



# Impact of top management leadership styles on ERP assimilation and the role of organizational learning



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## ABSTRACT

We developed a theoretical model of how leadership style and organizational learning culture impact ERP assimilation and tested this model with data collected from organizations that have used ERP systems for at least 1 year. We found that the influence of transformational leadership on organizational learning was strong but mediated by the learning culture and that of transactional leadership on organizational learning was weak but direct. These results offer new perspectives on ERP assimilation theory and provide guidance for top management to exercise specific leadership behavior to achieve ERP assimilation and long-term ERP success.

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## 1. Introduction

In this era of intense competition and globalization, organizations are increasingly relying on integrated enterprise systems, such as enterprise resourcing planning (ERP) systems, to support business operations and competitive strategies. The popularity of ERP systems has grown dramatically over the last three decades. However, because of the scale and complexity of ERP systems, organizations often fail to fully utilize and explore the systems' capabilities to achieve business goals after the systems are committed to routine operations [1,2]. Extant literature suggests that few companies have fully appropriated the expected benefits from their ERP systems [3]. However, spectacular ERP failures are frequent [4], and the failure rate of ERP projects is especially high in China [5,6].

Consequently, studies in the past decades have focused on the drivers of ERP systems success, and top management leadership has been identified as one of the most critical success factors [7–11,94,96]. Because the use of an ERP system requires significant mutual adaptation of the system and the organization over an extended period of time, Shao et al. [12] argued that top management needs to exhibit specific leadership behavior to

motivate and inspire other managers and employees, resolve conflicts and rebalance powers, and reward desirable conducts at different phases of the system lifecycle: adoption, implementation, assimilation, and extension.

However, few studies have explored the relationship between top management leadership style and ERP success. Research that examines the impact of top management leadership style on ERP success has just begun to emerge (e.g., [10–16]). Yet most of these studies focused on ERP adoption and implementation, and only a few studies have explored the significant role of top management leadership style in ERP assimilation phase (e.g., [10–12]). We know little about the role different top management styles play in facilitating the assimilation of ERP systems after the systems are committed to routine use. Extant studies are often short on details of exactly how, where, and why “top management support” contributes to ERP success across its lifecycle [9].

The primary difference between the assimilation phase and the two preceding phases (adoption and implementation) is that in the assimilation phase, most of the radical customizations and business process reengineering activities are complete; thus, the most critical tasks are to understand how the system works in the context of business operations and how to use the system not only for improving routine business functions but also in new and innovative ways to solve emerging business problems [17]. Because of the technical complexity and integrative nature of most ERP systems, ERP assimilation is a long-term learning process that demands both exploitative and exploratory learning by users;

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doing without understanding is simply not an option in ERP assimilation. How to balance between exploitative and exploratory learning of ERP systems, to meet the complex demands and ensure the system's current and future viability, is a delicate challenge for any organization in the assimilation phase [18,19]. In this study, we draw upon the leadership theory and organizational learning theory to explore how top management leadership styles affect the assimilation of ERP systems by influencing organizational learning.

Although the leadership theory is rich and diverse, the transformational and transactional leadership framework [20,21] is particularly salient in the context of organizational learning. This is because organizational learning literature suggests that both transformational and transactional leadership are critical drivers of exploitative and exploratory learning [22]. In addition, organizational culture, more specifically the learning culture, is positively associated with both these two types of organizational learning [23], and top management has a strong influence on organizational culture [24]. However, no studies to our knowledge have developed a comprehensive model to examine the interrelationships of these constructs, especially in the context of ERP assimilation. Therefore, there is a significant gap in the literature regarding the joint effect of different types of leadership style, organizational culture, and organizational learning on ERP assimilation in organizations.

Given the significant role top management plays in fostering organizational culture [24,25], promoting organizational learning, and eventually assuring ERP systems success over their lifecycle [26,17,12], we propose that it is important to use a theory-driven approach to integrate leadership style, organizational learning culture, and organizational learning (exploitative and exploratory) into a single comprehensive model to develop a better understanding of the interactions among these factors and the impact of top management leadership on ERP success at the confluence of these interactions. This understanding will provide more effective guidelines to manage ERP and other large-scale enterprise systems.

Therefore, the primary objectives of this study are three fold. First, we want to examine the joint effect of leadership styles and organizational learning culture on both exploitative and exploratory learning of ERP systems in the assimilation process. Second, we want to establish how the exploitive and exploratory learning of ERP systems impact assimilation at organizational level. Finally, we want to test links between the two leadership styles and the two approaches to ERP systems learning. None of these relationships has been tested before with empirical data. To accomplish these research objectives, we build on the prior theoretical work by Shao et al. [12] on leadership styles and ERP lifecycle and adopted a theory-driven empirical study approach to test an integrated model that considers top management leadership style, organizational learning, and ERP assimilation theories and constructs.

## 2. Literature review

### 2.1. Transformational and transactional leadership

Leadership theory has developed significantly during the last century, and a paradigm shift occurred in the mid-1970 when new theories of leadership emerged under the labels of transformational and transactional leadership. Burns [20] argued that transactional leadership occurs when one person takes the initiative in making contact with others for the purpose of an exchange of something valued, whereas transformational leadership is based more on the compliance of follower through shifting their beliefs and values. Bass [21] refined this idea in his studies of leadership. He argued that transactional leaders “focus on what can clearly work, keeping time constraints in mind, doing what seems to be most efficient and free of risk”; therefore, they are mostly concerned with “how to best keep the system running for which they are responsible, reacting to problems generated by observed deviances, looking to modify conditions as needed, and remaining ever mindful of the organizational constraints within which they must operate” (p. 105). In contrast, “transformational leaders attempt and succeed in raising colleagues, subordinates, followers, clients, or constituencies to a greater awareness about the issues of consequence” (p. 17); therefore, “transformational leaders are more likely to be proactive than reactive in their thinking; more creative, novel, and innovative in their ideas; more radical or reactionary than reforming or conservative in ideology” (p. 105).

Bass [21] further argued that a significant characteristic that distinguishes transformational leadership from transactional leadership concerns with organizational culture. Transactional leaders tend to operate within existing culture and support the status quo, whereas transformational leaders frequently work toward changing organizational culture in line with their vision and prefer to seek new ways of working and new opportunities. In this study, we used the multifactor leadership questionnaire (MLQ) developed by Bass and Avolio [27] to define and measure transformational and transactional leadership. The MLQ framework refines the two leadership styles into seven subdimensions, and the description of each specific subdimension is shown in Table 1.

It is important to note that according to Bass [21], transformational and transactional leadership are not two ends of a spectrum but two separate dimensions of leadership, and a leader could possess both transformational and transactional qualities at the same time. Therefore, effective leaders are often described as those who integrate both transformational and transactional leadership characteristics and are able to exercise different leadership styles at different times or in different situations for maximum effectiveness [21,28].

**Table 1**  
Descriptions of Transformational and Transactional Leadership Style.

Leadership style	Dimensions of leadership style	Descriptions
Transformational leadership	Idealized attributes	Instills pride and gains respect and trust
	Idealized behaviors	Provides strategic vision and sense of mission
	Inspirational motivation	Communicates high expectations, uses symbols to focus efforts, express important purposes in simple ways
	Intellectual stimulation	Promotes intelligence, rationality, and careful problem solving
	Individualized consideration	Gives personal attention, treats each employee individually, coaches, advises
Transactional leadership	Contingent rewards	Contracts exchange of rewards for effort, promises rewards for good performance, recognizes accomplishments
	Management by exception	Watches and searches for deviations from rules and standards, takes corrective action

## 2.2. Organizational learning

Simon [98] argued that organizational learning “was learning by an individual that had consequences for an organizational decision” (p. 125). Jones [29] defined organizational learning as a process through which managers try to increase organizational members’ capabilities to better manage the organization and its environment. According to March [30], there are two types of qualitatively different learning activities between which organizations often divide attention and resources: exploration and exploitation. Exploration reflects organization behavior characterized by search, variation, risk taking, experimentation, play, flexibility, discovery, and innovation, whereas exploitation reflects organization behavior characterized by refinement, choice, production, efficiency, selection, implementation, and execution [30].

However, organizations do not have to choose between these two distinct learning activities, and some degree of ambidexterity is often the desired outcome [31,32]. Levinthal and March [33] argued that “the basic problem confronting an organization is to engage in sufficient exploitation to ensure its current viability and, at the same time, to devote enough energy to exploration to ensure its future viability” (p. 105). Organizations that engage in more exploration but less exploitative learning are more likely to suffer the costs of experimentation without gaining many of its benefits; in contrast, organizations that engage in more exploitation but less exploratory learning are likely to find themselves trapped in suboptimal stable equilibrium [30]. Thus, maintaining an appropriate balance between exploration and exploitation is a primary concern and objective in organizational survival and prosperity. An ambidextrous organization that is capable of operating simultaneously to explore and to exploit is likely to achieve superior performance than those emphasizing one at the expense of the other [34].

In this study, we used the organizational learning framework proposed by March [30] as the theoretical foundation to define exploitative learning and exploratory learning of ERP systems, as illustrated in Table 2.

## 2.3. Organizational learning culture

Organizational learning does not occur in isolation but within the confines of organizational context. Because learning by definition is an interactive and social process [35,98], organizational culture pertaining to learning will inevitably influence why learning occurs, how learning happens, what is being learned, and what consequences of learning are. Schein [24] defined organizational learning culture as a pattern of basic assumptions—*invented, discovered, or developed by a group as it learns to cope with its problems of external adaptation and internal integration*. Organizations that have developed a strong learning culture are good at creating, acquiring, and transferring knowledge and at modifying behavior to reflect new knowledge and insight [36].

On the basis of Schein’s [24] conceptualization of organizational culture, three social dimensions are frequently highlighted in the literature as values of organizational culture facilitating learning that focus on patterns of participation and interaction: psychological safety [37,38], participation in decision making [39,40], and

openness to diverse opinions [41,42]. Nemanich and Vera [23] suggested organizational learning culture as a multidimensional concept and used the three dimensions to measure organizational learning culture. Empirical results showed that the three learning culture factors loaded high on a single factor [23]. Drawing from these theoretical and empirical studies, we used the three dimensions to represent a higher-order construct of organizational learning culture. We did not consider other less widely accepted learning culture values because they were not consequential in prior empirical studies or were closely related to the dimensions we included [23]. Table 3 describes the definitions of the dimensions of organizational learning culture.

## 2.4. ERP assimilation

The definition of ERP assimilation stems from the literature on IT assimilation. ERP assimilation is conceptualized as the extent to which the use of ERP technology diffuses across the organizational projects or work processes and becomes routinized in the activities of those projects and processes [44,45]. Research on ERP assimilation is just emerging compared to research on ERP adoption and implementation [45,46,26,17]. Earlier studies judged ERP success according to its initial implementation, such as implementation cost, time, initial performance, and other aspects primarily from the project management perspective. There is no clear consensus on the subsequent phases after implementation in the ERP lifecycle, and they have not received adequate attention [12]. ERP assimilation is a long-term and continuous improvement process, and the business values of the system’s applications cannot be fully realized until the applications are extensively assimilated in an organization [45]. In the assimilation phase, an ERP system is in routine use but still frequently encounters unforeseen business events and user demands for new information either to be incorporated into the system or to be extracted from the system to support expanding business transactions and higher levels of decision-making. In a recent study, Liu et al. [26] defined the organizational-level ERP assimilation as “the extent to which the ERP technology is used in facilitating business processes and the degree it supports business decision making at operational and strategic levels” (p. 188). We adopted this definition in this study to develop the theoretical model and measure ERP assimilation.

## 2.5. Theoretical gaps in the extant literature

The extant literature has explored the relationship between top management leadership and organizational learning, relationship between top management leadership and organizational culture, and relationship between organizational culture and organizational learning in separate research streams and contexts. However, in organizational life, these three sets of relationships are clearly intertwined and cannot be separated. We found no published studies that have incorporated all three sets of relationships into one integrated theoretical model, either in the context of ERP assimilation or in other organizational contexts. Given the significant impact of enterprises systems, such as ERP, SCM, and CRM, on organizational performance and ultimately organizational survival in the highly competitive global economy,

**Table 2**  
Exploratory and Exploitative Learning of ERP Systems.

ERP systems learning	Definitions	References
Exploitative learning	Developing deep understanding of existing ERP system functionalities and capabilities through continuous refinement and execution	[30]
Exploratory learning	Developing innovative use of ERP system functionalities and new capabilities through experimentation and discovery	

**Table 3**  
Organizational Learning Culture.

Organizational learning culture	Definitions	References
Psychological safety	The degree to which employees feel they are safe from punishment for risk taking	[37]
Participation in decision-making	The degree to which employees are involved in determining future strategies	[70]
Openness to diverse opinions	The degree to which employees feel they are encouraged to bring forth different ideas	[71]

this literature gap has important theoretical and practical ramifications for scholars and managers.

In the ERP assimilation phase, how to make users develop better comprehension of ERP system functionalities and interconnected cross functional modules is a key challenge for management. On the one hand, an organization needs to exploit the ERP system to fully utilize its functionalities and capabilities for existing business processes and functions; on the other hand, the organization also needs to explore how to take advantage of these capabilities and functionalities to enable and support new and innovative business processes and functions that were not considered or intended when the system was designed and implemented. Thus, both exploitative learning and exploratory learning appear to be indispensable in ERP assimilation phase. One key question is, what should top management do to foster the ambidextrous learning in ERP assimilation? This critical issue is yet to be addressed in the ERP research literature.

### 3. Theory and hypotheses development

#### 3.1. Transformational leadership and organizational learning

The extant literature suggests that transformational leadership is a critical driving force behind psychological safety learning culture [23]. Transformational leaders attend to employees' individual needs and prefer to provide direct communication and advisory to employees; they are more likely to use emotional appeals to offer a compelling vision of the future and inspire followers to commit to a shared vision [58]. This leadership style is beneficial for gaining respect and trust from followers, and it encourages followers to devote more efforts toward organizational success by continuous learning of organizational systems without worrying too much about potential risks [47], especially when there are significant uncertainties associated with the outcomes of these learning activities within organizations [48,49]. Thus, we argue

**H1a.** Transformational leadership is positively related to the organizational learning culture of psychological safety.

The relationship between psychological safety culture and organizational learning has been addressed in the extant literature. Schein [24] argued that in a learning culture that values proactive problem solving and risk taking, organizational members tend to believe that changing the environment is desirable and thus are more willing to embrace change. Empirical studies suggest that psychological safety culture is beneficial for both exploitative and exploratory learning. Because both types of learning involve potential risk such as refinements to existing knowledge and experimentation with new functionalities, a risk-taking oriented culture is more likely to foster these learning behaviors by lowering the fear that individuals may be punished for some unanticipated outcomes or failures [23].

ERP systems are complex and of large scale, and adapting to a new ERP system will cause significant uncertainty among users because they are unsure about the resulting changes [50]. Similar argument can be made about making any changes to the prescribed use of the implemented ERP system and implementing

system extensions to augment its functionality for new business needs. To reduce or alleviate this uncertainty, top executives need to care about the individuals' concerns and attend to these concerns through communication and advisory to make the followers feel that they are safe from punishment if they take risks and explore new ideas [37]. Given the fact that an ERP system is integrated and complex, any exploitative and exploratory activities on the system can have high risks and lead to uncertain results. Thus, transformational leaders are more likely to foster a psychological safety learning culture within the organization by making individuals to feel that they are cared and encouraged [51], which enables and motivates users to exploit and explore the implemented ERP system for the benefit of the organization. Thus, we propose

**H1b.** The learning culture of psychological safety is positively related to the exploitative learning of ERP systems.

**H1c.** The learning culture of psychological safety is positively related to the exploratory learning of ERP systems.

The positive relationship between transformational leadership and the learning culture of participation in decision-making has been well-established in the literature. According to Bass and Avolio [27], transformational leadership can stimulate individuals to participate in organizational decision-making with clear articulation and communication of organizational goals and strategies. This type of leadership behaviors can alter individuals' belief in ways that foster psychological motivation, make them more likely to take a proactive orientation toward participation in organizational goals, and invoke stronger motivations for learning new knowledge and experimenting new ideas [52–54]. Thus, we propose

**H2a.** Transformational leadership is positively related to organizational learning culture of participation in decision-making.

Because an ERP system is a cross-functional transaction platform in which changes in any one component or subprocess could have considerable ripple effect on other components and subprocesses across an organization, a participative decision-making culture is required to foster organization-wide participation from different units to share information and knowledge related to the ERP system [55,47]. Ke and Wei [15] argued that participative culture benefits organizational learning in ERP implementation by providing employees a sense of ownership and control that encourage employees to embrace the ERP system.

In the context of acquisition integration, Nemanich and Vera [23] argued that participative decision-making culture supports both exploration and exploitation processes in organizations. According to the authors, participation in decision-making is important for exploration because participation increases individuals' willingness to accept change and can help overcome their tendency to cling to past routines. The cross-fertilization of perspectives that are integral to shared decision-making can lead to new intuition and fresh interpretation [56], which are essential to both exploratory and exploitive learning. Nemanich and Vera [23] further argued that “in order to make the creative leap

intrinsic to exploration, people need to build connections between what they are doing and why they are doing it. Analyzing alternatives in a participative system leads to a deeper appreciation of expected outcomes and mechanisms to achieve them, which facilitates exploration processes” (p. 24). Similar arguments can be made about exploitation as well because building a deep understanding of what, how, and why about the current processes and analyzing alternatives vis-à-vis expected outcomes are also the essential elements of exploitation. Hurley and Hult [39] found that when members of a group are encouraged to learn and develop and able to influence group decisions, the group is more innovative.

There is a strong parallel between acquisition integration and ERP assimilation in organizations. ERP systems may conflict with the vested interest and status quo of stakeholders from different departments or units within the organization [6], and organization-wide participation is more likely to resolve controversial issues by facilitating the goal congruence among different stakeholders [6]. Participative decision-making facilitates the understanding and appreciation of the ERP system, its functionality, the integrated nature of business processes embedded in the software, and the impact of changes in one part on the rest of the system and processes [39]. Therefore, participative learning culture motivates and encourages individuals to explore new and different ways of using the systems to support organizational goals and strategies [22,57]. Applying the same logic to ERP assimilation, we argue that

**H2b.** The learning culture of participation in decision-making is positively related to exploitative learning of ERP systems.

**H2c.** The learning culture of participation in decision-making is positively related to exploratory learning of ERP systems.

Transformational leadership is also a critical driver of the organizational learning culture of openness to diverse opinions. Openness to diverse opinions refers to the degree to which employees feel they are encouraged to bring forth different ideas. By definition, transformational leaders are more open and attentive to individual ideas and can foster an organizational culture that is open to diverse ideas by intellectual stimulation and interpersonal consideration [21,54]. Schein [24] argued that “the learning leader should stimulate diversity and promulgate the assumption that diversity is desirable at the individual and the subgroup levels” (p. 401). He further stated that such diversity will create subcultures that are necessary for learning innovation if these subcultures are connected to value each other to ensure cross-culture communications and understanding throughout the organization [24]. Through the influence of inspirational motivation and intellectual stimulation, transformational leaders can enhance employees’ intrinsic motivation to develop new ideas and question outmoded operating rules, and this type of leadership behavior is more likely to foster a learning culture that welcomes different ideas [58,47]. Thus, we hypothesize

**H3a.** Transformational leadership is positively related to organizational learning culture of openness to diverse opinions.

Schein [24] argued that a learning culture that welcomes different opinions is beneficial for organizational learning because getting feedback and taking time to reflect, analyze, and assimilate the implications of what the feedback has communicated is key to learning. A learning culture that is open to diverse opinions is congruent to the organizational culture of tolerance for conflicts and risks frequently referred in the literature, which has been found to be positively related to organizational learning and innovation [15]. Fiol [59] argued that simultaneous agreement and disagreement in teams is critically important in corporate

innovative efforts, and successful innovations require a collective understanding that incorporates new and different ideas.

In the context of ERP implementation, Ke and Wei [15] suggested that an open learning culture transmits a signal to all kinds of employees that their ideas are valued and important for the organization, and this in turn increases the employees’ confidence in utilizing and innovating ERP system’ functionalities to support organizational goals and strategies. The same logic applies to both exploratory and exploitative learning during ERP assimilation where learning happens primarily among organizational users with different levels of knowledge and skill, such as VIP users, power users, and transactions users [17]. In a learning culture that respects diverse opinions, transactions users would not feel intimidated by the presence of power users or VIPs when voicing their ideas about using the ERP system in innovative ways to meet new business needs. In the same vein, VIP users would be more open to the ideas of power users and transaction users on how to meet the new strategic business challenges through new modules or redefined business processes in the ERP systems [17]. This discussion leads to the following hypotheses:

**H3b.** The learning culture of openness to diverse opinions is positively related to exploitative learning of ERP systems.

**H3c.** The learning culture of openness to diverse opinions is positively related to exploratory learning of ERP systems.

### 3.2. Transactional leadership and organizational learning

The leadership theory suggests that organizational learning requires strategic leaders to frequently perform roles involving both transformational and transactional leadership behaviors [60]. This is because while transformational leaders change followers’ behavior largely by facilitating the organizational culture [24], transactional leaders change followers’ behavior primarily using exchange mechanisms such as rewards and incentives within existing culture [21,61]. In ERP assimilation phase, in addition to encouraging and inspiring users by exhibiting strategic vision and inspirational motivation, which are largely associated with transformational leadership style, top executives also need to establish clear expectations and rewards systems based on performance in using ERP systems for operations and innovations [12], which are largely exhibited in transactional leaders.

Transactional leaders monitor individual and team performance to anticipate mistakes and take corrective actions when needed and prefer to interact with employees on the basis of exchanges whereby individuals are explicitly rewarded for accomplishing predefined objectives [21]. Extant literature suggests that transactional leadership refines organizational learning by motivating organizational members to use and take advantage of knowledge stored in the organization’s structure, strategy, procedures, and systems [62,23]. Management by exception behavior has been found to be positively associated with incremental innovations that focus on making small, testable changes [63]. In the context of ERP assimilation, this style of leadership is beneficial to stimulate users to develop a deeper understanding of the system functionalities in support of routine business operations if the users know how they would be evaluated and rewarded [17].

Transactional leadership may also be positively associated with exploratory learning when leaders reward individuals and groups for developing creative and new ideas in support of future business development [17,12]. The extant literature suggests that contingent rewards can motivate individuals to exercise creative thinking in examining current ways of doing things by articulating explicit agreements regarding what the leader expects from organizational

members and how they will be rewarded for their efforts and commitment [64]. In ERP assimilation phase, this type of leadership behavior is more likely to stimulate employees to explore ERP system features and think innovatively about how the system could be used and transfer what they have learned into their work in support of new business operations and future competitive strategies [64]. However, modification of behavior through exchange transactions is unlikely to cause significant changes in the belief system of the individuals, which are an essential element of culture and the primary mechanism of transformational leaders. Thus, in contrast to transformational leadership style, we do not assume and there is clear literature support that organizational learning culture plays any significant mediating role between transactional leadership style and organizational learning. This line of logic leads to the following hypotheses:

**H4.** Transactional leadership is positively related to exploitative learning of ERP systems.

**H5.** Transactional leadership is positively related to exploratory learning of ERP systems.

### 3.3. Organizational learning and ERP assimilation

Prior studies have shown that firms may simultaneously pursue exploratory and exploitative learning in external knowledge acquisition and internal knowledge integration [65,66]. Exploitative learning and exploratory learning can be complementary, and the simultaneous development of these two types of learning has positive impacts on organizational innovation and performance [30,67,68]. For instance, Kim and Atuahene-Gima [69] found that exploratory market learning enhances the differentiation of new products but does not hinder product cost efficiency, whereas exploitative market learning improves the cost efficiency of new products but does not impair product differentiation. The authors argue that exploratory and exploitative market learning should be implemented in parallel to create successful positional advantages of the new product.

In ERP assimilation phase, both types of learning are essential. On the one hand, an organization needs to have employees who develop a deeper understanding of the ERP system’s functionalities and capabilities to support routine business operations [17]. Because an ERP system is often complex and of large scale, the training in implementation phase is often not adequate for the employees to understand the business logic and processes within the ERP system, and continuous training and self-learning are necessary. On the other hand, new business requirements may emerge in support of new markets, products, and services, and thus, experimentation and exploration of the system’s

functionalities are also needed [54]. To satisfy these new business requirements, exploratory learning of the ERP system becomes indispensable in assimilation phase. Drawing upon this analysis, we argue that

**H6.** Exploitative learning of ERP systems is positively related to ERP assimilation.

**H7.** Exploratory learning of ERP systems is positively related to ERP assimilation.

In addition to these theoretically relevant constructs, we also included critical control variables in the research model to better account for differences among the sample organizations. The three control variables are sales, ownership, and ERP use time (number of years since the systems implementation has been completed). We selected these three variables because of their potential impact on ERP assimilation [45]. We summarized and illustrated these research hypotheses in an integrated theoretical model, as shown in Fig. 1. In the following sections, we describe how this model is tested with empirical data and discuss our main findings.

## 4. Research methodology

### 4.1. Survey instrument

The questionnaire was designed on the basis of the extant literature and adapted to the context of ERP assimilation. We designed 3–4 items for each construct, and all items were measured on a seven-point Likert scale. Most of the scales were adopted from the original literature, but many scales were adapted or modified to fit the ERP assimilation context. The original references of each construct and measurements are provided in Table 4.

A pilot study was conducted first before the final data collection to improve the quality of the instrument. A total of 70 EMBA students enrolled in a large Chinese university were invited to participate, and 50 completed questionnaires were received. Data analysis suggested that most of the items loaded high on their intended constructs. We deleted a few items with factor loadings lower than 0.7 to improve the validity of the constructs [72]. The final survey instrument is included in Appendix A.

### 4.2. Data collection

We initially contacted a large ERP software provider in Harbin, China, and selected their clients as a convenient sample. In addition, we also contacted firms in Shanghai, Beijing, and Shandong in China to improve the sample distribution. Considering that assimilation only happens after ERP implementation is complete and the ERP system is in routine use, it is important to

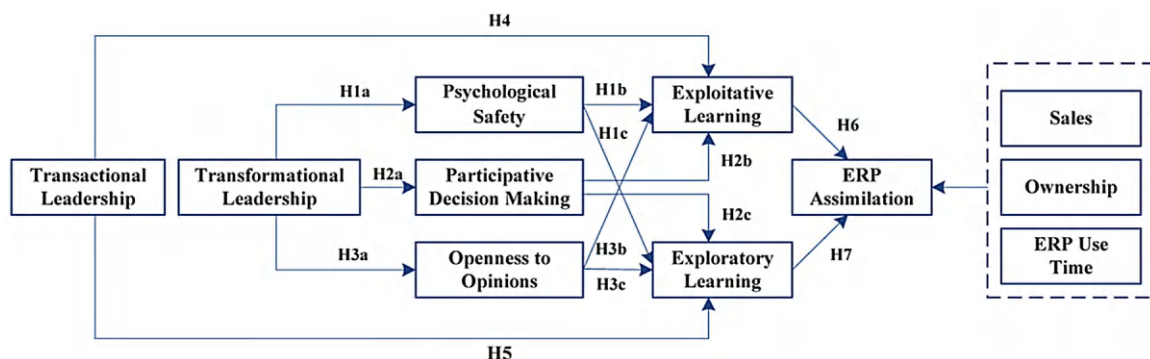


Fig. 1. Research Model and Hypotheses.

**Table 4**  
Operationalization of Constructs.

Constructs	Subconstructs	Items	References
Transformational leadership	Idealized attributes	IA1-A4	[27]
	Idealized behaviors	IB1-IB4	
	Inspirational motivation	IM1-IM4	
	Intellectual stimulation	IS1-IS4	
	Interpersonal consideration	IC1-IC4	
Transactional leadership	Contingent rewards	CR1-CR4	[27]
	Management by exception	MBE1-MBE4	
Organizational learning culture	Psychological safety	PS1-PS4	[37]
	Participation in decision-making	PD1-PD4	[70]
	Openness to diverse opinions	OP1-OP4	[71]
ERP systems learning	Exploitative learning	EIL1-EIL4	[23]
	Exploratory learning	EOL1-EOL4	
ERP assimilation		AS1-AS3	[26]

include firms that have been using ERP system for long enough time to allow for significant assimilation to occur. We set this time threshold as 1 year, and thus, all the firms in the sample must have used ERP systems for at least 1 year. In addition, all the firms must have appointed at least one top executive to be in charge of the ERP systems after the implementation phase was completed. Finally, we obtained 190 firms that satisfied our requirements.

To reduce the common method bias in survey-based research, we collected data from different sources within each sample firm following the recommendation by Podsakoff et al. [73]. The questionnaires were sent by email to a top executive and his direct subordinate (e.g., director of IT department) separately. The top executive was asked to self-evaluate his/her leadership style and ERP assimilation, whereas the direct subordinate was asked to evaluate the top executive's leadership style, the organizational learning culture, and exploitative learning and exploratory learning of ERP systems. The questionnaires for the top executive and the direct subordinate are included in Tables A1 and A2 of Appendix A, respectively.

A total of 322 questionnaires were received from the 190 firms, with 160 from the top executives and 172 from the direct subordinates. Nonresponse bias was examined by comparing the responding and nonresponding companies' industry type, ownership, and sales income, and a *t*-test suggested that there are no significant differences ( $p < 0.05$ ). We matched the questionnaires from the top executives and the direct subordinates and deleted the unmatched ones from the samples. This resulted in 153 valid paired samples from 153 firms. We combined the dataset from the top executive and the direct subordinate and finally got 153 valid data cases.

We then examined the missing values in the dataset. In total, there were 21 cases with missing values in the dataset. We used the listwise deletion approach and deleted the 21 incomplete cases from the dataset [74]. There were also 32 cases with incomplete information in firm characteristics. We reinvestigate these firms by email or phone to complete the firm characteristics information with regard to ownership, industry type, sales, and ERP use time. Finally, we got 132 complete data cases for data analysis. Profiles of the 132 sample firms are illustrated in Table 5.

From Table 5, we can see that most of the samples are small and medium-sized firms, and the majority of the sample firms had used ERP systems for much longer time, with an average of 5.2 years, and approximately half the firms having been using ERP systems for 5 years or longer.

After the final data collection, we conducted a pair-wised *t*-test to examine the consistency of leadership style evaluated by the top

**Table 5**  
Profiles of the Sample Firms.

Firm characteristics	Categories	Percentage
Firm ownership	State owned	39.1
	Joint venture	7.4
	Private	48.5
	Foreign invested	5
Industry type	Manufactures	36.6
	Retails	12.9
	Public administration	11.8
	Construction	8.5
	IT service	5.3
	Others	24.9
Sales income (million RMB)	10–100	26.7
	101–500	50.4
	501–1000	14.2
	1001–5000	6.8
	>5000	1.9
ERP in use (years)	1–2	13.8
	3–5	36.9
	5–10	34.6
	>10	14.7

executive themselves and their subordinates, and the result is given in Table B1 of Appendix B. The pair-wised *t*-test result suggested that there is no significant difference between self-reported and the subordinate's evaluation on leadership traits. Thus, we used the subordinate's evaluation of the top executive's leadership traits for data analysis, as suggested in previous empirical studies [75,22].

## 5. Data analysis and results

We used SmartPLS as the primary statistical tool to analyze the measurement model and the structural model for hypothesis testing [76]. The component-based partial least square (PLS) method was chosen primarily because of its ability to accommodate smaller data samples without requiring normal distribution of the data, and the sample size ( $N = 132$ ) in our study meets the common standards for PLS modeling in the literature [72,77]. Another reason for choosing PLS is that it is more suited for predictive applications and theory building in contrast to covariance-based SEM [77]. The bootstrapping procedure with resampling method was used in our study to estimate the

statistical significance of the parameter estimates to derive valid standard errors or t-values [78].

5.1. Measurement of the second-order constructs

The extant literature indicates that transformational leadership and transactional leadership are reflective second-order constructs [21,27]. Because SmartPLS does not directly permit the modeling of second-order constructs, following Chin [79], we computed the first-order factor scores and then used them as manifest indicators of the second-order constructs. We first examined the reliability and validity of the items for the five first-order constructs of transformational leadership and the two first-order constructs of transactional leadership, namely idealized attributes (IA), idealized behaviors (IB), inspirational motivation (IM), intellectual stimulation (IS), interpersonal consideration (IC), contingent rewards (CR), and management by exception (MBE), and the results are given in Table 6. Table 6 shows that the composite reliability of all the leadership factors have exceeded 0.85, and the item loadings of each leadership factor are above 0.8 ( $p < 0.01$ ), indicating a good reliability and validity of the items [80,81].

We used the factor loadings of each item as weights to calculate the factor scores of the seven first-order constructs, as suggested in the previous studies [79,82,83]. Specifically, we computed five sets of factor scores according to the item scores of IA, IB, IM, IS, and IC. The five factor scores were then used as indicators for the second-order construct transformational leadership in the model. Similarly, we computed two sets of factor scores depending on the item scores of CR and MBE and used the two factor scores as indicators for the second-order construct transactional leadership in the model.

**Table 6**  
Composite Reliability and Factor Loadings of Leadership Subconstructs.

Leadership factors	Items	Loadings	T value	Composite reliability
Idealized attributes	IA1	0.907	64.25	0.916
	IA2	0.895	46.43	
	IA3	0.864	45.79	
	IA4	0.913	84.00	
Idealized behaviors	IB1	0.819	90.17	0.888
	IB2	0.903	56.98	
	IB3	0.859	80.50	
	IB4	0.898	72.06	
Inspirational motivation	IM1	0.876	54.50	0.915
	IM2	0.916	85.34	
	IM3	0.910	70.05	
	IM4	0.879	60.54	
Intellectual stimulation	IS1	0.868	43.12	0.910
	IS2	0.912	67.25	
	IS3	0.865	59.58	
	IS4	0.907	72.82	
Interpersonal consideration	IC1	0.877	76.56	0.886
	IC2	0.885	41.12	
	IC3	0.817	34.07	
	IC4	0.875	55.70	
Contingent rewards	CR1	0.880	43.64	0.924
	CR2	0.914	82.01	
	CR3	0.916	71.28	
	CR4	0.908	64.58	
Management by exception	MBE1	0.853	47.93	0.904
	MBE2	0.914	92.60	
	MBE3	0.906	86.19	
	MBE4	0.854	30.73	

5.2. Measurement of the first-order constructs

We then examined the measurement model of the first-order constructs to analyze their reliability, convergent validity, and discriminant validity [77,80]. Construct reliability addresses how well the items for one construct correlate or move together, and it is assessed by the indicator of composite reliability. Table 7 suggests that the composite reliability of each construct is greater than 0.85, which is higher than the recommended value of 0.7, illustrating a good construct reliability in our study [80,81].

Convergent validity is defined as the degree to which the measurement items are related to the construct to which they are theoretically predicted to be related. As shown in Table 6, the item loadings of all the constructs are above 0.8, and all of the loadings are significant at  $p < 0.01$  ( $t > 2.576$ ). In addition, the AVE of each construct is above 0.8, indicating that the latent construct can account for at least 80% of the variance in their corresponding items. The above analysis suggests a good convergent validity of the constructs [80,81].

Discriminant validity refers to the degree to which items differentiate between constructs, and it can be assessed by two criteria: (1) The square root of the average variance extracted (AVE) by a construct from its indicators should be at least 0.707 ( $AVE > 0.50$ ) and should exceed that construct's correlation with other constructs [79,72] and (2) items should load highly on constructs they are intended to measure than on other constructs [82]. We first examined the discriminant validity by comparing the construct's correlation and the square root of the AVE of each construct. As shown in Table 8, the square root of the AVE (values on the diagonal in bold typeface) of each construct is above 0.707

**Table 7**  
Convergent Validity.

Constructs	Items	Loadings	t value	Composite Reliability	AVE
Transformational leadership	IA	0.89	52.60	0.97	0.86
	IB	0.94	46.13		
	IM	0.94	33.96		
	IS	0.93	52.35		
	IC	0.93	30.36		
Transactional leadership	CR	0.96	25.98	0.95	0.91
	MBE	0.95	30.18		
Psychological safety	PS2	0.91	41.36	0.94	0.83
	PS3	0.92	40.32		
	PS4	0.92	39.55		
Openness to diverse opinions	OP2	0.91	29.82	0.91	0.77
	OP3	0.91	43.36		
	OP4	0.91	34.94		
Participation in decision-making	PD1	0.87	29.82	0.94	0.84
	PD2	0.87	43.36		
	PD3	0.89	34.94		
ERP systems Exploitative learning	EIL2	0.96	75.54	0.97	0.91
	EIL3	0.94	85.69		
	EIL4	0.96	85.40		
ERP systems Exploratory learning	EOL2	0.98	98.25	0.97	0.92
	EOL3	0.95	73.84		
	EOL4	0.95	71.36		
ERP assimilation	AS1	0.96	53.32	0.97	0.91
	AS2	0.96	45.57		
	AS3	0.95	41.99		



**Table 8**  
Correlation Analysis of Latent Variables.

No.	Construct	Mean	Std.	1	2	3	4	5	6	7	8
1	Transformational leadership	4.42	0.69	<b>0.92</b>							
2	Transactional leadership	4.53	0.81	0.77	<b>0.95</b>						
3	Psychological safety	4.95	0.93	0.62	0.66	<b>0.91</b>					
4	Openness to diverse opinions	4.84	0.86	0.64	0.65	0.65	<b>0.87</b>				
5	Participation in decision making	4.74	0.75	0.69	0.67	0.71	0.75	<b>0.91</b>			
6	Exploitative learning	4.60	0.95	0.72	0.68	0.72	0.72	0.65	<b>0.95</b>		
7	Exploratory learning	4.76	0.86	0.66	0.67	0.74	0.71	0.65	0.76	<b>0.96</b>	
8	ERP assimilation	4.09	1.06	0.37	0.43	0.48	0.41	0.54	0.68	0.63	<b>0.95</b>

Note: Values on the diagonal and bold are AVEs.

and is greater than that construct’s correlation with other constructs, suggesting good discriminant validity.

We then examined the item cross-loadings of the constructs. As shown in Table B2 of Appendix B, each item loads higher on its assigned construct than on the other constructs, demonstrating a reasonable discriminant validity [80].

5.3. Structural model

After the confirmation that the measurement instrument exhibits satisfactory reliability, convergent validity, and discriminant validity, we tested our theoretical structural model using SmartPLS. The primary quality indicators for the structural model in PLS techniques are the significance of the path coefficients between latent variables and the R<sup>2</sup> values of the endogenous variables, which measure how much of the variances in the endogenous constructs are explained by the exogenous constructs specified in the model [84,77]. The PLS test result is illustrated in Fig. 2.

From Fig. 2, we can see that the majority of the hypothesized relationships are supported by the data, with only one exception. Transformational leadership is positively related with all three types of organizational culture, providing support for hypotheses H1a ( $\beta = 0.81, p < 0.01$ ), H2a ( $\beta = 0.60, p < 0.01$ ), and H3a ( $\beta = 0.72, p < 0.01$ ). Psychological safety is positively related with both exploitative learning and exploratory learning, providing support for hypotheses H1b ( $\beta = 0.40, p < 0.01$ ) and H1c ( $\beta = 0.35, p < 0.01$ ). This result indicates that in ERP assimilation phase, top executives need to promote a climate of psychological safety within the organization by attending to personal concerns and gaining respect and trust among followers, thus making organizational members feel safe from punishment for risk taking, which motivates them to exploit and explore ERP systems.

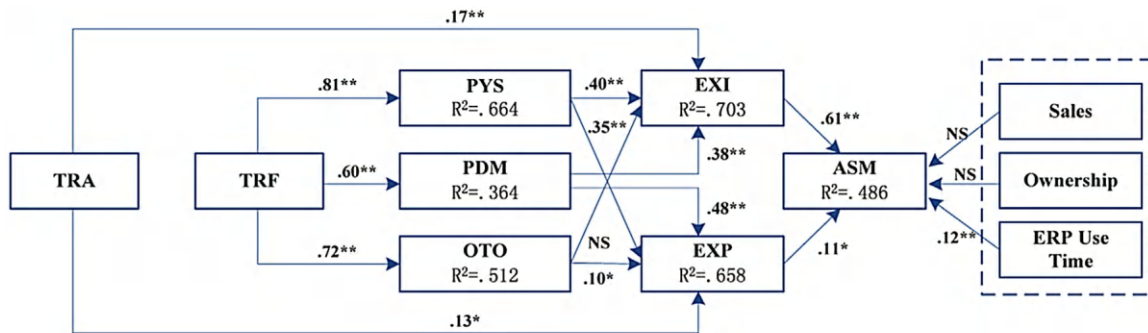
Participative decision-making culture is also positively related with both ERP exploitative and exploratory learning, supporting

hypotheses H2b ( $\beta = 0.38, p < 0.01$ ) and H2c ( $\beta = 0.48, p < 0.01$ ). This result suggests that in ERP assimilation phase, participation in decision-making is important for the employees to develop a deeper understanding of the system’s functionalities and explore new ways to use the system’s functionalities in support of organizational goals and strategies.

Interestingly, openness to opinions learning culture is positively related to exploratory learning, supporting hypothesis H3c ( $\beta = 0.10, p < 0.05$ ) but not to exploitative learning H3b ( $\beta = 0.03, p > 0.1$ ). This result suggests that a learning culture that encourage employees to bring forth different ideas is good to stimulate users to think innovatively for new possibilities with the current ERP system; however, this type of learning culture may not be beneficial for the users to develop a deeper understanding of the extant system functionalities by potentially causing conceptual or methodological confusion because of different opinions and viewpoints. We discuss this finding later in more details.

Transactional leadership has a direct positive impact on exploitative learning and exploratory learning of ERP systems, supporting hypotheses H4 ( $\beta = 0.17, p < 0.01$ ) and H5 ( $\beta = 0.13, p < 0.05$ ). The results indicate that in ERP assimilation phase, top executives also need to watch for conflicts and emerging issues related to routine ERP system use by monitoring and controlling and provide timely resolutions and guidance. In addition, the top executives need to establish rewards systems and set up clear rules to motivate critical users to be more active in learning and using ERP systems functionalities in support of daily operations in more effective ways.

The PLS results show that both exploitative learning and exploratory learning are positively related to ERP assimilation, supporting hypotheses H6 ( $\beta = 0.61, p < 0.01$ ) and H7 ( $\beta = 0.11, p < 0.05$ ). This result confirms our argument that strong assimilation of ERP system in organizational processes requires both deeper understanding of systems functionalities in the current business context and innovative use of the functionalities for new



(\*\*represents significance at p<0.01, \*represents significance at p<0.05)

Fig. 2. Structural Equation Model Analysis Results.

and unforeseen business requirements and applications that will inevitably emerge after an ERP system has been implemented for some time. This result, combined with other hypotheses related to transformational leadership, also reaffirms the argument of Shao et al. [12] that successful ERP assimilation demands top executives to exhibit mixed leadership style, and pure transactional or pure transformational leadership style is not optimal during the assimilation phase.

The structural equation model also shows that transformational leadership explains a significant portion of the variances in psychological safety, participative decision-making, and openness to opinions learning culture (66.4%, 36.4%, and 51.2%, respectively), indicating that transformational leadership is indeed a critical driver of organizational learning culture. The very high R<sup>2</sup> of exploitative learning and exploratory learning (70.3% and 65.8%, respectively) suggest that transformational leadership and transactional leadership are critical antecedents of organizational learning of ERP systems. The fairly high R<sup>2</sup> of ERP assimilation construct (48.6%) provides strong evidence of the explanatory power of the research model.

We referred to Baron and Kenny [85] to examine if there is a partial or full mediating effect of organizational learning culture between transformational leadership and ERP systems learning. Baron and Kenny [85] suggested that the mediation hypothesis is supported if the following conditions are satisfied: (1) the independent variable is associated with the dependent variable without the mediator, (2) the effect of independent variable on the dependent variable is reduced to zero (full mediation) or reduced by a significant amount (partial mediation) after adding the mediator, and (3) the mediator is associated with the dependent variable.

We conducted the following analysis in SmartPLS as suggested by Liang et al. [45]: (1) Remove the three types of organizational learning culture from the model and run the model to see if there is a direct link between transformational leadership and ERP systems learning; (2) Add a direct link between transformational leadership and ERP systems learning without removing the three types of organizational learning culture, and run the model to examine the significance of transformational leadership–ERP systems learning link.

We first removed the three types of organizational learning culture from the model and ran the model in SmartPLS. The analysis results suggested that the link between transformational

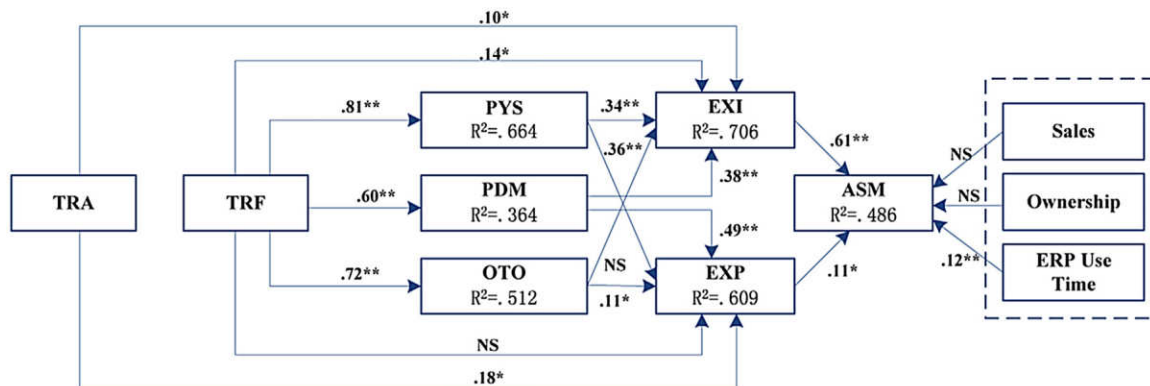
leadership and ERP systems exploitative learning ( $\beta = 0.43$ ) and the link between transformational leadership and exploratory learning ( $\beta = 0.23$ ) are all significant ( $p < 0.01$ ). We then added a direct link between transformational leadership and ERP systems learning in the original theoretical model. The analysis result of the model is shown in Fig. 3.

From Fig. 3, we can see that the path coefficient between transformational leadership and ERP systems exploitative learning reduced from 0.43 ( $p < 0.01$ ) to 0.14 ( $p < 0.05$ ), indicating that their relationship is partially mediated by psychological safety and participation in decision-making learning culture. However, the direct link between transformational leadership and ERP systems exploratory learning is not significant, suggesting that their relationship is fully mediated by psychological safety, participation in decision-making and openness to opinions learning culture.

With regard to the control variables, it is not surprising to see that time of ERP use is strongly related to the degree of ERP assimilation ( $\beta = 0.12$ ,  $p < 0.01$ ), indicating that accumulated experience can facilitate the assimilation level of ERP systems [99], whereas the other two control variables have no statistically significant relationships with ERP assimilation. This is in contrast with Liang et al. [45] who found that time of ERP use, as other control variables, is not significantly related to ERP assimilation. This difference may be attributable to the difference in ERP assimilation measurement in these two studies.

5.4. Assessing common method bias

Because all our data are self-reported, common method biases may still exist because of consistency motif and social desirability [73], even with the precaution taken in data collection, which has largely removed the method bias from the common respondent sources. As suggested by Podsakoff et al. [73], we conducted statistical analysis to check for common method bias. One of the most widely used techniques to check for common method bias is Harman’s one-factor (or single-factor) test [86]. The basic assumption of Harman’s one-factor test is that if a substantial amount of common method variance is present, either (1) a single factor will emerge from the factor analysis or (2) one general factor will account for the majority of the variance among all measures [73]. Following Podsakoff and Organ [86], we conducted an exploratory factor analysis using SPSS with all the items in our research model. The result is given in Table B3 of Appendix B. It



(\*\*represents significance at p<0.01, \*represents significance at p<0.05)

Fig. 3. Structural Equation Model Analysis Results II.

shows that there are eight factors with eigenvalues above 1, accounting for 88.77% of the total variance. More importantly, the first factor only accounted for 28.75% of the total variance, an indication that common method bias is not a major concern in this sample.

Podsakoff et al. [73] argued that although the use of a single-factor test may provide an indication of whether a single factor accounts for all the covariance among the items, it cannot statistically control for method effects and some other statistical remedies are needed to examine the common method bias. Following Liang et al. [45], we added a common method factor whose indicators included all the principal constructs' indicators in the structural equation model implemented using SmartPLS [76]. We calculated each indicator's variance substantively explained by the principal construct and the variance explained by the method construct, and the analysis result is shown in Table B4 of Appendix B ( $R_1^2$  represents indicators' variances explained by the principal construct;  $R_2^2$  represents indicators' variances explained by the method construct).

Table B4 indicates that all of the substantive factor loadings are significant, while most of the method factor loadings are insignificant. In addition, the average variances explained by the principal and method construct are 0.815 and 0.021, respectively, and ratio of substantive variance to method variance is approximately 39:1. Given the small magnitude and insignificance of method variance, we conclude that common method bias is not a serious concern in our study based on this criterion [45].

## 6. Discussion

In this study, we argue that top management should exercise appropriate leadership skills at different phases of the ERP system lifecycle for the ERP system to be effective for the critical "top management support" that has been widely recognized in the literature, and a combination of transformational and transactional leadership is the most appropriate in the assimilation phase. From the organizational learning perspective, our study establishes a research model to integrate leadership style, organizational learning culture, and ERP assimilation. We tested the research model with data from 132 Chinese firms that have implemented ERP systems for more than 1 year with an average of 5 years. The empirical results show that both transformational and transactional leadership styles are related to the level of ERP assimilation in the sample firms, and organizational learning is a significant mediating construct between top management leadership styles and levels of ERP assimilation.

More interestingly, we found that the two leadership styles influence organizational learning, a strong antecedent to ERP assimilation, through different mechanisms. On the one hand, transformational leadership, through its focus on motivating and inspiring followers through vision and value, impacts organizational learning by fostering at least three types of organizational learning culture. This result is consistent with the prior literature on leadership and culture that transformational leadership frequently work toward facilitating organizational culture to be in line with their vision [21,61,24]. In addition, we extend the organizational learning literature by identifying how transformational leadership influences the specific learning culture subtypes (psychological safety, participation in decision-making, and openness to opinions) and how these subtypes influence two specific organizational learning approaches (exploratory and exploitative) in the context of ERP assimilation. For instance, we find that while transformational leadership appears to have equally strong influence on all three subtypes of learning culture, the subtype "openness to diverse opinions" has no statistically significant impact on exploitative learning and only weak

influence on exploratory learning. This is quite surprising given the favorable theoretical arguments in the learning literature. However, this may be attributable to the possibility that some respondents do not fully believe that diverse opinions help either exploratory or exploitative learning. In fact, Fiol [59] argued that organizational learning occurs in the balance of two seemingly contradictory prescriptions: to generate diversity and build consensus; therefore, unlike individual learning, organizational learning involves developing enough consensus around those diverse interpretations for organized action to occur.

On the other hand, we confirmed that transactional leadership, through its focus on rewarding mechanisms and managing exceptions, directly influences the learning behaviors of employees, albeit this direct influence is not as strong as the one exerted by the learning subcultures in either statistical significance or magnitude of the path coefficients. This is consistent with the prior literature that transactional leaders tend to operate within the existing culture and support the status quo; thus, there is no direct relationship between transactional leadership and organizational culture [21,58].

The final interesting observation from our empirical results is the fairly significant difference between the impacts of two learning approaches on ERP assimilation. Although both exploitative and exploratory learning approaches have statistically significant impact on ERP assimilation and together they explain 48.6% the variances in the ERP assimilation construct, exploitative learning clearly dominates ERP assimilation as compared to exploratory learning (0.61 at  $p < 0.01$  vs. 0.11 at  $p < 0.05$ ). Although this is a new and interesting result, it is not completely surprising in the context of ERP assimilation. The majority of the firms that implemented ERP systems purchased the software package from established international ERP vendors such as SAP and Oracle or well-known Chinese ERP vendors such as UFIDA. Although a fair amount of customization and configuration is allowed within the frameworks of these packaged products, significant post-implementation reconfigurations or software add-ons to meet new and unforeseen business requirement or changes do not happen frequently. This explains why exploitative learning plays a more dominant role in ERP assimilations than exploratory learning.

### 6.1. Theoretical contributions

Our findings have significant contributions to organizational theories and information systems literature, including information systems success, IT assimilation, leadership, organizational culture, and organizational learning. Although the role of top management in IT assimilation in general and ERP assimilation in particular has been examined in the IS literature [44,45,26], the leadership theory suggests that there are two distinguishable leadership styles exhibited by top management that influence the behavior of the followers through different mechanisms. Shao et al. [12] provided some preliminary case evidence; however, few published studies have empirically tested how leadership style influences the effectiveness of "top management" support that is widely recognized in ERP literature, especially in the context of ERP assimilation. By integrating transformational and transactional leadership style, organizational learning, organizational learning culture, and ERP assimilation into an integral model, our study identifies critical paths through which transformational and transactional leadership impact exploitative learning and exploratory learning of ERP systems, which in turn impact ERP assimilation. The empirical results show that the positive relationship between transformational leadership and ERP systems learning is partially mediated by three types of organizational learning culture, whereas transactional leadership is directly related with ERP systems learning. These findings confirm the

long-standing theoretical arguments that transformational leaders change follower behavior largely by changing the organizational culture, whereas transactional leaders change followers' behavior primarily by using direct exchange mechanisms such as rewards and incentives [21,61,24].

Second, this study provides new theoretical perspectives for extending IT assimilation theory [44,45] by showing the critical role of organizational learning in technology assimilation and how top management could impact the effectiveness of organizational learning. Purvis et al. [44] were the first to articulate the role of top management in IT assimilation by including the construct of top management championship as the primary driver of IT assimilation. Liang et al. [45] refined top management championship construct into top management beliefs and top management participation in their ERP assimilation model. This study offers two new perspectives on IT assimilation. We first concretized the relatively abstract constructs of management beliefs and participation with specific leadership styles, i.e., transformational and transactional; we then showed that assimilation is a result of organizational learning. Therefore, top management, through their specific actions, influences IT assimilation primarily through organizational learning either by facilitating the learning culture or directly influencing the learning behavior of employees.

Third, our study also contributes to the organizational learning theory. Continuous learning of ERP systems is identified as a major challenge in ERP assimilation phase [17]. However, few studies have examined critical antecedents for learning ERP systems. By applying March's [30] exploitative and exploratory learning theoretical framework, we argue that ERP assimilation is a continuous learning process, and both exploitative learning and exploratory learning are indispensable for the employees to develop a deeper understanding, which enables them to use the system's functionalities and capabilities for both normative and innovative applications. Further, we posit that transformational and transactional leadership are important drivers of both exploitative and exploratory learning of ERP systems. The empirical results support these arguments that extend the ERP assimilation literature from an organizational learning perspective.

Fourth, our study showed for the first time in leadership and organizational learning literature that not all leadership styles contribute to organizational learning equally, at least not in the context of ERP assimilation. The test results suggested that transformational leadership has much stronger and more significant impact on both exploratory and exploitative learning than transactional leadership. Transformational leadership accomplishes this significant impact primarily by facilitating the organization's learning culture.

Finally, our study contributes to the leadership theory by integrating transformational leadership, organizational learning culture, and organizational learning in the same model to examine their joint effect on an organizational phenomenon—ERP assimilation. To our knowledge, this is the first empirical study that examined the joint effect of leadership style and organizational culture on ERP success in the post-implementation phase. The leadership theory suggests that transformational leadership is an antecedent of organizational learning culture. However, few empirical studies have been conducted to examine how organizational learning culture is influenced by transformational leadership. We examined the mediating effect of three types of organizational learning culture, in terms of psychological safety, participative decision-making, and openness to opinions, between transformational leadership and two types of ERP systems learning. These hypothesized mediating effects were strongly supported by the empirical data, confirming that the influence of transformational leadership on employee behavior starts with

facilitating organizational culture. These results have refined our understanding of how transformational leadership and organizational learning culture work together to influence learning and ERP assimilation in organizations.

## 6.2. Practical contributions

The findings of our study also have some significant practical implications for managing ERP assimilation in organizations. Our study shows that transformational and transactional leadership are critical antecedents to organizational learning and ERP assimilation. We identified the specific mechanism through which top management can exercise effective influence on ERP assimilation. The results provide some prescriptive guidelines for top management with regard to the significance of exhibiting a mixture of transformational and transactional leadership styles in ensuring ERP success in the assimilation phase.

The finding that ERP assimilation requires a combination of transformational and transactional leadership skills calls for greater attention on the selection of top executives who will be in charge of ERP systems in the assimilation phase. A top executive who possesses most, if not all, of the characteristics of transformational and transactional leaders, as shown in Table 1, may not be as common as those who are distinctly one style or the other, which may not be as impractical as one might think. Prior studies have shown that it is possible for one leader to exhibit both transformational and transactional traits in different situations or time [28], and the case findings of Shao et al. [12] suggested that such leaders do exist in the context of ERP assimilation. In practical cases, many Chinese corporations have successfully utilized ERP systems to support their operational processes and business strategies. For example, Mr. Ruimin Zhang, CEO of Haier Corp., is famous for his strategic vision and execution power. On the one hand, he facilitated an innovation culture within Haier; on the other hand, he focused on executions and established a set of performance rewards systems. His leadership style has been critical in fostering both exploitative learning and exploratory learning of ERP systems inside Haier.

Our study also provides guidance for top executives with regard to what types of organizational learning culture and learning approach need to be carefully fostered. Specifically, our finding that learning culture, especially the dimensions of psychological safety and participative decision-making, has stronger impact on both exploitative and exploratory learning than direct influence from top executives shows that top executives must focus on developing strong learning cultures during the ERP assimilation phase. Given the strength of the influence of learning culture, it is even conceivable that a strong transformational leader with a focus on building learning culture is able to compensate for the lack of transactional skills in leading a successful ERP assimilation.

Last but not the least, the finding that exploitative learning is more dominant than exploratory learning in the ERP assimilation phase sheds some light on how to manage organizational learning effectively in ERP assimilation. Given the fact that psychological safety and participative decision-making are the two most significant learning cultures toward exploitative learning and transformational leadership is most significantly associated with these two learning cultures, top executives are advised to pay more attention to the transformational leadership style and associated actions when trying to move ERP assimilation to the next level in their organizations. In addition, because transactional leadership style indeed has some, albeit less strong, impact on exploitative learning as well, some degree of transactional actions, such as establishing effective mechanism for rewarding good assimilative actions and behavior, will complement the transformational effort and benefit the assimilation endeavor.

### 6.3. Limitations

As a theory-driven empirical study, our findings are inevitably subject to the limitations of theory, i.e., data and methodology, which also leave open many future research opportunities. First, with data from 132 firms, our sample was relatively small for the complex structural model tested in this study. The requirement of two matching samples from each firm significantly increased the challenge in data collection. With a larger sample, more reliable statistics may be generated and more sophisticated tests may be performed. Second, in this study, we used cross-sectional data to test the theoretical model and its hypotheses. Future research could take a longitudinal approach to examine the impact of transformational leadership and organizational learning culture on ERP assimilation. A longitudinal study could provide further insights into whether transformational leadership and a learning culture can help organizations simultaneously sustain a pattern of both continuous improvement and innovative usage of systems functionalities over time. Third, although our leadership theory dictates that transformational leaders change behavior by facilitating culture, we have assumed that transactional leadership influences followers' learning behavior directly and is not mediated by organizational learning culture because of the exchange nature of the influence. It is not clear in the literature whether culture is a significant factor in transactional leadership. Future research is needed to further explore this interesting but unanswered question. Fourth, we relied on the widely used MLQ instrument for measuring the two leadership styles. However, we recognize that there are significant debates in the leadership literature about the validity of the two leadership style constructs and the associated MLQ measurements [88,60,89]. Thus, using different leadership constructs and measurement instruments might yield interesting contrasts and insights in future research. Fifth, the relatively high correlations among the major constructs are of some concern. Although common method bias and discriminant validity checks do not raise significant issues, item cross-loading appears to be a primary source of the high correlations. Future research may need to further refine the measurement items for each construct to achieve more accurate results.

### 7. Conclusions

In this study, we examined the important question of how transformational and transactional leadership styles impact ERP assimilation while considering two types of organizational learning activities and organizational learning culture. Using a

sample of firms that have been using ERP systems for an average of 5 years, we tested a theoretical model and largely confirmed our theoretically derived hypotheses that (1) both transformational and transactional leaders significantly influence organizational learning and thus ERP assimilation, (2) organizational learning culture serves as a critical mediator between transformational leadership and ERP systems learning, and (3) although both exploitative and exploratory learning contribute to ERP assimilation, the former is a more dominant force than the latter. These findings fill significant gaps in the ERP and leadership research literature and provide practical guidance for managing ERP systems in organizations.

This study opens a new stream of research that examines the effectiveness of top management leadership styles in the context of ERP assimilation and enterprise systems in general. Much remains to be learned with regard to the inter-relationships among top management leadership style, organizational culture, and organizational learning of new technology and complex IT systems. For one, transformational and transactional leadership can be further broken up into their first-order constructs to empirically examine the impacts of individual dimensions (e.g., IA, IB, IM, IS, IC, CR and MBE) on ERP assimilation and how such impacts are mediated by exploitative learning and exploratory learning of ERP systems at a finer level. In addition, it is also interesting to extend the organization-level model to individual level and develop a new theoretical model that examines the impact mechanisms of top management leadership style on individual-level assimilation of ERP systems. Last but not the least, future research can also consider firm performance in the theoretical model and empirically examine how top management leadership styles impact firm performance by assimilation of ERP systems.

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### Appendix A. The Survey Instrument

**Table A1**  
Survey Instrument for the Top Executive.

Transformational Leadership Style–Self Report		
Idealized Attributes	I instill pride in others for being associated with me	1 2 3 4 5 6 7
	I go beyond self-interest for the good of the firm	1 2 3 4 5 6 7
	I act in ways that build others respect for me	1 2 3 4 5 6 7
	I display a sense of power and confidence	1 2 3 4 5 6 7
Idealized Behaviors	I talk about my most important values and beliefs	1 2 3 4 5 6 7
	I specify the importance of having a strong sense of purpose	1 2 3 4 5 6 7
	I consider the moral and ethical consequences of decisions	1 2 3 4 5 6 7
	I emphasize the importance of having a collective sense of mission	1 2 3 4 5 6 7
Inspirational Motivation	I talk optimistically about the future	1 2 3 4 5 6 7
	I talk enthusiastically about what needs to be accomplished	1 2 3 4 5 6 7
	I articulate a compelling vision of the future	1 2 3 4 5 6 7
	I express confidence that goals will be achieved	1 2 3 4 5 6 7
Intellectual Stimulation	I re-examine critical assumptions to question whether they are appropriate	1 2 3 4 5 6 7
	I seek different perspectives when solving problems	1 2 3 4 5 6 7

**Table A1** (Continued)

Transformational Leadership Style–Self Report		
Individual Consideration	I get others to look at problems from many different angles	1 2 3 4 5 6 7
	I suggest new ways of looking at how to complete assignments	1 2 3 4 5 6 7
	I spend time teaching and coaching	1 2 3 4 5 6 7
	I treat others as individuals rather than just as a member of a firm	1 2 3 4 5 6 7
	I consider an individual as having different needs, abilities, and aspirations from others	1 2 3 4 5 6 7
	I help others to develop their strengths	1 2 3 4 5 6 7
Transactional Leadership Style–Self Report		
Contingent Reward	I provide others with assistance in exchange for their efforts	1 2 3 4 5 6 7
	I discuss in specific terms who is responsible for achieving performance targets	1 2 3 4 5 6 7
	I make clear what one can expect to receive when performance goals are achieved	1 2 3 4 5 6 7
	I express satisfaction when others meet expectations	1 2 3 4 5 6 7
Management by Exception	I focus attention on irregularities, mistakes, exceptions, and deviations from standards	1 2 3 4 5 6 7
	I concentrate my full attention on dealing with mistakes, complaints, and failures	1 2 3 4 5 6 7
	I keep track of all mistakes	1 2 3 4 5 6 7
	I direct my attention toward failures to meet standards	1 2 3 4 5 6 7
Enterprise Systems Assimilation		
Question 1: In this study, we define levels of organizational ERP assimilation based on the following definitions:		
1.1 ERP is used for routine business operations supporting.		
1.2 ERP is used to support our company's short and medium operational plans (e.g., marketing, production, finance).		
1.3 ERP is used to support our company's long-term strategic plans (e.g. marketing, production, finance).		
Please circle the number you think most closely represents your company's level of using the ERP system to support:		
Business Process Decision-making Business Strategy		
1 2 3 4 5 6 7		
Question 2: In this study, we define levels of organizational ERP assimilation based on the following definitions:		
2.1 ERP is used to process data generated by daily business transactions in our company.		
2.2 ERP provides necessary data to support our company's operational decision making.		
2.3 ERP is used to help top management team to determine the company's strategic goals.		
Please circle the number you think most closely represents your company's level of using the ERP system to support:		
Business Process Decision-making Business Strategy		
1 2 3 4 5 6 7		
Question 3: In this study, we define levels of organizational ERP assimilation based on the following definitions:		
3.1 In our company, transactional and production data are organized and integrated by the ERP system.		
3.2 In our company, the ERP system provides analytical reports that are used for making operational decisions.		
3.3 ERP is used to help top management team to define the company's future strategic direction.		
Please circle the number you think most closely represents your company's level of using the ERP system to support:		
Business Process Decision-making Business Strategy		
1 2 3 4 5 6 7		

**Table A2**

Survey Instrument for the IT Director.

Transformational Leadership Style–The Top Executive		
1-Strongly Disagree 4-Neutral 7-Strongly Agree		
Idealized Attributes	The top executive instills pride in us for being associated with him/her	1 2 3 4 5 6 7
	The top executive goes beyond self-interest for the good of the firm	1 2 3 4 5 6 7
	The top executive acts in ways that build respect for him/her	1 2 3 4 5 6 7
	The top executive displays a sense of power and confidence	1 2 3 4 5 6 7
Idealized Behaviors	The top executive talks about his/her most important values and beliefs	1 2 3 4 5 6 7
	The top executive specifies the importance of having a strong sense of purpose	1 2 3 4 5 6 7
	The top executive considers the moral and ethical consequences of decisions	1 2 3 4 5 6 7
	The top executive emphasizes the importance of having a collective sense of mission	1 2 3 4 5 6 7
Inspirational Motivation	The top executive talks optimistically about the future	1 2 3 4 5 6 7
	The top executive talks enthusiastically about what needs to be accomplished	1 2 3 4 5 6 7
	The top executive articulates a compelling vision of the future	1 2 3 4 5 6 7
	The top executive expresses confidence that goals will be achieved	1 2 3 4 5 6 7
Intellectual Stimulation	The top executive re-examines critical assumptions to question whether they are appropriate	1 2 3 4 5 6 7
	The top executive seeks different perspectives when solving problems	1 2 3 4 5 6 7
	The top executive gets us to look at problems from many different angles	1 2 3 4 5 6 7
	The top executive suggests new ways of looking at how to complete assignments	1 2 3 4 5 6 7
Individual Consideration	The top executive spends time teaching and coaching	1 2 3 4 5 6 7
	The top executive treats us as individuals rather than just as a member of a firm	1 2 3 4 5 6 7

**Table A2** (Continued)

Transformational Leadership Style–The Top Executive		
	The top executive considers an individual as having different needs, abilities, and aspirations from others	1 2 3 4 5 6 7
	The top executive helps us to develop our strengths	1 2 3 4 5 6 7
Transactional Leadership Style–The Top Executive		
Contingent Rewards	The top executive provides us with assistance in exchange for our efforts	1 2 3 4 5 6 7
	The top executive discusses in specific terms who is responsible for achieving performance targets	1 2 3 4 5 6 7
	The top executive makes clear what one can expect to receive when performance goals are achieved	1 2 3 4 5 6 7
	The top executive expresses satisfaction when others meet expectations	1 2 3 4 5 6 7
Management by Exception	The top executive focuses attention on irregularities, mistakes, exceptions, and deviations from standards	1 2 3 4 5 6 7
	The top executive concentrates my full attention on dealing with mistakes, complaints, and failures	1 2 3 4 5 6 7
	The top executive keeps track of all mistakes	1 2 3 4 5 6 7
	The top executive directs our attention toward failures to meet standards	1 2 3 4 5 6 7
Organizational Learning Culture		
1-Strongly Disagree 4-Neutral 7-Strongly Agree		
Psychological Safety	It is safe to take a risk on the organization	1 2 3 4 5 6 7
	It is not difficult to ask other members of the organization for help	1 2 3 4 5 6 7
	Members of the organization are able to bring up problems and tough issues	1 2 3 4 5 6 7
Openness to Diverse Opinions	Different points of view are encouraged in work.	1 2 3 4 5 6 7
	We are prepared to rethink decisions when presented with new information.	1 2 3 4 5 6 7
	In meetings, we seek to understand everyone’s point of view.	1 2 3 4 5 6 7
Participation in Decision-making	Employees have a real say in how the organization carries out its work	1 2 3 4 5 6 7
	Most members in the organization get a chance to participate in decision making	1 2 3 4 5 6 7
	The organization is designed to let everyone participate in decision making.	1 2 3 4 5 6 7
Exploitative and Exploratory Learning of ERP Systems		
1-Strongly Disagree 4-Neutral 7-Strongly Agree		
Exploitative Learning	We frequently refine the provision of existing system functions	1 2 3 4 5 6 7
	We regularly implement small adaptations to existing system functions	1 2 3 4 5 6 7
	The employees follow established procedures of system use to execute regular work efficiently	1 2 3 4 5 6 7
Exploratory Learning	We continuously search for new system functions	1 2 3 4 5 6 7
	We frequently explore new system functions that go beyond existing enterprise systems	1 2 3 4 5 6 7
	We frequently utilize new system functions to support new business processes.	1 2 3 4 5 6 7

**Appendix B. Additional Test Statistics**

**Table B1**

Paired t-test of Leadership Traits.

	Mean	Standard Deviation	95% confidence interval of the difference		Df.	Significance (two-tailed)	
			Lower	Upper			
Pair 1	SFIA1 – IA1	–0.07	1.06	–0.28	0.14	131	0.51
Pair 2	SFIA2 – IA2	–0.05	0.99	–0.25	0.15	131	0.62
Pair 3	SFIA3 – IA3	0.07	1.18	–0.06	0.20	131	0.15
Pair 4	SFIA4 – IA4	0.02	0.97	–0.17	0.21	131	0.84
Pair 5	SFIB1 – IB1	–0.09	1.35	–0.40	0.14	131	0.34
Pair 6	SFIB2 – IB2	–0.11	1.02	–0.46	–0.06	131	0.12
Pair 7	SFIB3 – IB3	0.09	0.94	–0.10	0.28	131	0.34
Pair 8	SFIB4 – IB4	0.00	1.13	–0.22	0.22	131	1.00
Pair 9	SFIM1-IM1	0.10	1.02	–0.04	0.36	131	0.12
Pair 10	SFIM2-IM2	–0.11	0.93	–0.33	0.04	131	0.11
Pair 11	SFIM3-IM3	–0.08	0.99	–0.43	–0.04	131	0.18
Pair 12	SFIM4-IM4	0.10	1.19	–0.14	0.33	131	0.40
Pair 13	SFIS1-IS1	0.05	1.02	–0.05	0.15	131	0.25
Pair 14	SFIS2-IS2	0.06	1.11	–0.16	0.28	131	0.59
Pair 15	SFIS3-IS3	–0.06	0.97	–0.33	0.15	131	0.15
Pair 16	SFIS4-IS4	–0.09	1.04	–0.44	–0.03	131	0.12
Pair 17	SFIC1 – IC1	–0.11	1.14	–0.43	0.02	131	0.28
Pair 18	SFIC2 – IC2	–0.09	1.26	–0.56	–0.06	131	0.16
Pair 19	SFIC3 – IC3	–0.10	1.11	–0.27	0.07	131	0.65
Pair 20	SFIC4 – IC4	0.09	1.06	–0.02	0.40	131	0.18
Pair 21	SFCR1 – CR1	–0.08	1.04	–0.28	0.13	131	0.44
Pair 22	SFCR2 – CR2	0.09	0.94	–0.10	0.28	131	0.34
Pair 23	SFCR3 – CR3	–0.10	1.19	–0.23	0.04	131	0.20
Pair 24	SFCR4 – CR4	0.07	1.06	–0.08	0.14	131	0.22
Pair 25	SFMBE1-MBE1	–0.02	1.08	–0.23	0.19	131	0.85

**Table B1** (Continued)

		Mean	Standard Deviation	95% confidence interval of the difference		Df.	Significance (two-tailed)
				Lower	Upper		
Pair 26	SFMBE2-MBE2	-0.08	1.00	-0.28	0.12	131	0.43
Pair 27	SFMBE3-MBE3	-0.09	1.03	-0.31	0.09	131	0.29
Pair 28	SFMBE4-MBE4	0.108	0.96	-0.03	0.35	131	0.20

Note: SF represents self-reported leadership traits by the top executive.

**Table B2**

Item Loading and Cross-loading.

	TRF	TRA	PYS	OTO	PDM	EXI	EXP	ASM
IA	<b>0.94</b>	0.76	0.69	0.73	0.59	0.70	0.61	0.41
IB	<b>0.95</b>	0.72	0.60	0.62	0.53	0.61	0.54	0.29
IM	<b>0.94</b>	0.77	0.70	0.67	0.55	0.68	0.60	0.35
IS	<b>0.95</b>	0.71	0.71	0.68	0.52	0.64	0.55	0.30
IC	<b>0.93</b>	0.72	0.72	0.69	0.64	0.74	0.68	0.38
CR	0.70	<b>0.96</b>	0.70	0.54	0.59	0.69	0.65	0.43
MBE	0.78	<b>0.95</b>	0.79	0.69	0.59	0.66	0.62	0.40
PS2	0.76	0.75	<b>0.91</b>	0.77	0.64	0.75	0.68	0.49
PS3	0.74	0.68	<b>0.92</b>	0.71	0.52	0.62	0.57	0.38
PS4	0.70	0.71	<b>0.92</b>	0.69	0.61	0.74	0.71	0.96
OP2	0.69	0.63	0.75	<b>0.91</b>	0.66	0.63	0.54	0.37
OP3	0.68	0.60	0.74	<b>0.91</b>	0.68	0.61	0.61	0.41
OP4	0.60	0.53	0.68	<b>0.91</b>	0.63	0.54	0.62	0.33
PD1	0.69	0.64	0.68	0.77	<b>0.87</b>	0.70	0.67	0.46
PD2	0.41	0.46	0.53	0.50	<b>0.87</b>	0.60	0.61	0.49
PD3	0.46	0.52	0.48	0.58	<b>0.89</b>	0.63	0.68	0.47
EIL2	0.62	0.63	0.66	0.57	0.71	<b>0.96</b>	0.79	0.66
EIL3	0.69	0.65	0.75	0.62	0.65	<b>0.94</b>	0.75	0.64
EIL4	0.74	0.75	0.79	0.66	0.75	<b>0.96</b>	0.76	0.66
EOL2	0.62	0.68	0.69	0.63	0.73	0.76	<b>0.98</b>	0.60
EOL3	0.57	0.60	0.67	0.57	0.72	0.75	<b>0.95</b>	0.60
EOL4	0.64	0.63	0.69	0.65	0.69	0.75	<b>0.95</b>	0.64
AS1	0.34	0.41	0.43	0.38	0.52	0.66	0.62	<b>0.96</b>
AS2	0.41	0.47	0.50	0.42	0.52	0.68	0.63	<b>0.96</b>
AS3	0.31	0.36	0.46	0.36	0.50	0.62	0.58	<b>0.95</b>

**Table B3**

Harmon One-factor Test Results.

Component	Extraction Sums of Squared Loadings	
	Percentage of Variance	Cumulative percentage
1	28.75	28.75
2	18.43	47.18
3	15.15	62.33
4	8.07	70.40
5	6.88	77.28
6	5.16	82.44
7	3.47	85.91
8	2.86	88.77

**Table B4**

Common Method Bias Analysis.

Construct	Indicator	Substantive factor loading	R <sub>1</sub> <sup>2</sup>	Method factor loading	R <sub>2</sub> <sup>2</sup>
Transformational Leadership	IA	0.855**	0.731	0.099	0.010
	IB	0.982**	0.964	-0.203*	0.041
	IM	0.905**	0.819	0.041	0.002
	IS	0.953**	0.908	-0.125	0.016
	IC	0.770**	0.592	0.187*	0.035
Transactional Leadership	CR	0.970**	0.941	-0.064	0.004
	MBE	0.871**	0.759	0.065	0.004
Psychological Safety	PS2	0.693**	0.480	0.242**	0.059
	PS3	0.958**	0.918	-0.267**	0.071
	PS4	0.911**	0.830	0.014	0.000
Openness to Diverse Opinions	OP2	0.871**	0.759	0.047	0.002
	OP3	0.859**	0.738	0.064	0.004



Table B4 (Continued)

Construct	Indicator	Substantive factor loading	R <sub>1</sub> <sup>2</sup>	Method factor loading	R <sub>2</sub> <sup>2</sup>
	OP4	0.970**	0.941	−0.112	0.013
Participation in Decision-making	PD1	0.606**	0.367	0.315**	0.099
	PD2	0.949**	0.901	−0.203*	0.041
	PD3	0.997**	0.994	−0.127	0.026
Exploitative Learning	EIL2	0.949**	0.901	−0.205 <sup>†</sup>	0.042
	EIL3	0.928**	0.861	−0.031	0.001
	EIL4	0.746**	0.557	0.230 <sup>†</sup>	0.053
Exploratory Learning	EOL2	0.971**	0.941	−0.018	0.000
	EOL3	0.990**	0.980	−0.065	0.004
	EOL4	0.871**	0.759	0.084	0.007
ERP Assimilation	AS1	0.968**	0.937	−0.015	0.000
	AS2	0.910**	0.828	0.067	0.004
	AS3	0.985**	0.970	−0.052	0.003

Note: \*\*represents significance at  $p < 0.01$ , \*represents significance at  $p < 0.05$ .

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