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Unsupervised Learning of Organizational Learning Patterns: The Roles of Knowledge Sharing and Cognitive Flexibility

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A B S T R A C T

Objective: The objective of this study was to autonomously identify latent patterns of organizational learning among corporate professionals and examine the differentiating roles of knowledge sharing and cognitive flexibility within these profiles.

Methods and Materials: A descriptive, quantitative cross-sectional design was employed, collecting data from a sample of $N = 452$corporate professionals in Egypt via a validated, self-administered online questionnaire. The analytical framework utilized unsupervised machine learning, specifically Principal Component Analysis for dimensionality reduction and K-means clustering to extract distinct learning profiles. Subsequently, Multivariate Analysis of Variance (MANOVA) and Tukey's post-hoc tests were conducted to evaluate how knowledge sharing and cognitive flexibility differed across the autonomously generated clusters.

Findings: The K-means clustering algorithm identified an optimal three-cluster solution ($k = 3$): a Passive Learning Profile ($n = 145$, 32.1%), an Adaptive Learning Profile ($n = 194$, 42.9%), and a Proactive Learning Profile ($n = 113$, 25.0%). The MANOVA results revealed a highly significant omnibus effect across the clusters, Wilks' $\Lambda = .51$, $p < .001$. Univariate and post-hoc analyses demonstrated that individuals in the Proactive Learning Profile exhibited significantly higher levels of knowledge sharing ($M = 4.45$) and cognitive flexibility ($M = 4.51$) compared to those in the Adaptive Profile ($M = 3.82$ and $M = 3.95$, respectively; $p < .001$) and the Passive Profile ($M = 3.14$ and $M = 3.39$, respectively; $p < .001$).

Conclusion: Fostering a highly proactive and generative organizational learning environment fundamentally depends on deliberately cultivating both interpersonal knowledge exchange networks and individual cognitive adaptability.

Keywords: *Organizational Learning, Knowledge Sharing, Cognitive Flexibility, Unsupervised Machine Learning*

1 Introduction

In an era characterized by rapid technological advancement, global market volatility, and unprecedented organizational complexity, the capacity of organizations to learn, adapt, and innovate has emerged as a critical determinant of sustained competitive advantage (Hoang & Le, 2025; Meher et al., 2024). Organizational learning, conceptualized as the process through which organizations acquire, interpret, distribute, and institutionalize knowledge to modify behavior and improve performance, represents a fundamental mechanism enabling enterprises to navigate turbulent environments and maintain strategic relevance (Antunes & Pinheiro, 2020; Marsick & Watkins, 2023). Contemporary scholarship has increasingly recognized that organizational learning is not a monolithic phenomenon but rather manifests through diverse patterns, profiles, and configurations that vary substantially across individuals, teams, and institutional contexts (Li et al., 2023; Meher & Mishra, 2022). Understanding these heterogeneous learning patterns and the factors that differentiate high-performing learning profiles from less effective ones has become a central preoccupation for both organizational researchers and practitioners seeking to optimize human capital development and knowledge management systems (Abubakr & Kalifa, 2025; Castaneda & Rojas, 2024).

Among the multitude of factors influencing organizational learning effectiveness, knowledge sharing has consistently emerged as a pivotal enabler of collective learning processes and organizational knowledge creation (Balweh et al., 2022; Kim, 2021). Knowledge sharing, defined as the voluntary exchange of task-relevant information, expertise, and insights among organizational members, serves as the fundamental mechanism through which individual knowledge is transformed into organizational knowledge assets (Salimi & Mousavi, 2019; Takhsha et al., 2020). Empirical evidence demonstrates that knowledge sharing practices significantly enhance organizational learning capacity by facilitating the dissemination of best practices, reducing redundant problem-solving efforts, accelerating innovation cycles, and fostering collaborative learning cultures (Castaneda & Rojas, 2024; Hoang & Le, 2025). Recent investigations have revealed that knowledge sharing operates through both formal channels, such as structured training programs and knowledge management systems, and informal mechanisms, including spontaneous peer interactions and communities of practice (Marsick & Watkins, 2023; Sorakraikitikul & Siengthai, 2014). Furthermore, research indicates that the effectiveness of knowledge sharing is contingent upon various organizational conditions, including leadership styles, organizational culture, technological infrastructure, and reward systems (Alves et al., 2022; Kim & Park, 2020). Transformational leadership, in particular, has been identified as a critical antecedent of knowledge sharing behavior, with leaders who articulate compelling visions, provide intellectual stimulation, and demonstrate individualized consideration significantly enhancing employees' willingness to share tacit and explicit knowledge (Hoang & Le, 2025; Kim & Park, 2020). Moreover, organizational cultures characterized by psychological safety, trust, and collaborative norms have been shown to facilitate knowledge sharing by reducing perceived risks associated with knowledge disclosure and creating supportive environments for learning experimentation (Castaneda & Rojas, 2024; Sorakraikitikul & Siengthai, 2014).

The relationship between knowledge sharing and organizational learning has been extensively documented across diverse industrial sectors and geographical contexts, with studies consistently demonstrating positive associations between knowledge exchange practices and learning outcomes (Meher & Mishra, 2022; Mohammadi Moghaddam et al., 2017). In the financial services sector, research has revealed that both tacit and explicit knowledge sharing significantly contribute to organizational learning capacity, with tacit knowledge sharing playing a particularly crucial role in developing adaptive capabilities and innovative service delivery models (Abubakr & Kalifa, 2025; Castaneda & Rojas, 2024). Similarly, investigations in educational institutions have demonstrated that teacher knowledge sharing, facilitated by supportive organizational cultures and transformational leadership, substantially enhances collective learning and pedagogical innovation (Hoang & Le, 2025; Rafiei Zadeh, 2024). Furthermore, studies examining knowledge-based companies have highlighted the critical importance of integrating knowledge sharing mechanisms into human resource management systems to optimize knowledge creation and organizational learning processes (Bahari & Taheri Rouzbahani, 2023; Balweh et al., 2022). The mediating role of knowledge sharing in the relationship between various organizational antecedents and learning outcomes has also received considerable scholarly attention, with evidence suggesting that knowledge sharing serves as a critical transmission mechanism through which leadership behaviors,

IJIMOB
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organizational culture, and structural arrangements influence learning effectiveness (Kim, 2021; Meher et al., 2024).

While knowledge sharing represents a crucial interpersonal and organizational-level enabler of learning, individual cognitive capabilities, particularly cognitive flexibility, constitute equally important determinants of learning effectiveness at the individual level (Li et al., 2023; Zhang & Zheng, 2021). Cognitive flexibility, conceptualized as the mental capacity to shift perspectives, adapt thinking strategies, and integrate diverse information sources in response to changing environmental demands, represents a fundamental cognitive competence underlying adaptive learning and problem-solving (Antunes & Pinheiro, 2020; Moiri et al., 2022). Individuals with high cognitive flexibility demonstrate superior capacity to recognize patterns across disparate knowledge domains, generate creative solutions to novel problems, and adjust learning strategies in response to feedback and changing task requirements (Meher et al., 2024; Zhang & Zheng, 2021). In organizational contexts, cognitive flexibility enables employees to effectively navigate ambiguous situations, integrate contradictory information, and develop nuanced understandings of complex organizational phenomena (Antunes & Pinheiro, 2020; Li et al., 2023). Moreover, cognitive flexibility facilitates the absorption and application of shared knowledge by enabling individuals to contextualize new information, connect it with existing knowledge structures, and adapt it to specific situational demands (Balweh et al., 2022; Meher & Mishra, 2022).

The interplay between knowledge sharing and cognitive flexibility in shaping organizational learning patterns represents a particularly promising yet underexplored area of inquiry (Li et al., 2023; Zhang & Zheng, 2021). Theoretical frameworks suggest that these two factors operate synergistically, with knowledge sharing providing the informational resources necessary for learning while cognitive flexibility determines the capacity to effectively process, integrate, and apply shared knowledge (Antunes & Pinheiro, 2020; Meher et al., 2024). Organizations characterized by both robust knowledge sharing practices and employees with high cognitive flexibility are theorized to exhibit superior learning agility, enabling them to rapidly sense environmental changes, interpret their strategic implications, and implement adaptive responses (Abubakr & Kalifa, 2025; Li et al., 2023). Furthermore, the concept of ambidextrous organizational learning, which emphasizes the simultaneous pursuit of exploitative learning (refining existing capabilities) and explorative learning (developing new capabilities), appears to be particularly dependent on the combination of extensive knowledge sharing networks and cognitively flexible individuals capable of balancing competing learning demands (Balweh et al., 2022; Li et al., 2023).

Despite the substantial body of research examining organizational learning, knowledge sharing, and cognitive capabilities, several critical gaps remain in the existing literature (Alves et al., 2022; Takhsha et al., 2020). First, the majority of prior studies have employed variable-centered analytical approaches that examine relationships among constructs at the aggregate level, potentially obscuring important heterogeneity in how organizational learning manifests across different subpopulations of employees (Meher et al., 2024; Rafiei Zadeh, 2024). Person-centered approaches, which identify distinct profiles or patterns of learning within populations, offer complementary insights by revealing qualitatively different configurations of learning behaviors and their associated characteristics (Antunes & Pinheiro, 2020; Moiri et al., 2022). Second, while numerous studies have examined knowledge sharing and cognitive factors as predictors of organizational learning, relatively few have investigated how these factors differentiate among naturally occurring learning profiles within organizational populations (Kim, 2021; Zhang & Zheng, 2021). Third, the application of advanced analytical techniques, particularly unsupervised machine learning methods, to organizational learning research remains limited despite their considerable potential for uncovering latent patterns and structures in complex organizational data (Bahari & Taheri Rouzbahani, 2023; Li et al., 2023). Unsupervised learning algorithms, such as clustering techniques, offer powerful tools for identifying naturally occurring groupings of individuals based on their learning characteristics without imposing a priori theoretical constraints, thereby enabling more exploratory and data-driven insights (Balweh et al., 2022; Meher & Mishra, 2022).

Furthermore, contextual considerations suggest that organizational learning patterns may vary substantially across different cultural, economic, and industrial contexts, necessitating empirical investigations in diverse settings (Castaneda & Rojas, 2024; Mohammadi Moghaddam et al., 2017). The Egyptian corporate context, characterized by ongoing economic transformation, increasing integration into global markets, and evolving organizational practices, represents a particularly relevant setting for examining

IJIMOB
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organizational learning dynamics (Abubakr & Kalifa, 2025; Salimi & Mousavi, 2019). Understanding how knowledge sharing and cognitive flexibility differentiate learning profiles among Egyptian professionals can provide valuable insights for organizations operating in emerging markets and transitional economies (Rafiei Zadeh, 2024; Takhsha et al., 2020). Additionally, the identification of distinct learning profiles and their associated characteristics can inform targeted interventions and human resource development strategies tailored to the specific needs and capabilities of different employee segments (Hoang & Le, 2025; Meher et al., 2024).

The aim of this study was to autonomously identify latent patterns of organizational learning among corporate professionals and examine the differentiating roles of knowledge sharing and cognitive flexibility within these profiles.

2 Methods and Materials

The present study employed a descriptive, quantitative cross-sectional research design to autonomously explore the latent patterns of organizational learning and to thoroughly investigate the contributing roles of knowledge sharing and cognitive flexibility among corporate professionals. The target population for this empirical research comprised full-time employees working across diverse multinational and local enterprises situated throughout Egypt, ensuring a varied representation of organizational cultures, sectors, and operational frameworks. A non-probability convenience sampling technique, augmented by snowballing strategies, was utilized to recruit participants over a structured three-month data collection period. The researchers distributed the survey links through professional networking platforms and direct correspondence with human resource departments. After carefully screening the initial pool of respondents to eliminate invalid, duplicate, or largely incomplete submissions, a final exact sample of 452valid responses was retained for the subsequent computational and statistical analyses. This specific sample size was meticulously evaluated and deemed highly adequate to meet the rigorous statistical requirements of the advanced machine learning algorithms utilized in this study, providing sufficient statistical power to uncover reliable underlying patterns within the data without risking the overfitting of the analytical models.

To accurately capture the multifaceted nature of the variables under investigation, a comprehensive and self-administered online questionnaire was developed, refined, and deployed as the primary data collection instrument. The survey was meticulously assembled utilizing established psychometric scales adapted from prior seminal literature to ensure high reliability and robust validity within the Egyptian corporate context. Organizational learning, serving as the foundational construct of the investigation, was assessed using a standardized multidimensional inventory that measures continuous learning, inquiry, dialogue, team collaboration, and embedded systemic structures. Knowledge sharing behaviors were evaluated through a comprehensively validated scale that distinctly captures both the proactive donation of knowledge and the active collection of knowledge among colleagues, accurately reflecting the bidirectional flow of information that is critical for organizational adaptability. Cognitive flexibility was measured employing a widely recognized inventory that rigorously gauges an individual's awareness of alternative solutions, willingness to adapt to novel and unpredictable situations, and self-efficacy in managing dynamic organizational demands. All items across these core constructs were anchored on a standard five-point Likert scale, ranging from strongly disagree to strongly agree. Prior to the main deployment, the composite survey underwent a rigorous pilot testing phase with a small subset of the target population to verify linguistic clarity, contextual relevance, and the internal consistency of the translated Arabic items, thereby minimizing potential measurement errors and mitigating common method bias.

The analytical framework for this study was distinctively driven by unsupervised machine learning techniques designed to autonomously discover hidden structures and natural groupings within the organizational learning data, functioning completely independent of predefined outcome labels. Initially, the raw extracted dataset underwent comprehensive preprocessing procedures, which included the algorithmic imputation of any remaining missing values, the robust standardization of all continuous variables to achieve a mean of 0and a standard deviation of 1, and thorough outlier detection to ensure the utmost stability of the subsequent algorithms. Principal Component Analysis was subsequently applied as a sophisticated dimensionality reduction technique to distill the numerous survey items into a refined set of core principal components, thereby successfully alleviating the curse of dimensionality and significantly enhancing computational efficiency. Following this critical preparation, the K-means clustering algorithm, a premier unsupervised learning method, was executed on the

IJIMOB
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extracted components to segment the sample into distinct, internally cohesive profiles of organizational learning. The optimal number of clusters, mathematically denoted as k, was meticulously determined by systematically evaluating the silhouette scores and rigorously applying the elbow method to the within-cluster sum of squares. Once the optimal organizational learning patterns were firmly established by the unsupervised clustering model, subsequent inferential statistical procedures, including multivariate analysis of variance and detailed post-hoc tests, were conducted to rigorously examine how the specific levels of knowledge sharing and cognitive flexibility significantly differed across these autonomously generated clusters. This multifaceted, data-driven analytical approach allowed for a profound and highly objective understanding of how specific cognitive and communicative traits characterize and define distinct organizational learning archetypes.

3 Findings and Results

To establish a foundational understanding of the relationships between the core constructs, bivariate correlations, alongside descriptive statistics (means and standard deviations), were computed. As anticipated, significant positive relationships were observed among the variables. Organizational learning demonstrated a strong positive correlation with both knowledge sharing ($r = .62$, $p < .001$) and cognitive flexibility ($r = .55$, $p < .001$). Furthermore, knowledge sharing and cognitive flexibility were significantly and positively correlated ($r = .48$, $p < .001$). The detailed descriptive statistics and the intercorrelation matrix for the primary study variables are presented in Table 1.

Table 1

Descriptive Statistics and Bivariate Correlations of Study Variables

Variable	***M***	***SD***	**1**	**2**	**3**
1. Organizational Learning	3.84	0.72	–		
2. Knowledge Sharing	3.76	0.81	.62**	–	
3. Cognitive Flexibility	3.91	0.68	.55**	.48**	–

Following the descriptive analysis, the unsupervised machine learning protocol was initiated to extract latent organizational learning patterns. First, a Principal Component Analysis (PCA) was conducted on the multidimensional organizational learning inventory to reduce dimensionality. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was .89, and Bartlett's Test of Sphericity was highly significant ($\chi^2 = 1845.32$, $p < .001$), confirming the data's suitability for dimension reduction. The PCA extracted four primary components—identified as Continuous Learning, Inquiry and Dialogue, Team Collaboration, and Systemic Structures—which cumulatively explained 71.4%of the total variance.

Standardized component scores were then subjected to the K-means clustering algorithm. To determine the optimal number of clusters (k), the within-cluster sum of squares (WCSS) was plotted against various values of k(the elbow method), and average silhouette scores were computed. The elbow plot exhibited a distinct inflection point at $k = 3$, which concurrently corresponded to the highest average silhouette score ($S = 0.58$), indicating well-defined and cohesive group structures. Consequently, a three-cluster solution was retained.

Cluster 1 ($n = 145$, 32.1%) was characterized by negative standardized centroids across all dimensions, representing a "Passive Learning Profile." Cluster 2 ($n = 194$, 42.9%) displayed near-zero or slightly positive centroids, representing an "Adaptive Learning Profile." Finally, Cluster 3 ($n = 113$, 25.0%) exhibited highly positive standardized centroids across all dimensions, distinctly representing a "Proactive Learning Profile." The final standardized cluster centers for the four organizational learning components are detailed in Table 2.

IJIMOB
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Table 2

Final K-Means Cluster Centers (Standardized Z-Scores) for Organizational Learning Dimensions

Organizational Learning Dimension	Cluster 1: Passive ($n = 145$)	Cluster 2: Adaptive ($n = 194$)	Cluster 3: Proactive ($n = 113$)
Continuous Learning	−1.12	0.15	1.24
Inquiry and Dialogue	−0.98	0.08	1.31
Team Collaboration	−1.05	0.22	1.15
Systemic Structures	−1.20	0.11	1.42

To investigate the roles of knowledge sharing and cognitive flexibility in characterizing these autonomously generated organizational learning patterns, a Multivariate Analysis of Variance (MANOVA) was performed. The three organizational learning clusters served as the independent variable, while knowledge sharing and cognitive flexibility were entered as the dependent variables. Box's M test was strictly evaluated and deemed non-significant ($p > .05$), confirming the homogeneity of covariance matrices.

The multivariate results revealed a statistically significant omnibus difference between the three organizational learning profiles on the combined dependent variables, Wilks' $\Lambda = .51$, $F(4,896) = 89.24$, $p < .001$, partial $\eta^2 = .28$. Given the significant multivariate effect, separate univariate Analyses of Variance (ANOVAs) were subsequently examined for each dependent variable. The univariate tests confirmed that the clusters differed significantly in terms of both knowledge sharing, $F(2,449) = 156.38$, $p < .001$, partial $\eta^2 = .41$, and cognitive flexibility, $F(2,449) = 112.45$, $p < .001$, partial $\eta^2 = .33$. The complete MANOVA and univariate ANOVA results are comprehensively outlined in Table 3.

Table 3

Multivariate and Univariate ANOVA Results for Knowledge Sharing and Cognitive Flexibility across Clusters

Effect	Wilks' Λ	Multivariate F	$df1, df2$	p	Partial η^2	Univariate F(KS)	Univariate F(CF)
Cluster Profile	.51	89.24	4,896	<.001	.28	156.38**	

Because the univariate ANOVAs indicated highly significant differences, post-hoc comparisons using Tukey's Honestly Significant Difference (HSD) test were conducted to specify exactly where the mean differences (MD) lay between the three distinct profiles. For knowledge sharing, the Proactive Learning Profile (Cluster 3) demonstrated significantly higher scores ($M = 4.45$, $SD = 0.52$) compared to both the Adaptive Learning Profile (Cluster 2) ($M = 3.82$, $SD = 0.61$; $MD = 0.63$, $p < .001$) and the Passive Learning Profile (Cluster 1) ($M = 3.14$, $SD = 0.68$; $MD = 1.31$, $p < .001$). Furthermore, the Adaptive Learning Profile engaged in significantly more knowledge sharing than the Passive Learning Profile ($MD = 0.68$, $p < .001$).

Similarly, for cognitive flexibility, individuals in the Proactive Learning Profile (Cluster 3) exhibited the highest levels ($M = 4.51$, $SD = 0.48$), significantly surpassing those in the Adaptive Learning Profile (Cluster 2) ($M = 3.95$, $SD = 0.55$; $MD = 0.56$, $p < .001$) and the Passive Learning Profile (Cluster 1) ($M = 3.39$, $SD = 0.62$; $MD = 1.12$, $p < .001$). The Adaptive Learning Profile also showed significantly greater cognitive flexibility than the Passive Learning Profile ($MD = 0.56$, $p < .001$). These findings conclusively demonstrate that higher levels of knowledge sharing and cognitive flexibility linearly align with more advanced, proactive organizational learning archetypes. The exhaustive post-hoc comparisons are presented in Table 4.

Table 4

Tukey's HSD Post-Hoc Comparisons for Knowledge Sharing and Cognitive Flexibility

Dependent Variable	Comparison (Cluster I vs. Cluster J)	Mean Difference ($I - J$)	Standard Error (SE)	p-value	95%CI Lower	95%CI Upper
Knowledge Sharing	Proactive (3) vs. Adaptive (2)	0.63	0.07	<.001	0.46	0.80
	Proactive (3) vs. Passive (1)	1.31	0.08	<.001	1.13	1.49
	Adaptive (2) vs. Passive (1)	0.68	0.07	<.001	0.52	0.84

IJIMOB
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Cognitive Flexibility	Proactive (3) vs. Adaptive (2)	0.56	0.06	<.001	0.42	0.70
	Proactive (3) vs. Passive (1)	1.12	0.07	<.001	0.96	1.28
	Adaptive (2) vs. Passive (1)	0.56	0.06	<.001	0.42	0.70

4 Discussion

The present investigation employed unsupervised machine learning techniques to identify latent organizational learning profiles among Egyptian corporate professionals and examined how knowledge sharing and cognitive flexibility differentiated these autonomously generated clusters. The K-means clustering algorithm revealed an optimal three-cluster solution, identifying a Passive Learning Profile (32.1%), an Adaptive Learning Profile (42.9%), and a Proactive Learning Profile (25.0%). Multivariate analysis of variance demonstrated highly significant omnibus effects across clusters (Wilks' $\Lambda = .51$, $p < .001$), with subsequent univariate and post-hoc analyses revealing that individuals in the Proactive Learning Profile exhibited significantly higher levels of both knowledge sharing ($M = 4.45$) and cognitive flexibility ($M = 4.51$) compared to those in the Adaptive Profile ($M = 3.82$ and $M = 3.95$, respectively; $p < .001$) and the Passive Profile ($M = 3.14$ and $M = 3.39$, respectively; $p < .001$). These findings provide empirical support for the proposition that organizational learning manifests through distinct, heterogeneous patterns within organizational populations and that both interpersonal knowledge exchange mechanisms and individual cognitive capabilities play critical differentiating roles in determining learning profile membership.

The identification of three distinct learning profiles aligns with theoretical frameworks suggesting that organizational learning is not a uniform phenomenon but rather exhibits considerable variability across individuals and contexts (Antunes & Pinheiro, 2020; Meher et al., 2024). The Passive Learning Profile, characterized by the lowest levels of knowledge sharing and cognitive flexibility, represents approximately one-third of the sample and suggests a segment of the workforce that engages minimally with organizational learning processes. This finding resonates with research highlighting barriers to knowledge sharing and organizational learning, including workplace ostracism, organizational silence, and lack of supportive organizational conditions (Alves et al., 2022; Takhsha et al., 2020). The Adaptive Learning Profile, representing the largest segment at 42.9%, demonstrates moderate engagement with learning processes and suggests a substantial proportion of employees who participate in organizational learning activities but may not fully leverage available knowledge resources or exhibit maximal cognitive adaptability. The Proactive Learning Profile, though representing only one-quarter of the sample, exhibits the highest levels of both knowledge sharing and cognitive flexibility, suggesting a segment of highly engaged learners who actively seek, exchange, and apply knowledge while demonstrating superior cognitive adaptability (Li et al., 2023; Zhang & Zheng, 2021).

The finding that knowledge sharing significantly differentiates organizational learning profiles provides strong empirical support for theoretical propositions emphasizing the centrality of knowledge exchange mechanisms in organizational learning processes (Castaneda & Rojas, 2024; Hoang & Le, 2025). Individuals in the Proactive Learning Profile demonstrated substantially higher knowledge sharing behaviors compared to those in Adaptive and Passive profiles, suggesting that active participation in knowledge exchange networks constitutes a defining characteristic of highly effective organizational learners. This result aligns with extensive prior research documenting positive associations between knowledge sharing and organizational learning outcomes across diverse contexts (Meher & Mishra, 2022; Mohammadi Moghaddam et al., 2017). The substantial difference in knowledge sharing levels between Proactive and Passive profiles ($\Delta M = 1.31$) underscores the magnitude of this differentiation and suggests that knowledge sharing represents not merely a marginal contributor but rather a fundamental dimension distinguishing learning effectiveness. These findings corroborate research in financial services demonstrating that knowledge sharing significantly enhances organizational learning capacity and service innovation (Abubakr & Kalifa, 2025; Castaneda & Rojas, 2024), as well as studies in educational contexts revealing that knowledge sharing, facilitated by transformational leadership and supportive organizational cultures, substantially enhances collective learning (Hoang & Le, 2025; Kim & Park, 2020).

The mediating role of knowledge sharing in translating organizational conditions into learning outcomes, as documented in previous research (Kim, 2021; Meher et al.,

IJIMOB
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2024), provides additional context for interpreting the present findings. Individuals in the Proactive Learning Profile may benefit from organizational environments characterized by knowledge-centered cultures, transformational leadership, and supportive organizational climates that facilitate knowledge exchange (Hoang & Le, 2025; Sorakraikitikul & Siengthai, 2014). Conversely, those in the Passive Learning Profile may experience organizational conditions that inhibit knowledge sharing, such as communication barriers, lack of psychological safety, or inadequate knowledge management infrastructure (Alves et al., 2022; Takhsha et al., 2020). The finding that knowledge sharing differentiates learning profiles also aligns with research emphasizing the importance of both tacit and explicit knowledge sharing in organizational learning processes (Balweh et al., 2022; Castaneda & Rojas, 2024), suggesting that effective organizational learners engage in diverse forms of knowledge exchange encompassing both codified information and experiential insights.

The significant differentiation of learning profiles based on cognitive flexibility provides compelling evidence for the critical role of individual cognitive capabilities in organizational learning effectiveness (Li et al., 2023; Zhang & Zheng, 2021). Individuals in the Proactive Learning Profile exhibited substantially higher cognitive flexibility ($M = 4.51$) compared to those in Adaptive ($M = 3.95$) and Passive ($M = 3.39$) profiles, suggesting that the capacity to shift perspectives, adapt thinking strategies, and integrate diverse information sources represents a defining characteristic of highly effective organizational learners. This finding aligns with theoretical frameworks emphasizing cognitive flexibility as a fundamental competence underlying adaptive learning and problem-solving in complex organizational environments (Antunes & Pinheiro, 2020; Moiri et al., 2022). The substantial difference in cognitive flexibility between Proactive and Passive profiles ($\Delta M = 1.12$) indicates that cognitive adaptability represents a major dimension distinguishing learning effectiveness and suggests that organizations seeking to enhance learning capacity must attend to both interpersonal knowledge exchange mechanisms and individual cognitive development.

The simultaneous differentiation of learning profiles based on both knowledge sharing and cognitive flexibility provides empirical support for theoretical propositions suggesting synergistic relationships between these factors (Li et al., 2023; Meher et al., 2024). The Proactive Learning Profile's elevation on both dimensions suggests that highly effective organizational learning emerges from the combination of robust knowledge exchange practices and superior cognitive adaptability, with each factor potentially amplifying the effects of the other. This finding resonates with research on ambidextrous organizational learning, which emphasizes the importance of both extensive knowledge sharing networks and cognitively flexible individuals capable of balancing exploitative and explorative learning demands (Balweh et al., 2022; Li et al., 2023). Individuals with high cognitive flexibility may be better positioned to effectively absorb, integrate, and apply knowledge acquired through sharing mechanisms, while active participation in knowledge sharing may provide the diverse informational inputs necessary for developing and exercising cognitive flexibility (Antunes & Pinheiro, 2020; Meher & Mishra, 2022).

The distribution of the sample across the three learning profiles, with the Adaptive Profile representing the largest segment (42.9%), the Passive Profile representing approximately one-third (32.1%), and the Proactive Profile representing one-quarter (25.0%), provides important insights into the current state of organizational learning in the Egyptian corporate context. The relatively small proportion of individuals exhibiting proactive learning patterns suggests substantial untapped potential for enhancing organizational learning capacity through targeted interventions addressing both knowledge sharing practices and cognitive flexibility development (Rafiei Zadeh, 2024; Salimi & Mousavi, 2019). The substantial proportion of individuals in the Passive Learning Profile (32.1%) indicates a significant segment of the workforce that may be disengaged from organizational learning processes, potentially due to organizational barriers, individual motivational factors, or lack of supportive conditions (Alves et al., 2022; Takhsha et al., 2020). These findings align with research emphasizing the importance of organizational conditions, including leadership behaviors, organizational culture, and structural arrangements, in facilitating or inhibiting knowledge sharing and learning (Kim & Park, 2020; Sorakraikitikul & Siengthai, 2014).

The application of unsupervised machine learning techniques to identify organizational learning profiles represents a methodological contribution that demonstrates the value of data-driven, exploratory approaches in organizational research (Bahari & Taheri Rouzbahani, 2023; Balweh et al., 2022). The K-means clustering algorithm's identification of three distinct profiles without imposing a

IJIMOB
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priori theoretical constraints provides empirically derived insights into the natural heterogeneity of organizational learning patterns. This approach complements traditional variable-centered analyses by revealing qualitatively different configurations of learning behaviors and their associated characteristics (Meher & Mishra, 2022; Moiri et al., 2022). The subsequent use of multivariate analysis of variance to examine how theoretically relevant variables differentiate identified clusters demonstrates the potential for integrating unsupervised learning techniques with traditional statistical methods to yield rich, multifaceted insights into organizational phenomena.

The findings have important implications for understanding the relationship between individual-level factors and organizational-level learning outcomes. Research has demonstrated that organizational learning culture, workplace spirituality, and supportive organizational climates significantly influence knowledge sharing behaviors and learning effectiveness (Marsick & Watkins, 2023; Sorakraikitikul & Siengthai, 2014). The present findings suggest that these organizational-level factors may operate by facilitating the development of proactive learning profiles characterized by high knowledge sharing and cognitive flexibility. Organizations seeking to enhance learning capacity should therefore attend to both creating supportive organizational conditions that facilitate knowledge exchange and developing individual cognitive capabilities that enable effective knowledge absorption and application (Hoang & Le, 2025; Meher et al., 2024). The mediating role of knowledge sharing in the relationship between organizational conditions and learning outcomes, as documented in previous research (Kim, 2021; Meher et al., 2024), suggests that interventions targeting organizational culture, leadership behaviors, and structural arrangements may enhance learning effectiveness by promoting knowledge sharing behaviors that characterize proactive learning profiles.

The finding that cognitive flexibility significantly differentiates learning profiles also has important implications for human resource management and employee development practices (Bahari & Taheri Rouzbahani, 2023; Moiri et al., 2022). Organizations may benefit from incorporating cognitive flexibility assessments into selection processes, identifying individuals with high cognitive adaptability for roles requiring substantial learning and adaptation. Additionally, training and development programs targeting cognitive flexibility enhancement, such as perspective-taking exercises, creative problem-solving training, and exposure to diverse knowledge domains, may help shift individuals from passive or adaptive learning profiles toward more proactive patterns (Antunes & Pinheiro, 2020; Zhang & Zheng, 2021). The integration of knowledge sharing mechanisms into human resource management systems, as suggested by previous research (Bahari & Taheri Rouzbahani, 2023; Balweh et al., 2022), represents another important avenue for enhancing organizational learning capacity by facilitating the knowledge exchange behaviors that characterize proactive learning profiles.

5 Conclusion

This study successfully leveraged advanced unsupervised machine learning techniques to autonomously uncover the hidden structural patterns of organizational learning within the corporate landscape, moving beyond traditional variable-centered analyses. By applying a rigorous data-driven clustering approach, the research empirically identified exactly 3distinct organizational learning archetypes: the Passive, Adaptive, and Proactive Learning Profiles. The findings unequivocally demonstrate that a corporate workforce does not operate as a monolithic learning entity; rather, employees naturally segment into these distinct behavioral cohorts based on their underlying cognitive and communicative tendencies. Crucially, the analytical results established that knowledge sharing and cognitive flexibility are not merely tangential operational benefits, but are the fundamental drivers that separate highly generative, proactive learners from their passive and reactive counterparts. Employees who exhibit the highest levels of cognitive elasticity and who actively engage in the bidirectional exchange of critical information consistently populate the Proactive Learning Profile, which represents the optimal state of continuous organizational evolution and resilience. Conversely, a distinct lack of these communicative and cognitive traits inevitably traps individuals in a state of passive organizational inertia. Consequently, the transition from a stagnant or merely adaptive workforce to a truly thriving learning organization requires a deliberate, dual-focused strategic intervention. Organizational leaders and management must systematically dismantle rigid operational silos to foster a psychologically safe environment where continuous knowledge donation and collection are structurally incentivized and culturally embedded into daily workflows. Simultaneously, enterprise talent development initiatives must prioritize the active

IJIMOB
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enhancement of individual cognitive agility, equipping employees with the dynamic mental frameworks necessary to navigate unpredictable market ambiguity and unlearn obsolete business practices. Ultimately, this research provides a robust, empirical blueprint for modern human resource practitioners, illustrating that cultivating an innovative corporate ecosystem depends intrinsically on nurturing the synergistic relationship between collaborative knowledge networks and highly adaptive human cognition.

Several limitations of the present study warrant acknowledgment and consideration in interpreting the findings. First, the cross-sectional design precludes causal inferences regarding the relationships among organizational learning profiles, knowledge sharing, and cognitive flexibility. While the findings demonstrate that these variables significantly differentiate learning profiles, the temporal ordering and causal mechanisms underlying these associations remain unclear. Longitudinal research designs tracking individuals over time would be necessary to establish whether knowledge sharing and cognitive flexibility precede the development of proactive learning profiles or whether profile membership influences subsequent knowledge sharing behaviors and cognitive development. Second, the reliance on self-report measures for all study variables introduces potential common method bias, which may inflate observed associations among constructs. Although self-report measures are appropriate for assessing subjective perceptions and behaviors, future research would benefit from incorporating objective performance indicators, peer ratings, or behavioral observations to complement self-reported data. Third, the sample was drawn exclusively from Egyptian corporate professionals, which may limit the generalizability of findings to other cultural, economic, or organizational contexts. Cultural factors, organizational structures, and economic conditions may influence the manifestation of organizational learning patterns and the relative importance of knowledge sharing and cognitive flexibility in differentiating learning profiles.

Fourth, the K-means clustering algorithm, while powerful for identifying distinct groupings, requires researchers to specify the number of clusters and assumes spherical cluster shapes, which may not fully capture the complexity of organizational learning patterns. Alternative clustering approaches, such as hierarchical clustering, density-based clustering, or mixture modeling, might reveal different profile structures or additional nuances in learning patterns. Fifth, the study focused exclusively on knowledge sharing and cognitive flexibility as differentiating variables, potentially overlooking other important factors that may distinguish learning profiles, such as motivation, self-efficacy, goal orientation, or emotional intelligence. A more comprehensive examination of multiple individual and organizational factors would provide a richer understanding of the characteristics distinguishing different learning profiles. Sixth, the study did not examine potential moderating factors that might influence the relationships between profile membership and outcomes, such as organizational size, industry sector, or job characteristics. Understanding how contextual factors moderate the manifestation and consequences of different learning profiles would enhance the practical applicability of findings.

Future research should address the limitations of the present study and extend understanding of organizational learning profiles through several promising directions. Longitudinal research designs tracking individuals over extended periods would enable examination of the stability of learning profiles over time, identification of factors precipitating transitions between profiles, and establishment of causal relationships between knowledge sharing, cognitive flexibility, and learning profile development. Such research could reveal whether learning profiles represent stable individual characteristics or malleable patterns that respond to organizational interventions and environmental changes. Additionally, longitudinal designs would permit examination of how different learning profiles relate to long-term career outcomes, organizational commitment, and performance trajectories, providing insights into the practical consequences of profile membership.

Comparative research examining organizational learning profiles across diverse cultural, economic, and organizational contexts would enhance understanding of the generalizability and contextual specificity of findings. Cross-cultural studies could reveal whether the three-profile structure identified in the Egyptian context replicates in other settings or whether different cultural values, organizational practices, and economic conditions give rise to alternative profile configurations. Such research would also illuminate how cultural dimensions, such as individualism-collectivism or power distance, influence the manifestation of knowledge sharing and cognitive flexibility within learning profiles. Multi-industry and multi-organizational studies would enable examination of how organizational characteristics, such as size, structure, technology intensity, and competitive environment,

IJIMOB
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influence the distribution of learning profiles and the factors differentiating them.

Methodological extensions employing alternative analytical approaches would provide complementary insights into organizational learning patterns. Latent profile analysis, which uses model-based clustering techniques, could identify profiles while simultaneously estimating measurement error and providing statistical tests for optimal profile solutions. Growth mixture modeling could examine trajectories of learning development over time and identify distinct developmental pathways. Network analysis approaches could illuminate how knowledge sharing networks differ across learning profiles and how network position influences profile membership. Qualitative research employing in-depth interviews or ethnographic observation could provide rich, contextualized understanding of the lived experiences of individuals in different learning profiles and the organizational conditions facilitating or inhibiting proactive learning patterns.

Intervention research examining the effectiveness of targeted programs designed to shift individuals from passive or adaptive profiles toward proactive learning patterns would have important practical implications. Experimental or quasi-experimental designs could evaluate the impact of knowledge sharing interventions, such as communities of practice, mentoring programs, or knowledge management system implementations, on learning profile transitions. Similarly, cognitive flexibility training programs could be evaluated for their effectiveness in enhancing cognitive adaptability and facilitating movement toward proactive learning profiles. Such research would provide evidence-based guidance for organizational development initiatives and human resource management practices aimed at enhancing organizational learning capacity.

Organizations seeking to enhance learning capacity and shift employees toward proactive learning profiles should implement comprehensive strategies addressing both knowledge sharing practices and cognitive flexibility development. Creating organizational cultures that value, recognize, and reward knowledge sharing represents a foundational step in facilitating the knowledge exchange behaviors characteristic of proactive learners. Organizations should establish formal knowledge sharing mechanisms, such as knowledge management systems, communities of practice, and cross-functional collaboration platforms, while simultaneously fostering informal knowledge exchange through physical workspace design, social events, and relationship-building activities. Leadership development programs should emphasize transformational leadership behaviors that inspire knowledge sharing, including articulating compelling visions, providing intellectual stimulation, and demonstrating individualized consideration for employee development needs.

Human resource management practices should be aligned with organizational learning objectives through multiple mechanisms. Selection processes should incorporate assessments of both knowledge sharing orientation and cognitive flexibility, identifying candidates predisposed toward proactive learning patterns. Onboarding programs should explicitly communicate organizational expectations regarding knowledge sharing and provide new employees with opportunities to develop relationships and integrate into knowledge exchange networks. Performance management systems should include knowledge sharing behaviors and learning outcomes as evaluation criteria, with corresponding recognition and reward structures reinforcing these behaviors. Career development pathways should provide opportunities for employees to develop cognitive flexibility through diverse job assignments, cross-functional projects, and exposure to varied organizational contexts.

Training and development initiatives should target both knowledge sharing skills and cognitive flexibility enhancement. Knowledge sharing training should address both technical skills, such as documentation and communication competencies, and interpersonal skills, such as active listening and collaborative problem-solving. Cognitive flexibility development programs should incorporate perspective-taking exercises, creative problem-solving challenges, scenario planning activities, and exposure to diverse knowledge domains. Mentoring and coaching programs pairing employees in passive or adaptive learning profiles with those exhibiting proactive learning patterns can facilitate knowledge transfer and model effective learning behaviors. Organizations should also address barriers to knowledge sharing and learning, such as excessive workload, time pressure, competitive reward structures, or lack of psychological safety, through systematic assessment and targeted interventions. Regular assessment of organizational learning patterns using clustering approaches similar to those employed in this study can help organizations monitor the distribution of learning profiles, identify segments requiring targeted support, and evaluate the effectiveness of learning enhancement initiatives over time.

Authors' Contributions

IJIMOB
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All authors have contributed significantly to the research process and the development of the manuscript.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were observed.

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