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Research Article

The Adoption of Open Source Software Among Universities in Iraq: The Moderating Role of AI Capability

Mustafa Moosa Qasim,[1] **Ali Raad Abdulkareem**,[2] **and Radhwan Sneesl**[3]

[1]*Department of Intelligent Medical Systems, College of Computer Science and Information Technology, University of Basrah, Basrah, Iraq*
[2]*College of Physical Education and Sport Sciences, University of Basrah, Basrah, Iraq*
[3]*College of Science, University of Basrah, Basrah, Iraq*

Correspondence should be addressed to Radhwan Sneesl; radhwan.sneesl@gmail.com

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Open source software (OSS) is a trendy innovation that is being used by all organizations. However, the usage of OSS is still limited in higher education. This research examines the adoption of OSS among universities in Iraq, focusing on the moderating role of artificial intelligence (AI) capabilities. The research is aimed at exploring how factors such as perceived ease of use (PEOU), compatibility, perceived risk, security, and cost-effectiveness influence OSS adoption. Using a quantitative research methodology, data was collected from 272 university decision-makers and analysed using Smart PLS 4. The results of the study indicate that factors such as PEOU, compatibility, perceived risk, security, and cost-effectiveness have a significant positive influence on the adoption of OSS. The research findings provide valuable insights for decision-makers in university settings who are grappling with the intricate process of adopting OSS. These findings offer valuable insights for higher education institutions in Iraq and other developing regions seeking to adopt OSS.

Keywords: adoption; artificial intelligence; higher education; open source software; software engineering; TAM

1. Introduction

Software engineering advances have transformed organizational processes throughout sectors, providing a range of software solutions to meet various goals [1]. Flexibility, cost-effectiveness, and the ability to foster innovation, collaboration, and transparency make open source software (OSS) a good choice [2]. OSS allows customisation and cooperation without restrictions, unlike proprietary software. Continuous development and community-driven innovation are possible with open-access models [3]. Other corporations are adopting OSS, but higher education, particularly in developing countries, has not [4]. Universities, like other institutions, must adapt to the rapidly changing educational landscape. Higher education may benefit from OSS's operational efficiency, software cost savings, and collaborative learning [5]. System compatibility, security, and organizational readiness make OSS adoption in academia difficult [6]. These issues need a thorough approach to studying university OSS adoption determinants.

This research handles complexity using the technology acceptance model (TAM) and technology–organization–environment (TOE) frameworks. Users' perceived ease of use (PEOU) and utility perceptions impact technology adoption, according to the TAM [7]. TOE characteristics like compatibility and security affect tech adoption [8, 9]. The main difficulties include OSS compatibility with present systems, security and data integrity, and workflow disruption hazards [10, 11]. In developing countries, resource and infrastructural constraints may make OSS adoption tougher. Thus, we examine technological, organizational, and environmental factors affecting OSS adoption in Iraqi institutions using the TAM and TOE frameworks [12]. The literature has not thoroughly explored this topic [13]. Iraqi

universities confront considerable difficulties owing to the technical infrastructure and expertise lacking. Research has stressed the importance of these elements in technology adoption [14].

The research on how developing technologies, particularly artificial intelligence (AI), affect OSS adoption is lacking [14, 15]. AI can increase system reliability, compatibility, and data integrity to mitigate OSS risks, including security vulnerabilities [16]. There is little empirical data on how AI capabilities affect OSS adoption in developing country higher educational institutions [17]. Against this background, limited studies examined the adoption of OSS by universities in general [18, 19] and in Iraqi higher education in particular [20–23]. Studies also showed that there are mixed findings related to the determinants of adoption with a special focus on the security and risk perspective while ignoring other important determinants such as compatibility and the PEOU as well as the role of technology such as AI capability in mitigating the risk and supporting the adoption of OSS [24–27]. Therefore, the aims are to examine the effect of these variables in promoting the adoption of OSS by universities in Iraq. Iraq is in the stage of developing academic research, and one aspect of this direction is to incorporate technologies within higher education [20].

OSS is widely recognized for its cost-effectiveness, flexibility, and collaborative potential, yet its adoption in higher education remains under-researched, particularly in developing countries like Iraq. Universities in Iraq face unique challenges, such as limited technological infrastructure, security concerns, and a lack of skilled personnel, which hinder the widespread adoption of OSS. Previous research has concentrated on OSS adoption in established educational institutions, leaving Iraqi higher education without a clear grasp of how to use it. This research addresses that gap by exploring the main variables affecting OSS adoption and how AI capabilities act as a moderating variable. The study addresses this gap to contribute to the technology adoption debate in developing nations and provide practical recommendations for university decision-makers. Therefore, this study is in line with the government's agenda to improve the contribution of higher education and to make it linked to industry. The study is also aimed at examining the moderating role of AI capabilities in improving the adoption of OSS by universities. The remainder of this paper discusses the literature review, research methodology, data analysis, and findings, as well as discussion and implications, along with the conclusion of this research.

2. Literature Review

This section discusses the theoretical framework of this investigation as well as the OSS and the conceptual framework along with the hypothesis's development of this research.

2.1. Theoretical Framework. Theories provide frameworks that direct the identification, analysis, and interpretation of crucial factors influencing individuals' or organizations' choices to adopt technology such as OSS. A widely used theory in technology adoption studies is the TAM. This model considers PEOU and usefulness. PEOU influences technology adoption [5]. OSS integration and interface are vital in higher education when its implementation is contemplated. Academic users are more encouraged to use a system that is straightforward to use. Interfaces that are simple to use, well-documented, and intuitive are important [6]. TAM values system utility and compatibility. Academic users are more likely to embrace OSS if it fits their systems and processes. Customizing OSS to academic users' needs and activities is crucial because it develops and fosters the intention toward using the OSS [9].

The TOE framework addresses organizational and environmental variables, including perceived risk. Technology adoption debates often centre on perceived risk [17]. Perceived risk is a critical factor that can hinder or encourage the use of a new system or technology [20]. Along with perceived risk, security and computability are essential variables of TOE, and some researchers referred to these variables as technology-related factors [23, 28]. Another important theory to consider is the resource-based view (RBV), which notes that organizations can use their resources to minimize costs and achieve a competitive advantage. Therefore, cost-effectiveness and AI capability are critical resources and capabilities that can be used by organizations to achieve better performance [29, 30]. Therefore, based on the conceptualization of the three theories, this research uses the TAM to explain PEOU and TOE to explain compatibility, security, and perceived risk. The RBV also explains cost-effectiveness and AI capability.

2.2. Open Software Usage in Higher Education. OSS in higher education is attracting attention for its cost reductions, flexibility, and collaborative possibilities. Many studies have examined higher education OSS adoption. The research has shown the motives, obstacles, and effects of academic institutions integrating open-source technologies [11, 31]. Higher education has seen financial gains from embracing OSS [18]. By reallocating proprietary software licensing revenues, universities can support infrastructure, research, and student services [7]. Research shows that universities can adapt OSS to their academic and administrative requirements. Higher education institutions customize OSS to meet their different needs [8]. Student learning benefits from open-source projects by contributing to real-world projects, acquiring practical experience, and developing marketable skills by participating in OSS initiatives [12]. Higher education values collaboration, and this is enabled using open source [19]. Universities can benefit from engaging in OSS groups, sharing information, and working with international developers [13].

The topic of security and reliability has been extensively studied in relation to OSS in higher education. Various studies have examined the perceptions surrounding these aspects. Studies indicate that open-source solutions have demonstrated comparable levels of security and dependability to proprietary alternatives, dispelling common misunderstandings [32]. Despite the clear advantages, research also recognizes difficulties in the implementation of OSS. Typical obstacles involve reluctance to change, worries regarding support and training, and the necessity for cultural shifts

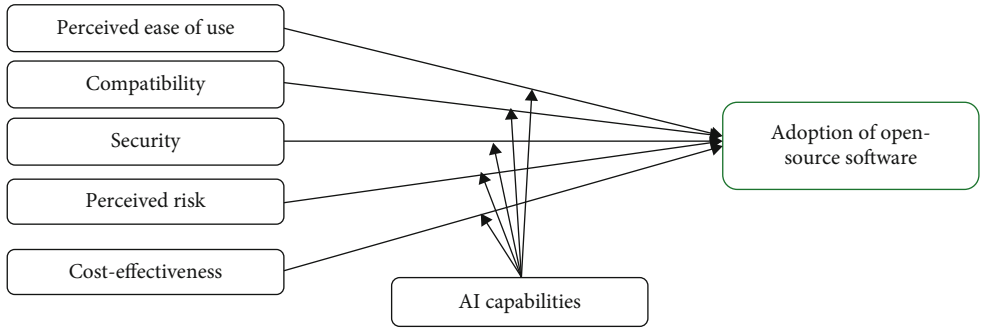

Figure 1: Conceptual framework.

within institutions [33, 34]. Several case studies offer valuable insights into the adoption experiences of specific universities. The studies analyse the reasons, approaches, and results of implementing OSS, providing useful insights for other organizations contemplating similar changes [32, 35–37].

Research often studies student and instructor views on OSS use. Effectively integrating open source into academic procedures requires understanding stakeholder views [38]. Adoption and integration techniques may benefit from this understanding [39]. Several studies examine OSS in open educational resource production and dissemination. The convergence of open source and open education influences higher education's open efforts [40]. Overall, OSS integration in higher education is complicated and ever-changing. This research investigates Iraqi universities' OSS adoption.

2.3. Conceptual Framework and Hypothesis Development. Based on TOE and TAM as well as RBV theories, this research proposed that PEOU, compatibility, security, perceived risk, and cost-effectiveness have a significant effect on the adoption of OSS. The study also proposed that using AI capabilities is a critical factor in moderating the effect of PEOU, compatibility, security, perceived risk, and cost-effectiveness on the adoption of OSS. Figure 1 shows the conceptual model of this investigation.

2.3.1. PEOU. PEOU refers to the physical and mental efforts that are required to use OSS. Research suggests stakeholders in universities perceived OSS as easy to use, and there is a positive link between PEOU and the adoption of OSS [41, 42]. TAM proposed that PEOU is critical for using technology. This is because PEOU plays a crucial role in shaping user attitudes and intentions toward adoption [43, 44]. In the realm of universities, where the user base varies greatly in technical proficiency, the importance of a user-friendly interface and intuitive functionalities cannot be overstated [45]. The study conducted by [46, 47] found that the degree of ease of using a technology can have a positive impact on the decision to adopt the technology. Similarly, other researchers have noted that the PEOU is an important predictor of using a new technology [42, 45]. Therefore, the following is proposed:

H1: PEOU has a positive effect on OSS adoption.

2.3.2. Compatibility. OSS is more likely to be adopted when it is highly compatible with existing university systems. This idea is in line with the TOE [48]. This suggests that seamless integration of OSS with existing university systems can reduce disruption and increase overall efficiency, thereby increasing the likelihood of adoption [24, 25]. The TOE emphasizes the importance of compatibility in the adoption process, emphasizing that innovations deemed compatible with existing practices have a greater chance of being adopted by individuals or organizations [49, 50]. Thus, it suggests a positive effect of compatibility on OSS adoption.

H2: Compatibility has a positive effect on OSS adoption.

2.3.3. Perceived Risk. When universities choose to adopt OSS, they face a range of potential risks that must be addressed in order to successfully integrate OSS into their systems [32]. Risks of university use of OSS may include a lack of dedicated vendor support, potential integration difficulties, and a steeper learning curve for users accustomed to proprietary software [37, 51]. Potential risks arise from safety concerns, reliance on community support, and legal and licensing issues [33, 34]. In addition, universities may face difficulties related to allocation, risk perception, and resistance between staff and students. Studies have found that perceived risk has a significant impact on the use of OSS [32, 35–37]. Therefore, it makes the following hypothesis:

H3: Perceived security has a significant effect on OSS adoption.

2.3.4. Security. Security is an important aspect that must be taken with extreme care and attention. It is critical to implement the necessary measures and protocols to prevent potential threats and intrusions [39]. By prioritizing security, universities can ensure that sensitive information is protected and systems are maintained [40]. Universities are more likely to adopt OSS when they see stronger security measures in place. The work by [52] on security lays the groundwork for comprehending the significance of strong security measures. In educational institutions, secure solutions for handling sensitive data, research findings, and student information are critical [39]. Hence, if stakeholders view open-source solutions as offering robust security measures, it increases the appeal and probability of software

adoption [37]. Accordingly, this research proposes a positive link between a high level of security and the adoption of OSS. Thus, the following is hypothesized:

H4: Security has a significant effect on OSS adoption.

2.3.5. Cost-Effectiveness. Cost-effectiveness indicates that universities are more inclined to adopt OSS when they perceive it to be cost-effective. Universities must consider cost-effectiveness as a key factor when dealing with budget constraints [30]. RBV recognizes resources such as OSS as a valuable resource that aids in cost optimization and effective resource allocation [53]. When stakeholders view open-source solutions as more cost-effective and valuable than proprietary alternatives, it strengthens the software's economic viability [54, 55]. Within this context, the adoption of OSS enables universities to strategically allocate resources, redirecting funds toward research, student services, or infrastructure development. Hence, the evaluation of cost-effectiveness plays a pivotal role in the decision-making process for universities contemplating the implementation of OSS [56, 57]. Accordingly, the following is proposed:

H5: Cost-effectiveness has a significant effect on OSS adoption.

2.3.6. Moderating Effect of AI Capabilities. The five variables—PEOU, compatibility, perceived risk, security, and cost-effectiveness—and university OSS adoption are complicated and dynamic, influencing adoption decisions. AI's modulation of this connection complicates interpretation. AI can enhance OSS PEOU [58]. AI-driven chatbots or virtual assistants can quickly resolve user issues, affecting PEOU and OSS adoption [59]. By using complex algorithms and data integration methods, AI makes OSS and other technical infrastructures work together [60]. AI-powered systems may automatically adapt OSS to processes, reducing compatibility issues [61]. By continuously monitoring and analysing security vulnerabilities, AI can mitigate OSS adoption risks [26]. AI's predictive analytics can foresee and manage disruption problems, reducing OSS adoption risk [27].

Machine learning algorithms can learn and adapt to new security risks, making OSS more resilient to cyberattacks [62]. Continuous monitoring and analysis using AI is essential for proactive security [63]. This manages the association between perceived security measures and academic OSS adoption [64]. AI may automate regular processes, reduce operational overhead, and improve resource allocation tactics to make OSS adoption more cost-effective [65]. This makes OSS attractive to institutions with limited budgets. AI capabilities significantly affect the factors indicated and academic institutions' use of OSS. AI strongly influences higher education OSS adoption decisions. It boosts security, user experience, compatibility, risk reduction, and cost-effectiveness. Therefore, this investigation proposes AI capabilities as a moderating variable in the relationship among the variables. Accordingly, the following is proposed:

H6: AI capabilities moderate the effect of PEOU on OSS adoption.

H7: AI capabilities moderate the effect of compatibility on OSS adoption.

H8: AI capabilities moderate the effect of perceived risk on OSS adoption.

H9: AI capabilities moderate the effect of security on OSS adoption.

H10: AI capabilities moderate the effect of cost-effectiveness on OSS adoption.

3. Research Methodology

This research uses the positivism paradigm to understand empirically the factors that affect the adoption of OSS. The study is based on a quantitative approach. The population includes the universities of Iraq. There are 85 universities in Iraq. However, based on the objective of this research, which aims to examine the adoption of OSS, the study focuses on managerial staff in the decision-making who are aware and knowledgeable about the OSS. This is often the case in the engineering and information technology (IT) faculties. Therefore, this study focuses on these two faculties with a special focus on the managerial staff who are working in these faculties. Thus, this study uses purposive sampling due to the need of those who are aware of the OSS. The study collects the responses from these respondents using a questionnaire. The measurements of the variables were adopted from previous studies. Measurement of OSS adoption consists of five items adopted from [66].

The measurement of PEOU consists of four items adopted from [43], the measurement of compatibility consists of six items and was adopted from [48], perceived risk consists of five items and was adopted from [67], security consists of five items and was adopted from [68], and last, cost-effectiveness consists of five items and was adopted from [69]. The questionnaire was translated into Arabic using back-to-back translation procedures. Next, the scale of the variables was validated by experts to ensure that the scale can measure the variables effectively. Three experts have participated in this validation process. Mainly, the correction was related to the accuracy of the translation and wording of the questions. Comments and feedback from the experts were considered to improve the quality of the measurement. Next, a pilot test was conducted, and all the Cronbach's alpha (CA) were greater than 0.70. Values of CA ranged between 0.719 and 0.891. Table 1 shows the measurement of the variables as well as the results of CA for the pilot study. It shows the mean (M), standard deviation (Std.), and CA.

A link was created and sent to academic staff with managerial positions in Iraqi universities. Details of these individuals were obtained online. The questionnaire included an introduction to inform the respondents about their rights and ensure the anonymity of the responses. The time estimated was stated, and the right to withdraw at any time without prior notification was ensured. Data was collected via a structured questionnaire distributed to 283 respondents, of which 272 valid responses were analysed. The data was analysed using Smart PLS 4 to evaluate both the measurement and structural models and to test the moderating effect of AI capabilities on the relationships between the identified factors and OSS adoption. The data is analysed

Table 1: Measurement of the variables, mean, and Cronbach's alpha.

Variable	Source	Items	*M*	Std.	CA
Perceived ease of use (PEOU)	[36]	1. "I find OSS easy to use." 2. "It is easy for me to become skillful in using OSS." 3. "Interacting with OSS does not require a lot of mental effort." 4. "I find OSS to be user-friendly."	3.19	0.535	0.858
Compatibility	[41]	1. "OSS is compatible with our current IT systems." 2. "Using OSS fits well with the existing software and processes." 3. "OSS integrates easily with other tools we use." 4. "OSS does not conflict with existing organizational systems." 5. "OSS aligns with the technological infrastructure of the university." 6. "OSS is compatible with our academic and administrative processes."	3.1	0.369	0.918
Perceived risk	[60]	1. "I am concerned about the security of data when using OSS." 2. "There is a high level of uncertainty associated with OSS adoption." 3. "Using OSS could lead to unexpected problems." 4. "OSS might be risky due to the lack of vendor support." 5. "I perceive a high level of risk in adopting OSS for our university's needs."	3.09	0.385	0.837
Security	[61]	1. "OSS provides adequate security features." 2. "I believe OSS can protect sensitive information." 3. "OSS offers the same level of security as proprietary software." 4. "I feel confident about the security protocols in OSS." 5. "OSS ensures data integrity and confidentiality."	2.91	0.56	0.911
Cost-effectiveness	[62]	1. "OSS helps reduce software-related costs." 2. "Using OSS provides financial savings for the university." 3. "OSS is a cost-effective solution for our IT needs." 4. "Adopting OSS allows us to allocate resources more efficiently." 5. "The use of OSS reduces overall operational costs for the university."	3.06	0.494	0.759
AI capabilities	[51–53]	1. "AI capabilities enhance the functionality of OSS." 2. "AI tools improve the user experience when interacting with OSS." 3. "AI capabilities help mitigate the perceived risks associated with OSS." 4. "AI integration increases the security of OSS." 5. "AI-driven solutions optimize the cost-effectiveness of OSS adoption."	3.52	0.685	0.916

using Smart PLS 4, in which the measurement model and structural model are assessed and discussed in the next section. Smart PLS 4 is more efficient in testing moderators compared with other software, and this justifies its usage in this study [70].

4. Findings

This section presents the study's findings, encompassing a detailed examination of the data, descriptive information about respondents and variables, and analyses conducted using Smart PLS 4.

4.1. Data Examination. The data of this study was examined for missing values, outliers, normality, and multicollinearity. A total of five responses were identified as having large numbers of missing values, and they were removed. The outliers were checked, and six responses were removed due to outliers' issues. This has made the valid responses account for 272. The data is normally distributed because the value of skewness and kurtosis is less than absolute one (1). This is in line with the suggestions of [70]. In addition, there is no issue of multicollinearity because the value of tolerance is higher than 0.20, and the value of variation inflation factors (VIFs) is less than five (5). Table 2 also shows the descriptive information of the variables. All the variables have a *M* score above the midpoint of 2.5.

4.2. Profile of Respondents. The respondent demographic profile represents a varied and inclusive sample of academic and managerial staff in the university setting. The majority of individuals are middle-aged, with 33.8% falling between the ages of 30 and 40 and 34.9% falling between the ages of 41 and 50. It is worth mentioning that the gender distribution among participants is imbalanced, with 77.9% being male and 22.1% being female. A large proportion of the respondents possess a Ph.D. (58.8%), highlighting their strong academic credentials. The academic ranks encompass

Table 2: Normality, multicollinearity, and descriptive of the variables.

Variable	Descriptive of variables	Normality		Multicollinearity	
	Mean	Skewness	Kurtosis	Tolerance	VIF
Open source software	2.96	−0.359	−0.580	—	—
Compatibility	3.10	−0.369	−0.388	0.441	2.268
Perceived risk	3.09	−0.385	−0.516	0.448	2.231
Security	2.91	−0.560	−0.833	0.394	2.536
Cost-effectiveness	3.06	−0.494	−0.524	0.484	2.066
Perceived ease of use	3.19	−0.535	−0.661	0.563	1.776
AI capabilities	3.52	−0.145	−0.685	0.964	1.037

a wide range of positions, with the most common being senior lecturers (54.0%) and lecturers (36.8%). Experience levels within these ranks also vary, with some individuals having less than 5 years of experience (9.6%) and others having 20–25 years of experience (27.2%). Table 3 shows the descriptive information of respondents.

4.3. Measurement Model. The evaluation of the measurement model required a thorough analysis of important parameters, such as factor loading, reliabilities, and validities. The examination of factor loading was essential to ensure the reliability of the measurement, as it indicates the strength of the relationship between observed variables and their underlying constructs. Significant factor loadings indicate a robust association between the observed items and the latent constructs they aim to assess. In this study, some items were removed due to low factor loadings. The deleted items include cost-effectiveness, perceived risk, and security. The evaluation of reliability aimed to ensure the stability and consistency of the measurement instruments by assessing the internal consistency of the set of items. We evaluated the CA coefficients for each construct to determine their reliability. Higher values were indicative of greater reliability. In addition, the composite reliability was assessed, and they were both acceptable as shown in Table 4.

Further, the study thoroughly examined the validity of the measurement model, evaluating both convergent and discriminant validities. Convergent validity explores the correlation between items within the same construct, while discriminant validity evaluates the distinctiveness of different constructs. As shown in Table 4, the values of VIF are above 0.50, indicating that the convergent validity has been achieved. The discriminant validity was checked using the heterotrait–monotrait ratio of correlations (HTMT) based on the recommendation of [70]. The correlation between variables is less than 0.85, indicating that there is no issue of discriminant validity.

Figure 2 shows the measurement model of the study. The figure shows the factor loading for all items. It shows that factor loading is higher than the threshold of 0.70 as suggested by [70].

4.4. Structural Model. The structural model of this study is shown in Figure 3. It shows that the R-square values for the direct effect model accounted for 0.674, and for the moderating effect model, it is 0.807, indicating that 67.4% and 80.7% of the variation in OSS adoption can be explained by PEOU, compatibility, perceived risk, security, cost-effectiveness, and AI capabilities as a moderator.

Table 3: Descriptive information of respondents.

Variable	Label	Frequency	Percent
Age	Less than 30	6	2.2
	30–40	92	33.8
	41–50	95	34.9
	51–60	66	24.3
	Above 60 years	13	4.8
Gender	Male	212	77.9
	Female	60	22.1
Education	Master	112	41.2
	PhD	160	58.8
Rank	Lecturer	100	36.8
	Senior lecturer	147	54.0
	Assistant professor	17	6.3
	Associate professor	1	0.4
	Professor	7	2.6
Experience	Less than 5 years	26	9.6
	5–10 years	38	14.0
	11–15 years	74	27.2
	15–20 years	60	22.1
	20–25 years	74	27.2

The f-square is also shown in Table 5. It shows that the values are higher than 0.02 and some values are below 0.02, indicating a weak size effect. The results of hypothesis testing provide valuable insights into the factors influencing the adoption of OSS among the surveyed participants. Table 5 shows the results of testing the hypotheses.

PEOU (H1) and compatibility (H2) both demonstrated significant positive relationships with OSS adoption, reinforcing the notion that user-friendly interfaces and system compatibility contribute substantially to the acceptance of OSS. Perceived risk (H3) also positively affected OSS adoption, indicating that a deeper knowledge of perceived risk influences decision-making. We found that security (H4) and cost efficiency (H5) were important. Research suggests security and cost-effectiveness encourage OSS adoption in

Table 4: Reliabilities and validities.

Variable	Convergent validity			Discriminant validity						
	CA	CR	AVE	AIC	COMP	CE	OSSA	PEOU	PR	SE
AI capabilities	0.916	0.919	0.742	—						
Compatibility	0.918	0.918	0.710	0.072						
Cost-effectiveness	0.759	0.874	0.657	0.240	0.494					
OSS adoption	0.847	0.849	0.825	0.207	0.713	0.635				
Perceived ease of use	0.858	0.861	0.889	0.105	0.581	0.461	0.635			
Perceived risk	0.837	0.847	0.842	0.047	0.681	0.296	0.628	0.519		
Security	0.911	0.913	0.791	0.059	0.625	0.439	0.724	0.63	0.611	—

Abbreviations: AIC, AI capabilities; AVE, average variance extracted; CA, Cronbach's alpha; CE, cost-effectiveness; COMP, compatibility; CR, composite reliability; OSSA, OSS adoption; PEOU, perceived ease of use; PR, perceived risk; SE, security.

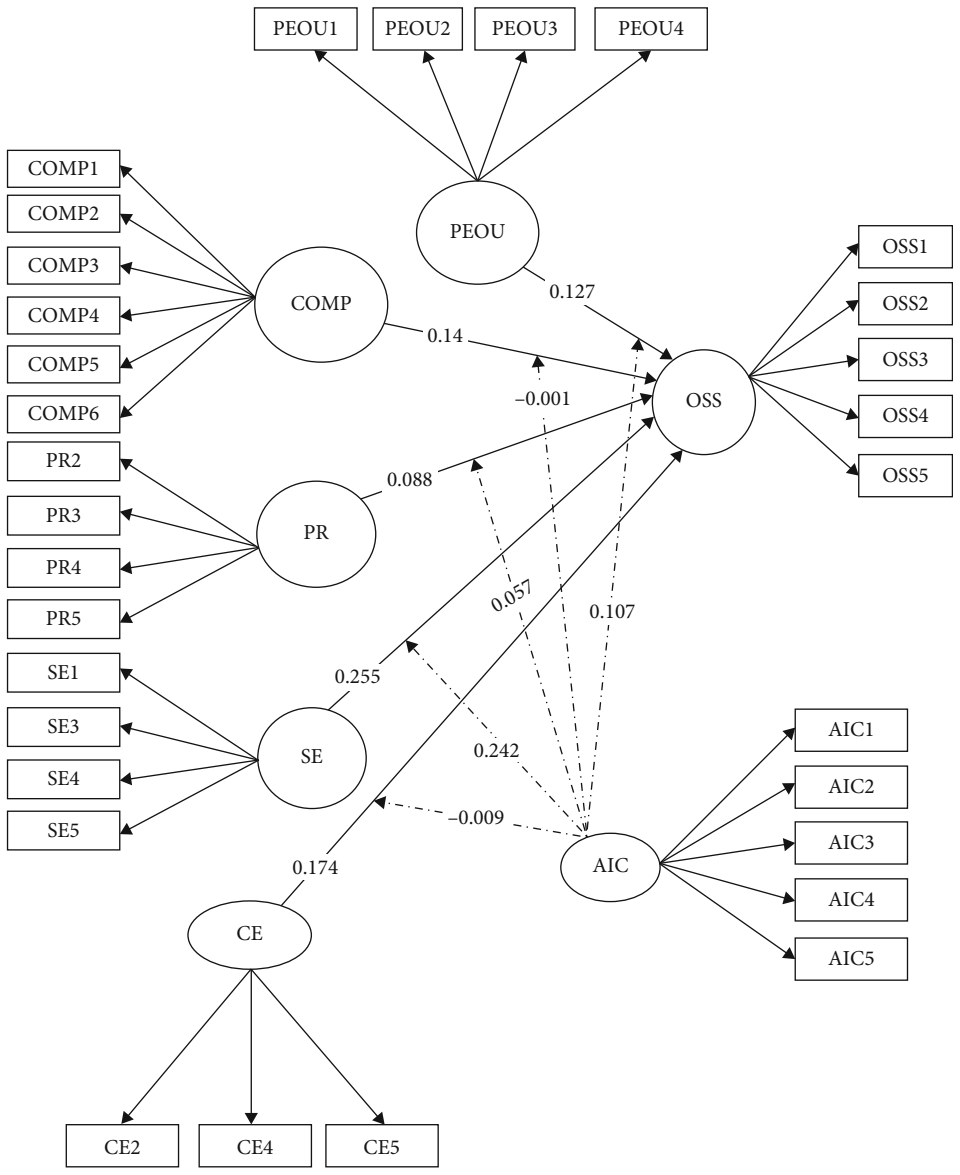

Figure 2: Measurement model.

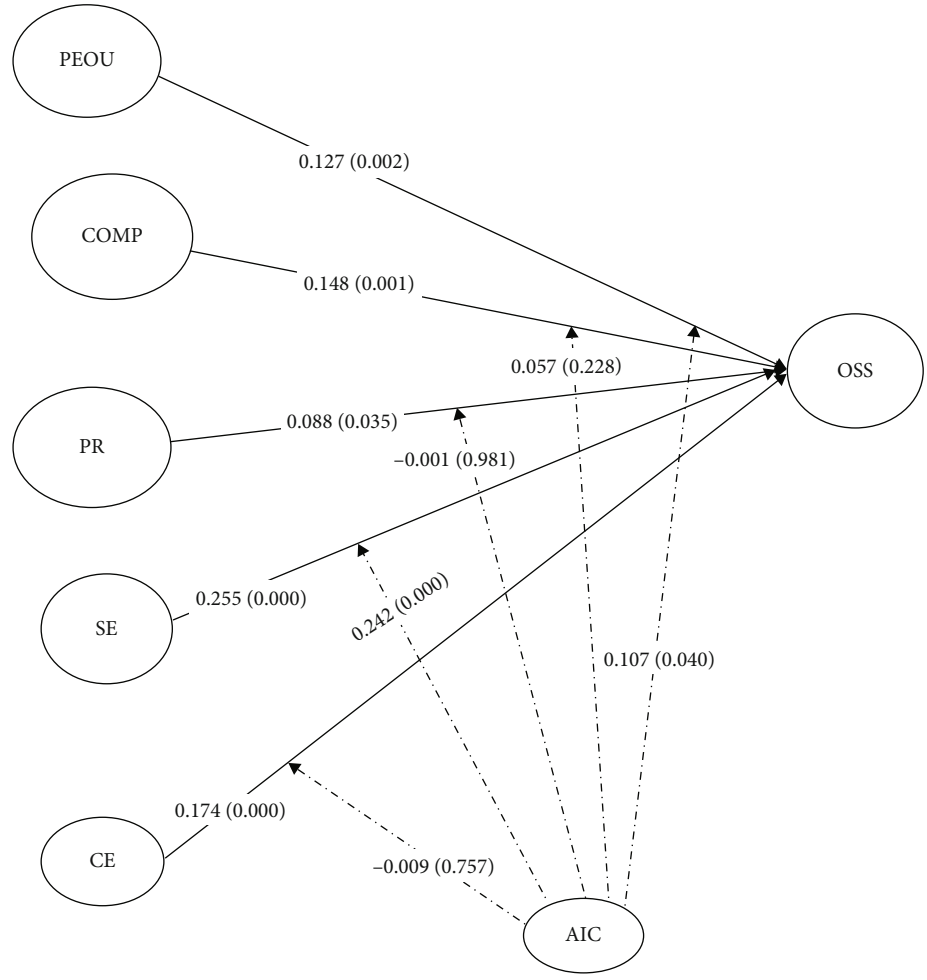

Figure 3: Structural model.

Table 5: Result of hypothesis testing.

H	Path	*B*	Std.	*T* -value	*p* values	f^2	R^2	Conclusion
H1	PEOU → OSSA	0.127	0.041	3.098	0.002	0.045		Supported
H2	COMP → OSSA	0.148	0.044	3.390	0.001	0.050		Supported
H3	PR → OSSA	0.088	0.042	2.107	0.035	0.021	0.674	Supported
H4	SE → OSSA	0.255	0.052	4.895	≤ 0.001	0.164		Supported
H5	CE → OSSA	0.174	0.037	4.678	≤ 0.001	0.097		Supported
H6	AIC × PEOU → OSSA	0.107	0.052	2.052	0.040	0.109		Supported
H7	AIC × COMP → OSSA	0.057	0.047	1.207	0.228	0.007		Rejected
H8	AIC × PR → OSSA	−0.001	0.048	0.023	0.981	0.000	0.807	Rejected
H9	AIC × SE → OSSA	0.242	0.066	3.691	≤ 0.001	0.028		Supported
H10	AIC × CE → OSSA	−0.009	0.03	0.309	0.757	0.001		Rejected
	AIC → OSSA	0.263	0.051	5.165	≤ 0.001			

academic and administrative environments. AI moderated the effect of PEOU (H6) on OSS adoption, indicating AI's importance in user experience. AI capabilities did not moderate the effect of compatibility (H7), perceived risk (H8), and cost-effectiveness (H10). Interestingly, AI-security interactions (H9) are significant, indicating that AI capability moderated the effect of security on OSS adoption.

5. Discussion

This research examined how certain factors can impact OSS adoption by universities. The findings showed that PEOU, compatibility, perceived risk, security, and cost-effectiveness are key variables in the adoption of OSS. This study's assumptions are founded on well-established

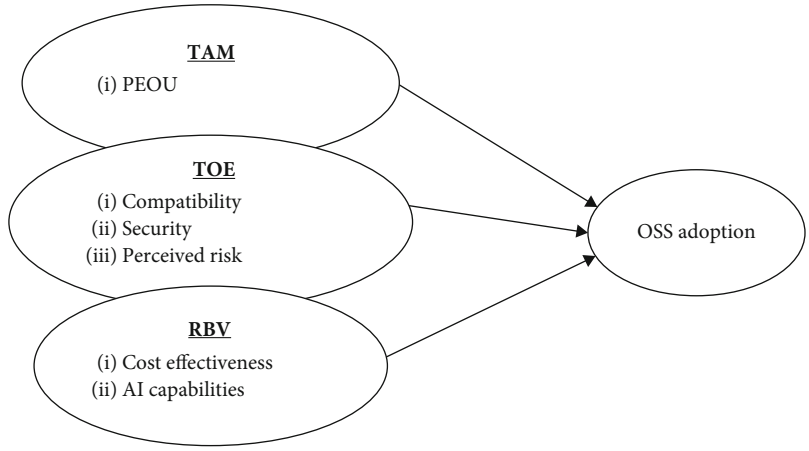

Figure 4: Combination between theoretical frameworks to support OSS adoption.

theories and validated by empirical facts, helping to explain the complexity of OSS adoption. System user-friendliness can boost OSS adoption. This is in line with the suggestions of TAM and PEOU, which can enhance the usage of a new technology. Several studies have stressed the importance of stakeholders' positive opinions of OSS's ease of use when contemplating its adoption [40, 41, 45, 46]. The findings also showed that OSS adoption is affected positively by the compatibility of the system. The findings align with the TOE, which emphasizes that compatible systems are desired by organizations [47]. Researchers found that system integration reduces interruptions and boosts efficiency [25, 26], supporting the findings of this study regarding the positive role of compatibility. This TOE argued that perceived risks and barriers to adopting OSS strongly impact decision-making. This analysis supports previous studies on perceived risks and university OSS adoption [31, 34–36].

The research emphasizes university security and proposes that good security measures might boost OSS adoption. Studies on safe data management in educational institutions highlighted the important role of security in OSS adoption [38, 51]. Universities generally have budgetary constraints; therefore, this study found that OSS's perceived cost-effectiveness drives its adoption. OSS is crucial for cost optimization and resource allocation in the RBV viewpoint [30, 52]. The findings indicated that AI capability moderated the relationship between PEOU and security with OSS adoption. This finding agrees with numerous previous studies regarding the role of AI as a moderator [59, 60]. Other researchers found that AI affects the complicated interactions between these variables and academic OSS adoption [28, 61, 62].

Figure 4 shows the interrelationship between the theoretical framework to support the hypotheses of this study. The TAM emphasizes PEOU, showing how OSS usability affects adoption. The TOE framework's technical dimension compatibility, perceived risk, and perceived security relate to this variable. The RBV includes AI capability and cost-effectiveness as key factors. AI capability moderates the link between OSS adoption and its affecting elements, improving system functioning and managing risk and security. Cost-effectiveness highlights OSS's financial advantages and positions it as a university cost-optimizer. This combination of TAM, TOE, and RBV offers a complete paradigm for analysing OSS adoption, with each framework adding elements that affect technical readiness and strategic resource utilisation.

Therefore, the findings of this study provide a comprehensive framework for understanding the complicated relationships between PEOU, compatibility, perceived risk, security, cost-effectiveness, and AI capabilities in university OSS adoption.

6. Implications

This study examines the complicated realm of university OSS adoption to contribute to theoretical and practical knowledge. The study contributed to theory by combining TAM, TOE, and RBV theories and examined AI's moderating impact. The integration of the three theories with AI as a moderator has increased the explanatory power of OSS adoption. Moderators based on AI enhance theoretical frameworks. This research uses the RBV to perceive OSS as a resource and highlight cost-effectiveness from a strategic theoretical perspective. This integration shows universities how to strategically leverage open-source technologies. The OSS adoption research analyses PEOU, compatibility, perceived risk, security, and cost-effectiveness. This viewpoint examines the theoretical foundation for complex organization OSS deployment analysis. This study benefited developing nation literature, especially in Iraq. It sheds light on how educational institutions might employ and use OSS.

This research helps universities deploy OSS effectively. Higher education decision-makers consider PEOU, compatibility, security, perceived risk, and cost-effectiveness. Colleges use OSS to save costs and improve resource allocation for strategic decision-making. Reallocating funds to research and infrastructure upgrades can maximize university resource allocation. Understanding how robust security measures enhance OSS adoption focuses on security. Universities must prioritise security policy creation and dissemination. This will help them address issues and make

data management safer. AI can improve OSS usability and compatibility. Chatbots and virtual assistants can help universities provide timely support, boost students' and stakeholders' satisfaction, and resolve implementation issues.

Universities can reduce OSS adoption risks with tailored measures. Addressing vendor assistance, integration issues, customisation, and feature gaps is critical. The study stresses following organizational approaches. OSS can help universities reduce interruptions and boost productivity. The study gives insights that help improve technology adoption theory. It also helps universities make informed OSS choices. Using several theoretical frameworks and AI as a moderating component, researchers can better understand the complex dynamics of OSS implementation in higher education.

7. Conclusion

The results enrich the academic debate on technology usage in higher education and inform university decision-makers. PEOU, compatibility, perceived risk, security, and cost-effectiveness strongly impact OSS adoption. The empirical study confirmed these elements' importance and showed their influence on university decision-making. AI moderated only the effect of PEOU and security on OSS adoption. AI is transforming user experience and security by explaining the OSS adoption.

Despite the importance of the findings of this study, there are some limitations to be considered in future work. The usage of purposive sampling has limited the generalizability of the findings. These findings can be generalized to the participant universities in Iraq. Additionally, the findings are limited to higher educational institutions in Iraq. Therefore, replicating this study is important for generalizing the findings. Future studies can be conducted on other countries, such as the regional or Middle-Eastern countries or developing countries. Additional variables can be examined in future studies. This includes the relative advantage, social influence, and facilitating conditions or IT infrastructure. The level of IT knowledge in OSS adoption can be a moderating variable in future studies. Since OSS adoption is still limited in universities in developing countries, more studies using different approaches, such as qualitative or focus groups, are needed. Qualitative research like interviews and focus groups may improve quantitative findings and stakeholder understanding. This research presents a theoretical framework, empirical data, and applied implications for higher education technology adoption. Results emphasize the importance of OSS adoption. OSS goes beyond technology. This unique resource may shape universities' digital futures. Therefore, more studies are needed, and policymakers should ensure the ease of using OSS as well as its security, risk-free, and compatibility.

Data Availability Statement

The data that support the findings of this study are available upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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