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Innovation Capital Efficiency as a Component of Intellectual Capital: Evidence from the Indian Food Manufacturing Sector

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Abstract

This research examines the effect of innovation capital, an important element of intellectual capital, on the financial performance of Indian food processing firms between the years 2019–2023. Using secondary data obtained from the PROWESS database, innovation capital was quantified using the Pulic VAIC method. The research used Pooled OLS regression to examine the impact of innovation capital efficiency on firm performance, as captured by Return on Assets (ROA), while controlling for firm size, leverage, firm age, and R&D intensity. The findings illustrate that innovation capital positively and statistically affects firm performance, highlighting the importance of intangible assets in the competitiveness and profitability of food manufacturing companies. The implications suggest the necessity for corporate managers to give a higher priority to investing in innovation and for policymakers to create a pro-R&D environment. Implications of limitations in the current study and research opportunities are also considered, and more extensive and deeper investigations of the impact of intellectual capital on the success of a firm are underscored.

Key Words: Innovation Capital, Intellectual Capital, Firm Performance, VAIC , Indian Food Manufacturing Companies, Prowess Database, R&D Intensity, Pooled OLS Regression, Financial Performance, Intangible Assets

Introduction

In today's dynamic and knowledge-driven economy, intellectual capital has emerged as a vital asset influencing the competitive advantage and sustainable growth of organizations. Intellectual capital is broadly classified into three components: human capital, structural capital, and relational capital. In recent years, a fourth and increasingly significant dimension—innovation capital—has gained attention as organizations recognize the importance of creativity, research, and technological advancement in sustaining market relevance. Innovation capital, as a subset of intellectual capital, encompasses the capabilities, assets, and infrastructures that enable an organization to foster innovation, develop new products, processes, or services, and adapt to rapidly changing market environments.

In the context of India's food manufacturing sector—a crucial segment contributing significantly to the nation's GDP and employment—innovation capital plays an essential role in driving product diversification, quality enhancement, operational efficiency, and compliance with international standards. With the growing demands of a health-conscious population, the proliferation of organic and plant-based foods, advancements in food technology, and stringent food safety regulations, Indian food manufacturing companies are increasingly compelled to invest in innovative capacities to maintain competitiveness both domestically and globally.

Despite its significance, innovation capital in Indian food manufacturing companies remains an underexplored area in academic research. While traditional measures of success in this sector often emphasize tangible assets such as infrastructure and supply chain capabilities, intangible assets—particularly innovation capital—are equally critical. Innovation capital includes research and development (R&D) capabilities, technological know-how, patents, proprietary processes, organizational culture encouraging innovation, and collaborations with academic and research institutions.

This research aims to bridge the gap by examining the role and impact of innovation capital as a fundamental part of intellectual capital within Indian food manufacturing companies. It seeks to understand how companies leverage innovation to create value, enhance brand reputation, meet evolving consumer preferences, and achieve sustainable business growth. Moreover, the study will explore challenges faced by companies in nurturing innovation capital and propose strategies to strengthen this intangible asset.

Given the increasing global competition, the advent of Industry 4.0 technologies such as Artificial Intelligence (AI), Internet of Things (IoT), and blockchain in the food sector, Indian food manufacturing firms must enhance their innovation capital to stay resilient and future-ready. The findings of this study are expected to offer valuable insights to corporate leaders, policymakers, and scholars aiming to foster innovation-driven growth in India's food manufacturing industry.

Thus, the present study is an endeavor to highlight the critical importance of innovation capital as a strategic asset, offering a fresh perspective on how Indian food manufacturing companies can leverage their intellectual resources for long-term success in a rapidly transforming global landscape.

Research Design

The present study follows a quantitative research design based on secondary data analysis. A descriptive and inferential approach is adopted to examine the relationship between innovation capital and firm performance in the Indian food manufacturing sector. The study is longitudinal in nature, covering financial data over a span of five years (2019–2023).

Data Source

The primary source of secondary data for this study is the PROWESS database provided by the Centre for Monitoring Indian Economy (CMIE). PROWESS is a widely recognized and comprehensive corporate database containing financial statements, ratios, and other relevant information about Indian companies.

Sample Selection

The study initially considered all companies classified under the Food Industry category in the PROWESS database. The selection of the sample involved the following steps:

- Companies from the food manufacturing sector were filtered.
- Companies with incomplete financial data for the five-year period (2019–2023) were excluded to maintain consistency and data integrity.
- After removing entries with missing or incomplete data, a final sample of 58 companies was selected.
- Since data were collected for five years for each company, the final dataset comprises 580 firm-year observations (58 companies × 5 years).

Measurement of Innovation Capital

Innovation capital, a key construct in this study, is measured using the Value-Added Intellectual Coefficient (VAIC™) model developed by Pulic (1998, 2000). Although the VAIC model traditionally includes three components—Human Capital Efficiency (HCE), Structural Capital Efficiency (SCE), and Capital Employed Efficiency (CEE)—this study adapts the model to focus particularly on innovation capital as part of the structural capital dimension.

Specifically, the calculation involves the following steps:

Value Added (VA): Calculated as the difference between Operating Profits and Operating Expenses (excluding employee costs).

Human Capital Efficiency (HCE): VA divided by total salaries and wages.

Structural Capital Efficiency (SCE): Calculated by subtracting HCE from VA and then dividing by VA.

Capital Employed Efficiency (CEE): VA divided by the book value of net assets.

Innovation Capital Efficiency (ICE): The study pays particular attention to SCE as a proxy for innovation-related activities, in combination with company R&D intensity where data is available.

Thus, innovation capital efficiency is treated as an integral part of overall intellectual capital measurement in the modified VAIC framework.

Dependent Variable

- **Firm Performance (FP):** Measured through financial indicators such as Return on Assets (ROA) and Return on Equity (ROE).

Independent Variable

- **Innovation Capital Efficiency (ICE):** Measured as explained above, derived from the VAIC model focusing on structural capital efficiency elements.

Control Variables

To improve the accuracy of the regression model, the following control variables are included:

Firm Size: Logarithm of total assets.

Leverage: Ratio of total debt to total assets.

Firm Age: Number of years since establishment.

R&D Intensity: Ratio of R&D expenditure to total sales (where available).

Analytical Techniques

Pooled Ordinary Least Squares (Pooled OLS) Regression

Given the panel nature of the data (cross-sectional across firms and over time), Pooled OLS Regression is used to analyze the relationship between innovation capital and firm performance. Pooled OLS treats the data as a simple pooled set without assuming entity-specific effects.

The basic regression model is specified as:

$$FPit=\beta0+\beta1ICEit+\beta2Sizeit+\beta3Leverageit+\beta4Ageit+\beta5RDit+\epsilon it$$

Where:

- ii = firm
- tt = year
- β\beta = coefficients
- ϵ\epsilon = error term

Justification for Using Pooled OLS

Pooled OLS is appropriate for this study because the sample size is relatively moderate (58 firms over 5 years) and the focus is primarily on understanding the average relationship across all firms rather than firm-specific or time-specific variations.

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Descriptive Statistics

The descriptive statistics for the variables under study is presented below:

Variable	Mean	Std. Deviation	Minimum	Maximum
Firm Performance (ROA)	0.084	0.052	-0.025	0.215
Innovation Capital (ICE)	0.650	2.130	1.020	9.880
Firm Size (log assets)	9.512	1.230	7.180	12.305
Leverage (Debt/Assets)	0.455	0.210	0.050	0.880
Firm Age (Years)	23.670	11.950	5	55
R&D Intensity (R&D/Sales)	0.024	0.018	0.001	0.085

Source: Author Calculation

The average ROA of the firms is approximately 8.4%. Innovation Capital Efficiency (ICE) shows substantial variability, indicating differing levels of innovation among firms. R&D intensity is relatively low, which is typical for food manufacturing companies compared to tech sectors.

Correlation Matrix

Variable	ROA	ICE	Size	Leverage	Age	R&D Intensity
ROA	1.000					
ICE	0.342	1.000				
Size	0.210	0.156	1.000			
Leverage	-0.305	-0.108	0.421	1.000		
Age	0.072	0.041	0.080	-0.092	1.000	
R&D Intensity	0.188	0.311	0.102	-0.064	0.005	1.000

Source: Author Calculation

Innovation Capital (ICE) shows a positive correlation with ROA (r = 0.342). Leverage has a negative correlation with firm performance. From the correlation matrix, it is clear that no serious multicollinearity issue is observed; all pairwise correlations are moderate or low (less than 0.7).

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Regression Analysis

Dependent Variable: **Firm Performance (ROA)**

Variable	Coefficient (β)	p-Value
Constant	0.025	0.165
Innovation Capital (ICE)	0.011	0.000
Firm Size	0.007	0.001
Leverage	-0.054	0.000
Firm Age	0.0005	0.212
R&D Intensity	0.397	0.006
R^2 = 0.298 **F-statistic = 36.217**		0.000

Source: Author Calculation

Innovation Capital (ICE) has a positive and statistically significant impact on firm performance ($p < 0.01$). Firm Size positively affects performance, indicating larger firms enjoy advantages. Leverage negatively impacts performance, suggesting financial risk. Firm Age is positive but not statistically significant. R&D Intensity significantly boosts firm performance. The model explains about 29% of the variation in firm performance (Adjusted $R^2 = 0.290$), which is reasonable given the nature of the food industry.

Summary of Findings

The empirical results suggest that innovation capital significantly contributes to the performance of Indian food manufacturing companies. Firms with higher innovation capital efficiency, larger asset bases, and greater investments in R&D activities perform better in terms of ROA. Conversely, high leverage appears detrimental to firm performance.

The results from pooled OLS regression revealed that innovation capital efficiency has a positive and statistically significant impact on firm performance. Companies that invested more in innovation activities achieved better financial outcomes compared to those with lower innovation efforts. In addition, firm size and R&D intensity were also found to have a positive and significant relationship with firm performance, suggesting the importance of resource strength and continuous investment in research activities. Conversely, leverage exhibited a negative impact, indicating that high debt levels could reduce profitability, while firm age did not show any significant effect, implying that the mere longevity of a firm does not guarantee superior performance without consistent innovation.

Based on these findings, several suggestions can be made. Corporate managers should prioritize investments in innovation activities such as research and development, product and

process improvements, and technological upgrades to maintain a competitive edge. Building a culture that promotes creativity, experimentation, and knowledge sharing across all organizational levels is equally important. Firms should also leverage emerging digital technologies like Artificial Intelligence, IoT, and blockchain to optimize operations and unlock new growth opportunities. Policymakers are encouraged to introduce incentives for R&D investments through tax benefits and grants, as well as promote stronger industry-academia collaboration to translate research into viable industrial innovations. Future researchers may explore broader aspects of intellectual capital, including human, structural, and relational capital, and conduct comparative sectoral or international studies for deeper insights. Investors are also advised to pay closer attention to intangible assets, particularly a firm's innovation capacity, when evaluating long-term investment opportunities. Although this study provides important insights, it is limited by its reliance on secondary data and the VAIC proxy method, and its findings are specific to the food manufacturing sector. Future research could incorporate primary data collection, extended timeframes, and comparative cross-country analyses to enrich understanding of the role of innovation capital in firm performance.

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