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The impact of innovation on intellectual capital: Evidence from the Saudi Electricity Company

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ABSTRACT

This study investigates the impact of innovation on intellectual capital within the Saudi Electricity Company, using a descriptive-analytical approach. Data were collected through a questionnaire distributed to a sample of employees, and hypotheses were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results demonstrate that fostering an innovative organizational culture significantly enhances all three dimensions of intellectual capital. These findings support the argument that promoting innovation contributes positively to the development of intellectual capital components in the company.

1. Introduction

Innovation is considered a means of keeping pace with the achievements and developments of various institutions and sectors. Innovation works to find new solutions to support and develop an existing idea, but in a better way, to confront obstacles and raise the general level of the institution under study (the Saudi Electricity Company, Al-Jouf Branch). Innovation is the main pillar of success and uniqueness, which depends on distinction. In this section, the study addresses the most important concepts related to innovation, as well as (the importance, characteristics, influential factors, stages, steps, obstacles, and incentives of innovation) and the impact of this on intellectual capital (Arshad et al., 2024).

The development witnessed at the global level, and the accompanying change in various fields and sectors, such as the economic, industrial, or educational fields, in light of the adoption of systems based on technology and knowledge by many countries, and the increased interest in research and development in various fields, whether in the cognitive or human aspect, all of which have led to the emergence of great competition between various local and international institutions, which has made the latter seek to maintain their position, and cognitive interest in the age of information and knowledge has become the most important element and intellectual capital has become the real capital of institutions through the fundamental role it plays in the process of innovation and renewal and various processes of change, and it represents the focus of ideas capable of transforming knowledge into value and creativity.

The secret behind the success of institutions and their continued competitiveness lies in their acquisition of human resources that consider the challenges they face, invest in them, and exploit and preserve creative energies to ensure the ability to grow, survive, and gain a competitive advantage. Innovation does not stop at finding a new idea but rather goes beyond that to put this concept into practice, as innovation requires taking advantage of new concepts in order to benefit companies, and is considered one of the most important and necessary strategic methods that contribute to building and upgrading institutions. Intellectual capital also works to enhance innovation and develop units and is considered one of the most important sources that the institution exploits in building smart organizations (Alnatsheh et al., 2023). The concept of intellectual capital has emerged as a result of knowledge-based economic transformation, and this bitter matter called for the emergence of new management fields, namely innovation, as this is increasingly seen as an accurate indicator of an organization's ability to succeed and compete. To fully realize their intellectual and collaborative creative potential, organizations need to understand how to develop and manage their resources. This is

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achieved by controlling operations, creating a portfolio to manage intellectual capital, and managing intellectual capital more effectively. Internal resources are an essential element of their competitive advantage, in addition to the fact that intellectual capital may create imaginary wealth by registering patents. Intellectual capital is considered one of the valuable assets of an organization, but due to its intangible nature, few leaders appreciate it. Saudi Electricity Company faces several challenges in the fields of innovation and intellectual capital development. Among these challenges, we find the urgent need to use modern technologies, such as artificial intelligence and the smart internet, to improve operational efficiency and increase sustainability. The company is working to build strategic partnerships with research institutions and universities to exchange knowledge and enhance its innovation processes. The Saudi Electricity Company was chosen for the ease of availability of data and information about the company as well as to analyze the impact of innovation on intellectual capital. There is a local and international interest in the energy industry in the Kingdom of Saudi Arabia and the leading companies in this field. Focusing on a specific company is an opportunity for an in-depth and comprehensive analysis of how innovation affects multiple aspects of intellectual capital, such as skills, knowledge, organizational capabilities, and corporate culture. Modern technologies and analytical tools can be employed to accurately and in detail understand this impact (official website of the Saudi Electricity Company). Therefore, the research problem is represented in the main question of the study: What is the impact of innovation on intellectual capital as applied to the Saudi Electricity Company, Al-Jouf Region Branch?

This study is divided into two parts. First, it is concerned with enhancing the available knowledge about the relationship between innovation and intellectual capital, especially in the context of the energy and public utilities sector. It also provides a specific model for applying academic theories and concepts to realistic practical cases, which increases our understanding of how innovation affects different contexts. The scientific importance of the current study lies in the lack of sufficient attention to the relationship between innovation and intellectual capital, as the research project adds many effective dimensions of innovation to the Arab library, ensuring the improvement of the administrative creativity process, and motivating researchers to conduct new studies that examine the dimensions of the independent and dependent variables in the Electricity Company in Saudi Arabia, especially in the Al-Jouf region. Second, the applied importance appears in coming up with a set of results, through the analysis of which a set of recommendations can be made for decision-makers in the Electricity Company in Saudi Arabia in the Al-Jouf region. The results of this study can be used to develop training and development programs for employees in the Saudi Electricity Company, which enhance their skills and competencies and contribute to improving research and development processes within the company by providing innovative models and strategies.

This study is structured into multiple phases, with Section 2 focusing on hypothesis formulation and the literature review. Section 3 describes the methodology and research strategy. Section 4 emphasizes the Data Analysis and Findings. Finally, Section 5 presents the discussion, conclusions, and implications of the study.

2. Literature review and development of hypotheses

This section includes analytical studies of a number of previous studies with the study variables, whether independent or dependent, followed by a comment on previous studies, and then a summary of the most important points of the study that distinguish it and address the research gap in it.

Saidi et al. (2024) investigated the integration of small towns into industrial production networks in Algeria, focusing on the roles of state-owned enterprises and local capacities. While not centered on the banking sector, the research provides insights into how institutional structures and human capital contribute to regional development and organizational performance. The findings underscore the importance of enhancing various dimensions of intellectual capital to foster innovation and competitiveness in Algerian institutions.

Sohel Rana and Hossain (2023) investigated the impact of intellectual capital (IC)—comprising human, structural, and relational capital—on firm performance and sustainable growth among nonfinancial companies listed on the Dhaka Stock Exchange. The findings reveal that IC components significantly influence sustainable growth, emphasizing the necessity for organizations to recognize and develop their intellectual capital to achieve sustainable competitive advantages. Hasanein and Elrayah (2025) investigated the impact of psychological empowerment on employee creativity within the Saudi hotel industry. Utilizing a survey of 536 hotel staff and employing structural equation modeling, the research examines how psychological empowerment directly affects employee creativity and affective commitment. The findings highlight the significant role of psychological empowerment in enhancing employee creativity, emphasizing the importance of fostering supportive work environments to stimulate innovation in the hospitality sector.

Ashraf et al. (2023) explored the critical role of IC in ensuring the sustainable performance and growth of European hospitality firms, both large and small, during the unprecedented COVID-19 crisis. It provides insights into how components of IC—human, structural, and relational capital—impact firm profitability and asset growth, highlighting the importance of investing in IC to enhance innovation

and competitive advantage. Elshaiekh et al. (2024) examined the readiness of Sultan Qaboos University students for the knowledge-based economy, focusing on their awareness, perceptions, and skills. Utilizing a quantitative approach with a questionnaire distributed to students across various colleges, the research identifies significant relationships between enhancing students' knowledge-based economy skills and both awareness of the knowledge-based economy and the impact of technology on education and employment. The study emphasizes the importance of training programs to enhance individuals' understanding of intellectual capital's significance within the information economy context.

Furthermore, Lee et al. (2023) sought to determine the impact of various aspects of intellectual capital–human, structural, and relational–on organizational innovation advancement at Ahmed Draia University in Adrar State. The primary data collection tool was a questionnaire, complemented by descriptive and analytical methodologies. The research uncovered several key findings, notably the direct impact of intellectual capital's multiple dimensions on innovation at Ahmed Draia University, totaling 0.718. The study also reveals that intellectual capital plays a crucial role in stimulating organizational innovation. Among the conclusions of the study was a recommendation to link the granting of conditional licensing to academic institutions that have produced numerous original research works and technologies with demonstrated societal benefits.

Aljuboori et al. (2021) investigated the influence of intellectual capital, comprising human, relational, and organizational components, on the performance of small and medium-sized industrial firms in Malaysia. They examined the mediating role of innovative capacity using data from 262 employees and analyzed it using SPSS and Smart LPs software. The findings reveal that innovative capabilities enhance the link between intellectual capital and organizational performance, leading to increased competitive advantage. The researchers advised managers of these organizations to implement daily innovation-promoting strategies rather than relying on specific initiatives. Similarly, Obeidat et al. (2021) explored the impact of intellectual capital on achieving competitive advantage and the mediating effect of innovation in this relationship. This study focused on 342 administrative employees from three Jordanian telecommunications companies: Orange, Zain, and Umniah. The results indicate a significant influence of intellectual capital on competitive advantage, with innovation playing a crucial mediating role. The authors recommend that organizations fully grasp the importance of intellectual capital in gaining a competitive edge and adopt a unified institutional approach to its utilization. Mehralian et al. (2024) examined the connection between dynamic capabilities and innovative ingenuity, considering the roles of intellectual capital and innovative orientation. This research targeted the Iranian pharmaceutical industry, involving 151 companies from 2018-2019. Data collection included electronic questionnaires and interviews with executive directors. The study concludes that intellectual capital significantly affects innovative ingenuity through dynamic capabilities.

Numerous studies have explored the impact of innovation on intellectual capital, by adopting a unique approach. These investigations revealed distinctions between Arab and non-Arab nations. This study will examine the selection of valuable research, emphasizing their key features and offering commentary on points of convergence and divergence. The research notes that the studies under review span from 2020 to 2023 and encompass various countries and states, demonstrating their temporal and geographic range. It also identifies the scientific gaps addressed in this study. The studies were categorized based on their primary variables and were conducted by both Arab and international researchers, first focusing on the innovation aspect, followed by Arab studies examining the intellectual capital dimension.

In presenting the main and subsidiary research problems, this study proposes the following central hypothesis:

H: Does a statistically significant correlation exist between innovation and intellectual capital in the context of the Saudi Electricity Company, particularly in the Al-Jouf region?

From this, the following sub-hypotheses are derived.

H1: Is there a statistically significant link between continuous improvement and intellectual capital as applied to the Saudi Electricity Company, specifically in the Al-Jouf region?

H2: Does a statistically significant relationship exist between value creation and intellectual capital in the Saudi Electricity Company, with a focus on the Al-Jouf region?

H3: Is there a statistically significant connection between resource allocation and intellectual capital in the Saudi Electricity Company, particularly in the Al-Jouf area?

H4: Does a statistically significant association exist between maintaining focus and intellectual capital in the Saudi Electricity Company, specifically in the Al-Jouf region?

H5: Is there a statistically significant relationship between fostering an innovative corporate culture and intellectual capital in the Al-Jouf branch of the Saudi Electricity Company?

3. Methodology and research design

The research population encompasses all the elements and components related to the issues or phenomena being investigated. This represents the entire set of elements pertinent to the problem under examination. In this study, the research population comprised 250 employees of both genders, including technical staff, administrative personnel, and laborers. Examining the entire

research population is uncommon in scientific studies because of the general challenges researchers face in accessing all members of the original population and the associated high cost. The unit of analysis serves as a crucial component in the research process, with data being systematically and methodically analyzed. This analysis aims to uncover the relationships between the variables and derive key findings and conclusions from the data. For this study, the unit of analysis is identified as "the worker" within the Saudi Electricity Company. This study uses PLS-SEM, which excels in handling research models with numerous interconnected latent variables (constructs). It is specifically designed to manage intricate models featuring a large number of constructs, indicators, and pathways. PLS-SEM offers an efficient solution when the research aims to investigate multiple direct and indirect variable relationships. This approach is particularly advantageous compared with conventional methods such as regression or covariance-based SEM (CB-SEM), which often struggle with model complexity or require larger sample sizes.

4 . Data analysis and findings

4.1. Sample characteristics

Table 1 shows that the sample predominantly consists of middle-aged males with advanced education. Over 80% are men, with most participants between 30-50 years old. Education levels are high, as nearly two-thirds hold post-graduate degrees. Experience levels are balanced, with a slight majority having 10-20 years in the field.

This demographic profile suggests a specialized professional environment with a significant gender imbalance. The workforce appears well-educated and experienced but lacks diversity in terms of age and gender. These characteristics may limit the generalizability of our findings to broader populations and should be considered when interpreting the results of this sample.

Table 1: Sample characteristics and demographic profile

Characteristic	Category	Frequency	Percent
Gender	Male	151	83.9%
	Female	29	16.1%
Age	Less than 30 years old	22	12.2%
	From 30 to less than 40 years old	102	56.7%
	From 40 to less than 50 years old	46	25.6%
	From 50 years and over	10	5.6%
Qualification	Postgraduate	113	62.8%
	Diploma	45	25.0%
	Secondary	15	8.3%
	Other	7	3.9%
Experience	Less than 10 years	69	38.3%
	10-20 years	79	43.9%
	More than 20 years	32	17.8%

4.2. Measurement model assessment

Measurement model assessment as shown in Fig. 1 evaluates the reliability and validity of the constructs used in this study (Hair et al., 2017). We examined indicator reliability, internal consistency reliability, convergent validity, discriminant validity, and multicollinearity.

4.3. Indicator reliability

Indicator reliability analysis (Table 2) shows that all indicators have outer loadings above the recommended threshold of 0.7, indicating excellent reliability (Hair et al., 2017). Indicator reliability was assessed through the outer loadings of each item on its respective construct (Hair et al., 2019).

4.4. Internal consistency reliability

All constructs demonstrate excellent internal consistency reliability (Table 3), with Cronbach's Alpha and Composite Reliability values well above the recommended threshold of 0.7 (Nunnally and Bernstein, 1994). Convergent validity is strongly supported with all AVE values above the recommended threshold of 0.5 (Fornell and Larcker, 1981). Finally, internal consistency reliability was assessed using Cronbach's Alpha and Composite Reliability (Fornell and Larcker, 1981; Hair et al., 2017).

4.5. Discriminant validity

Discriminant validity was assessed using the Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio (HTMT) as shown in Tables 4 and 5 (Fornell and Larcker, 1981; Henseler et al., 2015).

The Fornell-Larcker criterion was met for all constructs, with the square root of AVE (diagonal elements) exceeding correlations with other constructs (Fornell and Larcker, 1981).

The HTMT analysis shows some ratios exceeding the conservative threshold of 0.85 (Henseler et al., 2015), particularly between HC and SC (0.945), RC and SC (0.931), and RA and MF (0.931). This finding suggests potential discriminant validity issues between these constructs.

4.6. Multicollinearity

All VIF values were below the critical threshold of five, indicating no severe multicollinearity issues at the indicator level (Hair et al., 2011).

Multicollinearity was assessed using the Variance Inflation Factor (VIF) for all indicators (Table 6) (Hair et al., 2019).

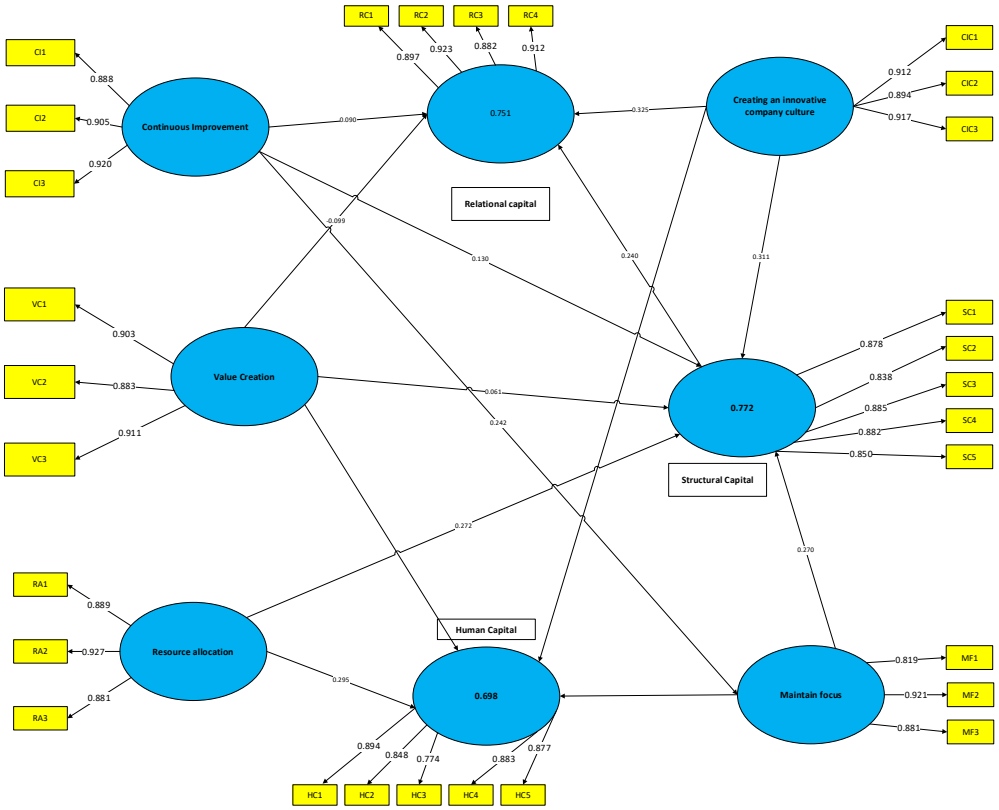

Fig. 1: Measurement model assessment

Table 2: Outer loadings

Construct	Indicator	Outer loading
Continuous improvement	CI1	0.888
	CI2	0.905
	CI3	0.920
Creating an innovative company culture	CIC1	0.912
	CIC2	0.894
	CIC3	0.917
Human capital	HC1	0.894
	HC2	0.848
	HC3	0.774
	HC4	0.883
	HC5	0.877
Maintain focus	MF1	0.819
	MF2	0.921
	MF3	0.881
Resource allocation	RA1	0.889
	RA2	0.927
	RA3	0.881
Relational capital	RC1	0.897
	RC2	0.923
	RC3	0.882
	RC4	0.912
Structural capital	SC1	0.878
	SC2	0.838
	SC3	0.885
	SC4	0.882
	SC5	0.850
Value creation	VC1	0.903
	VC2	0.883
	VC3	0.911

Table 3: Internal consistency reliability and convergent validity

Construct	Cronbach's Alpha	rho_A	Composite reliability	AVE
Continuous improvement	0.889	0.897	0.931	0.818
Creating an innovative company culture	0.893	0.896	0.934	0.824
Human capital	0.908	0.909	0.932	0.733
Maintain focus	0.846	0.856	0.907	0.765
Relational capital	0.925	0.926	0.947	0.817
Resource allocation	0.881	0.883	0.927	0.808
Structural capital	0.917	0.918	0.938	0.751
Value creation	0.881	0.882	0.927	0.808

Table 4: Fornell-Larcker criterion

Construct	CI	CIC	HC	MF	RC	RA	SC	VC
CI	0.904							
CIC	0.736	0.908						
HC	0.655	0.743	0.856					
MF	0.757	0.766	0.785	0.875				
RC	0.701	0.789	0.854	0.814	0.904			
RA	0.682	0.736	0.771	0.805	0.780	0.899		
SC	0.741	0.806	0.865	0.817	0.859	0.788	0.867	
VC	0.816	0.735	0.703	0.777	0.686	0.730	0.749	0.899

Table 5: Heterotrait-Monotrait ratio (HTMT)

Construct	CI	CIC	HC	MF	RC	RA	SC	VC
CI								
CIC	0.824							
HC	0.722	0.820						
MF	0.869	0.874	0.892					
RC	0.769	0.867	0.929	0.917				
RA	0.765	0.827	0.860	0.931	0.863			
SC	0.816	0.887	0.945	0.921	0.931	0.877		
VC	0.917	0.828	0.784	0.893	0.758	0.828	0.831	

Table 6: Variance inflation factor (VIF) values

Indicator	VIF	Indicator	VIF	Indicator	VIF
CI1	2.456	HC1	3.384	RC1	3.751
CI2	2.605	HC2	2.685	RC2	4.441
CI3	2.722	HC3	1.727	RC3	3.179
CIC1	2.662	HC4	3.075	RC4	3.814
CIC2	2.521	HC5	2.954	SC1	3.064
CIC3	2.865	MF1	1.795	SC2	2.490
RA1	2.360	MF2	2.801	SC3	2.957
RA2	3.071	MF3	2.225	SC4	2.995
RA3	2.329	VC1	2.512	SC5	2.591
		VC2	2.256		
		VC3	2.722		

4.7. Structural model assessment

4.7.1. Path coefficients and significance

The results as shown in Table 7 and Fig. 2, show that creating an innovative company culture, maintaining focus, and resource allocation have significant positive influences on human, relational, and Structural Capital. Continuous Improvement and Value Creation do not have significant effects on dependent variables (Hair et al., 2017).

4.7.2. Coefficient of determination (R^2)

The R^2 values (Table 8) indicate that the model explains 69.8% of the variance in Human Capital, 75.1% of the variance in relational capital, and 77.2% of the variance in Structural Capital, which is considered to be moderate to substantial (Hair et al., 2011).

4.7.3. Predictive relevance (Q^2)

The Q^2 values (Table 9) for Human Capital (0.497), relational capital (0.597), and Structural Capital (0.565) indicate that the model has large predictive relevance for these constructs (Hair et al., 2019).

4.8. PLS predict

Table 10 presents the PLS prediction results for key indicators, comparing the performance of the (PLS) and Linear Model (LM) approaches. The results showed that the PLS model generally outperformed the LM benchmark across most indicators, with lower RMSE, MAE, and MAPE values, indicating better predictive accuracy. Both models demonstrate good out-of-sample predictive power, as evidenced by the positive Q^2_ predicted values for all the indicators (Hair et al., 2019). The PLS model exhibits higher Q^2_predict values for most indicators, suggesting superior predictive relevance compared with the LM benchmark. This analysis supports the robustness of the PLS model in predicting human Capital (HC), relational Capital (RC), and Structural Capital (SC) indicators within the context of this study.

5 . Discussion

Evaluation of the structural model revealed numerous significant correlations among the variables examined. This segment offers a descriptive analysis of the hypotheses based on PLS-SEM outcomes. Establishing an innovative organizational culture was found to have a substantial positive impact on all three aspects of intellectual capital. In particular, it favorably affected human capital (β=0.242, p<.01, 95% CI [0.067, 0.414]), relational capital (β=0.325, p<.001, 95% CI [0.141, 0.484]), and structural capital (β=0.311, p<.001, 95% CI [0.142, 0.469]). These findings support the proposition that nurturing an innovative culture within a company contributes to the growth of its intellectual capital elements. The magnitude of these relationships ranged from small to medium ($0.063 \leq f^2 \leq 0.138$), suggesting their statistical and practical importance.

Table 7: Structural model results

Relationship	Path coefficient (β)	T statistics	P-values	95% CI lower	95% CI upper	f^2	Support
Continuous improvement -> human capital	-0.050	0.548	0.583	-0.215	0.133	0.002	Rejected
Continuous improvement -> relational capital	0.090	1.007	0.314	-0.079	0.272	0.009	Rejected
Continuous improvement -> structural capital	0.103	1.254	0.210	-0.056	0.269	0.013	Rejected
Creating an innovative company culture -> human capital	0.242	2.803	0.005	0.067	0.414	0.063	Supported
Creating an innovative company culture -> relational capital	0.325	3.788	0.000	0.141	0.484	0.138	Supported
Creating an innovative company culture -> structural capital	0.311	3.748	0.000	0.142	0.469	0.138	Supported
Maintain focus -> human capital	0.323	2.708	0.007	0.070	0.537	0.083	Supported
Maintain focus -> relational capital	0.368	3.135	0.002	0.128	0.586	0.131	Supported
Maintain focus -> structural capital	0.270	2.620	0.009	0.071	0.474	0.078	Supported
Resource allocation -> human capital	0.295	3.191	0.001	0.103	0.463	0.088	Supported
Resource allocation -> relational capital	0.256	2.541	0.011	0.048	0.439	0.080	Supported
Resource allocation -> structural capital	0.227	2.962	0.003	0.064	0.368	0.069	Supported
Value creation -> human capital	0.099	1.014	0.310	-0.096	0.290	0.008	Rejected
Value creation -> relational capital	-0.099	1.028	0.304	-0.284	0.095	0.010	Rejected
Value creation -> structural capital	0.061	0.659	0.510	-0.130	0.233	0.004	Rejected

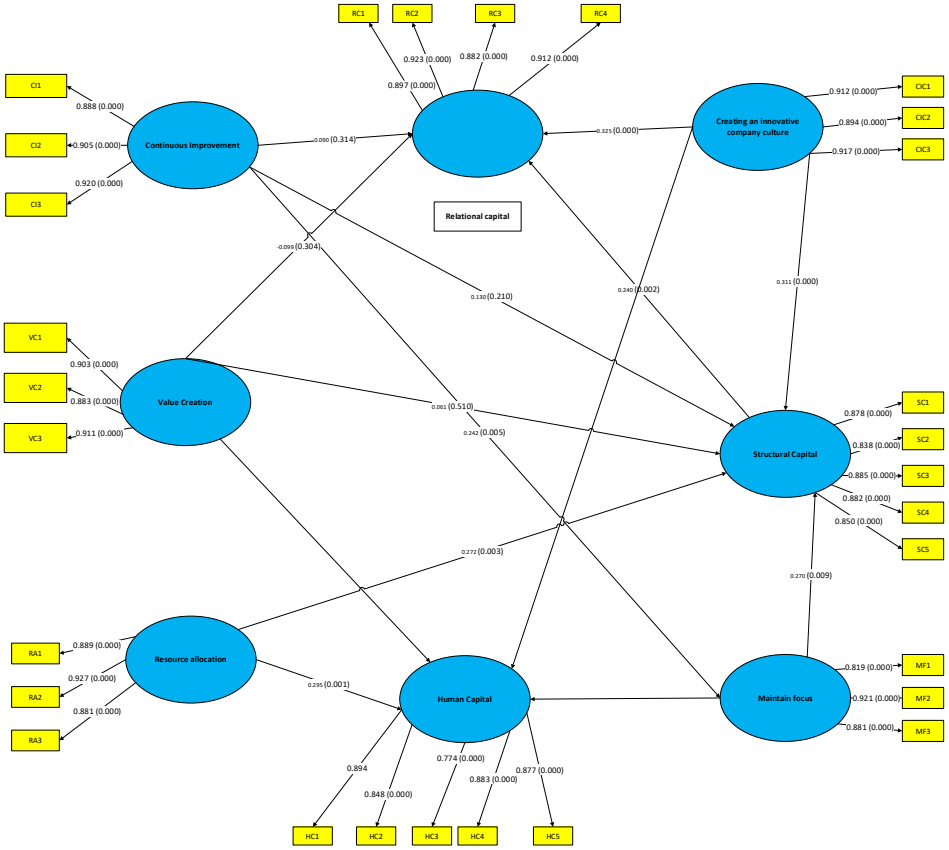

Fig. 2: Path coefficients and significance

Table 8: R^2 values for endogenous constructs

Construct	R^2 value	R^2 adjusted
Human capital	0.698	0.689
Relational capital	0.751	0.744
Structural capital	0.772	0.766

R^2 values of 0.75, 0.50, and 0.25 are considered substantial, moderate, and weak, respectively

Table 9: Q^2 values for endogenous constructs

Construct	SSO	SSE	Q^2 (=1-SSE/SSO)
Human capital	900.000	452.515	0.497
Relational capital	720.000	289.801	0.597
Structural capital	900.000	391.368	0.565

Sustaining focus also exhibited significant positive associations with all three intellectual capital dimensions. It positively influences human capital (β=0.323, p<.01, 95% CI [0.070, 0.537]), relational capital (β=0.368, p<.01, 95% CI [0.128, 0.586]), and structural capital (β=0.270, p<.01, 95% CI [0.071, 0.474]). These results corroborate the hypothesis that a company's capacity to maintain its focus enhances intellectual capital. The effect sizes of these associations were small to medium ($0.078 \leq f^2 \leq 0.131$), indicating noteworthy practical implications. The allocation of resources was found to have considerable positive effects on all three IC components of intellectual capital. It positively

impacted human capital (β=0.295, p<.01, 95% CI [0.103, 0.463]), relational capital (β=0.256, p<.05, 95% CI [0.048, 0.439]), and structural capital (β=0.227, p<.01, 95% CI [0.064, 0.368]). These outcomes support the hypothesis that efficient resource allocation within an organization contributes to the development of intellectual capital. The effect sizes for these relationships were small ($0.069 \leq f^2 \leq 0.088$), signifying a modest yet meaningful practical significance.

Table 10: PLS predict results for key indicators

Indicator	PLS RMSE	LM RMSE	PLS MAE	LM MAE	PLS MAPE	LM MAPE	PLS Q^2_predict	LM Q^2_predict
HC1	0.621	0.665	0.444	0.471	13.667	14.362	0.479	0.401
HC2	0.676	0.734	0.476	0.519	14.959	16.281	0.389	0.280
HC3	0.674	0.663	0.466	0.457	17.982	16.861	0.513	0.528
HC4	0.587	0.622	0.409	0.441	13.733	14.506	0.519	0.460
HC5	0.609	0.665	0.439	0.470	13.723	14.614	0.508	0.414
RC1	0.570	0.612	0.389	0.407	13.097	13.826	0.600	0.538
RC2	0.585	0.609	0.393	0.427	14.316	15.169	0.601	0.567
RC3	0.669	0.732	0.433	0.485	16.170	18.091	0.572	0.488
RC4	0.702	0.744	0.458	0.508	18.185	19.328	0.559	0.504
SC1	0.601	0.624	0.412	0.415	14.331	14.291	0.524	0.488
SC2	0.533	0.574	0.386	0.413	11.442	12.122	0.532	0.457
SC3	0.540	0.567	0.361	0.387	12.503	13.067	0.619	0.579
SC4	0.556	0.605	0.372	0.411	12.770	14.290	0.593	0.517
SC5	0.581	0.627	0.390	0.429	13.256	14.258	0.506	0.424

Unexpectedly, no significant correlations were found between continuous improvement and any aspect of intellectual capital. The path coefficients linking continuous improvement to human capital (β=-0.050, p=.583, 95% CI [-0.215, 0.133]), relational capital (β=0.090, p=.314, 95% CI [-0.079, 0.272]), and structural capital (β=0.103, p=.210, 95% CI [-0.056, 0.269]) were all statistically insignificant. These results fail to support the hypotheses, suggesting that continuous improvement initiatives enhance intellectual capital components. The minimal effect sizes ($0.002 \leq f^2 \leq 0.013$) further underscored the lack of practical significance. Likewise, value creation showed no significant association with the intellectual capital dimensions. The path coefficients connecting value creation to human capital (β=0.099, p=.310, 95% CI [-0.096, 0.290]), relational capital (β=-0.099, p=.304, 95% CI [-0.284, 0.095]), and structural capital (β=0.061, p=.510, 95% CI [-0.130, 0.233]) were all statistically insignificant. These findings do not support the hypothesis that value-creation activities contribute to the enhancement of intellectual capital components.

6. Conclusion and implication of the study

The effect sizes were negligible ($0.004 \leq f^2 \leq 0.010$), confirming a lack of practical significance. This study aims to determine the impact of innovation on intellectual capital by applying it to the Saudi Electricity Company. The study uses a descriptive-analytical approach, and the questionnaire is used as a tool for the study. It is distributed to a sample of the community under study, which consists of a group of workers in the Saudi Electricity Company. This section provides a narrative analysis of the hypotheses based on the PLS-SEM results. The results revealed that creating an innovative company culture has significant positive effects on all three dimensions of intellectual capital. Moreover, these results support the hypothesis that fostering an innovative culture within an organization contributes to the development of its intellectual capital components.

This study has some future prospects, the impact on sustainability as well as social responsibility, as the focus will be on how to use innovation to achieve sustainability goals, which can lead to the development of intellectual capital and improve performance in general. Moreover, developing research methods as technology advances, new research methods will emerge that help study the impact of innovation on intellectual capital in a deeper and more accurate way. Finally, innovation in intellectual capital management new tools and techniques will emerge to manage intellectual capital more effectively and may include big data analysis and artificial intelligence.

List of abbreviations

PLS-SEM	Partial least squares structural equation modeling
IC	Intellectual capital
CI	Continuous improvement
CIC	Creating an innovative company culture
HC	Human capital
MF	Maintain focus
RA	Resource allocation
RC	Relational capital
SC	Structural capital
VC	Value creation
AVE	Average variance extracted
VIF	Variance inflation factor
HTMT	Heterotrait-monotrait ratio
R^2	Coefficient of determination
Q^2	Predictive relevance
RMSE	Root mean square error
MAE	Mean absolute error
MAPE	Mean absolute percentage error
LM	Linear model
SSO	Sum of squares of observations
SSE	Sum of squared errors

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Compliance with ethical standards

Ethical considerations

This study was conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments. Informed consent was obtained from all individual participants included in the study. Participation was voluntary, and confidentiality of responses was ensured.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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