Dynamics between intellectual capital and firm performance: A study of Indian listed Construction, Energy and Information Technology firms

Pankaj Anand[1], Anindita Adhikary[2], Jitendra Kumar[3], Harishankar Vidyarthi[4], Subhadeep Mukherjee[5]

[1]Department of Management Studies, Sikkim Manipal Institute of Technology, Majhitar, Sikkim Manipal University, Gangtok, Sikkim, India.
[2]Department of Management Studies, Sikkim Manipal Institute of Technology, Majhitar, Sikkim Manipal University, Gangtok, Sikkim, India.
[3]Faculty of Management & Commerce, Ramaiah University of Applied Sciences, Bangalore, Karnataka, India.
[4]Department of Management Studies, Institute of Public Enterprise, Hyderabad, Telangana, India.
[5]Faculty of Management & Commerce, Ramaiah University of Applied Sciences, Bangalore, Karnataka, India.
Corresponding Author Email ID: Pankajjhaanand@gmail.com

Abstract:

Purpose: This study explores the influence of intellectual capital on firm performance among BSE listed Construction, Energy and Information Technology firms in India.

Design/methodology/approach: This study analyses data from 70 listed Indian construction, energy and information technology companies using Panel-Corrected Standard Error regression analysis over the year 2014-2021.

Findings: The empirical findings reveal that Indian publicly listed construction, energy and information technology firms exert a positive influence on firm performance over the study period. Notably, Human Capital emerges as a critical determinant that significantly impacts firm performance in all three sectors followed by capital employed efficiency.

Originality/Value: This study represents the first comprehensive examination of the relationship between intellectual capital and firm performance in listed construction, energy and information technology firms. It is also pioneering in its application of Panel Corrected Standard Error regression analysis, alongside VAIC and MVAIC models, to analyse the relationship between IC and various measures of firm performance within this sector.

Keyword: Intellectual Capital, Firm Performance, Construction, Energy, Information technology, India.

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1. Introduction:

A company's value often surpasses its book value because of inclusion of both physical and intellectual capital. The rise of knowledge-based firms has shifted focus from tangible physical inputs such as capital and machinery to intangible ones, primarily known as intellectual capital *(Ge & Xu, 2020; Vidyarthi, 2019; Goh & Lim, 2004)*. Physical capital consists of tangible assets such as land, labour, and money, while intellectual capital encompasses intellect-based resources that contribute to organizational value for stakeholders *(Alipour, 2012)*. Intellectual capital consists of human capital, intellectual property, brands, organizational processes, reputation, customer relations, patents, and innovation. *Pulic (1998, 2004)* demonstrated that physical, human, and structural capital collectively form intellectual capital. *Bontis (2000)* extended intellectual capital by adding relational capital, underlining the importance of investments in maintaining relationships with stakeholders. Thus, following Bontis (2000), intellectual capital can be subdivided into human capital, structural capital, physical capital employed and relational capital. Modern perspectives suggest that intellectual capital significantly enhances an organization's distinctive resource capacity *(Xu & Li, 2020; Smriti & Das, 2018; Marr et al., 2003).*Human Capital (HC) represents knowledge, experience, education and the skills of employees in the organisation *(Aslam & Haron, 2020; Ge & Xu, 2020),* human capital is essential for organizational performance, particularly in driving innovation, enabling effective problem-solving, and executing strategic plans. It serves as the foundation for developing new ideas, tackling intricate problems, and implementing strategic plans, thereby contributing to an organization's competitive advantage and long-term success *(Busayo & Yahaya, 2024).* While structural capital is non-human knowledge that includes organizational charts, databases, process manuals, routines, strategies and other things whose value is higher than its material value (*Aslam & Haron, 2020; Ge & Xu, 2020*). It establishes the foundational framework and provides the necessary tools that enable knowledge sharing, enhance operational efficiency, and foster innovation within an organization. By creating a supportive infrastructure, SC facilitates the seamless exchange of information and optimization of processes, thereby improving performance *(Busayo & Yahaya, 2024).*Capital Employed (CE) is the total amount of money put in the organisation *(Isola 2020) consisting of both* equity and debt financing within a business to generate profits. This includes not only the financial resources derived from shareholders and creditors but also the totality of physical assets such as machinery, buildings, and equipment. Finally, relational capital involves strategic investment in advertising and other expenditures that support the development and maintenance of relationships with a wide array of stakeholders, such as customers, suppliers, shareholders, and government entities. It includes both formal business collaborations and a network of informal relationships with customers, suppliers, financial institutions, and non-profit organizations. Effective management of relational capital is critical for an organization's ability to achieve operational efficiency, enhance customer loyalty, and maintain a favourable position within its industry *(Ge & Xu, 2020, Vidyarthi, 2019).*

In today's competitive landscape, intellectual capital is pivotal for gaining and sustaining competitive advantage, thereby enhancing firm performance *(Vishnu & Gupta, 2013; Marr et al., 2003).* However, studies examining the association between intellectual capital and firm performance have produced mixed findings. While some researchers have observed a positive influence *(Singla, 2020; Hamdan et al., 2017; Clarke et al., 2011),* others have reported little or no impact *(Chan, 2009; Shiu, 2006; Firer & Williams, 2003).* Given these disparities, this study aims to explore the impact of intellectual capital on firm performance of BSE - listed construction, energy and information technology firms in India. The present research addresses the following questions: (a) How does intellectual capital influence firm performance? (c) What are the impacts of the individual components of intellectual capital on firm performance? To answer both questions, this study uses annual data of the BSE listed firms in the construction, energy and information technology sector over the year 2014 to 2021.

This study adds to the existing literature by analysing the effects of intellectual capital on firm performance within the construction, energy and information technology sector. Studies on the impact of intellectual capital on firm performance in the Indian context have not been widely conducted, particularly in the context of listed companies in the construction, energy and information technology sectors. To date, we have not found any India-centric study exploring intellectual capital - firm performance dynamics in Indian construction, energy and information technology sector companies. Our research found that human capital is a major factor contributing to a firm's intellectual capital.

The Construction, Energy, and Information Technology sectors were selected due to their critical contributions to India's GDP, employment, and economic development. These sectors represent diverse operational environments—construction is infrastructure-driven, energy is capital-intensive, and IT is innovation- and knowledge-intensive. Their combined relevance and reliance on both tangible and intangible assets provide a robust context for examining the impact of intellectual capital on firm performance. The construction sector plays a vital role in India's economy, contributing 8-9% to GDP and providing employment to over 70 million people, particularly in unskilled and semi-skilled roles. It drives economic growth through infrastructure development, supports industries such as cement and steel, and attracts significant investments through government initiatives and foreign direct investment (FDI). The energy sector is capital-intensive and needs support to ensure a sustainable and efficient energy supply which is critical to the nation's economic growth and development. Additionally, it informs policymakers and top-level management of these company's investment strategies to enhance energy security by properly allocating available resources. The information technology sector contributes 8% of GDP and is a major source of foreign exchange through exports. It provides direct employment to over 4 million people, fosters innovation, and supports India's transition to a digital economy. This sector enhances India's global competitiveness by serving as a hub for outsourcing and tech services, driving growth in both domestic and international markets. This study also addresses previous limitations by analysing the effects of intellectual capital components on firm performance. Moreover, it uses the modified VAIC (MVAIC) model, including relational capital, as a measure of intellectual capital *(Tiwari et al., 2023; Xu & Li, 2020; Ge & Xu, 2020; Vidyarthi, 2019)*. The findings will help top management in the Indian construction, energy and information technology sectors to optimize intellectual capital and surpass their competitors.

The study is structured as follows: Section 2 reviews key prior studies to contextualize the current research. Section 3 outlines the methodology, including the sample data, timeframes, variable descriptions, and analysis techniques. Section 4 discusses the empirical findings and Section 5 concludes the study.

Assessing company performance is complex owing to multiple factors. This study used Return on Assets (ROA), Return on Equity (ROE), and Asset Turnover Ratio (ATO) to measure firm performance.

2. Literature Review:

The Resource-Based View (RBV) advocates that a firm's competitive advantage is driven by its unique resources and capabilities (*Smriti & Das, 2021*; *Ge & Xu, 2020; Nadeem et. al., 2017; Appuhami & Bhuyan, 2015*). Intellectual capital, encompassing HC, SC and RC is a key resource in the RBV framework. These intangible assets are considered unique, valuable, and inimitable, which aligns with the RBV's emphasis on leveraging resources to gain a competitive edge. The VAIC and MVAIC frameworks have been used by numerous researchers as measures of IC by numerous researchers (*Smriti & Das, 2021*; *Ge & Xu, 2020; Nadeem et. al., 2017; Appuhami & Bhuyan, 2015*).

2.1: Impact of Intellectual capital on Firm Performance:

The relationship between IC and firm performance has been widely analysed across sectors (including banking, IT, pharmaceuticals, and manufacturing) and across countries, including China, Africa, Australia, India, Nigeria, Taiwan, and Indonesia *(Bansal & Singh, 2020; Ge & Xu, 2020; Goh & Lim, 2004; Vidyarthi, 2019; Mohapatra et al., 2019; Nadeem et al., 2017; Alipour, 2012; Clarke et al., 2011)*. These studies typically employ the VAIC or MVAIC framework to estimate IC, with firm performance assessed through market or firm indicators *(Gao et. al., 2024; Ge & Xu, 2021; Xu & Li, 2020; Dalwai & Mohammadi, 2020; Rahayu & Ramadhanti, 2019; Adesina, 2019; Mubaraq & Haji, 2014; Wu et al., 2012; Clarke et al., 2011)*.

Similarly, the relationship between intellectual components and firm performance yielded different results. *Chen et. al., 2024,* found SC to have a positive impact over private hospital performance, *Alhassan & Asare (2016)* found a minimal impact of structural capital (SC) on bank productivity, whereas *Tandon et al. (2016)* failed to link SC and financial performance among listed firms. *Mention & Bontis (2013)* found that human capital had a substantial impact on bank performance in Luxembourg and Belgium but could not establish significance of structural capital, similarly, *Gao et. al., (2024)* also found human capital to have a significant impact over IC among the Chinese listed agriculture companies.

Bayraktaroglu et al. (2019) found that innovation capital efficiency impacts structural capital efficiency (SCE) and profitability in Turkish manufacturing firms, with intellectual capital efficiency mediating between capital employed efficiency and profitability. *Singla (2020)* found that intellectual capital significantly impacts earnings and valuation in Indian real estate and infrastructure firms, with capital employed efficiency (CEE) boosting profits. These studies highlight diverse insights into intellectual capital's individual components influence on firm performance. A prevailing consensus suggests that intellectual capital significantly affects firm performance (*Chen et. al., 2024; Ramirez et al., 2020; Isola et al., 2020; Vidyarthi, 2019; Hamdan et al., 2017*). However, few others found little or no significance of intellectual capital on firm performance (*Chan, 2009; Shiu, 2006; Firer & Williams, 2003*), presenting scope for future research.

These studies highlight the complex linkage between intellectual capital and firm performance, underscoring the need for industry and country specific analysis. Thus, we see that past researcher's findings are not conclusive, so the following hypothesis is proposed:

H1: Intellectual capital has a positive impact on firm performance.

H2: HCE/SCE/CEE/RCE has positive impact on firm Performance.

3. Methodology and data

3.1. Empirical model

To assess the IC - firm performance dynamics among the listed construction, energy and information technology firms over 2014 - 2021, we use the following empirical model:

Table 1: Functional representation of empirical models	
FP = f (VAIC, LEV, SIZE, AGE)	$FP_{it} = \beta_0 + \beta_1\,VAIC_{it} + \beta_2\,LEV_{it} + \beta_3\,SIZE_{it} + \beta_4\,AGE_{it} + \varepsilon_{it}$ (1)
FP = f (MVAIC, LEV, SIZE, AGE)	$FP_{it} = \beta_0 + \beta_1\,MVAIC_{it} + \beta_2\,LEV_{it} + \beta_3\,SIZE_{it} + \beta_4\,AGE_{it} + \varepsilon_{it}$ (2)
FP = f (HCE, SCE, CEE, LEV, SIZE, AGE)	$FP_{it} = \beta_0 + \beta_1\,HCE_{it} + \beta_2\,SCE_{it} + \beta_3\,CEE_{it} + \beta_4\,LEV_{it} + \beta_5\,SIZE_{it} + \beta_6\,AGE_{it} + \varepsilon_{it}$ (3)
FP = f (HCE, SCE, CEE, RCE, LEV, SIZE, AGE)	$FP_{it} = \beta_0 + \beta_1\,HCE_{it} + \beta_2\,SCE_{it} + \beta_3\,CEE_{it} + \beta_4\,RCE_{it} + \beta_5\,LEV_{it} + \beta_6\,SIZE_{it} + \beta_7\,AGE_{it} + \varepsilon_{it}$ (4)
Where, FP denotes firm performance measured by ROA, ROE and ATO respectively. VAIC – value added intellectual coefficient, MVAIC – modified value-added intellectual capital, HCE – human capital, SCE – structural capital, CEE – physical capital employed, RCE – relational capital, LEV - leverage, SIZE – firm size, and AGE – firm age. Also, the term "εit" denotes the error term for firm i at time t. β0 is the constant term.	

3.2: Variables used Description:

Variables used to analyse the data were categorized as: dependent, control, and independent variables. A brief overview of these variables is provided below.

Dependent variables:

- **Return on Assets (ROA):** This assesses a firm's ability to create profits from its total assets *(Smriti & Das, 2021, 2018; Xu & Li, 2020; Kamath, 2019).*
- **Return on Equity (ROE):** ROE represents the ratio of total income to shareholders funds *(Tiwari & Arora, 2024)*
- **Asset Turnover Ratio (ATO):** This ratio indicates a firm's productivity by comparing total revenue to the book value of total assets *(Xu & Li, 2020; Kamath, 2019; Smriti & Das, 2018; Narwal & Yadav, 2017).*

Control variables:

• **Leverage (LEV):** This is the ratio of total liabilities to total assets *(Shahwan & Fathalla, 2020; Appuhami & Bhuyan, 2015).*
• **Size (SIZE):** It is the natural logarithm of company's total assets *(Xu & Li, 2020; Aslam, 2020; Shahwan & Fathalla, 2020; Alipour, 2012).*
• **AGE:** Natural logarithm of the number of years since its establishment *(Dalwai & Mohammadi, 2020; Zaid et al., 2020; Mohapatra et al., 2019).*

Independent Variables:

VAIC (Value Added Intellectual Capital) Framework: This study adopts the Value-Added intellectual capital approach given by *Pulic (1998)* framework and further extended by *Bontis (2000)* to compute firm level intellectual capital. The framework uses annual financial data to calculate firm specific intellectual capital constituents, and thus aids management in informed decision-making. Studies *(Smriti & Das, 2021, 2018; Xu & Li, 2020; Vidyarthi, 2019; Alipour, 2012)* have demonstrated reliability of VAIC in assessing cross-sectional firm data. Stakeholders can use this to understand a company's intangible assets. The VAIC estimation process involves calculating the firm's Value Added (VA) to gauge the effective utilization of intellectual capital, aiming to maximize limited and intangible resources. VA is calculated as follows:

$$VA = W+D+A+O,$$

where, VA, value added by a company is determined as the summation of; W, compensation to employees; D, depreciation expenses; A, amortization; O, operating profit. Furthermore, intellectual capital efficiency is calculated as:

$$ICE = HCE + SCE + CEE$$

Following *Ramírez et al. (2017),* HCE evaluates the association between VA and HC, representing the VA produced for each monetary unit invested in employees. Total HC encompasses employee wages and salaries. HCE is calculated as:

$$VA/HC = HCE$$

HC is subtracted from VA to obtain the total SC of the firm. SCE measures the SC's VA efficiency, as follows:

$$SC/VA = SCE$$

The third component of the framework is the calculation of CEE, which examines the linkage between VA and CE. Following *Pulic (1998, 2004),* CEE is evaluated as follows:

$$VA/CE = CEE$$

The distinction between total assets and intangible assets is termed total CE, signifying the total capital employed. The VAIC method assesses the relative contributions of intellectual, physical, and financial capital to value creation.

$$VAIC = SCE + HCE + CEE.$$

Although advantageous, VAIC has been criticized in previous literatures *(Ge & Xu, 2020; Xu & Li, 2020; Vidyarthi, 2019)* for overlooking a firm's relational assets. To address these concerns, the current study, aligned with other researchers *(Tiwari et al., 2023; Xu & Li, 2020; Ge & Xu, 2020),* integrates RCE with VAIC to comprehensively assess intellectual capital. This addition is crucial for sustaining favourable relationships with clients and acquiring new customers significantly affects firm performance. RCE is calculated as:

$$RCE = RC / VA,$$

where, RC = Marketing, Selling or Advertising expenses. Thus, the final intellectual capital using the MVAIC model is calculated as:

$$MVAIC = HCE + SCE + CEE + RCE = VAIC + RCE$$

Despite its limitations, the VAIC framework remains popular among practitioners and researchers for the assessment of intellectual capital. It enables the calculation of intellectual capital efficiency and facilitates a comparative analysis across sectors and countries. To improve accuracy and reliability, the researchers chose to supplement the VAIC framework with the MVAIC model.

3.3: Sample and data collection:

This study uses secondary data, extracted from the CMIE – ProwessIQ database, covering 70 BSE listed construction (25), energy (25) and information technology (20) firms from 2014 to 2021. The sample is unbalanced in nature with 546 firm year observations.

Table 2: Variables used and their measures:

Panel A: This provides definition of all variables used in the study

Variables	Definition
Net Income (PAT net of P&E) / Total Assets *(Smriti & Das, 2018, 2021; Kamath 2019; Xu & Li, 2020)*	
Net Income (PAT net of P&E) / Shareholders Funds *(Appuhami & Bhuyan, 2015; Tiwari & Arora, 2024)*	
Total Income / Total Asset *(Narwal & Yadav 2017; Smriti & Das, 2018; Kamath 2019; Xu & Li, 2020)*	
VAIC=HCE + SCE + CEE *(Smriti & Das, 2018, 2021; Vidyarthi, 2019; Alipour, 2012; Xu & Li, 2020.)*	
M-VAIC=HCE + SCE + CEE + RCE *(Smriti & Das, 2018, 2021; Vidyarthi, 2019; Alipour, 2012; Xu & Li, 2020)*	
HCE = VA/HC. Human capital efficiency (HCE); VA, value added; HC, total salary and wage costs *(Smriti & Das, 2018, 2021; Vidyarthi, 2019; Alipour, 2012; Xu & Li, 2020)*	
Capital employed efficiency (CEE) CEE= VA/CE, Capital employed efficiency coefficient (CEE); VA, value added; CE, book value of the net assets *(Smriti & Das, 2018, 2021; Vidyarthi, 2019; Alipour, 2012; Xu & Li, 2020)*	
SCE= (VA−HC) / VA, Structural capital efficiency (SCE); VA, Value added; HC, total salary and wage costs *(Smriti & Das, 2018, 2021; Vidyarthi, 2019; Alipour, 2012; Xu & Li, 2020)*	
RCE=RC / VA, RC = Marketing, Selling or Advertising expenses; VA, Value added *(Smriti & Das, 2018, 2021; Vidyarthi, 2019; Alipour, 2012; Xu & Li, 2020)*	
VA= W + D + A + O, where VA, value added by firm computed as sum of; W, Wages to Employees; D, depreciation expenses; A, Amortization; O, Operating Profit *(Smriti & Das, 2018, 2021; Alipour, 2012; Ramirez et. al. 2020)*	
LEV= Total Liabilities/Total Assets *(Appuhami & Bhuyan, 2015; Shahwan & Fathalla, 2020)*	
Log (Total Assets) *(Alipour, 2012; Xu & Li, 2020; Aslam, 2020; Shahwan & Fathalla, 2020)*	
Natural logarithm of the number of years since the firm's inception *(Mohapatra et. al., 2019; Dalwai & Mohammadi, 2020; Zaid et. al., 2020)*	

Empirical Results:

4.1: Composition of Intellectual Capital of construction, energy and information technology firms

Table 3 indicates that the means of VAIC and MVAIC are 6.021 and 6.076 respectively, which suggests that the selected construction sector companies were able to generate ₹ 6.021 and ₹ 6.076 respectively for every ₹1 invested. HCE has the highest contribution to IC (VAIC and MVAIC), with RCE making the least contribution. Similarly, energy sector companies generate around ₹9.961 to ₹10.007 for every rupee spent by them through superior value creation with respect to construction companies. Further, HCE is the highest contributor to IC (VAIC and MVAIC), with RCE being the least contributor as seen in construction firms. However, in case of information technology firms, estimates indicate that for every rupee invested by these companies, they generate a return of only ₹4.698 to ₹4.785. Furthermore, HCE was identified as the primary contributor to intellectual capital (as measured by VAIC and MVAIC), followed by CEE, which was the second highest contributor. Finally, overall sample consisting of all 70 firms from the construction, energy and information technology, the mean of VAIC and MVAIC are 6.9268 and 6.9902, respectively, which implies that on an average, these firms created value of ₹ 6.9268 and ₹ 6.9902 for every ₹ 1.00 invested. Also, it is found that HCE is the highest contributor to intellectual capital, followed by CEE, SCE and RCE respectively.

Fig. 1-4 : VAIC / MVAIC Constituents of for the construction, energy and information technology firms during 2014-2021

Figure 1 (A): VAIC Constituents for construction firms

Figure 1(B): MVAIC Constituents for construction firms

Figure 2 (A): VAIC constituents for energy firms

Figure 2 (B): MVAIC constituents for energy firms

Figure 3 (A): VAIC constituents for Information technology firms

Figure 3 (B): MVAIC constituents for Information technology firms

Figure 4(A): VAIC constituents for overall sample
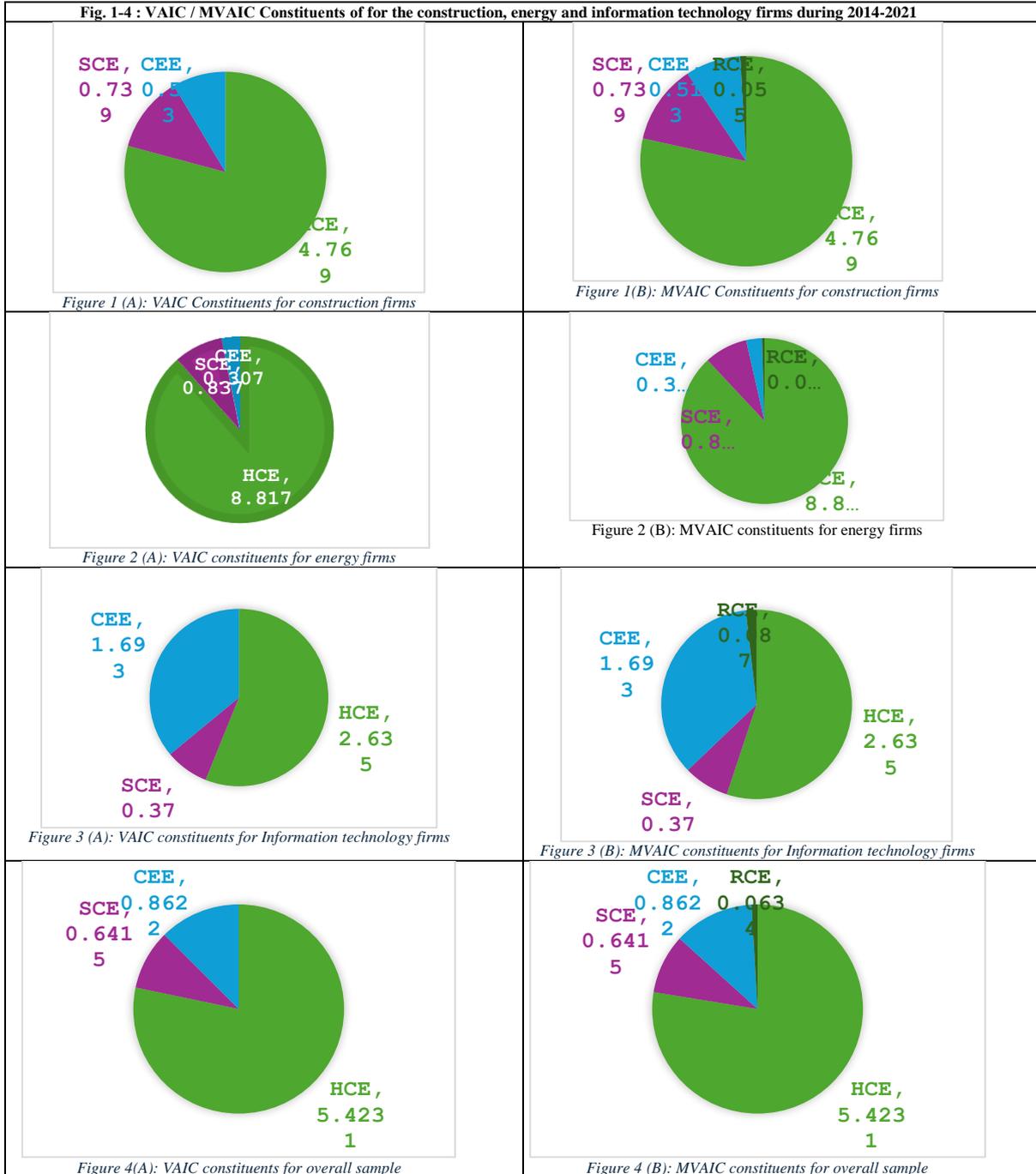

Figure 4 (B): MVAIC constituents for overall sample

Table 3 : Summary Statistics of the variables under consideration for the construction, energy and information technology firms during 2014-2021																				
	Construction Sector					Energy sector					Information technology Sector					Overall Sample				
Variable	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max
ROA	160	0.044	0.039	-0.026	0.217	191	0.048	0.078	-0.472	0.266	195	0.129	0.1	-0.463	0.35	546	0.076	0.088	-0.472	0.350
ROE	160	0.1	0.07	-0.063	0.406	191	-0.235	4.739	-65.315	0.902	195	0.189	0.155	-0.678	1.007	546	0.015	2.806	-65.315	1.007
ATO	160	0.407	0.291	0.007	1.244	191	0.595	0.556	0	3.178	195	0.955	0.42	0	2.79	546	0.669	0.497	0.000	3.178
VAIC	160	6.021	4.771	-4.914	29.3	191	9.961	7.575	-5.459	40.467	195	4.698	10.004	0	123.451	546	6.927	8.216	-5.459	123.451
MVAIC	160	6.076	4.785	-4.931	29.322	191	10.007	7.556	-5.002	40.47	195	4.785	9.992	0	123.499	546	6.990	8.204	-5.002	123.499
HCE	160	4.769	4.33	-6.073	28.316	191	8.817	7.378	-2.951	39.163	195	2.635	5.14	0	44.279	546	5.423	6.387	-6.074	44.279
SCE	160	0.739	0.518	-1.24	5.673	191	0.837	0.692	-5.609	6.016	195	0.37	0.22	-0.601	0.977	546	0.642	0.552	-5.609	6.016
CEE	160	0.513	1.227	-5.393	12.011	191	0.307	0.716	-8.478	2.871	195	1.693	8.311	0	116.923	546	0.862	5.059	-8.478	116.923
RCE	160	0.055	0.305	-3.055	0.86	191	0.047	0.244	-2.637	1.119	195	0.087	0.128	0	1.285	546	0.063	0.232	-3.055	1.285
LEV	160	0.087	0.102	0	0.39	191	0.191	0.154	0	0.654	195	0.031	0.071	0	0.794	546	0.103	0.134	0.000	0.794
SIZE	160	8.909	1.083	6.329	11.939	191	9.489	1.588	5.62	13.787	195	7.802	2.044	-2.813	11.607	546	8.716	1.796	-2.813	13.787
AGE	160	3.353	0.577	2.079	4.317	191	3.073	0.885	0	4.718	195	3.132	0.634	0	4.331	546	3.176	0.726	0.000	4.719

Source: Author's computation

Note: ROA – Return On Assets, ROE – Return on Equity, ATO - Asset Turn Over Ratio, VAIC – Value Added Intellectual Coefficient, MVAIC – Modified Value-Added Intellectual Capital, HCE – Human Capital Efficiency, SCE – Structural Capital Efficiency, CEE – capital Employed Efficiency, RCE – Relational Capital Efficiency, LEV - Leverage, SIZE -firm size and AGE - firm age of existance.

4.2. *Intellectual Capital – Firm Performance Dynamics*

We initiate our regression analysis with construction, energy, information technology and over all panels. The Panel Corrected Standard Error (PCSE) regression results in Table 3 (A) show that VAIC and MVAIC have a significant and positive impact on ROA and ROE, whereas they have an insignificant impact over ATO. In addition, HCE and CEE have a positive and significant impact on ROA and ROE at 5% confidence level, whereas SCE and RCE have insignificant impacts on firm performance measures.

Among control variables, leverage and firm size are found to have negative impact on ROA and ROE, but statistically significant in case of ROA only. Further, firm age has positive and significant impact only on ROA but not in case ROE.

Table 4 (A): Panel Corrected Standard Error regression results for construction sector

	ROA	ROA	ROA	ROA	ROE	ROE	ROE	ROE	ATO	ATO	ATO	ATO
VAIC	.0011***				.0026***				-0.0003			
MVAIC		.001**				.0025***				-0.0002		
HCE			.0012**	.0013**			.0022**	.0022**			0.0009	0.0013
SCE			-0.002	-0.0057			-0.0002	-0.0067			-.0215*	-.0314**
CEE			.001**	.001**			.0094**	.0096**			0.0004	0
RCE				-0.01				-0.0166				-0.028
LEV	-.0585**	-.0582**	-.0605**	-.0641**	-.0925*	-.092*	-.1078**	-.1077**	0.1332	0.1323	0.1109	0.0957
SIZE	-.0228***	-.0228***	-.0232***	-.0232***	-0.0101	-0.0101	-0.0112	-0.011	-0.0042	-0.0029	-0.0203	-0.0138
AGE	.0209***	.0208***	.0191**	.0181**	0.0244	0.0246	0.025	0.0211	0.0479	0.046	.0787**	0.06
Constant	.1703***	.1707***	.1812***	.1879***	0.0942	0.0935	0.1028	.1199*	0.2155	0.2096	0.2626	0.2754
Observations	160	160	160	160	160	160	160	160	160	160	160	160
R-squared	0.5148	0.5147	0.5255	0.5341	0.2813	0.2798	0.2963	0.3064	0.2192	0.2209	0.1902	0.1907

Source: Author's compilation

*Note: *** p<.01, ** p<.05, * p<.1*

Table 4 A

Table 4 (B): Panel Corrected Standard Error regression results for Energy sector

	ROA	ROA	ROA	ROA	ROE	ROE	ROE	ROE	ATO	ATO	ATO	ATO
VAIC	.003***				.174***				.0228***			
LEV	-.176***	-.177***	-.191***	-.164***	-13.962***	-13.952***	-14.121***	-10.909***	-.633***	-.634***	-.635***	-.645***
SIZE	0	0	0.001	0	.559***	.546***	.579***	.656**	-0.007	-0.007	-0.007	-0.007
AGE	-0.003	-0.003	-0.005	-0.002	-0.382	-0.354	-0.596	-1.020**	-.081***	-.081***	-.080***	-.081***
MVAIC		.003***				.156***				.023***		
HCE			.004***	.003***			.163***	.122***			.024***	.023***
SCE			0.004	-0.012			.431*	-2.300**			0.007	.053***
CEE			0.003	0.001			0.003	-0.371			0.015	.015*
RCE				-.061*				-11.247***				.182***
_cons	0.044	0.044	0.035	0.059	-4.688***	-4.475***	-4.294***	-0.41	.753***	.750***	.758***	.714***
Observations	191	191	191	191	191	191	191	191	191	191	191	191
R-squared	0.141	0.136	0.152	0.177	0.106	0.101	0.107	0.242	0.383	0.388	0.386	0.394

Source: Author's compilation

*Note: *** p<.01, ** p<.05, * p<.1*

Table 4 B

Now, coming to energy firms, PCSE regression results presented in Table 3 (B) indicate that VAIC and MVAIC positively and significantly impact all the firm performance indicators – ROA, ROE and ATO. Among the components of intellectual capital, only HCE is found to have a significant and positive impact over all the firm performance indicators – ROA, ROE and ATO, whereas RCE is found to have a significant but negative impact over both ROA and ROE, but positive and significant impact on ATO. The control variable, leverage has a significant but negative impact on all three firm performance indicators, ROA, ROE and ATO. Firm size is found to have significant and negative impact on ROE. Firm age is having significant but negative impact on ATO only.

Table 4 (C): Panel Corrected Standard Error regression results for Information Technology firms

	ROA	ROA	ROA	ROA	ROE	ROE	ROE	ROE	ATO	ATO	ATO	ATO
VAIC	.001**				.0044***				.0083***			
MVAIC		.001**				.0043***				.0082***		
HCE			-.0078***	-.008***			-.0116***	-.0112***			0.0135	.0147**
SCE			.2818***	.2616***			.4466***	.4298***			.31*	0.1328
CEE			0.0012	0.0012			.006***	.0059***			0.0051	0.0051
RCE				-0.0927				-0.0844				-.4443**
LEV	-0.111	-0.1108	-0.0574	-0.0679	-0.0572	-0.0569	-0.0024	-0.0184	0.2322	0.2321	0.2427	0.3067
SIZE	.009***	.009***	.0096***	.0086***	0.0042	0.0042	0.0014	0.0007	-.0352**	-.035**	-.0329**	-.0326**
AGE	.0457***	.0457***	.0187***	.02***	.0817***	.0817***	.039***	.041***	.0997*	.0996*	0.075	0.089
Constant	-.0932***	-.0936***	-.0988***	-.0808***	-.1129*	-.114*	-.0904***	-.078**	.8571***	.8548***	.7727***	.8454***
Observations	195	195	195	195	195	195	195	195	195	195	195	195
R-squared	0.272	0.2717	0.5772	0.5591	0.3277	0.3265	0.682	0.67	0.4523	0.4504	0.4772	0.4807

Source: Author's compilation

*Note: *** p<.01, ** p<.05, * p<.1*

Table 4 C

The regression results show that VAIC and MVAIC have a positive and significant impact on all the firm performance indicators – ROA, ROE and ATO in case of Information Technology firms. Among the IC components, structural capital has a positive and significant impact

on ROA, ROE and partially ATO. Further, capital employed efficiency (CEE) has a significant and positive impact on ROE at the 1% significance level. Surprisingly, human capital is having negative and significant impact on both ROA and ROE. RCE is having significant but negative impact on ATO. Among the control variables, firm size has positive impact on ROA, but negative impact on ATO at 1% significance level. Firm age is found to have a significant and positive impact on all the firm performance indicators – ROA, ROE and ATO.

Overall, intellectual capital has a significant and positive impact on firm performance measures. Among the intellectual capital sub-components, only HCE was found to have a significant contribution, for others, while SCE was the second highest contributor for both the construction and energy sectors, CEE emerged as the second highest contributor for the Information Technology sector. RCE was found to have the least contribution among all intellectual capital sub-components in all three sectors. The average annual intellectual capital measures show that intellectual capital is driven mainly by HCE, followed by CEE, SCE, and RCE. The average annual intellectual capital and the four constituents of the sample shows an irregular pattern in value creation mainly because of their substantial reliance on imported raw materials, currency volatility, economic stability, and other macroeconomic factors.

4.3: Robustness Check

To check the robustness of the study, we conducted a comprehensive study combining the data points of all three sectors and then analysed the cumulative impact of intellectual capital on form performance.

Table 4 D

Table 4 (D): Panel Corrected Standard Error regression results for overall panel												
	ROA	ROA	ROA	ROA	ROE	ROE	ROE	ROE	ATO	ATO	ATO	ATO
VAIC	.0013***				.0314***				.0073***			
MVAIC		.0013***				.029***				.0074***		
HCE			.0012**	.0013***			.0641***	.0751***			.0139***	.0132***
SCE			0.0049	-0.006			.2046*	-.6786***			-0.0095	-0.0167
CEE			.0023***	.0022***			.0052**	0.0031			.0064***	.0064***
RCE				-.0358**				-3.262***				-0.0398
LEV	-.1985***	-.1985***	-.1996***	-.1877***	-8.0979***	-8.0928***	-8.4912***	-7.6674***	-.3876**	-.3863**	-.49***	-.4617***
SIZE	-0.0028	-0.0028	-.004*	-0.0039	0.0218	0.0164	-0.0212	-0.0166	-.0468***	-.047***	-.0608***	-.0588***
AGE	.0119*	.0119*	.0118**	.0115*	-0.044	-0.041	-0.0787	-.2701**	0.0082	0.0085	0.0094	0.0114
Cotantns	.0659***	.0657***	.0734***	.0833***	0.1201	0.1658	0.4356	1.6792***	1.0382***	1.0382***	1.1371***	1.1337***
Observations	546	546	546	546	546	546	546	546	546	546	546	546
R-squared	0.2272	0.2249	0.2717	0.2859	0.0584	0.0578	0.0626	0.0984	0.3862	0.3862	0.4175	0.4343
Source: Author's Estimation												
*Note: *** p<.01, ** p<.05, * p<.1*												

Regression results presented in Table 3(D) indicates that IC measured either through VAIC or MVAIC has positive impact on the firm performance measures: ROA, ROE, and ATO at 1% significance level. This result is consistent with previous findings *(Singla, 2020; Hamdan et al., 2017; Clarke et al., 2011).* Among IC sub-components namely human capital and capital employed have positive and significant impacts on firm performance measures namely ROA, ROE, and ATO at 5% significance level. Further, structural capital has positive impact on ROE at 10% significance level. Additionally, RCE is negatively associated only with ROA and ROE 5% significance level. Furthermore, leverage is negatively associated with firm performance at the 1% significance level. This indicates that these firms, being capital intensive in nature, need to optimise their borrowings, as these borrowings brings the obligation of timely repayment of the debt components. Thus, these firms face diminishing return because of their debt obligations. However, we find a statistically significant association between firm size and firm performance when measured through ATO, but not in the case of ROA or ROE. These firms not able to maintain the same asset turnover ratios as they become larger in size over time. Further, firm age is having positive impact on their return on asset as the firms become more mature in their business.

4.4: Theoretical Implications:

Intellectual capital, as examined through the VAIC and MVAIC frameworks, is a key resource for enhancing firm performance, as postulated under the RBV. These insights underscore the importance of investing in intellectual capital resources such as employee skills, knowledge, and experience, which aligns with the RBV's emphasis on leveraging unique, valuable, and inimitable resources to gain a competitive edge. Among the intellectual capital sub-components, human capital is the main driving factor for superior intellectual capital. The remaining components such as structural capital, relational capital or capital employed remain much below in these firms. Therefore, their direct effect on firm performance is not as visible. Therefore, these firms should look for possible ways to gradually enhance these components in future course to improve their performance. The significant and positive impact of relational capital on the asset turnover ratio found in this study aligns with this theory and highlights the importance of maintaining strong relationships with external stakeholders.

4.5: Managerial Implications

The findings highlight that, to enhance performance, top-level management in constructor, energy and information technology firms should prioritize continuous employee development, optimize organizational processes and technology infrastructure, and foster strong stakeholder relationships. Firms should cultivate a culture of innovation, regularly assess and benchmark their intellectual capital, and align it with their company's strategic goals. Proactively addressing economic and market fluctuations, promoting knowledge sharing, and ensuring that intellectual capital initiatives support long-term objectives are essential strategies for achieving sustainable competitive advantage and long-term success among energy sector companies.

5. Conclusion:

We examined the effect of intellectual capital on firm performance of BSE -500 listed construction, energy, and Information Technology sector from 2014 to 2021. We observe that intellectual capital is mainly driven by human capital, capital employed, structural capital, and relational capital as computed using VAIC and MVAIC methodologies. Furthermore, the average values of VAIC and MVAIC were 6.9268 and 6.9902, respectively. Our regression results confirm the positive and significant impact of intellectual capital, measured through VAIC and MVAIC, on firm performance. Thus, it reaffirms the resource-based theory proposition regarding the critical role of intellectual capital in a firm's competitive advantage. Among the intellectual capital sub-components, human capital and capital employed positively impacts all performance measures, harnessing human capital through proper training and development and retaining the best talents will help firms in long-run to gain competitive advantage over others. However, this study has two limitations. First, our sample covers only India's listed top firms in construction, energy, and information technology sector during 2014-21 but not unlisted firms due to data availability limitations. Many firms in the sample are subject to international shocks as they are heavily dependent on the import of their raw materials, currency fluctuations, economic stability and other macro-economic factors. Second, our results provide insights specifically relevant to firms from 3 sectors only, the results are not applicable across all industries and sectors due to their focus on listed Indian construction, energy and information technology sector firms. Future research can benefit from incorporating data from diverse industries and nations.

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