

Promoting Engagement Through Enterprise Information System Integration: Mediating Role of Self-Determination and Moderating Effect of Leadership Style

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Abstract:

Introduction: Enterprise Information System Integration (EISI) plays a pivotal role in enhancing organizational operational efficiency and empowering employees. Despite its growing importance, limited research explores how EISI impacts employee engagement. Addressing this gap is crucial for enterprises aiming to optimize both technological and human capital.

Objectives: This study aims to investigate the relationship between EISI and employee engagement by integrating the Information System Success Model with Self-Determination Theory. Additionally, it examines the moderating role of transformational leadership and the mediating role of self-determination in this relationship.

Methods: A quantitative research design was employed, utilizing structural equation modeling (SEM) to analyze 500 valid questionnaires collected from Chinese enterprise information system users. The proposed hypotheses were tested to understand the direct and mediated effects of EISI on employee engagement.

Results: The findings reveal that effective EISI significantly enhances employee engagement. Self-determination plays a crucial mediating role, highlighting the importance of fulfilling employees' psychological needs in this process. Furthermore, transformational leadership positively moderates the relationship between EISI and employee engagement, amplifying the beneficial effects of EISI.

Conclusions: This study provides valuable insights for enterprises, emphasizing the need to optimize information systems and adopt transformational leadership styles to foster higher employee engagement. These findings offer theoretical support and practical guidance for leveraging EISI to enhance workplace productivity and employee satisfaction.

Keywords: Enterprise Information System Integration (EISI); employee engagement; transformational leadership; system organizational optimization

INTRODUCTION

With economic globalization and the rapid development of information technology, the position and role of enterprise information systems in enterprise management have become increasingly significant [1]. Enterprise information system integration significantly improves the operational efficiency and decision-making quality of organizations by integrating internal data and business processes, introducing advanced management ideas and standard business processes [2], and becoming a key tool for enterprises to cope with the uncertainty of the external environment and to improve their competitive advantage [3]. Through EISI, organizations are able to achieve the seamless integration of internal data and information flows [4] and enhanced strategic decision-making capabilities through business intelligence [5]. In China, with the growth of the market economy and the extensive application of information technology, the application and reliance of enterprises on information system integration have been growing [6]. However, organizations still face many challenges in the implementation of information system integration [7]. For example, the compatibility between different systems and the effectiveness of data flow need to be improved; the complexity of information system integration faces great challenges, especially in the coordination between different technologies and business requirements [8]. Nevertheless, the application of EIS integration in China continues to intensify and expand.

Research has extensively explored the implementation success factors of EISI and its impact on organizational performance [9,10]. Studies have shown that information system integration significantly improves the overall performance of firms by optimizing their productivity, resource allocation, and decision-making processes [11]. In addition, the critical role of leadership style in the success of information system implementation [12,13] and the impact of organizational culture on the process of knowledge sharing and system digestion and assimilation in the later stages of system implementation have also received attention [14]. While research on corporate information systems has been quite rich [15,16], there is relatively little research on

how information systems affect employee engagement through self-determination theory and especially little research on how this self-determination process works under the influence of transformational leadership styles. Reference [17] found that the success of the late implementation of an ERP system relies on a number of factors, including corporate culture, employee training, technical support, and management commitment. In addition, in the Chinese context, successful ERP implementation relies not only on the technical fit of systems and processes, but also on the influence of management style and culture on employee behavior [18]. Transformational leadership style is able to influence self-determination motivation by stimulating employees' initiative and responsibility, which in turn is effective in enhancing employees' work engagement [19]. Therefore, exploring how transformational leaders can enhance employees' self-determination and engagement through corporate information systems has significant theoretical and practical value.

This study aims to explore how effective EISI can enhance employee engagement; to integrate the relevant theories of leadership style theory, self-determination theory, and organizational behavior to explore the mechanism of the impact of enterprise information system integration on employee engagement; and to examine the moderating role of transformational leaders in it, all to provide certain practical guidance for Chinese enterprises when implementing information systems.

OBJECTIVES

1.Theoretical Basis and Literature Review

1.1 Effective EISI

In the field of research on the relationship between information systems and organizational performance, system quality, information quality, and service quality are key factors that affect user satisfaction and system usage intention. The effective integration of information systems is not only the foundation for achieving these goals, but also crucial for improving user satisfaction, system usage intention, and ultimately organizational performance, as it is shown in Figure 1. Reference [20] investigated the different effects of information quality, system quality, and service outcome quality on trust and distrust beliefs, and how these beliefs affect relationship commitment and perceived risk. Reference [21] focused on how different dimensions of information quality affect consumer satisfaction and acceptance of mobile information services. Their research results indicate that there is a significant positive relationship between all dimensions of information quality and user satisfaction, and there is also a positive relationship between user satisfaction and intention to use the service again. Reference [22] further explored the relationship between information system quality and organizational impact in their study, emphasizing the importance of service quality in the model and pointing out that information system service quality is an important predictor of organizational performance. Reference [23] proposed the 3Q model, which investigates the roles of service quality, system quality, and information quality in website adoption. The research results indicate that the perception of service quality is influenced by system quality and information quality, and service quality has a direct impact on usage intention. Reference [24] integrated DeLone and McLean's information system integration model and self-determination theory to study the continuous use intention of Internet banking users. The study found that intrinsic motivation and identified rules are the most important human motivation factors encouraging users to continue using Internet banking.

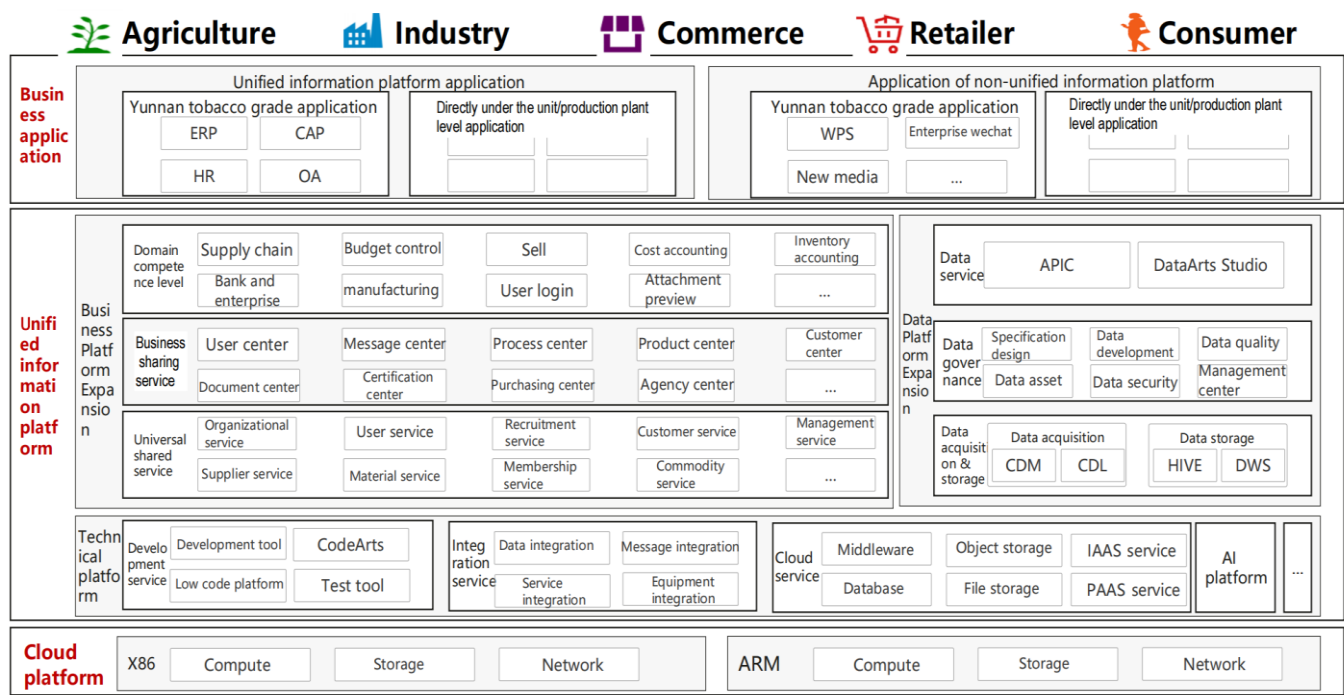


Figure 1. Promoting EISI to achieve organizational effectiveness.

Effective information system integration can optimize business processes, reduce repetitive work and errors, and improve operational efficiency. The process-oriented approach in [25] emphasizes this point, stating that by integrating different systems, enterprises can achieve more efficient data flow and decision support. Reference [26] further emphasizes that by implementing appropriate information systems, organizations can promote employee learning and adaptability and improve their work efficiency and innovation capabilities. In the process of information system integration, data management and privacy protection are important considerations. Reference [27] explored the importance of information system integration for improving data security and governance and promoting sustainable business practices. Reference [15] proposed that data quality and security are key factors for successful EISI. The technical compatibility between different systems is another major challenge in EISI. Inconsistencies in technical standards and protocols may lead to issues with data transmission and processing, affecting the overall performance of the system [25]. Reference [28] suggests that organizational culture and change management play important roles in EISI. A successful integration project requires the support of the organization's senior management and effective communication and training plans to ensure that all employees can adapt to the new systems and technologies.



Figure 2. Overview of Enterprise Information System Integration Modules.

1.2 Employee Engagement

Employee engagement can be understood through Social Exchange Theory (SET), which states that employees who feel supported by the organization will reciprocate with higher levels of engagement. In addition, employee engagement has a significant impact on work-related outcomes such as affective commitment, organizational citizenship behavior (OCB), and turnover intention [29]. Reference [30] explored the impact of employee engagement on quality management systems. They found that employees' attitudes, subjective norms, perceived behavioral control, and intentions towards quality management systems had a significant positive relationship with employee engagement. This suggests that employee engagement in the organization can be enhanced by increasing employee awareness and attitude towards the quality management system. Reference [31] studied the relationship between human resource management (HRM) practices and employee engagement. These practices were found to be positively correlated with employee engagement, which suggests that employee engagement can be promoted through effective HRM practices. Reference [32] proposed a model of caring human resource management and employee engagement, explaining how caring human resource management practices affect employee engagement through organizational climate, providing a new perspective and model for related research. Reference [33] further analyzed the relationship between human resource management practices, employee engagement, and perceived organizational support. Their research findings indicate that these three human resource management practices (career development, job safety, and performance feedback) are positively correlated with employee engagement, and this relationship is moderated by perceived organizational support. When the perception of organizational support is high, the relationship between human resource management practices and employee engagement is stronger.

1.3 Transformational Leadership Style

Reference [34] explored how the leadership style of direct superiors affects the motivation of enterprise resource planning (ERP) users to continue using the system from the perspective of the continuous use of information systems. They found that both transformational leadership and transactional leadership can positively influence employees' intrinsic and extrinsic motivation, which in turn affects user satisfaction and perceived usefulness, ultimately impacting the intention to continue using ERP systems. Transformational leadership has received widespread attention for its ability to inspire positive organizational outcomes. Transformational leadership stimulates employees' intrinsic motivation, promotes their work engagement, and improves job performance by meeting their basic psychological needs such as abilities, relevance, and autonomy [35]. Research has shown that there is a positive relevance between transformational leadership and employees' work engagement. Work engagement is

an important indicator reflecting employees' positive work attitude, including vitality, engagement, and focus [36]. The self-determination theory provides a theoretical basis for understanding how transformational leadership promotes work engagement by meeting employees' basic psychological needs [37]. Self-determination is influenced by environmental and internal factors and is related to quality of life. Individuals in different living environments have differences in self-determination and other aspects [38]. Reference [39] proposed that self-leadership intervention can affect healthcare workers' work engagement, perceived performance, and health by integrating self-determination theory and self-leadership theory. It emphasizes the positive role of self-leadership in work engagement and performance, as well as the mediating role of work engagement, supplementing the theory of self-leadership with autonomous motivation mechanisms. Reference [19] further expands this field by exploring how employees' perception of transformational leadership affects work engagement through different self-determination motivations. The research results indicate that employees' perception of transformational leadership is not only directly positively correlated with job engagement, but this relationship is also strengthened through the mediating effects of intrinsic motivation, self-motivation, and control motivation. This discovery emphasizes the role of leaders in stimulating employees' intrinsic motivation and how this motivation can be translated into higher work engagement and better job performance.

2. Hypothesis Development

2.1. EISI on Self-Determination

System quality is one of the important factors for measuring the overall success of information systems. System quality usually refers to the technical and functional performance of information systems, including usability, reliability, response speed, security, and other aspects [40,41]. In this study, we believe that the digital literacy of enterprise information systems will help them meet three different basic psychological needs of SDT. Autonomy refers to the degree to which individuals choose and control their behavior [42]. A well-designed and easy-to-use information system can enable employees to use the system more autonomously to complete tasks without relying on technical support or external assistance [43,44]. In addition, high-quality enterprise systems can support employees' autonomous decision making and innovative thinking, enabling them to better complete tasks [45,46].

On the dimension of relationships, individuals feel emotional connections and social support with others, as well as a sense of understanding, respect, and acceptance [47]. Enterprise information systems can provide smooth communication channels and collaboration platforms, which can help employees communicate more conveniently with colleagues and management [48]. In addition, various interactive activities based on information systems help employees establish and maintain interpersonal relationships, and strengthen emotional connections among team members [49,50].

Competence refers to an individual's self-awareness of their skills, knowledge, and abilities in a specific field [51]. On the dimension of ability perception, individuals believe that they have sufficient abilities to achieve goals and cope with challenges. This level of self-perceived competence can stimulate positive behavior and effort, thereby enhancing individual engagement in tasks [52]. When employees are able to easily and effectively use information systems, they are more likely to feel capable when performing tasks [43]. When the system can provide sufficient functionality to support employees in completing tasks, employees will feel more confident because they can better cope with various challenges in their work [53]. The following hypotheses are thus put forward:

H1a: The system quality of EISI has a positive impact on autonomy in work.

H1b: The system quality of EISI has a positive impact on competence in work.

H1c: The system quality of EISI has a positive impact on relevance in work.

2.2. Information Quality of EISI on Self-Determination

Information quality refers to the indicators that measure the value that information provides to its users, including accuracy, completeness, consistency, and timeliness [54]. Reference [55] uses structures that are accurate, complete, timely, and formatted to improve information quality. Information quality is crucial for the success of EISI, and high-quality information is an important support for business processes and decisions [56–58]. High-quality and timely updated information enables employees to access the information they need at the right time, enabling them to make autonomous decisions faster [59]. Good communication quality helps establish trust among employees, which in turn enhances their enthusiasm for participating in organizational goals and strengthens team cohesion [60]. Therefore, information systems support employees' autonomous decision-making ability by providing reliable, relevant, and timely information, enabling them to make wise decisions independently [61]. Information systems also enhance employee relationships by promoting better communication and

collaboration, making them feel more connected to their colleagues and the organization as a whole [62]. The following hypotheses are thus put forward:

H2a: The information quality of EISI has a positive impact on autonomy in work.

H2b: The information quality of EISI has a positive impact on competence in work.

H2c: The information quality of EISI has a positive impact on relevance in work.

2.3. Service Quality of EISI on Self-Determination

Service quality is typically defined as the gap between customers' expectations of service and their actual service experience [63]. In the enterprise information system environment, service quality reflects the overall satisfaction of information system users with IT services and their perception of system utility [22]. A high-quality service typically manifests as system usability, reliability, and responsiveness to user needs, which can enhance employees' ability to autonomously choose and operate systems in their work [37]. A high-quality information system provides a better user experience, making it easier for employees to access the information and tools they need, thereby producing a feeling of greater autonomy in decision-making and task execution processes [47]. In addition, high-quality services can provide timely and effective support, which helps reduce the uncertainty and frustration employees encounter while using the system, further enhancing their sense of autonomy and job satisfaction [51]. When employees use information systems and can quickly master the operation of the system and efficiently complete tasks, they will develop a sense of control, thereby enhancing their confidence in their abilities [64]. When the system provides smooth communication tools and stable services, employees are more likely to establish and maintain contact with colleagues and feel a stronger sense of belonging and group identity [65]. When the service quality of the information system is high, employees will encounter fewer problems when using the system, which means they can complete work tasks more smoothly and reduce frustration and isolation caused by technical issues [66]. The following hypotheses are thus put forward:

H3a: The service quality of EISI has a positive impact on autonomy in work.

H3b: The service quality of EISI has a positive impact on competence in work.

H3c: The service quality of EISI has a positive impact on relevance in work.

2.4. Self-Determination on Employee Engagement

Employee engagement is defined as "an individual's physical, cognitive, and emotional energy invested simultaneously in positive, comprehensive work performance [67]," which is a dynamic, dedicated, and absorptive positive work attitude [36]. High perceived autonomy makes employees feel that their behavior and decisions are driven by intrinsic motivation rather than external pressure or control [42]. When employees can complete tasks based on their judgment and interests, they are more likely to invest more time and energy [68] and show higher enthusiasm, commitment, and work engagement [69]. Autonomy gives employees a sense of freedom and flexibility in their work, which reduces stress and dissatisfaction caused by external control, increases their satisfaction and happiness, and promotes higher levels of work engagement [47]. Employees' competence enhances their self-efficacy in completing tasks, which drives them to actively respond to work challenges and increases their investment and persistence in their work [70]. At the same time, the improvement in employees' competence also reduces anxiety and frustration at work, making them more willing to take on more responsibilities proactively and demonstrate higher work enthusiasm and commitment [71,72]. When employees feel a strong sense of relevance, they are more likely to identify with the organization's goals and values and are willing to put in more effort for the organization's success [73]. Perceived relevance also enhances cooperation and trust among employees, making them more willing to participate in team activities, share information and resources, and thus demonstrate higher work engagement and enthusiasm [74].

The combined effects of perceived autonomy, perceived competence, and perceived relevance in self-determination make employees more motivated and enthusiastic to pursue work goals and actively participate in work tasks [75], thereby enhancing employee engagement [76]. The following hypotheses are thus put forward:

H4a: The autonomy of enterprise employees has a positive impact on engagement.

H4b: The competence of enterprise employees has a positive impact on engagement.

H4c: The relevance of enterprise employees has a positive impact on engagement.

2.5. The Moderating Effect of Transformational Leadership Style

The characteristic of a transformational leader is the ability to influence the attitudes and behaviors of subordinates through inspiring motivation, intellectual stimulation, and personal consideration [77]. Transformational leaders achieve higher levels of performance and creativity by elevating their subordinates' intrinsic motivation beyond the exchange value [34]. Transformational leadership can enhance employee engagement by meeting their basic psychological needs such as autonomy, competence, and relationships [34]. The satisfaction of these psychological needs can not only directly improve work engagement, but also further enhance work performance and the quality of task completion [78]. In the daily work environment, the behavior of transformational leadership promotes employee self-efficacy and optimism [79], enhances employee psychological ownership to promote employee engagement, and thus improves employee work performance [80]. The following hypotheses are thus put forward:

H5a: Transformational leadership positively moderates the impact of employees' autonomy on work engagement.

H5b: Transformational leadership positively moderates the impact of employees' competence on work engagement.

H5c: Transformational leadership positively moderates the impact of employees' relevance on work engagement.

METHODS

All the application measures in this study were derived from the relevant literature, as shown in Table 1. The initial questionnaire was in English, but as the survey was conducted in China, we translated it into Chinese. We invited two researchers with doctoral degrees to verify the consistency of the expression in the scale to ensure that the translation was consistent with the original scale. Participants were asked to use a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) to indicate their level of agreement or disagreement with the project (system quality, information quality, service quality, perceived autonomy, perceived competence, perceived association, employee engagement, and transformational leadership style).

Table 1. Table of research references.

Variable Constructs	Sources	Indicators
Information System Service Quality (SERQ)	1: [81]	1. The platform has the latest hardware and software.
	1 and 2: [63]	1. The physical facilities of the platform are visually attractive.
		2. The appearance of the facilities matches the services provided.
	1, 2, and 3: [81]	1. The platform delivers on promises made about completing tasks.
		2. The platform shows genuine willingness to solve users' problems.
		3. The platform is reliable.
	1, 2, and 3: [40,81]	1. Services are delivered at promised times.
		2. The platform maintains error-free records.
		3. The platform's operating hours suit all users.
		1. Users are accurately informed about when services will be performed.
Perceived Autonomy in Self-Determination	1, 2, 3, 4, 5, 6, 7, and 8: [63,81]	2. Users feel confident in the platform.
		3. Users receive personalized attention.
		4. Employees provide prompt services.
		5. The platform is never too busy to respond to users.
	1: [40,63]	6. The platform keeps users' best interests in mind.
		7. The platform understands users' specific needs.
		8. The platform provides individualized attention to users.
	1: [52,82]	1. Employees possess the knowledge to perform tasks efficiently.
		1. Most of the time, I feel a sense of accomplishment when using the unified platform.
		1. My supervisor recognizes my proficiency in using the platform.
Perceived Relatedness in Self-Determination	1 and 2: [37,82]	2. Through my work, I learn new and interesting skills using the platform.
		1. I feel capable when using the platform at work.
	1: [82]	1. While using the platform, I feel that my colleagues care about me.
		2. I feel close and connected to important individuals (leaders, colleagues, subordinates).
		3. I experience warmth with colleagues while using the platform.
Perceived Relatedness in Self-Determination	1, 2, and 3: [52,83]	1. I feel connected with colleagues who care about me and whom I care about.
	1: [52]	

Perceived Competence in Self-Determination	1 and 2: [71,83]	1. I feel confident in completing tasks using the platform. 2. I feel I can successfully complete difficult tasks with the platform.
	1 and 2: [52,71]	1. I feel capable of handling my responsibilities with the platform. 2. I feel competent in achieving my goals using the platform.
Transformational Leadership Style (TLS)	1, 2, 3, and 4: [78,84]	1. My supervisor articulates their most important values and beliefs through the platform. 2. My supervisor seeks diverse opinions when solving problems. 3. My supervisor introduces new methods for using platform features. 4. My supervisor communicates a compelling vision regarding the platform.
	1, 2, 3, and 4: [34,84]	1. My supervisor emphasizes the importance of having a collective mission. 2. My supervisor encourages viewing problems from different perspectives. 3. My supervisor holds an optimistic outlook on the platform's future. 4. My supervisor enthusiastically discusses the work that needs to be done.
System Quality (SYSQ)	1 and 2: [40,41]	1. The platform is easy to navigate for work. 2. The platform provides appropriate functionalities for tasks.
	1 and 2: [22,85]	1. The platform helps me easily find the information I need. 2. The platform's structure is logical and well-organized.
Information Quality (INFQ)	1, 2, and 3: [22,85]	1. The platform provides the most up-to-date information. 2. The platform provides information that is easy to understand. 3. The platform provides complete information.
	1 and 2: [63,81]	1: The information center staff are always willing to provide help when I need support for the unified platform. 2: The information center provides necessary help when I encounter problems using the unified platform.
Information System Service Quality (SERQ)	1 and 2: [40,85]	1: The information center staff provide unified platform-related services at the promised time. 2: The information center staff have sufficient knowledge to answer my questions about the unified platform.
		1. Being part of this organization is highly appealing to me. 2. One of the most exciting things is participating in this organization's activities. 3. Being part of this organization makes me feel alive. 4. Being part of this organization is exciting to me. 5. I am highly engaged in this organization.
Employee Engagement (EE)	1, 2, 3, 4, and 5: [32,86]	

Data Collection

The purpose of this study was to explore the relationship between the use of enterprise employee information systems and employee engagement and to analyze the mediating role of self-determination and the moderating role of transformational leadership styles. To achieve the purpose of this study, a questionnaire survey was used as a data collection tool to conduct quantitative research. We collected the data of the current Internet users in China who use the enterprise information system for office work as a sample. These data were collected using a purposive sampling method for this survey. Participants were registered through a representative sampling service and were asked to fill out the questionnaire online. After completing the questionnaire survey, they would receive a fixed amount of compensation. We set a filtering question at the beginning of the questionnaire to determine whether participants who filled out the questionnaire would use the enterprise information system for office work. After a one-month data collection period from August to September 2024, a total of 560 responses were obtained, resulting in 553 valid questionnaires. Table 1 shows the survey results regarding the characteristics of the participants, and Table 2 displays the demographic information of the participants.

Table 2. Descriptive statistics of participant demographic information.

Variable	Category	Frequency
Gender	Male	267 (48.28%)
	Female	286 (51.72%)
Age	18–25	80 (14.47%)
	26–30	190 (34.36%)
	31–40	151 (27.31%)
	41–50	92 (16.64%)
	51–60	39 (7.05%)
	Over 60 years old	1 (0.18%)
	Junior high school and below	2 (0.36%)
Education	High school or vocational school	81 (14.65%)
	Junior college	140 (25.68%)
	Undergraduate	237 (49.01%)
	Master's degree or above	39 (10.31%)

RESULTS

We used partial least squares (PLS) for statistical analysis. The reason for adopting PLS is that it seems to be suitable for exploratory work and prediction, as well as analyzing complex relationships and models [87]. In addition, PLS is widely used in the investigation and research of employee engagement in enterprises. We used SmartPLS 4.0 for data analysis. To analyze the data, we conducted (I) reliability and validity tests, (II) discriminant validity tests, and (III) structural model tests.

Before attempting to test the model, we decided to evaluate the reliability of the questionnaire by testing the Cronbach alpha coefficient and Composite Reliability of the test items, and to evaluate the convergence validity of the questionnaire by testing the average variance (AVE). The test [88] results exceeded the critical values, with a Cronbach's alpha coefficient and Composite Reliability both greater than 0.7, and with an AVE both greater than 0.5. The results are shown in Table 3.

Table 3. Reliability and validity analysis.

Constructs	Cronbachs Alpha	Composite Reliability	AVE
SYSQ	0.881	0.883	0.737
SERQ	0.874	0.876	0.726
PR	0.870	0.875	0.720
PC	0.874	0.876	0.726
PA	0.880	0.882	0.735
OE	0.872	0.874	0.722
INFQ	0.830	0.838	0.746

We tested discriminant validity using two cross-factor loadings [89] and the square root of mean variance (AVE). As shown in Tables 4 and 5, the discriminant validity was good.

Table 4. Cross-factor load table.

Items	INFQ	EE	PA	PC	PR	SERQ	SYSQ
INFQ1	0.875	0.336	0.275	0.314	0.285	0.349	0.284
INFQ2	0.848	0.305	0.247	0.203	0.249	0.323	0.275
INFQ3	0.867	0.318	0.275	0.249	0.303	0.3	0.239
EE1	0.286	0.832	0.286	0.251	0.305	0.318	0.357
EE2	0.316	0.842	0.289	0.26	0.358	0.318	0.305
EE3	0.328	0.856	0.331	0.3	0.335	0.296	0.373
EE4	0.327	0.867	0.319	0.329	0.331	0.372	0.409
PA1	0.302	0.346	0.857	0.293	0.307	0.299	0.304
PA2	0.244	0.313	0.845	0.352	0.279	0.337	0.305

PA3	0.252	0.288	0.854	0.3	0.348	0.3	0.26
PA4	0.257	0.288	0.873	0.265	0.317	0.315	0.291
PC1	0.257	0.301	0.251	0.86	0.332	0.282	0.396
PC2	0.241	0.266	0.285	0.861	0.299	0.296	0.308
PC3	0.229	0.302	0.318	0.85	0.326	0.264	0.393
PC4	0.294	0.275	0.353	0.837	0.249	0.286	0.314
PR1	0.272	0.364	0.314	0.347	0.864	0.286	0.431
PR2	0.257	0.354	0.295	0.335	0.853	0.327	0.37
PR3	0.313	0.251	0.293	0.285	0.842	0.221	0.363
PR4	0.265	0.348	0.332	0.229	0.834	0.27	0.319
SERQ1	0.366	0.298	0.298	0.231	0.271	0.865	0.317
SERQ2	0.336	0.343	0.312	0.268	0.286	0.85	0.36
SERQ3	0.263	0.35	0.329	0.301	0.289	0.849	0.293
SERQ4	0.32	0.314	0.302	0.319	0.27	0.844	0.323
SYSQ1	0.259	0.387	0.268	0.409	0.408	0.396	0.863
SYSQ2	0.218	0.356	0.277	0.32	0.38	0.293	0.861
SYSQ3	0.303	0.366	0.334	0.336	0.363	0.294	0.854
SYSQ4	0.273	0.351	0.287	0.361	0.356	0.314	0.856

The red boxes in the provided tables highlight the diagonal elements of the matrix, representing factor loadings. The values inside the red boxes are the highest loadings for each item

Table 5. Discriminant validity.

	INFQ	OE	PA	PC	PR	SERQ	SYSQ
INFQ	0.864						
OE	0.371	0.85					
PA	0.309	0.362	0.857				
PC	0.300	0.337	0.354	0.852			
PR	0.325	0.391	0.364	0.355	0.848		
SERQ	0.375	0.384	0.365	0.331	0.328	0.852	
SYSQ	0.307	0.426	0.339	0.417	0.439	0.379	0.859

Structural Model and Hypothesis Testing

Hypothesis testing uses the bootstrap method (including 5000 sub samples) to study the statistical importance of each path coefficient, using the T-test. The analysis results are shown in Figure 4, and the path coefficients and hypothesis testing results are shown in Table 6. According to the output results of PLS4.0, assuming H1–H4 are all true, the system quality, information quality, and service quality of EISI have a significant positive impact on the perceived autonomy, perceived competence, and perceived relevance of enterprise employees' self-determination. Ultimately, the perceived autonomy, perceived competence, and perceived relevance of enterprise employees have a positive impact on employee engagement.

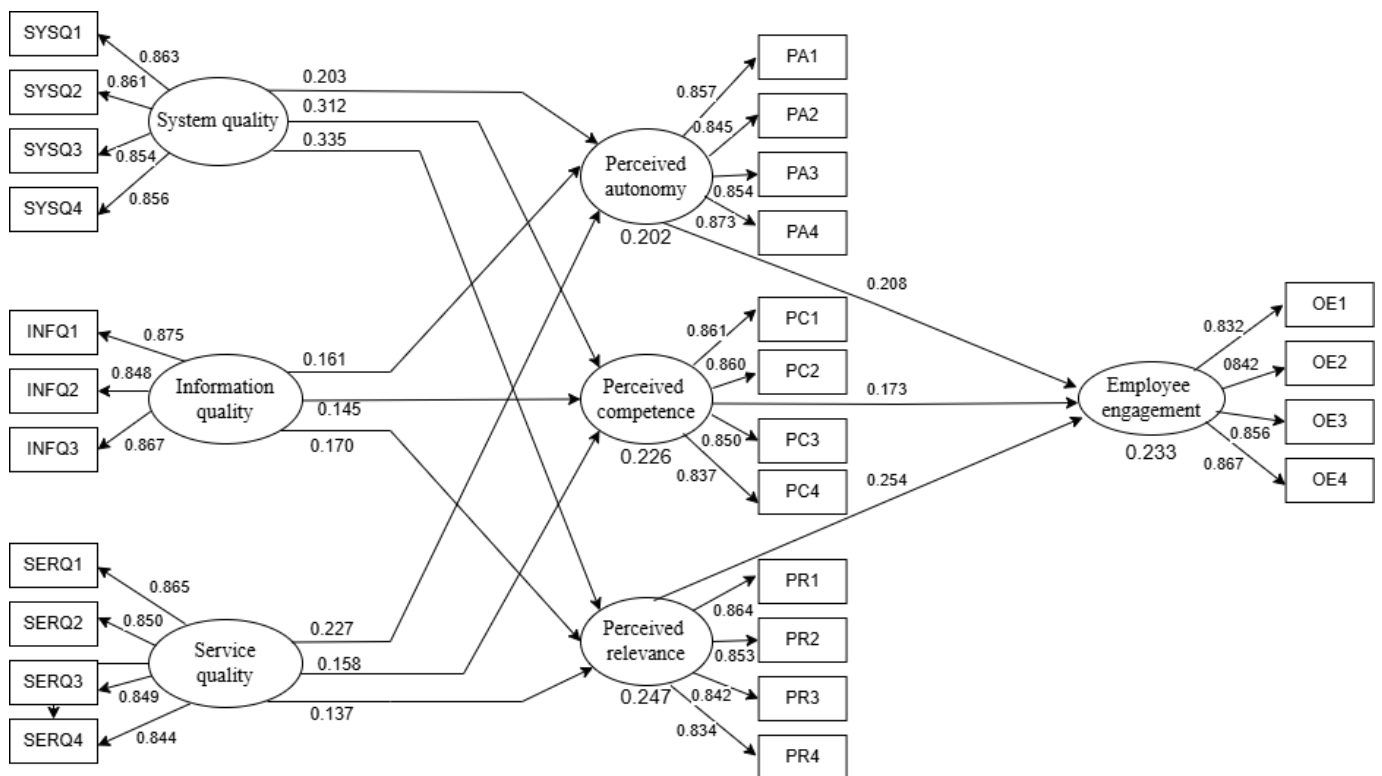


Figure 4. t-Test results.

Table 6. Hypothesis test results.

Paths	Original Sample	Sample Mean (M)	Standard Deviation (STDEV)	T Statistic	p Value
INFQ -> PA	0.161	0.161	0.043	3.781	0.000
INFQ -> PC	0.145	0.145	0.043	3.37	0.001
INFQ -> PR	0.17	0.171	0.041	4.157	0.000
PA -> EE	0.208	0.208	0.038	5.414	0.000
PC -> EE	0.173	0.173	0.041	4.237	0.000
PR -> EE	0.254	0.254	0.04	6.319	0.000
SERQ -> PA	0.227	0.227	0.041	5.487	0.000
SERQ -> PC	0.158	0.158	0.041	3.83	0.000
SERQ -> PR	0.137	0.137	0.042	3.283	0.001
SYSQ -> PA	0.203	0.205	0.043	4.717	0.000
SYSQ -> PC	0.312	0.313	0.039	7.96	0.000
SYSQ -> PR	0.335	0.336	0.04	8.314	0.000

Moderating Effect Inspection

James proposed that if the relationship between variables Y and X is a function of variable M, then M is called the moderating variable. The moderating variable can be qualitative or quantitative, which can affect the positive or negative relationship between the dependent and independent variables [90]. Therefore, we further used SPSS Process 4.0 software and a standard guide program with 5000 samples for stratified analysis. The results confirmed that the impact of perceived autonomy on employee engagement changed significantly at different levels of transformational leadership: for low-level transformational leadership, $\beta = -0.091$, $p = 0.382$; for intermediate-level transformational leadership, $\beta = 0.409$, $p = 0.004$; and for high-level transformational leadership, $\beta = 0.176$, $p = 0.171$. The impact of perceptual ability on employee engagement has also undergone significant changes at different levels of transformational leadership: for low-level transformational leadership, $\beta = -0.242$, $p = 0.024$; for intermediate-level transformational leadership, $\beta = 0.057$, $p = 0.693$; and for high-level transformational leadership, $\beta = 0.107$, $p = 0.385$. The impact of perceptual ability on employee engagement has also undergone significant changes at different

levels of transformational leadership: for low-level transformational leadership, $\beta = -0.160$, $p = 0.151$; for intermediate-level transformational leadership, $\beta = 0.043$, $p = 0.800$; and for high-level transformational leadership, $\beta = 0.033$, $p = 0.779$.

Overall, the path from $PA \times ML$ to EE is significant ($\beta = 0.1374$, $t = 5.6035$, $p = 0.000$); The $PC \times ML$ to EE pathway is significant ($\beta = 0.1318$, $t = 4.9307$, $p = 0.000$), and the path from $PR \times ML$ to EE is significant ($\beta = 0.1346$, $t = 5.3363$, $p = 0.000$), as it is shown in Table 7. This indicates that transformational leadership has a significant positive moderating effect on the relationship between perceived autonomy, perceived competence, perceived relevance, and employee engagement in self-determination.

Table 7. Moderating effects at different levels.

Dependent Variable	Independent Variable	Transformational Leadership	Influence	LLCI	ULCI	p Value
Employee engagement	Perceived autonomy	low	-0.091	-0.298	0.115	0.382
		medium	0.409	0.133	0.684	0.004
		high	0.176	-0.077	0.430	0.171
		total	0.1374	0.0893	0.1856	0.000
	Perception ability	low	-0.242	-0.452	-0.033	0.024
		medium	0.057	-0.226	0.339	0.693
		high	0.107	-0.135	0.349	0.385
		total	0.1318	0.0793	0.1842	0.000
	Perceived association	low	-0.160	-0.379	0.059	0.151
		medium	0.043	-0.291	0.377	0.800
		high	0.033	-0.201	0.268	0.779
		total	0.1346	0.0851	0.1842	0.000

To further test the moderation effect and more intuitively display the moderation effect of perceived utility, we plotted interaction effect graphs at different levels of perceived utility [91]. All variables were dispersed during the calculation process, with moderating values assigned as $-1SD$ and $+1SD$, respectively. As shown in Figure 5, the slope of the straight line reflects the impact of perceived autonomy on employee engagement. The graph shows a positive relevance between perceived autonomy and employee engagement. The higher the perceived autonomy of enterprise employees, the higher their level of engagement. The stronger the transformational leadership of a company, the stronger the positive relevance between perceived autonomy and employee engagement. Therefore, the positive moderating effect of transformational leadership on perceived autonomy and employee engagement has been verified.

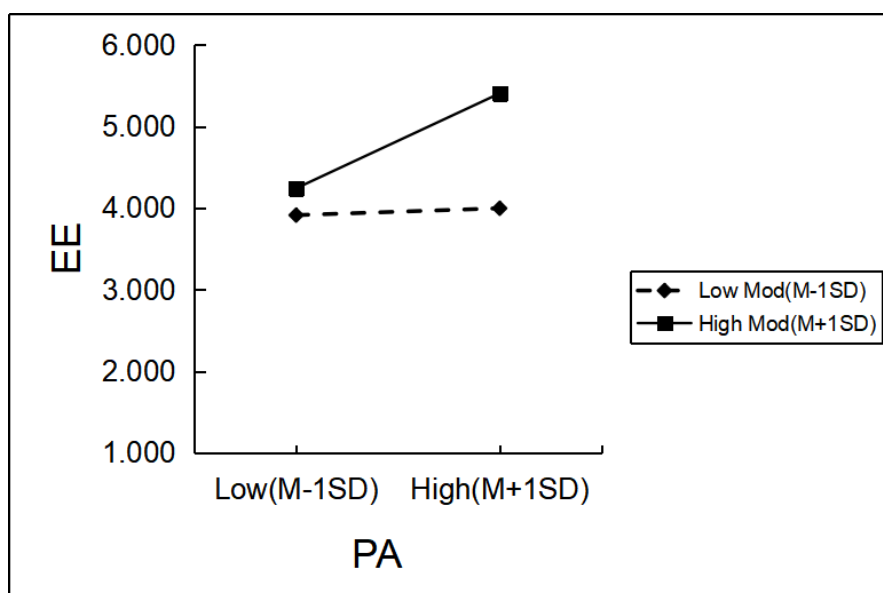


Figure 5. The impact of perceived autonomy on employee engagement.

As shown in Figure 6, the slope of the straight line reflects the impact of perceptual ability on employee engagement. The graph shows a positive relevance between perceptual ability and employee engagement. The higher the perception ability of enterprise

employees, the higher their engagement. The stronger the transformational leadership of a company, the stronger the positive relevance between perceived competence and employee engagement. Therefore, the positive moderating effect of transformational leadership on perceived competence and employee engagement has been verified.

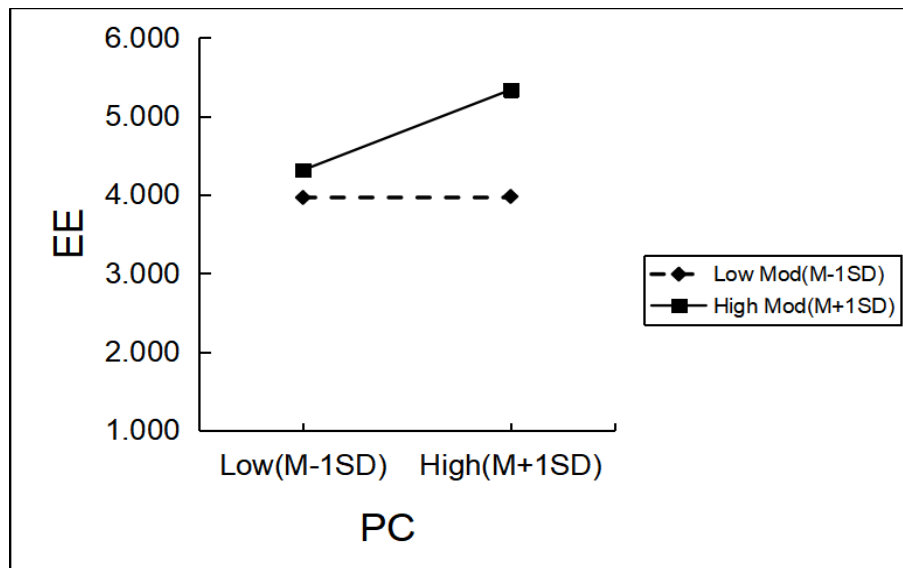


Figure 6. The impact of perceptual ability on employee engagement.

As shown in Figure 7, the slope of the straight line reflects the impact of perceived associations on employee engagement. The graph shows a positive relevance between perceived association and employee engagement. The higher the perceived relevance among enterprise employees, the higher their level of engagement. The stronger the transformational leadership of a company, the stronger the positive relevance between perceived relevance and employee engagement. Therefore, the positive moderating effect of transformational leadership on perceived relevance and employee engagement has been verified.

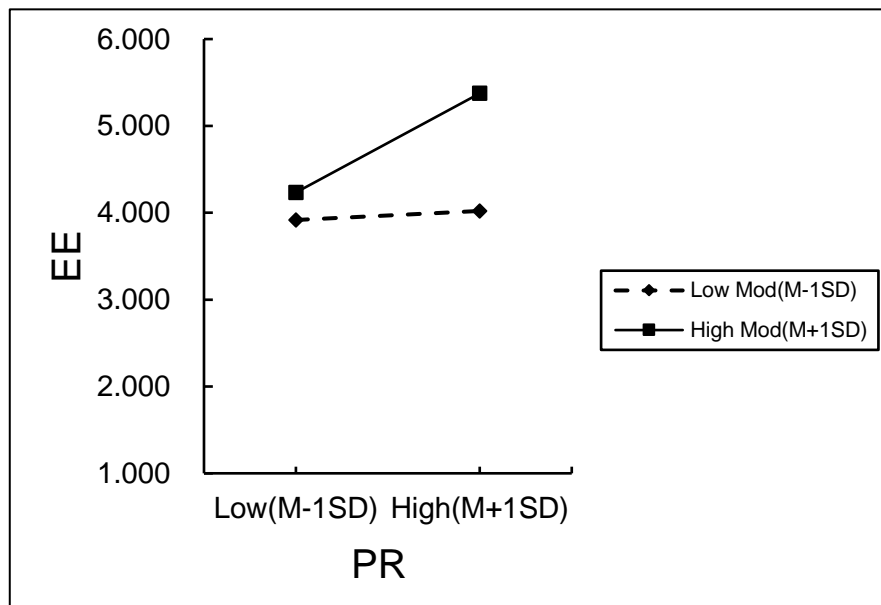


Figure 7. The impact of perceived relevance on employee engagement.

DISCUSSION

First, this study extends the impact of enterprise information system quality on employee engagement by proposing and testing a model, integrating transformational leadership theory [77], self-determination theory [51], and the information system success model [40], and it also explores the impact mechanism of system quality, service quality, and information quality of EISI on employee engagement. Previous studies have extensively explored the understanding of various positive outcomes of employee engagement in the context of enterprise information system usage, such as the relationship between employee behavior and

system quality [30]; the relationship between information system quality (including system quality, information quality, and service quality) and organizational performance [22,92]; and its positive impact on employee learning ability, adaptability, and job satisfaction [26]. However, previous research seems to have overlooked the impact of changes in psychological needs on employee engagement when using EISI. This study explores the intrinsic impact of the quality of EISI on employees' psychological needs by introducing self-determination theory, and ultimately affects the intrinsic motivation process of employee engagement, as well as the moderating role of transformational leadership in this process, addressing the two limitations mentioned above [38,93].

Secondly, the results of this study indicate that the quality of an enterprise's information systems (system quality, information quality, and service quality) positively affects employees' intrinsic motivation (perceived autonomy, perceived competence, and perceived relevance), which is consistent with previous research on the impact of information system quality on intrinsic motivation [38,94]. Employees' intrinsic motivation ultimately affects their level of engagement, further supporting previous research perspectives. The application of self-determination theory in the workplace environment further reinforces this finding, stating that when employees' basic psychological needs are met, it stimulates their higher work engagement and positive behavior, and that employees' intrinsic motivation is a key factor affecting their engagement [51]. This theoretical framework clearly points out that employees' intrinsic motivation serves as a bridge between their psychological satisfaction and engagement, thus not only verifying the conclusions of previous research, but also providing new perspectives and strategies for understanding and enhancing employee engagement.

Most importantly, this study reveals the positive moderating effect of transformational leadership on the relationship between employee self-determination and engagement. By proving that the leadership of direct managers enhances the positive effect of employees' engagement by mobilizing their self-determination needs during the use of EISI, transformational leadership strengthens these needs. Research has shown that transformational leadership can effectively promote employees to be more engaged and proactive in their work, and this moderating effect is particularly significant within the framework of self-determination theory. Therefore, in the context of transformational leadership, the positive impact of perceived autonomy, perceived competence, and perceived relevance on employee engagement will be further amplified [19,95]. This finding emphasizes the important role of transformational leadership in promoting employee intrinsic motivation and work engagement, which is consistent with previous research on the relationship between transformational leadership and employee work engagement. This paper further discusses the mechanism of action in the context of employee information system usage.

Theoretical Implications

Theoretical framework integration: this study provides a more comprehensive explanation for understanding the relationship between enterprise EISI and employee engagement by integrating multiple theoretical frameworks, which helps enrich and expand the existing theoretical system.

Expanding the success model of information systems: this study extends the application of the success model of information systems in the field of EISI, and adds new dimensions to the model by exploring the relationship between information system quality and employee engagement.

Application of self-determination theory: this study applies self-determination theory to the field of EISI, providing a new perspective on understanding the relationship between information system quality, employee psychological needs, and engagement, which helps improve the understanding of employee intrinsic motivation.

Practical Implications

Optimizing EISI design: Research provides guidance for organizations to optimize EISI design. By improving the quality of information systems and implementing effective leadership styles, organizations can stimulate employees' intrinsic motivation, increase work engagement, and improve organizational performance.

Cultivate transformational leadership: this study helps promote the development of transformational leadership skills in management through training and development programs, in order to better support employees' self-determination needs, encourage employees to be more actively engaged in their work, and enhance their engagement.

Promote employee self-determination: this study encourages companies to create a work environment that supports employee autonomy, abilities, and a sense of relationships, by providing necessary resources and support to help employees better complete tasks and enhance their engagement and satisfaction with their work.

Limitations and Future Research

Although this study provides valuable insights, there are also some limitations, such as the sample being limited to the Chinese region, which may limit the generalizability of the research results. Future research can explore similar relationships in different cultural backgrounds or consider other factors that may affect employee engagement, such as individual differences and organizational structure. In addition, this study used cross-sectional data and could not determine the causal relationship between variables. Therefore, future research can use a longitudinal design to further verify the causality of the relationship proposed in this study.

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