Journal of Ecohumanism
2025
Volume: 4, No: 1, pp. 1695 – 1717
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v4i1.5990

Enterprise Risk Management and IT Resources impact on Sustainable Competitive Advantage through mediating role of Knowledge Management Capability

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Abstract

This study seeks to determine impact of enterprise risk management (ERM) and information technology resources (ITR) on sustainable competitive advantage (SCA) through mediating role of knowledge management capability (KMC).An investigation based on empirical research was carried out on 183 software companies in Lahore, Rawalpindi, Islamabad and Karachi, Pakistan. A self-administered survey was conducted to obtain the data from software companies. The study employed stratified random sampling for participant selection and data were analyzed through partial least squares structural equation modelling (PLS-SEM).Results revealed ERM and KMC significantly contribute to SCA. However, ITR did not directly impact SCA, yet it showed an important mediated effect on SCA through KMC. Also, KMC mediates relationship between ERM and SCA. The outcomes of this study contribute to resource based view (RBV) theory by demonstrating that ERM, ITR and KMC play pivotal roles in achieving SCA within the IT industry. Policymakers and industry leaders are encouraged to support these areas to help companies anticipate risks, optimize resources and thrive in global markets.This study focused exclusively on private software companies located in four cities (Islamabad, Rawalpindi, Lahore and Karachi) within Pakistan. Additionally, the cross-sectional, survey-based methodology captured data only at a single point in time. The novelty of this article lies in fact that it addresses the gap in existing research through exploring effect of ERM and ITR on SCA through mediating role of KMC in Pakistani private software companies.

Keywords: *Enterprise Risk Management, Knowledge Management Capability, Information Technology Resources, Sustainable Competitive Advantage, PLS-SEM.*

Introduction

Sustainable competitive advantage is one of the critical issues faced by strategic management scholars and is considered one of the primary concerns of managers and entrepreneurs around the globe. The topic of how to achieve and sustain competitive advantage still remains subject of debate and critical issue among researchers (Navarro & Haag, 2024; Satar, 2024). Companies worldwide need significant attention to this issue in the era of industrial revolution 5.0 (Muhani et al., 2024). According to Anwar et al. (2018), SCA can enhance growth prospects and optimise profits, positively impacting a country's gross domestic product. Earlier research has shown that companies' inability to manage resources has led to a higher failure rate of these enterprises, irrespective of whether they operate in developed or developing nations (Arsawan et al., 2020). Therefore, academics in developing countries are also concerned about this phenomenon, in addition to managers and public policymakers (Singh et al., 2019).

According to bi-annual CHAOS reports from Standish Group (2016), IT project success rates are lower in the asia region which includes developing economies. IT sector is one of the crucial sectors among other industries in Pakistan. It can potentially be one of Pakistan's major economic sectors as IT provides export earnings to the Pakistan economy (Haq et al., 2019). Maintaining a sustainable competitive advantage could help to drive sustained growth in this sector and further increase its economic impact. However, software failures are one of the issues in IT sector (Alqahtani et al., 2024). Likewise, a comprehensive analysis by Strang & Vajjhala (2023) reveals that approximately 50% of IT-related projects worldwide fail, underscoring

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the persistent nature of this issue. In addition to causing problems for the client and creating chaos, software failure can also negatively impact economic growth (Kim et al., 2022; Zahid et al., 2018).

In Pakistan, IT Industry has mainly been directed by the concerned authorities. Pakistan Software Export Board (PSEB) and Pakistan Software Houses Association (PASHA) are responsible for promoting software exports to rest of the world. Currently, there are more than 10,000 IT companies registered with Securities and Exchange Commission Pakistan (SECP) (PSEB & MOITT, 2020).

The sustainable development goals (SDGs) 2030 provide a comprehensive framework for achieving sustainable development, covering areas including sustainable economic growth (United Nations, 2022). IT industry has a crucial role in achieving economic growth SDG goal. IT companies can establish a sustainable competitive advantage that benefits the environment and society (García de Leaniz & Ruiz, 2018) and generates long-term economic value (Li et al., 2019).

Pakistan is a noticeable victim of low sustainability; Global Sustainable Competitiveness Index (2022) listed Pakistan as 169 in sustainable competitiveness and 159 in economic sustainability out of 180 countries (SolAbility, 2022), which requires serious efforts for improvement. According to World Bank (2022), comparison of IT exports between Pakistan and its immediate neighbours shows an extreme difference as in the year 2000, IT exports USD (Pakistan 212 million, India 5 billion and China 1.7 billion) whereas in the year 2023 IT exports USD (Pakistan 2.72 billion, India 162.59 billion, China 58.1 billion), which shows Pakistan needs to take strategic steps to boost its IT industry and increase its competitiveness in the global market to catch up with its neighbours.

On the other hand, Pakistan's government has set a goal of increasing IT exports to $25 billion over the next five years (BRecorder, 2024). From a policy perspective, it is imperative for the Pakistani government to purposefully prioritise the information and communications technology sector in order to foster sustainable economic growth within the country (Iqbal et al., 2022). Consequently, to work toward the potential target of $25 billion in exports, Pakistani IT companies may benefit from sustainable competitive capabilities that could enhance their position to help them compete in the global market.

In addition, sustainable competitive advantage is studied in different sectors in Pakistan, but according to previous literature, sustainable competitive advantage has not been studied within the context of Pakistani private software companies. Meanwhile, Pakistan's IT business appears to have a high rate of software project failure worldwide (Jalil & Hanif, 2009). The software industry of Pakistan faces challenges in successfully executing software projects, with a high failure rate (Tian et al., 2022). Similarly, Ashfaq et al. (2021) stated that IT industry faces a worrisome project failure rate compared to other sectors. As a result, today's IT industry is confronting various dangers depending on its surroundings. The failure of the IT project causes economic losses and if these failures are prevented, the IT industry will grow even further and Pakistan's economy will improve significantly. Therefore, further investigation of the SCA in the context of Pakistani software companies is required.

Enterprise Risk Management is considered crucial to achieving sustainable competitive advantage (Lai et al., 2021). ERM is risk management system which enables firms to achieve higher competitive advantage (Yang et al., 2018) by effectively overseeing and structuring risk management activities (COSO, 2004; Elahi, 2013). It may be noted that organisations worldwide face rising levels of risk due to the increasing impact of random events that are very uncertain and unpredictable (World Economic Forum, 2021). The range and intensity of risks in the information technology industry have increased due to increased competition and slower growth. Companies in the IT industry are forced to manage projects with extreme care and proactive planning to ensure project success as project failures are not uncommon in this industry (Shen et al., 2018).

However, it is noteworthy that organizations in developed nations, such as United States, Australia, Canada and various European nations, were found to be more inclined towards adopting ERM as per findings of global risk management study (Deloitte, 2013), whereas institutions in developing countries were comparatively less likely to do so. In other words, affluent countries see a faster rate of ERM growth than

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underdeveloped nations (Subhani & Osman, 2011). Consequently, ERM is primarily limited to developed countries in earlier published studies.

Hence, in line with recommendations of various researchers in the ERM field to conduct more research in underdeveloped countries (Ahmad et al., 2014; Tahir & Razali, 2011b), therefore this study will broaden scope by evaluating ERM in the Pakistani IT industry, which is a Middle Eastern developing country with a dearth of research in this area. Therefore, this study explored how Pakistani IT companies' enterprise risk management systems might contribute to acquiring sustainable competitive advantage. Consequently, in light of the study's contextual background, identified gaps in current literature and absence of empirical proof related to ERM, IT Resources, KMC and SCA in Pakistani private software companies have led to formulation of four research objectives (RO) which are outlined below:

RO1: To examine relationship of enterprise risk management and IT resources with sustainable competitive advantage.

RO2: To examine relationship of knowledge management capability with sustainable competitive advantage.

RO3: To examine relationship of enterprise risk management and IT resources with knowledge management capability.

RO4: To analyse whether knowledge management capability mediates relationship of enterprise risk management and IT resources with sustainable competitive advantage.

To achieve these research objectives, this study employs a survey method with software companies as the unit of analysis. This article is structured as follows: after this introduction section, second section offers review of literature. The third and fourth sections cover methodology and results, respectively. The fifth section discusses study's findings and conclusions while the sixth section outlines implications. Lastly, the seventh section addresses the study's limitations and provides propositions for future research.

Literature Review

Resource Base View Theory

This research utilises resource-based view as its theoretical support. RBV is a management theory that emphasises how organisations leverage their assets and resources to achieve a competitive advantage in the marketplace (Wernerfelt, 1984; Barney, 1991). The resource based view of as enterprise highlights internal environment of enterprise as a crucial factor in achieving competitive advantage and emphasises resources that firms possess to compete in their environment. According to RBV perspective, competitive advantage can only be derived through resources and competencies which are strategically significant and valuable Barney (1991). RBV theory explains the crucial role of both tangible and intangible resources in achieving sustainable competitive advantage (Barney, 1991). This theory incorporates critical success factors for ERM, thus ensuring effective implementation of ERM and enhance organisation performance.

According to resource-based view, information technology can serve as a valuable asset in achieving competitive advantage (Hasanah et al., 2022; Siahaan, 2022; Tanriverdi, 2005). Knowledge-based resources and capabilities play a vital role in organizational learning, potentially leading to enhanced performance and sustained competitive advantage (Attia & Essam Eldin, 2018). Knowledge management capability encompasses a firm's ability to collect, generate, disseminate, combine, and utilize knowledge-based activities and resources both internally and externally to develop new knowledge (Attia & Essam Eldin, 2018; Chuang, 2004).

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Hypothesis Development

Enterprise Risk Management and Sustainable Competitive Advantage

Scholars have observed through empirical research that there exists a positive correlation among ERM and a firm's overall performance (Grace et al., 2015; Khan et al., 2016; Florio & Leoni, 2017). ERM facilitates organisations and management to improve capital allocation and investment prospects, which can lead to better market position (Beasley et al., 2008; COSO, 2004). Another potential rationale for considering ERM as a crucial resource for gaining sustained competitive advantages is its intrinsic nature and role within organisations. ERM enables organisations to integrate and manage their risks effectively. This, in turn, can provide a competitive advantage over other firms that do not manage their risks as effectively (COSO, 2004; Elahi, 2013). Implementing an effective risk management can empower organisations to secure a competitive advantage. Elahi (2013) demonstrated that appropriate risk management can result in four different benefits that may lead to competitive advantage. In light of above discussion, there is a dearth of studies that have conducted a comprehensive assessment of ERM by examining all of its COSO (2004) components.

Previous research often assessed ERM by taking its implementation as simple binary construct or by inquiring about its acceptance and level of implementation within a company (Daud et al., 2010; Liebenberg & Hoyt, 2003). In contrast, this study measures ERM based on all eight components outlined by Committee of Sponsoring Organizations of Treadway Commission COSO (2004), providing thorough understanding of ERM implementation. Therefore, this study seeks to fill aforementioned gaps by evaluating subsequent hypothesis:

H_1: There is positive significant relationship between enterprise risk management and sustainable competitive advantage.

Information Technology Resources and Sustainable Competitive Advantage

Information technology (IT) is widely regarded as a means to improve competitive advantage in the modern environment. Research by Dehning and Stratopoulos (2003) revealed that managerial IT skills contribute positively to sustainable competitive advantage. Cakmak and Tas (2012) examined that for businesses to gain a competitive edge, IT must be employed at a strategic level. Cohen and Olsen (2013) investigated that the interdependent system of IT resources significantly affects competitive performance. Gunasekaran et al. (2017) highlighted RBV importance in comprehending impact of big data and predictive analytics on organisational performance, ultimately leading to competitive advantage.

Consequently, corporations can harness IT resources to boost performance and competitive advantage by cutting expenses, boosting returns, streamlining procedures and fostering innovation (Mao et al., 2016; Mithas et al., 2012). In this context, IT resources such as IT infrastructure, IT human and IT relationship resources can significantly impact organisational competitiveness. Consequently, this study intends to fill the gap with examining whether IT resources meaningfully contribute to sustainable competitive advantage.

H_2: There is positive significant relationship between information technology resources and sustainable competitive advantage.

Knowledge Management Capability and Sustainable Competitive Advantage

The ability to manage knowledge is one of leading causes of organisational performance and competitive advantage (Chuang, 2004). Knowledge management is identified as a crucial aspect of enhancing organisational performance, which is crucial for an organisation's continued existence and competitive advantage (Shehabat, 2020). Knowledge management is projected as a strategy to leverage intellectual capital as a competitive asset, aiming to achieve sustainable competitive advantage and enhance organizational performance (Ling, 2013; Kianto et al., 2013; Ngah et al., 2015). KMC plays an important role in establishing competitive advantage and organisational success (Chuang, 2004). Mao et al. (2014) also

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looked into how information technology capability and knowledge capability affect the agility of an organisation. In the context of considerable environmental unpredictability and information intensity, IT capacity and knowledge capability are enhanced. Although both IT and knowledge skills positively influence organizational agility, knowledge capabilities are found to be more effective than IT capabilities. This study looks to address the gap identified above by investigating whether knowledge management capability is significantly associated with sustainable competitive advantage.

H_3: There is positive significant relationship between knowledge management capability and sustainable competitive advantage.

Enterprise Risk Management and Knowledge Management Capability

Lundqvist (2015) argues that ERM provides a top-down perspective of risk management, which makes it a more comprehensive approach than RM and overcomes its limitations. This research also draws attention to KMC as a mediator variable in the study. This variable is selected due to the belief that KMC, particularly in IT organisations, continue to receive inadequate attention at the management level. Doepgen's study verified that KM processes in IT industry have received very little attention to date (Hock-Doepgen et al., 2019). This study seeks to investigate correlation between ERM and KMC in IT companies in Pakistan, building on previous research that has identified a positive relationship but in different contexts (Abaoud, 2019; Kinyar, 2020). This study proposes the following hypothesis based on above-mentioned literature.

H_4: There is positive significant relationship between enterprise risk management and knowledge management capability.

Information Technology Resources and Knowledge Management Capability

IT is considered as a competitive tool by researchers and professionals (Liu et al., 2013). IT resources indirectly affect the competitive position and organisational performance by engaging with other resources or capabilities, companies can achieve a competitive advantage (Ashrafi & Mueller, 2015). Additionally, IT can improve business processes, both operational and managerial (Queiroz, 2017). Similarly, IT resources have a significant relationship with knowledge management capability (Akram et al., 2018; Bazrkar, 2020; Kumar, 2021; Mao et al., 2016). Present study was developed to assess association between ITR and KMC in Pakistani software companies. Whereas some of the researchers examined that there is a positive and significant association among IT resources and knowledge management capability but in the different contexts (Mao et al., 2014; Zhang et al., 2017; Akram et al., 2018; Iqbal et al., 2020). On basis of literature review presented above, this research proposes below hypothesis:

H_5: There is positive significant relationship between information technology resources and knowledge management capability.

Mediating Effect of KMC on ERM And SCA

Knowledge management capability is an important factor in measuring sustainable competitive advantage (Shehabat, 2020). Past researches have shown that knowledge management capability is significantly linked to achieving sustainable competitive advantage (Habib & Bao, 2019; Mahdi et al., 2019; Nguyen, 2009). Knowledge management capability also has a significant association with enterprise risk management (Mercier-Laurent, 2016; Rodriguez & Edwards, 2014). Considering the above arguments, this research hypothesises that KMC has significant correlation with ERM and SCA. Consequently, this study suggests that knowledge management capability serves as a liaison between enterprise risk management and sustainable competitive advantage. Therefore, it is hypothesised that:

H_6: Knowledge management capability mediates relationship between enterprise risk management and sustainable competitive advantage.

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Mediating effect of KMC on ITR and SCA

IT is considered as a competitive tool by researchers and professionals (Liu et al., 2013). Furthermore, IT resources indirectly affect the competitive position and organisational performance by engaging with other resources, leading towards competitive advantage (Ashrafi & Mueller, 2015). Additionally, IT can improve business processes, both operational and managerial (Queiroz, 2017). Similarly, IT resources has a significant relationship with knowledge management capability (Akram et al., 2018; Bazrkar, 2020; Kumar, 2021; Mao et al., 2016). Therefore, KMC, being an organisational capability that relies on processes, can leverage IT resources to improve performance of the organisation (Mao et al., 2015). These arguments indicate that KMC plays a role in linking ITR to SCA. On the other hand, effective IT resources enable organisations to improve business process ability, particularly knowledge management processes (Panda & Rath, 2018). Conversely, improved KMC leads to effective intellectual capital management, which enables creation of unique and valuable resources (Chuang, 2004). This ultimately results in a competitive advantage. If an organisation lacks KMC, it may not see positive takings from investments in IT resources. As a result, KMC is believed to act as a mediator in association between IT resources and competitive advantage. Considering these points., this study formulate following hypothesis:

H_7: Knowledge management capability mediates relationship between information technology resources and sustainable competitive advantage.

Methodology

Research Design, Population and Sampling

In present study, a quantitative approach was employed and survey in form of questionnaire through physical and web-based Google Form approach, were administered to participants for purpose of gathering data and assessing the hypotheses outlined earlier.

In the current study, probability sampling was employed to ensure that every respondent had an equal chance of being selected, thereby reducing bias in selection process (Sekaran & Bougie, 2013). This method is essential for achieving representativeness in survey research as it allows for generalizable conclusions about the population (Cornesse et al., 2020). The population was private software companies (8691) in Pakistan (PSEB & MOITT, 2020). The sample was software companies participating in ERM system from Lahore, Karachi, Rawalpindi and Islamabad cities as it consists of 90% of the software companies registered with SECP in Pakistan (PSEB & MOITT, 2020).

Specifically, stratified random sampling was utilized, where the population was segmented into subgroups based on cities and private companies were randomly selected from each subgroup. This approach enhances the sample's representativeness by ensuring that all relevant characteristics of the population are included (Chen et al., 2019; Creswell, 2012). The use of stratified random sampling is particularly effective in addressing potential biases that may arise from oversampling or undersampling certain groups within the population (Cornesse et al., 2020). By randomly selecting participants from each city, the authors ensured that sample precisely reflects diversity of target population, thus improving validity of study's findings (Yang et al., 2020).

Instrumentation

The research instrument consisted of 72 items, each evaluated through a 5-point Likert measure (1 = highly disagree, 5 = highly agree), capturing respondents' levels of agreement. To comprehensively assess ERM, this study utilized a questionnaire adapted from Saeidi et al. (2019), which included 36 items based on the COSO framework. These items covered key components such as "internal environment, objective setting, event identification, risk assessment, risk response, control activities, information and communication, and monitoring" (Saeidi et al., 2019, p.8). To analyse ITR comprising three components (IT infrastructure, IT human, IT relationship) resources, this study adapted 13 items from Shehzad et al. (2022). For measurement of KMC, which served as the mediating variable, 7 items were included. These items were adapted from

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Mao et al. (2016). Lastly, dependent variable SCA, was evaluated using 7 items adapted from Saeidi et al. (2019). The language of questionnaire was English. All variable scales underwent a pre-testing process for content and face validity, assessed by four academics connected to prestigious universities in Pakistan and Malaysia, focusing on item clarity and relevance. Additionally, two experts from the software industry were also involved in this evaluation. The authors measured reliability of study instrument with Cronbach's alpha test against each item in the questionnaire. Furthermore, every item in questionnaire underwent factor analysis, along with reliability and validity evaluations using PLS-SEM.

Statistical Analysis

The gathered data was evaluated through structural equation modelling (SEM) technique with partial least squares (PLS) as analytical tool. As per Hair et al. (2017), PLS-SEM is optimal strategy for composite models with several variables. Besides being able to manage non-normal data efficiently, it is also capable of analyzing both structural and measurement models at the same time. Initially, measurement model's reliability and validity were evaluated using outer loadings, composite reliability (CR) and average variance extracted (AVE), ensuring that scales used in the survey were accurate and consistent. Second, structural model was tested to evaluate study's hypotheses by using a bootstrapping technique.

4. Analysis and Results

4.1 Descriptive Statistics

The majority of respondents worked in software companies with 20-50 number of employees (55 out of 183, 30.05%), had an annual sales turnover of up to PKR 150 million (136 out of 183, 74.32%) and held Master's degrees (105 out of 183, 57.38%). Most were top-level managers (111 out of 183, 60.66%) with over ten years of experience (92 out of 183, 50.27%), predominantly male (164 out of 183, 89.62%), aged 30-49 (91 out of 183, 49.73%) and based in Karachi city (65 out of 183, 35.52%). This description highlights that Pakistan's private software sector has an experienced, educated and mostly male workforce.

Measurement Model Assessment

Figure 1 illustrates measurement model assessment which examines reliability and validity of the instrument.

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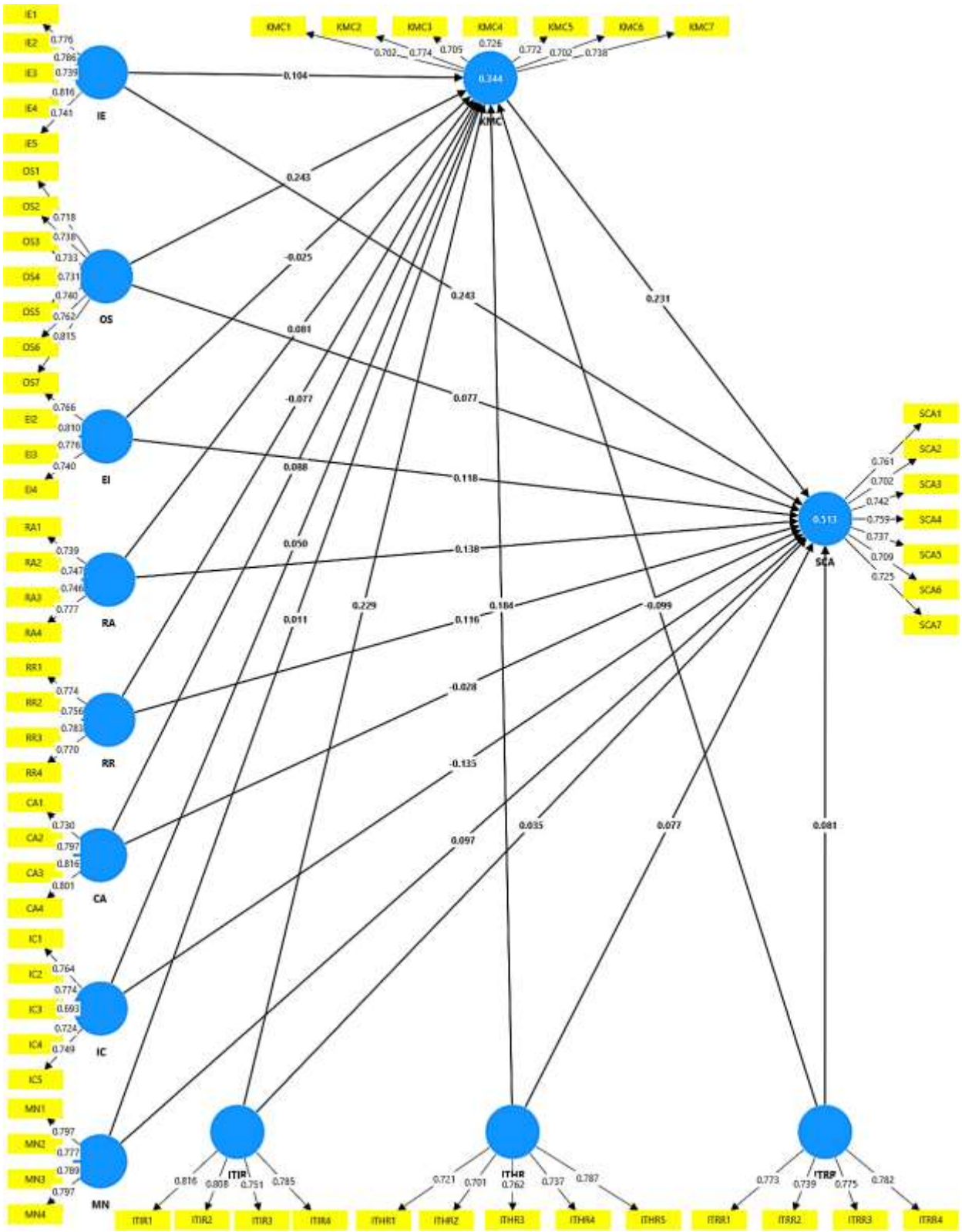
Figure 1. Measurement Model Assessment



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Convergent Validity

The proposed model reliability was evaluated using multiple established methods. Cronbach's alpha was employed as a primary measure of reliability. Indicators reliability was determined by examining the outer loadings while internal consistency was evaluated through composite reliability. To assess validity, both AVE and Heterotrait-Monotrait (HTMT) ratio were employed.

Recent methodological guidelines suggest retaining indicators with outer loadings exceeding 0.70 (Ringle et al., 2022). For items showing factor loadings in the range of 0.40 to 0.70, further evaluation using AVE and CR is recommended. The final retention decision is based on whether these indicators meet the established AVE and CR thresholds.

The analysis of constructs reveals that, except for one item (IC3 = 0.693), all outer loadings exceed the recommended threshold of 0.70 as shown in table 1. The CR value of 0.859 and the AVE value of 0.550 exceed the necessary thresholds for retaining any construct item. Likewise, the variance inflation factor (VIF) values fall between 1.344 and 2.022, are significantly less than the commonly accepted threshold of 5 (Sarstedt et al., 2019), suggesting that multicollinearity is not an issue in this model. To assess the model's validity, Cronbach's alpha was computed and both CR and AVE were analyzed as presented in Table 1.

The constructs indicated strong internal consistency, through Cronbach's alpha and composite reliability values surpassing 0.70, implying their suitability for further analysis (Hair et al., 2014). Additionally, AVE for each construct is above 0.50, confirming their validity and supporting their retention in the model (Fornell & Larcker, 1981). Consequently, all five constructs were determined to be suitable for further analysis.

Table 1. Measurement Model Results

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Variable	**Constructs**	**Items**	**Outer Loadings**	**VIF**	**Cronbach's Alpha**	**Composite Reliability**	**Average Variance Extracted**
			OL ≥ 0.70		**α ≥ 0.70**	**CR ≥ 0.70**	**AVE ≥ 0.50**
Sustainable Competitive Advantage					0.858	0.891	0.539
		SCA1	0.761	1.817			
		SCA2	0.702	1.571			
		SCA3	0.742	1.605			
		SCA4	0.759	1.849			
		SCA5	0.737	1.703			
		SCA6	0.709	1.616			
		SCA7	0.725	1.609			
Enterprise Risk Management	Internal Environment				0.830	0.880	0.596
		IE1	0.776	1.676			
		IE2	0.786	1.727			
		IE3	0.739	1.546			
		IE4	0.816	1.954			
		IE5	0.741	1.615			
	Objective Setting				0.869	0.899	0.561
		OS1	0.718	1.716			
		OS2	0.738	1.713			
		OS3	0.733	1.634			
		OS4	0.731	1.683			
		OS5	0.740	1.772			
		OS6	0.762	1.793			
		OS7	0.815	2.022			
	Event Identification				0.777	0.856	0.598
		EI1	0.766	1.469			
		EI2	0.810	1.540			

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		EI3	0.776	1.559			
		EI4	0.740	1.492			
	Risk assessment				0.746	0.839	0.566
		RA1	0.739	1.393			
		RA2	0.747	1.525			
		RA3	0.746	1.344			
		RA4	0.777	1.448			
	Risk Response				0.770	0.851	0.589
		RR1	0.774	1.490			
		RR2	0.756	1.444			
		RR3	0.783	1.634			
		RR4	0.770	1.555			
	Control Activities				0.795	0.867	0.619
		CA1	0.730	1.493			
		CA2	0.797	1.657			
		CA3	0.816	1.771			
		CA4	0.801	1.755			
	Information and communication				0.796	0.859	0.550
		IC1	0.764	1.570			
		IC2	0.774	1.513			
		IC3	0.693	1.440			
		IC4	0.724	1.435			
		IC5	0.749	1.565			
	Monitoring				0.801	0.869	0.624
		MN1	0.797	1.586			
		MN2	0.777	1.730			
		MN3	0.789	1.684			
		MN4	0.797	1.554			
					0.800	0.869	0.625

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IT Resources	IT Infrastructure	ITIR1	0.816	1.785			
		ITIR2	0.808	1.659			
		ITIR3	0.751	1.423			
		ITIR4	0.785	1.643			
	IT Human Resource				0.797	0.860	0.551
		ITHR1	0.721	1.387			
		ITHR2	0.701	1.471			
		ITHR3	0.762	1.635			
		ITHR4	0.737	1.645			
		ITHR5	0.787	1.588			
	IT Relation Resource				0.770	0.851	0.589
		ITRR1	0.773	1.470			
		ITRR2	0.739	1.498			
		ITRR3	0.775	1.422			
		ITRR4	0.782	1.630			
Knowledge Management Capability					0.855	0.890	0.536
		KMC1	0.702	1.563			
		KMC2	0.774	1.840			
		KMC3	0.705	1.557			
		KMC4	0.726	1.688			
		KMC5	0.772	1.911			
		KMC6	0.702	1.559			
		KMC7	0.738	1.679			

Discriminant Validity

Discriminant validity evaluates how distinct each construct is from the others in the model (Hair, 2017). The analysis employed both Fornell-Larcker criterion and HTMT to assess this distinctiveness. The results regarding discriminant validity are shown in Tables 2 and 3. The diagonal elements in Fornell-Larcker criterion analysis, representing each construct's square root of AVE, are notably higher than their corresponding row and column values. For instance, IE shows a diagonal value of 0.772, which exceeds all its vertical and horizontal correlations.

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https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v4i1.5990

Table 2. Farnell–Larcker Criterion

	IE	OS	EI	RA	RR	CA	IC	MN	ITIR	ITHR	ITRR	KMC	SCA
IE	**0.772**												
OS	0.453	**0.749**											
EI	0.451	0.553	**0.774**										
RA	0.452	0.519	0.527	**0.752**									
RR	0.412	0.613	0.490	0.475	**0.771**								
CA	0.474	0.400	0.460	0.510	0.462	**0.787**							
IC	0.394	0.614	0.482	0.548	0.481	0.415	**0.741**						
MN	0.391	0.570	0.395	0.442	0.486	0.380	0.442	**0.790**					
ITIR	0.227	0.267	0.229	0.317	0.188	0.310	0.365	0.168	**0.790**				
ITHR	0.324	0.312	0.247	0.328	0.240	0.374	0.287	0.220	0.399	**0.742**			
ITRR	0.306	0.217	0.244	0.278	0.138	0.262	0.382	0.262	0.386	0.443	**0.767**		
KMC	0.355	0.440	0.304	0.386	0.284	0.368	0.375	0.287	0.406	0.392	0.206	**0.732**	
SCA	0.551	0.508	0.476	0.507	0.457	0.422	0.379	0.439	0.316	0.394	0.317	0.500	**0.734**

Furthermore, Heterotrait-Monotrait ratio analysis was employed to provide additional validation support as recommended by Henseler et al. (2015). The HTMT correlations between constructs remained below conservative threshold of 0.85, with highest correlation observed between OS and RR at 0.744, indicating good discriminant validity. For example, the HTMT values between CA and other constructs ranged from 0.333 to 0.659, well within acceptable limits. These results from both Fornell-Larcker criterion and HTMT ratio analyses present compelling proof for discriminant validity of measurement model, confirming distinctiveness of each construct in the proposed framework (Franke & Sarstedt, 2019).

Table 3. *HTMT*

	IE	OS	EI	RA	RR	CA	IC	MN	ITIR	ITHR	ITRR	KMC	SCA
IE													
OS	0.529												
EI	0.558	0.669											
RA	0.574	0.637	0.691										
RR	0.508	0.744	0.643	0.621									
CA	0.586	0.477	0.594	0.659	0.589								

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DOI: https://doi.org/10.62754/joe.v4i1.5990

IC	0.480	0.732	0.610	0.715	0.602	0.518							
MN	0.477	0.674	0.497	0.562	0.613	0.469	0.541						
ITIR	0.272	0.316	0.291	0.408	0.237	0.382	0.457	0.207					
ITHR	0.393	0.361	0.308	0.411	0.301	0.466	0.353	0.262	0.504				
ITRR	0.379	0.265	0.308	0.365	0.182	0.333	0.487	0.313	0.478	0.564			
KMC	0.420	0.500	0.363	0.474	0.354	0.440	0.447	0.338	0.486	0.464	0.244		
SCA	0.643	0.580	0.576	0.625	0.556	0.509	0.452	0.521	0.379	0.462	0.377	0.581	

Structural Model Analysis

During structural model assessment, effect size was calculated and study's hypotheses were assessed using the bootstrapping method. The findings revealed value of R square 0.467 for sustainable competitive advantage, signifying that model accounts for 46.7% of the variation in dependent variable (Henseler et al., 2009).

Figure 2

Structural Model Assessment

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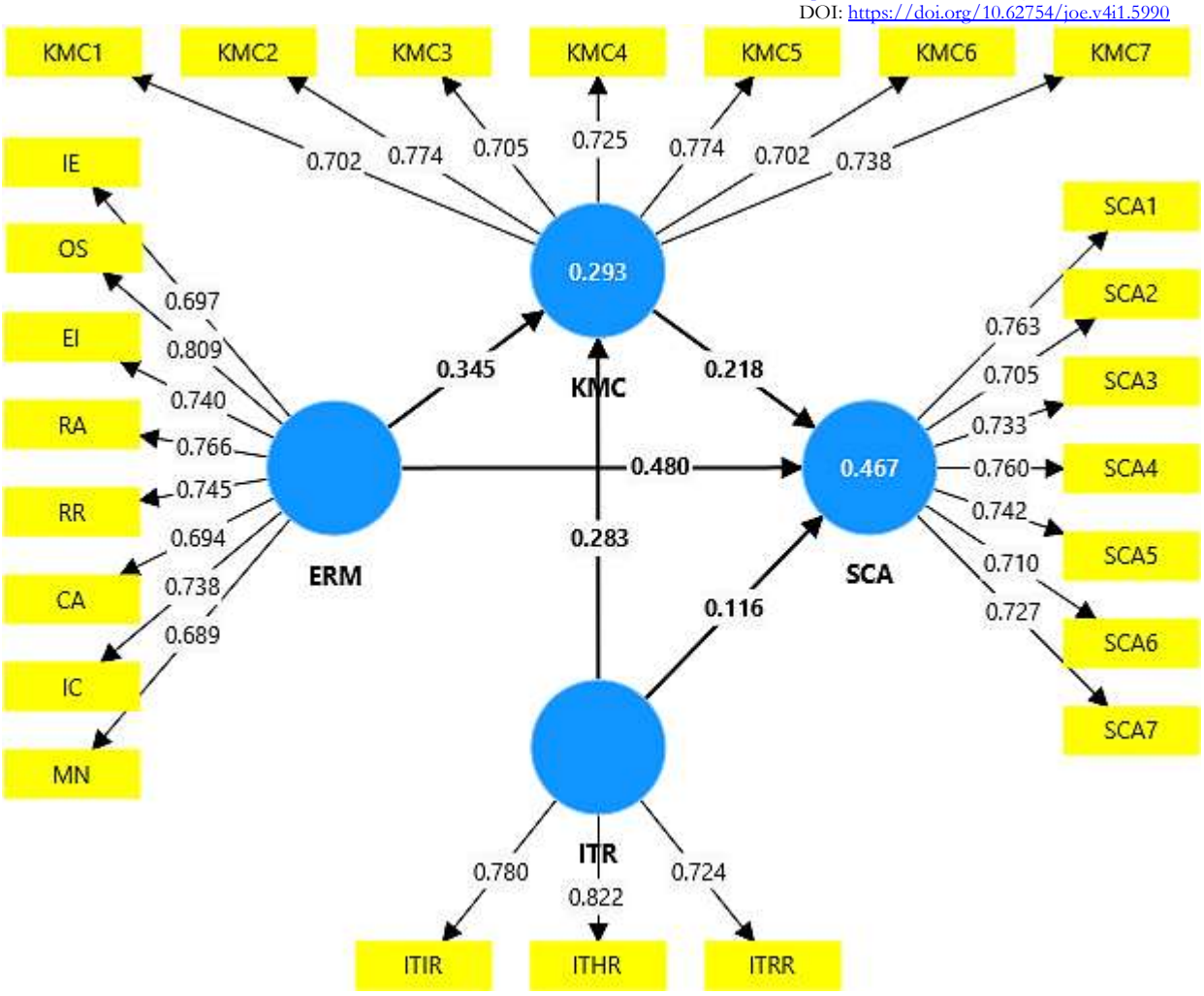

Effect Size

The model shows strong explanatory power for SCA with an R square of 0.467, which is above Cohen's (1988) threshold of 0.26 for a substantial effect. This means the predictors explain 46.7% of the variance in SCA. Among the predictors, ERM has largest effect size ($f^2 = 0.296$), indicating a medium to large impact on SCA, followed by KMC with a small effect ($f^2 = 0.063$). ITR demonstrate a very small effect ($f^2 = 0.018$). These f^2 values follow Cohen's (1988) guidelines, where 0.02 is small, 0.15 is medium and 0.35 is large. The Q^2 value of 0.241 for SCA indicates moderate predictive relevance while the Q^2 value of 0.152 for KMC also demonstrates moderate predictive relevance as both values are well above zero. The model also explains 29.3% of the variance in KMC ($R^2 = 0.293$), with ERM having a medium effect ($f^2 = 0.131$) and ITR a small effect ($f^2 = 0.088$). These results suggest that while all predictors help explain SCA, ERM has the most significant impact.

Table 4. Model Explanatory Power

Predictor(s)	Outcome	R Square	f Square	Q Square
ERM	SCA	0.467	0.296	0.241
ITR			0.018	
KMC			0.063	
ERM	KMC	0.293	0.131	0.152

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ITR			0.088	

Note. ERM = enterprise risk management, ITR = IT resources, KMC = knowledge management capability, SCA = sustainable competitive advantage

Hypothesis Testing

The analysis of direct relationships between variables revealed significant findings. Hypotheses H_1, H_3, H_4 and H_5 showed positive and significant results: H_1 (ERM → SCA) with a strong positive correlation (β = 0.480, t = 7.007, p = 0.000), H_3 (KMC → SCA) with a moderate positive correlation (β = 0.218, t = 2.850, p = 0.002), H_4 (ERM → KMC) with a moderate positive correlation (β = 0.345, t = 4.688, p = 0.000) and H_5 (ITR → KMC) with a moderate positive correlation (β = 0.283, t = 3.708, p = 0.000). These results support hypotheses H_1, H_3, H_4 and H_5. However, hypothesis H_2 (ITR → SCA) showed a weak positive correlation (β = 0.116, t = 1.621, p = 0.053) and was not supported. For indirect relationships, hypotheses H_6 and H7 were both positive and significant, confirming the mediating role of KMC: H6 (ERM → KMC → SCA) with a small effect (β = 0.075, t = 2.143, p = 0.016) and H_7 (ITR → KMC → SCA) with a small effect (β = 0.062, t = 2.254, p = 0.012). Thus, H_6 and H_7 were supported, confirming KMC's mediating effect. A summary of these hypotheses is presented in Table 5.

Table 5. Results of Path Analysis

Relationship	Path Coefficient (β)	T-value	P value	Confidence Interval		Decision
				LL	UL	
H_1: ERM → SCA	0.480	7.007	0.000	0.359	0.584	Supported
H_2: ITR → SCA	0.116	1.621	0.053	-0.003	0.233	Not Supported
H_3: KMC → SCA	0.218	2.850	0.002	0.095	0.345	Supported
H_4: ERM →KMC	0.345	4.688	0.000	0.218	0.460	Supported
H_5: ITR → KMC	0.283	3.708	0.000	0.153	0.403	Supported
H_6: ERM→KMC→SCA	0.075	2.143	0.016	0.029	0.143	Supported
H_7: ITR→KMC→SCA	0.062	2.254	0.012	0.025	0.116	Supported

Note. One-tailed test, SCA = sustainable competitive advantage, ERM = enterprise risk management, ITR = IT resources, ISQ = internal service quality, KMC = knowledge management capability.

Discussion and Conclusion

This research focuses on examining how ERM and ITR impact SCA through KMC, grounded in the RBV theory. According to RBV theory, a firm's competitiveness is determined by its capabilities or resources, which subsequently influence its performance (Barney, 1991; Wernerfelt, 1984). For a sustainable competitive advantage, companies need resources which are valuable, unique, difficult to copy and irreplaceable (Barney, 1991). This study confirms that this principle, known as the RBV theory, is relevant to the IT industry, highlighting that enterprise risk management and information technology resources, along with knowledge management capability are essential resources for achieving sustainable competitive advantage.

This study investigated four research objectives through seven hypotheses (H_1-H_7), including five direct relationships and two mediating relationships.

The initial hypothesis (H_1) focused on investigating direct impact of ERM on SCA within context of software companies. The findings revealed significant connection between ERM and SCA in the setting of software companies in Pakistan. These findings align with previous research, where empirical investigations

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have revealed meaningful positive impacts of ERM on sustainable competitive advantage (Beasley et al., 2005; Yang et al., 2018; Javaid & Aslam, 2021; Ricardianto et al., 2023; Saeidi et al., 2019), supporting theoretical foundations (Elahi, 2013; Nocco & Stulz, 2006) and established risk management framework (COSO, 2004a). Therefore, these studies collectively demonstrate direct impact of ERM on SCA.

The second hypothesis (H_2) focused on exploring direct relationship between ITR and SCA in software firms. Nonetheless, the current study failed to present empirical evidence supporting association between ITR and SCA. This aligns with results of earlier research, in which researchers also found no correlation between ITR and SCA (Nevo & Wade, 2010) who argue that while IT is essential but it is not sufficient alone for achieving SCA. This perspective is further supported by findings from (Almajali & Dahalin, 2011), indicating that the effectiveness of IT in fostering competitive advantage often depends on complementary resources and strategic alignment. While some studies suggest that IT infrastructure can enhance competitive advantage through improved operational efficiency and responsiveness, others argue that merely possessing IT capabilities does not guarantee a competitive edge without effective management and integration into business strategies (Bhatt et al., 2017; Jawi et al., 2023; Ling, 2011). This result challenges conventional wisdom in the IT industry and warrants careful consideration. Pakistani software companies might be underutilizing their IT resources. The presence of infrastructure, human resources and relationship resources in IT doesn't automatically translate into a competitive advantage if these resources are not leveraged to their full potential.

Third hypothesis (H3) focused on exploring direct connection between KMC and SCA in software firms. The research discovered a notable association between KMC and SCA, which aligns with the results of earlier studies (Alkhaldi, 2022; Dizaji et al., 2023; Habib & Bao, 2019; Lei et al., 2021; Mahdi & Nassar, 2021; Quartey, 2019; Shehabat, 2020). This shows that knowledge management capabilities are better at organizational learning and contribute to improved problem-solving, decision-making and overall organizational performance. Also, this indicates that KMC is a culturally appropriate and effective strategy for creating competitive advantage in this specific market.

Additionally, (H_4 and H_5) hypotheses investigated the relationship between ERM and ITR with KMC and results showed that both ERM and ITR have significant impact on KMC in software companies in Pakistan. Previous studies (Hanggraeni et al., 2019; Ghazieh & Chebana, 2021; Kanu, 2021; Olaniyi et al., 2023; Quang et al., 2024; Saeidi et al., 2020; Syrov, 2022) indicated that the integration of ERM with KMC can lead to enhanced organizational success and inline with the result of current study. Collectively, these studies underscore the critical role of KMC in maximizing the benefits of ERM within organizations. These findings collectively affirm that robust ERM frameworks not only mitigate risks but also create a supportive environment for enhanced knowledge management, ultimately leading to enhanced organizational performance. While the findings of fifth hypothesis indicated that a significant positive correlation exists between IT resources and knowledge management capability but in the different context of the studies (Akram et al., 2018; Iqbal et al., 2020; Mao et al., 2014; Panda & Rath, 2018; Zhang et al., 2017). Collectively, these studies affirm the assertion that IT resources positively influence KMC, albeit in varied contexts.

Two hypotheses (H_6 and H_7) were put forward to investigate whether KMC serves as a mediator in association between ERM and ITR on SCA. Findings confirmed that ERM and ITR indirectly affect SCA through KMC. In summary, the current study empirically verified KMC's mediating role in the connection between ERM and ITR. While earlier literature has looked at KMC's mediating effects with different variables, their results are consistent with the current study (Lei et al., 2021; Quang et al., 2024; Saeed & Yazdani, 2021). Previous studies also obtained similar results but with different variables. ITR indirectly affect the competitive position and organisational performance by means of their engagements with other resources or capabilities, leads towards competitive advantage (Ashrafi & Mueller, 2015). Similarly, Ali et al. (2023) demonstrate that knowledge management systems mediate relationship between strategic management orientation and organizational commitment, emphasizing role of KMC in translating ITR into improved business performance. Thus, results of this study are significant and offer a foundation for upcoming researchers to explore these connections in different contexts.

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Theoretical and Practical Implications

The current research contributes to RBV theory by evaluating how enterprise risk management and IT resources can serve as sources of sustainable competitive advantage. The research highlights the importance of these resources in achieving a competitive edge, emphasizing that ERM and IT resources must be valuable, rare, inimitable and non-substitutable to maintain a competitive advantage. This aligns with core tenets of the RBV theory and extends its application to the IT industry, thereby broadening its scope and relevance. Software companies should prioritize enterprise risk management by establishing a comprehensive framework that includes key components such as risk identification, assessment and response. By integrating these practices, companies can better anticipate and mitigate potential risks that could hinder their growth and success.

Subsequently, this research findings present significant practical suggestions for policymakers such as PSEB, PASHA and the IT Ministry of Pakistan. First, there is a strong positive link between enterprise risk management and sustainable competitive advantage, suggesting that policies should encourage software companies to adopt effective ERM practices to enhance their competitiveness. Additionally, knowledge management capability is found to significantly impact sustainable competitive advantage and mediate effects of ERM and IT resources with SCA. Therefore, promoting KMC through training, collaboration and knowledge-sharing initiatives should be a priority. Interestingly, while IT resources do not directly impact competitive advantage, they positively influence KMC. Thus, policies should also support the development of IT infrastructure and internal processes that strengthen knowledge management. Overall, an integrated approach focusing on risk management, IT resources and knowledge management can help Pakistani Software companies thrive in global markets.

Limitations and Recommendations

This study while making meaningful contributions, has limitations which could be explored in future research. A significant limitation is the exclusive focus on private software companies in four selected cities. Future studies could benefit from including a broader spectrum of companies, such as public sector software companies or those in different regions, to attain better understanding of factors shaping SCA. Secondly, the study employed a quantitative approach using survey questionnaire. The study's cross-sectional approach is another limitation as it captures data at one point in time. Future studies could benefit from using longitudinal designs to observe changes over time.

Moreover, this study primarily examined mediating role of knowledge management capability without delving into other potential mediators or moderators that could influence the relationship between independent variables (ERM, ITR) and sustainable competitive advantage. Future research could explore other mediators or moderators to enrich the understanding of how sustainable competitive advantage can be achieved and maintained. Lastly, the study focused on private software companies, excluding the public IT sector. As both sectors share similarities and face unique challenges, it would be valuable to investigate how the public IT sector navigates issues related to sustainable competitive advantage. Such comparative studies could provide insights into best practices and innovative strategies applicable across the IT industry as a whole.

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ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
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