictions for these systems nearly impossible. The origins of chaos theory date back to the late 19th and early 20th centuries, but it gained significant prominence in the 1960s with the pioneering work of Edward Lorenz, whose studies in weather prediction revealed that very small changes in input could drastically alter the weather forecast (Alsharif *et al.* 2021). Chaos theory has since been applied across various fields, including meteorology, engineering, economics, biology, and social science, illustrating its wide-ranging implications (Butkus *et al.* 2023; Dolan *et al.* 2003).

The fundamental principles of chaos theory revolve around the concept of nonlinear dynamical systems, which are systems where the output is not directly proportional to the input. In such systems, simple equations can generate complex behaviors and seemingly random states that are, in fact, deterministic, meaning they follow precise rules, but their sensitivity to initial conditions makes them appear unpredictable and disorderly (Lartey *et al.* 2020). A key characteristic of chaotic systems is what is known as "strange attractors," which are patterns of behavior that can eventually be recognized within the apparent randomness, providing a semblance of structure and predictability in what might initially appear completely random (Kartika and Febriansyah 2021).

Chaos theory challenges traditional notions of predictability and control in complex systems and has profound implications for how we understand and manage processes that are influenced by minute variations (Butkus *et al.* 2024). In the context of organizational leadership, particularly in environments as dynamic as those found in higher education institutions, chaos theory provides a valuable framework for understanding how small policy changes (Taran 2023), leadership decisions, or educational practices can have disproportionately large effects on the institution's future. This sensitivity to initial conditions underscores the importance of meticulous planning and flexible strategy formulation, enabling leaders to harness chaos for innovation and adaptability rather than be overwhelmed by it (De Meyer *et al.* 2002; Yel 2024).

Problem Statement

In the pursuit of understanding how higher education institutions in Khyber Pakhtunkhwa manage chaos, certain leadership strategies stand out as particularly effective. Strategic decision-making enables leaders to constantly be keen on long-range goals as they adjust their planning processes to the changing market conditions. The duty of openness and giving power to the employees keeps the information and decision-making flowing amongst teams and creates flexibility to meet changes. To prevent length, no problems created by constant training in promoting resilience to disruption are raised; however, assurance that an institution can bounce back from unrest quickly is useful in chaotic climates. Besides, relying on procurement represents a critical path to addressing multifaceted contexts because it grows communication as well as analytical skills.

Crisis preparedness, leadership development, and stakeholder engagement are all interlinked as integrated strategies that work hand in hand to guarantee that leadership within these universities survives and flourishes in the face of the inevitable uncertainties of their operating environments. These values entail the incorporation of adaptable, kinetic, and technological leadership in the learning environment to unlock organic procedural transformations into organizational development. The goal of this research is to investigate how higher education institutions in Khyber Pakhtunkhwa manage chaotic and constantly changing contexts, with a focus on the importance of adaptive leadership. Although existing approaches like strategic decision-making, crisis planning, and stakeholder involvement promote adaptation, there is still a considerable gap in applying chaos theory to leadership in this particular scenario.

The primary challenge is a lack of appropriate frameworks for translating chaos theory principles into practical leadership initiatives. In addition to maintaining organizational control and promoting innovation without affecting institutional stability, university administrators have to establish a balance between long-term objectives and short-term adaptation. The study aims to bridge the separation between theory and practice by addressing this gap, thereby providing practical insights for enhancing the effectiveness of leadership in dynamic educational environments.

Objectives of the Study

The goal of this study is to investigate how well-valued universities in the Khyber Pakhtunkhwa province use leadership strategies to manage chaotic environments. We have developed the following objectives to better understand the specific strategies and their impact on institutional resilience and adaptability. The study's distinctiveness is shown by its distinctive application of chaos theory to leadership in higher education, with a particular emphasis on Pakistani universities. Furthermore, the well-described practical contributions underscore the tangible solutions the findings offer to enhance institutional resilience and flexibility. A structured discussion of adaptive leadership models and their theoretical foundations has been added to make the study more academically rigorous. This supports the study's relevance and technical

depth. These contributions provide a valuable framework for university leaders to navigate uncertainty and promote sustainable organizational change (Mandzuk 2024).

1. The aim of this study is to explore the specific leadership strategies that higher education institutions in Khyber Pakhtunkhwa employed to navigate chaotic and uncertain environments in a positive manner.

2. The aim is to analyze the impact of specific strategies on institutional resilience and adaptability to external and internal changes.

3. To compare the leadership approaches of various universities in the region to determine best practices for managing chaos within higher education settings

Research Questions

According to the research objective, the following questions are to be answered in this study.

1. What adaptive leadership strategies are utilized at higher education institutions in Khyber Pakhtunkhwa to manage chaotic conditions?

2. How do these strategies influence the resilience and adaptability of these institutions?

3. How do leadership approaches vary across different universities in Khyber Pakhtunkhwa, and what can be learned from these variations to inform better management of chaos in higher education?

LITERATURE REVIEW

According to (Shahi 2024), the concept of chaos in organizations and, more specifically, in academic contexts, has been the subject of many previous research efforts that address leadership and strategy formulation in organizations as a complex process. As explained by the literature's authors, adaptive leadership provides options needed to manage challenges and risks resulting from chaos. The author also defines adaptive leadership as keeping, altering, reacting to, and learning to flourish in a changing environment. According to (Su *et al.* 2022), this requires leaders to be active in strategic formulation and coordination at the levels of structure building for enhanced organizational adaptability. One suggests that by creating a culture of adaptation and learning, organizations could manage the uncertainties ubiquitous in instances of chaos.

Institutional resilience and adaptability are critical metrics for assessing the effectiveness of leadership strategies in higher education, particularly in environments marked by chaos and uncertainty. Scholarly work in this area, such as that (Zu 2023), highlights the role of strategic human resource management in building resilience, positioning it as essential for an institution's ability to withstand and recover from disruptions. Furthermore, the adaptability of an institution, which refers to its capacity to evolve in response to changing external and internal demands, has been explored through frameworks like adaptive capacity (Khan *et al.* 2024). These studies suggest that the agility with which an institution can modify its functions and structures directly influences its long-term sustainability and effectiveness. This nexus between leadership strategies and institutional outcomes forms a critical area of inquiry, underscoring the importance of leadership in shaping the resilience and adaptive capabilities of educational institutions amid fluctuating circumstances.

According to (Shufutinsky *et al.* 2023), decentralized decision-making allows for quick response and encourages the whole staff to respond quickly to changes and challenges. This approach fits into chaos theory in that it recognizes the stochastic nature of organizations as positive, in contrast to aspiring towards a highly structured system where change cannot happen quickly, as has been discussed earlier. This strategy, however, is highly dependent on the training and delegation of the employees, the aspect that has to be part of the leadership system. In addition, the application of technology in chaos management has also been the subject of debate in the literature.

Technology can also help in the timely sharing of information, in bringing members of a team close together, and in an effective provision of analytical tools capable of being used to identify possible disruption. According to (Hongchai and Weber 2023), technology can assist in simplifying a complex system and increasing the transparency of the processes going on across operations, especially during chaotic conditions where the usual modes of managing cannot hold. What emerges from this integration of technology with adaptive strategies is the ability of leaders to not only cope with but actively harness the intrinsic chaos of the environment to foster growth and adapt change across organizational practices. The concept of leadership within chaotic environments has increasingly been scrutinized in scholarly literature, with numerous studies highlighting various strategies that enhance organizational effectiveness. Leadership strategies are fundamental to navigating the complexities and uncertainties of any dynamic operational landscape.

Nguyen *et al.* (2023) articulate the concept of adaptive leadership, which emphasizes the importance of modifying one's approach to meet the evolving demands of the organization and its environment. Adaptive leaders are proficient in recognizing the nuances of changing circumstances and responding with appropriate strategies that may not have been part of the original planning. This form of leadership is crucial in chaotic environments where predictability is low and the ability to respond to new challenges swiftly can determine organizational survival and success.

Another key strategy identified regarding leadership strategies is transformational leadership, which Sort *et al.* (2023) explored extensively. Transformational leaders inspire and motivate their followers to achieve more than what is usually expected of them, often exceeding their limitations. This strategy is particularly effective in chaotic settings as it fosters an environment of motivation and innovation, driving the organization forward through visionary leadership and strong, personal commitment. Effective communication is paramount in any leadership strategy but becomes critically important in managing chaotic environments. According to (Pratama and Suryosukmono 2024), strategic communication helps in building trust and clarity, which are essential during uncertainty. Leaders who communicate effectively ensure that all members of the organization understand the current challenges and the strategies in place to address them, which helps align the team's efforts toward common goals despite external pressures.

Empowering leadership strategy involves delegating authority and fostering a sense of autonomy among team members (Ribeiro *et al.* 2024) suggest that empowering leaders facilitates an environment where employees feel greater control over their work and are encouraged to take the initiative. This is particularly effective in chaotic scenarios where decision-making must be rapid at multiple organizational levels to respond effectively to evolving situations. Developing organizational resilience is a strategic priority that leaders must cultivate to manage and thrive in chaotic environ-

ments. As (Sánchez and De Batista 2023) explains, resilience in leadership involves the ability to recover from setbacks and the capacity to anticipate disruptions, adapt to new realities, and learn from the process. This strategic foresight is vital for organizations to survive chaotic conditions and emerge more substantial and more adaptable. With the advancement of digital tools, leaders increasingly rely on technology to manage complexity and chaos.

Swierczek (2024) argues that technology can enhance decision-making capabilities, improve communication processes, and facilitate better monitoring of both internal and external environments. The strategic use of technology can help leaders gather real-time data, engage with stakeholders more effectively, and implement strategies swiftly, making it an invaluable tool in chaotic environments. Finally, the ability to lead effectively through crises often seen as the pinnacle of managing chaos is a crucial leadership strategy. 'Crisis leadership' involves not only dealing with the crisis at hand but also preparing the organization for potential future crises. Duarte Alonso *et al.* (2023) note that crisis leadership requires an acute awareness of the challenges and the ability to keep the organization focused and functioning. Leaders who excel in crisis leadership are adept at navigating through uncertainty, making decisive choices, and maintaining morale, which are essential for sustaining the organization through turbulent times.

A significant gap in the current literature can be identified when reviewing the existing literature, which focuses on leadership approaches applied in higher education institutions during volatile and uncertain environments. The majority of studies have looked almost solely to stable and predictable contexts; less effort has been directed to investigating how these leadership behaviors affect institutional change and vulnerability in situations that are experiencing high levels of socio-political and economic transformation, for example, Khyber Pakhtunkhwa. Moreover, a dearth of empirical studies has been conducted about the dissimilar effects of these modes of leadership adoption with specific reference to various universities. This lack of research clearly defines the need to conduct broad research on how certain leadership styles can be well utilized to mitigate havoc hence promoting organizational success within contexts that are relatively under-researched and, therefore, inherently more tumultuous.

Thus, this study seeks to contribute to the existing body of scholarship by providing a comprehensive analysis of the leadership practices that can help improve the resilience and adaptability of the higher education institutions in Khyber Pakhtunkhwa province. While the extant literature investigates adaptive leadership and chaos theory independently, there is inadequate study on their interaction in higher education institutions, notably in Khyber Pakhtunkhwa. This investigation mitigates this disparity by furnishing a structured framework that integrates chaos theory into leadership strategies, thereby providing university leaders with practical insights to improve their adaptability and resilience. This study advances our understanding of how leadership may effectively navigate uncertainty in dynamic academic environments by merging theoretical models with real-world issues. Figure 1 shows the impact of dependent and independent variables.

METHODOLOGY

The implemented methodology for the study "Harnessing Chaos: Evaluating Adaptive Leadership Strategies in Higher Education Institutions of Khyber Pakhtunkhwa" is fundamentally quantitative, aimed at empirically analyzing the impact of leadership strategies on institutional resilience and adaptability. Following the approach outlined by (Tariq *et al.* 2024), the research quantifies attitudes and behaviors related to leadership strategies using numerical data, essential in capturing the nuances of managing chaos in educational settings. Data collection involves administering a structured questionnaire, based on a 5-point Likert scale, to faculty members across selected public sector universities in Peshawar. The questionnaire design is informed by comprehensive literature reviews and preliminary interviews, ensuring that the questions effectively capture the variables of interest—adaptive leadership, transformational leadership, communication strategies, empowering leadership, and technological integration.

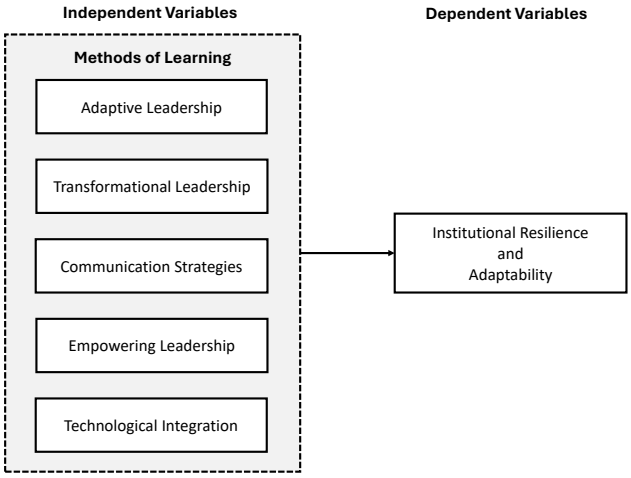

Figure 1 Conceptual Framework

To accommodate a substantial sample, 125 faculty members from each participating university are targeted, employing convenience sampling to facilitate ease of data gathering. The responses are then compiled and statistically analyzed using SPSS to examine the correlations and impacts of the leadership strategies. This analysis includes tests for reliability (Cronbach's alpha), normality (Kolmogorov-Smirnov & Shapiro-Wilk tests), and linearity, alongside regression and correlation tests to ascertain the relationships between the independent variables and the dependent outcomes of resilience and adaptability. The objective is to elucidate how different leadership approaches influence the ability of institutions to navigate and thrive amidst the dynamic challenges of their operational environments.

RESULTS

Demographic analysis of the study respondents reveals that the majority, 164 (65.6 %) participants were males, and 86 respondents (34.4%) as female, out of a total 250 participants. This distribution reflects a male-dominant sample, with females making up just over a third of the survey population. Likewise, regarding the age of the respondents, a majority number of the respondents were in the 21-35 years age group, i.e. 150 individuals or 60% of the total sample were in this age group. This is followed by those aged 36-50 years, who make up 21.2% of the sample with 53 respondents. The youngest group, below 21 years, includes 43 respondents (17.2%), and the smallest group, those above 50 years, consists of only 4 individuals (1.6%). This age distribution suggests a predominantly young to middle-aged demographic, with very few participants in the post-50 age category.

Furthermore, in terms of marital status, the majority of respondents (137 respondents, 54.8%) were married compared to those who were unmarried (113 respondents, 45.2%). The last category

in demographic information is the institutional affiliation of the respondents, which is divided between the University of Peshawar and Islamia College University, with a slightly higher representation from the University of Peshawar, which accounts for 54% of the respondents (135 individuals). In contrast, the respondents who belonged to Islamia College University represent 46% (115 respondents).

Chi-Square

In this study, a comprehensive case processing summary shows that all 250 cases were valid and included in the analysis, with no exclusions due to listwise deletion, ensuring a complete data set for accurate statistical evaluation, explained in Table 1. Similarly, Table 2 describes the reliability statistics revealed a Cronbach's Alpha of .411 across six items, which might suggest a moderate internal consistency within the dataset. Typically, a higher Cronbach's Alpha (above .7) is indicative of better internal consistency, suggesting that the scale used might require review or adjustment to enhance its reliability.

Table 1 Case Processing Summary

	N	%
Cases Valid	250	100.0
Excluded[a]	0	0.0
Total	250	100.0

Listwise deletion based on all variables in the procedure.

Table 2 Reliability Statistics

Cronbach's Alpha	N of Items
0.411	6

Moreover, Table 3 illustrates the Chi-square test to examine the relationship between different leadership strategies and the combined variable of institutional resilience and adaptability to change. The results of the Chi-Square tests indicate significant associations for all the variables tested.

Table 3 Test Statistics

Variable	Chi-Square (df, p)
Adaptive Leadership	164.552 (22, p = 0.000)[a]
Transformational Leadership	113.888 (20, p = 0.000)[b]
Communication Strategies	117.264 (22, p = 0.000)[a]
Empowering Leadership	153.312 (25, p = 0.000)[c]
Technological Integration	148.832 (20, p = 0.000)[b]
Institutional Resilience & Adaptability	144.592 (21, p = 0.000)[d]

[a] Min. expected freq. = 10.9; 0 cells < 5.
[b] Min. expected freq. = 11.9; 0 cells < 5.
[c] Min. expected freq. = 9.6; 0 cells < 5.
[d] Min. expected freq. = 11.4; 0 cells < 5.

In this regard Adaptive Leadership showed a Chi-Square value of 164.552 with 22 degrees of freedom, resulting in a significance level of .000. Likewise, Transformational Leadership registered a Chi-Square value of 113.888 with 20 degrees of freedom, also achieving a significance level of .000. Furthermore, Communication Strategies resulted in a Chi-Square value of 117.264 with 22 degrees of freedom, with a significance of .000. While Empowering Leadership had a Chi-Square value of 153.312 with 25 degrees of freedom, indicating a significance of .000. In this context Technological Integration reflected a Chi-Square of 148.832 with 20 degrees of freedom, also significant at .000. The dependent variable i.e Institutional Resilience & Adaptability to Change, had a Chi-Square value of 144.592 with 21 degrees of freedom and a significance level of .000.

These significant results reveal a statistically significant relationship between the leadership strategies employed and the institutional resilience and adaptability to change in the surveyed universities. This significant association underscores the impact of leadership practices on organizational outcomes in higher education settings. The tests also confirmed that all expected frequencies in the Chi-Square test were adequate, with no cell having expected frequencies less than 5, which supports the robustness of the statistical analysis.

Regression Analysis

The regression analysis is shown in the Model Summary and ANOVA in Table 4 and Table 5 respectively. The regression analysis gives a step-by-step analysis of the impact of intricate leadership approaches on organizational sustainability and flexibility toward change. First, with only Adaptive Leadership in Model 1, the R Square value is approximately equal to .002, this means that Adaptive Leadership is not a strong predictor of the dependent variable.

Table 4 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.045[a]	0.002	-0.002	0.06519
2	0.102[b]	0.010	0.002	0.06504
3	0.125[c]	0.016	0.004	0.06500
4	0.148[d]	0.022	0.006	0.06492
5	0.282[e]	0.079	0.061	0.06312

[a] Predictors: (Constant), Adaptive Leadership
[b] Predictors: (Constant), Adaptive + Transformational Leadership
[c] Predictors: (Constant), Adaptive, Transformational, Communication Strategies
[d] Predictors: (Constant), Adaptive, Transformational, Communication, Empowering
[e] Predictors: (Constant), All Above + Technological Integration

The ANOVA table for each of the models does support these conclusions: The F statistic increases significantly in Model 5, indicating the model has overall statistical significance on a p = 0.001 level. Such progressive addition of variables shows a systematic way of integrating different variables of leadership within an organization with Technological Integration being identified as a critical factor. When more predictor variables are introduced in the other models, the R Square value increases thereby implying a consistent enhancement of explaining the variability in institutional resilience and adaptability. Model 2, rather than Model 1, incorporates both Adaptive Leadership and Transformational Leadership, in addition to which the model provides a slightly

Table 5 ANOVA

Model	Source	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	0.002	1	0.002	0.507	0.477[a]
	Residual	1.054	248	0.004		
	Total	1.056	249			
2	Regression	0.011	2	0.005	1.294	0.276[b]
	Residual	1.045	247	0.004		
	Total	1.056	249			
3	Regression	0.017	3	0.006	1.303	0.274[c]
	Residual	1.039	246	0.004		
	Total	1.056	249			
4	Regression	0.023	4	0.006	1.377	0.242[d]
	Residual	1.033	245	0.004		
	Total	1.056	249			
5	Regression	0.084	5	0.017	4.210	0.001[e]
	Residual	0.972	244	0.004		
	Total	1.056	249			

[a] Predictors: Adaptive Leadership
[b] Transformational Leadership
[c] Communication Strategies
[d] Empowering Leadership
[e] Technological Integration
[f] Dependent Variable: Institutional Resilience & Adaptability

Table 6 Regression Coefficients for Leadership Models

Model	Variable	B	SE	Beta	t	Sig.
1	Constant	0.380	0.023		16.858	0.000
	Adaptive Leadership	0.037	0.052	0.045	0.712	0.477
2	Constant	0.403	0.027		14.661	0.000
	Adaptive Leadership	0.106	0.071	0.130	1.504	0.134
	Transformational L.	-0.121	0.084	-0.125	-1.441	0.151
3	Constant	0.379	0.035		10.959	0.000
	Adaptive Leadership	0.102	0.071	0.125	1.445	0.150
	Transformational L.	-0.125	0.084	-0.128	-1.481	0.140
	Communication S.	0.066	0.057	0.073	1.148	0.252
4	Constant	0.399	0.038		10.495	0.000
	Adaptive Leadership	0.104	0.071	0.127	1.468	0.143
	Transformational L.	-0.126	0.084	-0.129	-1.493	0.137
	Communication S.	0.077	0.058	0.085	1.324	0.187
	Empowering Leadership	-0.068	0.054	-0.081	-1.261	0.208
5	Constant	0.308	0.044		7.077	0.000
	Adaptive Leadership	0.084	0.069	0.103	1.224	0.222
	Transformational L.	-0.081	0.083	-0.083	-0.985	0.326
	Communication S.	0.051	0.057	0.056	0.891	0.374
	Empowering Leadership	-0.104	0.053	-0.123	-1.951	0.052
	Technological Integration	0.266	0.068	0.248	3.902	0.000

Dependent Variable: Institutional Resilience & Adaptability to Change

better fit (R Square = .010). However, the values of significance of these predictors indicate that in this stage none of them could influence the dataset significantly when both predictors were used in a model. Communication Strategies is added to the analysis with Model 3, in addition to the previous predictors, thus raising the R Square to .016, with no significant individual impacts of the predictors.

The trend continues with Model 4 where Empowering Leadership is added and the R Square upgraded to .022. These additions, however, fail to attain statistical significance as the individual predictors indicate that the effect sizes of these variables are likely small or whose combined explanatory value is compromised by multicollinearity as a result of the addition of more variables without necessarily improving the model's fit. Model 5 shows significant enhancement from the previous models with Technological Integration added alongside all the leadership approaches outlined above. This model yields an R^2 equal to .079 and an Adjusted R^2 equal to .061 of the total variances and the latter tells us that this model accounts for 6.1% of institutional resilience and adaptability, net of the number of predictors tested. Out of the lot, Technological Integration has the highest correlation to the dependent variable whereby $t = 3.902$ and $p = 0.0001$.

Table 6, the coefficients table gives a model-by-model description of the significance of each of the variables used in the analysis. As with the case of Technological Integration, positive and strong coefficient indicates a good relationship of the variable with resilience and adaptiveness of the institutional setting, while negative and insignificant coefficients of Empowering Leadership and Transformational Leadership were observed. These finer-grained

Table 7 Excluded Variables from Regression Models

Model	Variable	Beta In	t	Sig.	Partial	Tolerance
1	Transformational L.	-0.125[a]	-1.441	0.151	-0.091	0.537
	Communication S.	0.070[a]	1.096	0.274	0.070	0.990
	Empowering L.	-0.068[a]	-1.068	0.286	-0.068	0.999
	Technological Int.	0.240[a]	3.896	0.000	0.241	1.000
2	Communication S.	0.073[b]	1.148	0.252	0.073	0.989
	Empowering L.	-0.068[b]	-1.075	0.283	-0.068	0.999
	Technological Int.	0.232[b]	3.734	0.000	0.232	0.983
3	Empowering L.	-0.081[c]	-1.261	0.208	-0.080	0.977
	Technological Int.	0.227[c]	3.599	0.000	0.224	0.963
4	Technological Int.	0.248[d]	3.902	0.000	0.242	0.934

[a] Model: Constant, Adaptive Leadership
[b] Transformational Leadership
[c] Communication Strategies
[d] Empowering Leadership
[e] Dependent Variable: Institutional Resilience & Adaptability

data suggest that some leadership practices probably improve institutional flexibility and resiliency more or less directly, while others probably work in subtler or potentially fewer positive ways.

CONCLUSION

The study focused on investigating the effects of diversified leadership behaviors on adopting institutional resilience in the higher education context of Khyber Pakhtunkhwa, using regression analysis on quantitative data to examine the moderating link between leadership behaviors and organizational performance. The study shows that despite the previous suggestions that adaptive, transformational, communication, and empowering leadership styles have a significant impact on organizations, these leadership styles did not display significant independent effects in defining institutional resilience and flexibility. Still, the addition of technological integration as a leadership strategy was a significant advancement over the previous models. Integration of technology was found to be a meaningful predictor with positive impacts on institutional responsiveness and flexibility.

This implies that when higher education institutions are experiencing change and operating in uncertain environments, there is a need to integrate technology into leadership processes strategically. Aside from improving the ability to learn and prepare for adversity, it also helps strengthen the resiliency of the institution against threats. This research underscores the importance of leadership in the educational sector to adopt tech-savvy tactics to navigate and orchestrate their operating environments proactively to enhance institutional performance and sustainability. This study underscores the significance of diverse leadership styles and technological integration in fostering institutional resilience, but it also highlights certain limitations that require attention. Despite its value, quantitative data is the primary source of the research, which may not fully convey the complex nature of leadership dynamics in higher education.

Future research could include qualitative observations to provide a deeper understanding of leadership flexibility. Furthermore, this study only focuses on institutions in Khyber Pakhtunkhwa, Pakistan and expanding its scope to other locations could enhance its generalizability. Further research might examine the long-term effects of technology-driven leadership methods on institutional sustainability and other moderating variables that may affect higher education leadership resilience and adaptability.

Ethical standard

The authors have no relevant financial or non-financial interests to disclose.

Availability of data and material

Not applicable.

Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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