The Effect of Intellectual Capital on Firm Profitability and Efficiency: Evidence from Thai Listed Companies in the Agriculture and Food Industry

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Abstract

This article examines the effect of Intellectual Capital (IC) on the performances of selected Thai listed companies in the Agro and Food industry from 2017 to 2019. The sample consisted of 45 companies with 135 observations spanning three years. The Modified Value-Added Intellectual Coefficient (MVAIC) model was used to measuring IC, including capital employed, human capital, structural capital, and relational capital. Performance was measured using two distinct parameters: profitability and efficiency. The regression results revealed that MVAIC and its components (excluding relational capital) had a significantly positive impact on firm profitability. However, only capital employed affected firm efficiency. This study confirms that IC efficiency significantly enhances profitability. Therefore, firm managers or policymakers can use the MVAIC model to monitor and assess their assets and create business strategies to achieve a competitive advantage. Furthermore, this model might be used by investors and shareholders to make better investment decisions and evaluate a firm's market wealth.

Keywords: Intellectual capital, Profitability, Efficiency, Thai listed companies, Agro and food industry

Introduction

The traditional economic paradigm emphasizes physical and financial capital (Alipour, 2012). In this era, the determinant of productivity and value creation has moved from tangible inputs, such as capital, plants, machinery, and equipment (Carson et al., 2004), to qualified professionals and technically skilled knowledge workers (Vishnu & Gupta, 2014). Consequently, it has become increasingly critical in this period to develop new approaches for understanding and measuring organizational performance from the aspect of creating value using the business' knowledge-based resources. When knowledge is quantified and

communicated in value generation, it is commonly referred to as intellectual capital (Weqar et al., 2021).

Intellectual Capital (IC) encompasses all procedures and assets that are not generally recorded in the balance sheet. The International Accounting Standard (IAS 38: Intangible Assets) has made identifying and measuring IC items challenging for businesses. For this reason, IC is also known as the firm's hidden value (Shahzad et al., 2020). IC is a set of intangible assets that contribute to the firm's value (Jardon & Martinez-Cobas, 2021), including valuable knowledge-based resources and managerial tasks. These resources are primarily intangible and include human, structural, and organizational-stakeholder networks, and management activities such as strategy development, policy formulation, and implementation planning (Edvinsson & Malone, 1997; Weqar et al., 2021). The emergence of a new economy focused on information and knowledge has expanded IC's prominence. IC was developed into a critical concept describing the discrepancy between market capitalization and book value. As a result, IC has increasingly gained attention as a source of business value and a means of generating a competitive advantage (Nimtrakoon, 2015; Nadeem et al., 2019).

According to Carson et al. (2004), IC literature has been dominated by the fields of accounting and management. Most previous IC literature had concentrated on researching listed businesses in developed economies, such as the United States, the United Kingdom, Canada, and Australia (Xu & Li, 2019). Human Capital (HC), Structural Capital (SC), and Relational Capital (RC) are three broad categories of IC (Bontis, 1998). Various studies, including Phusavat et al. (2011); Nimtrakoon (2015); Amin et al. (2018); Weqar et al. (2020); have demonstrated that IC positively impacts a firm's financial performance and market value. IC can further serve as a predictor of future financial performance or financial health. IC information can assist CEOs, managers, shareholders, and investors in analyzing corporate performance and obtaining information from the firm's financial reports (Majumder et al., 2021).

Theorists and practitioners have developed several models for measuring IC and its components (Vishnu & Gupta, 2014). Harrison and Sullivan (2000) classified IC assessments into two broad categories: qualitative and quantitative data. Quantitative data is divided into nonmonetary and monetary categories. Of the models provided in past literature, the VAIC model (Pulic, 2000), as a monetary measure, has been extensively used (Nadeem et al., 2019). Over the years, this model has achieved prominence among researchers and corporations (Dalwai & Salehi, 2021). However, it has been criticized in literature, particularly for its exclusion of the concept of RC (Nadeem et al., 2019). This study, therefore, employs a modified value-added intellectual coefficient (MVAIC) model with the introduction of RC, as suggested by Nazari and Herremans (2007); Vishnu and Gupta (2014); Ulum et al. (2014); Nimtrakoon (2015); Xu and Li (2019). The literature on the effect or relationship between IC and performance using the MVAIC method has fewer articles than the original VAIC model. Moreover, the findings are contradictory. The results of this study aim to fill that void.

In Thailand, a limited number of studies on IC and its effect on organizational performance have been conducted in various preferred industries; namely banking, finance,

and insurance (Appuhami, 2007; Tran & Vo, 2018), manufacturing (Phusavat et al., 2011; Phusavat et al., 2013), technology (Nimtrakoon, 2015), and pharmaceuticals (Kerdpitak & Jermsittiparsert, 2019). However, to my knowledge, no paper has studied the specific case of Thai-listed agricultural and food companies. Thus, this research focuses on the Agro & Food industry, which has a long history in Thailand and employs approximately one-third of the total labor force (Hatane et al., 2021). This industry is essential because of the direct and indirect effects on employment and living costs for Thailand's population. Additionally, compared to other sectors, the values of listed companies in the agriculture and food sectors demonstrated considerable growth (Pongpanich et al., 2017).

To summarize, the research herein aimed to investigate the impact of IC and its components on the profitability and efficiency of Thai listed agricultural and food companies through a modified VAIC (MVAIC) model. Empirical data were drawn from Agro and Food companies listed on the Stock Exchange of Thailand (SET) from 2017 to 2019. Regression analysis was employed to test the proposed research hypotheses. This study contributes to the IC literature in many aspects. For example, this study adds RC to intellectual capital measurement via the MVAIC method, which has received little former attention in the literature. Additionally, limited research has focused on the IC components on two different performance measures: profitability (ROA and ROE) and efficiency (ATO) of the Agro and Food industry in emerging markets. Notably, the study provides insights for managers to monitor and assess their assets and establish business plans to gain a competitive advantage. Moreover, investors and shareholders may utilize the MVAIC model to make better investment decisions and evaluate their firm's performance and wealth.

The remainder of this article is organized as follows: the next section discusses the literature review on IC research, including the definition and classification of IC, IC and performance research, IC research in Thailand, research hypotheses, and conceptual framework. Section 3 explains the research methodology, which includes data collection, variable measurements, and regression models. Following that are the research findings, comprising descriptive statistics, correlation analysis, and regression results. A discussion and conclusion, as well as limitations and recommendations, are discussed in the last section.

Literature review

Definition and classification of IC

Although various researchers have defined intellectual capital, it has no commonly accepted definition and is debated in various disciplines and from numerous perspectives, such as economics, strategy, finance, accounting, human resources, reporting, and disclosure (Tran & Vo, 2018). Brooking (1996) stated that the IC is a collection of intangible assets of markets, intellectual property, employees, and infrastructure that enables businesses to function. IC was defined by Kaplan and Norton (1996), as investments in suppliers, customers, personnel, and technological innovation. According to Stewart (1997); IC is knowledge, information, intellectual property, and experience, as collective brainpower or practical knowledge can be

exploited to generate wealth. Edvinsson and Malone (1997) stated that IC represents the difference between the balance sheet and the investor evaluation.

It may be summarized that IC is a group of knowledge assets that an organization owns and controls and that significantly generates value for the company; comprising the tangible and intangible assets that incorporate knowledge and knowledge assets that form the basis of a firm's competency (Alipour, 2012; Jardon & Martinez-Cobas, 2021). Scholars have classified IC using various components. Traditionally, IC has been divided into three categories: human capital, structural (or organizational) capital, and relational (consumer) capital (Bontis, 1998; Edvinsson & Malone, 1997), on which there is an almost general agreement in literature (Cricelli et al., 2018).

Human capital (HC) is one of the core components of IC (Weqar et al., 2020), representing the collective capabilities of a company's workforce to handle consumer and operational challenges (Phusavat et al., 2011). It refers to employees' beliefs, attitudes, knowledge, experience, skills, creativity, teamwork, loyalty, training, education, problem-solving ability, loyalty, and motivation that can generate value for the firm (Alipour, 2012; Jardon & Martinez-Cobas, 2021).

Structural Capital (SC) refers to all non-human knowledge storehouses in organizations that deal with information systems and organizational structure, subsequently leading to business intellect (Alipour, 2012; Weqar et al., 2021). In addition, SC encompasses intellectual property (patents, licenses, and trademarks), firm technology, the organizational system, and culture (Jardon & Martinez-Cobas, 2021). The final category, relational capital (RC), refers to the value of business relationships with individuals and organizations directly or indirectly related to the business's value creation. This capital consists of connections with external stakeholders, networks of suppliers, distributors, trade organizations, and partners; as well as customer relationship management (image development, loyalty, and partner and investor networks), and brands (attitudes, preferences, reputations, and brand recognition) (Alipour, 2012; Jardon & Martinez-Cobas, 2021).

The three categories of IC may be incorporated in a report that documents some non-financial aspects of a company's responsibility and sustainability (Hatane et al., 2021). From an accounting perspective, IC, like other resources of a business entity, should be disclosed in financial statements (Roslender et al., 2006). However, IC was challenging to conceptualize, define, measure (Ståhle et al., 2011), and report in financial statements (Xu & Li, 2019). The limited provisions of IC accounting standards have motivated professionals to measure IC (Ulum et al., 2014) through different models developed by researchers from various fields (Xu & Wang, 2018); such as the Skandia Navigator, the intangible assets monitor, the balanced scorecard approach, market capitalization methods, and the value-added intellectual coefficient (VAIC). The IC measurement employed in this study is discussed further in the methodology section.

IC and firm profitability and efficiency

The relationship between IC and performance, measured through profitability and efficiency, has become the subject of intensive research for academics and practitioners. Most past research has shown that IC improves organizational performance in the current competitive environment. For example, Appuhami (2007) determined that a firm's IC has a significant positive association with the investors' capital gains on shares. Alipour (2012) indicated a strong correlation between IC and corporate profitability. Human capital efficiency, employed capital efficiency, structural capital efficiency, and profitability have a significant positive relationship with profitability. Weqar et al. (2020) also confirmed that the efficiency of IC significantly enhances profitability and productivity.

Xu and Li (2019) indicated that the most important value drivers for high-tech and non-high-tech SMEs firms are capital employed, human capital, and structural capital efficiency. The findings of Jardon and Martinez-Cobas (2021); also revealed that investments in human capital, structural capital, and relational capital increase a company's IC. Moreover, most important in the generation of IC is the investment in human capital.

Even though such literature suggests that IC should positively affect performance, some studies have produced results that contradict this assumption. For example, Firer and Mitchell Williams (2003); Tran and Vo (2018); Hang Chan (2009); found no relationship between IC and profitability. Recently, Weqar et al. (2021) reported that VAIC significantly impacted a company's profitability and productivity. The authors declared that only CEE had a significant positive effect on profitability. In terms of productivity, all IC components revealed an insignificant impact on financial performance.

Table 1 Summary of research on the effects of IC on performance using the MVAIC method

Authors	Sample	Dependent variables	The effect of IC on performance				
			MVAIC	**CEE**	**HCE**	**SCE**	**RCE**
Nimtrakoon (2015)	Listed firms in the technology sector of the five ASEAN economies	Market value, financial performance (Margin ratio, ROA)	+	+	+	+, *N*	*N*
Xu & Li (2019)	SMEs in China's manufacturing sector	Earnings quality (EBIT), profitability (ROA, NPM), efficiency (ATO)	+, *N*	+	+,-	+, -, *N*	+, *N*
Xu & Liu (2020)	Manufacturing firms listed on the Korea Stock Exchange	ROA, ROE, asset turnover ratio (ATO), market-to-book ratio (MB)	N/A	+, *N*	+, *N*	+, *N*	-, *N*
Weqar et al. (2020)	Finance sector, India	ROA, ATO	+	+, *N*	+	+, *N*	+, *N*
Xu & Zhang (2021)	Chinese agricultural listed companies	ROA, ROE	+	+, *N*	+	*N*	-, *N*

Notes: + indicates a significant positive impact; - signifies a significant negative impact; *N* means an insignificant impact, and N/A means not applicable.

As previously mentioned, the models or methods for measuring IC are diverse; most previous studies employed the original VAIC model, which some scholars have criticized. Therefore, the study employed the MVAIC method herein to determine IC due to the limitations of the original model, which is elaborated on in the methodology section. Table 1 summarizes the research on the impact of IC on performance using the MVAIC method. The results reveal fewer of articles compared to the original VAIC model. Moreover, the findings are contradictory. Xu and Li (2019) for instance, discovered that MVAIC has both a favorable yet insignificant impact on various performance aspects. On the other hand, Nimtrakoon (2015); Weqar et al. (2020); Xu and Zhang (2021); found a positive effect of IC (measured by MVAIC) on performance. Furthermore, the studies above yielded negative, positive, and insignificant impacts of MVAIC components on performance indicators, as shown in Table 1.

IC and research in Thailand

A limited number of studies on IC and its effect on organizational performance have been conducted in Thailand. In 2007, Appuhami (2007); examined the influence of IC on investor capital gains in the Thai banking, finance, and insurance sectors using data from listed companies within the Thai stock market. The empirical research discovered a significant positive association between a firm's IC and its investors' capital gains on shares. Phusavat et al. (2011) empirically examined the influence of IC and its components on manufacturing firms listed on the Thailand 100 stock exchange. The results showed that IC has a positive and significant impact on the performance of a manufacturing organization. Additionally, it influenced all four performance measures: ROE, ROA, revenue growth (GR), and employee productivity (EP).

Phusavat et al. (2013) extended the investigation of IC by examining its role in improving productivity measurement. This analysis was based on financial reports and a survey of 270 executives and managers. The findings verified their hypothesis that IC significantly affects value-added productivity and can be used as a proxy for measuring productivity. Nimtrakoon (2015) examined and compared IC and its four components of listed firms operating in the technology sector of five stock exchanges in the five largest ASEAN economies and tested the relationship between IC, market value, and financial performance. The author found that the MVAIC values were similar in all five ASEAN countries. However, corporations in different countries preferred to emphasize different MVAIC components to create corporate value. The results confirmed that organizations with higher IC tend to have higher market values. The association between IC and financial performance (measured by margin ratio and ROA) was also verified.

Tran and Vo (2018) investigated the causal effect of IC on financial performance. Their findings revealed that VAIC is unrelated to the banks' financial performances in the banking sector. CEE contributes the most to bank profitability of any VAIC component. On the other hand, HCE had a slightly negative effect on bank performance in the current period but positively affected future profitability. As a result, CEE could be considered the key driver of commercial banks in Thailand. Recently, Kerdpitak and Jermsittiparsert (2019) employed

survey questionnaires to explore the relationship between IC and firm performance in pharmaceutical firms, where empirical research revealed a significant association between IC and performance. HC, SC, and RC significantly enhanced Thai pharmaceutical companies' performances.

According to our Thai literature review, the preferred industries of study are banking, finance, insurance (Appuhami, 2007; Tran & Vo, 2018), manufacturing (Phusavat et al., 2011; Phusavat et al., 2013), technology (Nimtrakoon, 2015), and pharmaceuticals (Kerdpitak & Jermsittiparsert, 2019). However, there are no studies evidenced by Thai listed agricultural or food companies.

Research hypotheses and conceptual framework

The study predicts a significant effect of IC and its components on corporate performance indicators (ROA, ROE, ATO) for a sample of agricultural and food industry firms. The hypotheses (H) are based on the studied literature as previously discussed. Four significant hypotheses (H1-H4), detailed below, were developed. The first (H1) and the third hypotheses (H3) were further subdivided into two sub-hypotheses. Figure 1 illustrates the conceptual framework for this study.

H1: Intellectual capital has a positive effect on firm profitability.
H1a: MVAIC positively affects the return on assets (ROA).
H1b: MVAIC positively affects the return on equity (ROE).

H2: Intellectual capital has a positive effect on firm efficiency.
H2: MVAIC positively affects the asset turnover ratio (ATO).

H3: The components of intellectual capital positively affect firm profitability.
H3a: CEE, HCE, SCE, and RCE have a positive effect on the return on assets (ROA).
H3b: CEE, HCE, SCE, and RCE have a positive effect on the return on equity (ROE).

H4: The components of intellectual capital have a positive effect on firm efficiency.
H4: CEE, HCE, SCE, and RCE have a positive effect on the asset turnover ratio (ATO).

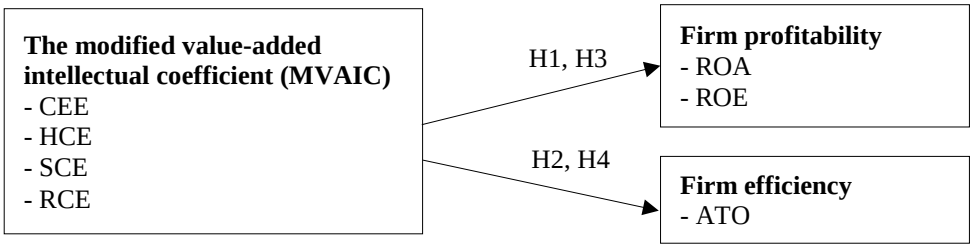

Figure 1 Research conceptual framework

Research methodology

Data collection

The initial sample included 61 agricultural and food companies listed on Thailand's stock exchange. After screening and removing firms with missing variables, the final sample consisted of 45 agriculture and food companies with 135 observations spanning three years (2017-2019). The annual reports of 45 companies were gathered using electronic data sources, such as the company's website or other electronic databases, like SETSMART and Thomson Reuters.

Variable measurements

Dependent variables

The measures of profitability and efficiency are taken as dependent variables for the regression equation. The measures of firm performance are considered based on previous research on IC. Guided by the literature of Nimtrakoon (2015); Xu and Li (2019); Weqar et al. (2020), return on assets (ROA) and return on equity (ROE) are generally used to measure a firm's profitability (Soewarno & Tjahjadi, 2020). ROA measures how profitable a company is concerning its total assets and is calculated by dividing net income by average total assets (Vishnu & Gupta, 2014). ROE represents returns to shareholders of common stocks and is determined by dividing net income by the average shareholders' equity (Xu & Wang, 2018) and is commonly regarded as an important financial indicator for investors (Weqar et al., 2021). The last measurement, asset turnover ratio (ATO), is used to describe a company's efficiency level, which measures a company's ability to use its assets to generate sales or revenue. It is a ratio of revenue or sales generated to the total value of assets (Xu & Li, 2019).

Independent variables

IC measurements are critical for management and reporting. Several methods or models for measuring IC and its components have been developed by theorists and practitioners (Vishnu & Gupta, 2014). Scholars have commonly employed the value-added intellectual capital (VAIC) model to quantify company IC efficiency in academic and practical investigations (Xu & Wang, 2018). This model, introduced by Pulic (2000; 2004), significantly outperforms other methods of IC measurement. Many experts view Pulic's VAIC as the most appropriate because it employs data from the firm's performance rather than the subjective measurement method (Isola et al., 2020). Capital employed and IC are two key resources for generating added value in a firm. The model assesses a firm's IC and physical and financial capital. More precisely, it evaluates Human Capital Efficiency (HCE), Structural Capital Efficiency (SCE), and Capital Employed Efficiency (CEE).

The VAIC model is based on audited financial data (Appuhami, 2007), which is objective and verifiable and can be used to compare cross-sectional data (Firer & Williams, 2003). This model measures the efficiency of IC and its components using conveniently accessible secondary data. The model is simple to calculate and apply and is uncomplicated for managers and employees of a corporate entity who are experienced with traditional accounting

practices (Alipour, 2012). Furthermore, external stakeholders can easily use VAIC to evaluate a company's intangible assets (Vishnu & Gupta, 2014; Shahzad et al., 2020).

However, the VAIC method has been criticized in literature, particularly for its exclusion of the concept of RC (Nadeem et al., 2019). Nazari and Herremans (2007); incorporated RC into the VAIC model and labeled it MVAIC. This model is consistent with current IC classifications. Marketing, selling, and advertising expenses serve as a proxy for RC. Such expenses are assumed to be incurred to create and sustain relationships with external stakeholders. Ulum et al. (2014); pointed out that MVAIC can evaluate the IC performance in all industries. In addition, previous research has indicated that the MVAIC model with the addition of RC is more accurate in measuring IC than the original VAIC model (Nimtrakoon, 2015; Xu & Li, 2019). Guided by Nazari and Herremans (2007); Vishnu and Gupta (2014); Ulum et al. (2014); Nimtrakoon (2015); Xu and Li (2019); the MVAIC and its four components; namely CEE, HCE, SCE, and RCE, are employed as independent variables. The widely used MVAIC equation is written as:

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

Within this equation, VA represents a company's value-added (VA) = total revenues (OUTPUT) - total expenses minus employee expenses (INPUT); capital employed efficiency (CEE) = VA / capital employed both physical and financial capital, measured by total assets-intangible assets (CE); human capital efficiency (HCE) = VA / human capital, measured by total employee expenses (HC); structural capital efficiency (SCE) = structural capital, measured by SC / VA; relational capital efficiency (RCE) = relational capital, measured through marketing, selling, and advertising expenses (RC) / VA. In this context, SC refers to hardware and software, trademarks, patents, licenses, and any other components that can enhance or have a significant impact on staff productivity. SC, unlike HC, is not an independent measure, as it is based on value production. Therefore, SC is calculated by subtracting HC from VA.

Control variables

According to prior literature, research examining the relationship between IC and performance has controls for company size (e.g., Alipour, 2012; Nimtrakoon, 2015; Xu & Li, 2019), age (e.g., Nimtrakoon, 2015; Amin et al., 2018; Xu & Zhang, 2021), and industry (Firer & Mitchell Williams, 2003; Jardon & Martinez-Cobas, 2021). Since the firms chosen for this study are all within the same industry, there was no need to account for that variable. Two control variables were calculated: Size = natural logarithm of total assets at year-end, and Age = the Age of the sample company. Table 2 outlines the variable's construction. Errors depicted in the equations are independent, as shown in the following section.

Table 2 A summary of the variables employed in this study

Variable	Type	Description
Firm profitability	Dependent	Measured through two proxies (ROA and ROE).
Firm efficiency	Dependent	Measured by ATO.
Intellectual capital	Independent	Measured through the MVAIC model, where MVAIC is the sum of CEE, HCE, SCE, and RCE.
Firm size	Control	Natural logarithm of total assets at year-end.
Firm age	Control	Number of the firm's operating years.

Regression models

Six regression models were developed to assess the impacts of IC on the selected agriculture and food firm's profitability and efficiency, as shown in Table 3. Models (1)-(3) investigate the relationships between MVAIC and ROA, ROE, and ATO, respectively. In contrast, Models (4)-(6) investigate the relationships between MAVIC's component and ROA, ROE, and ATO, respectively. The results of the analysis shall be used to answer the four hypotheses specified in the literature section.

Table 3 Regression models

Model	Equation
1	$ROA_{it} = \alpha + \beta_1 MVAIC_{it} + \beta_2 Size_{it} + \beta_3 Age_{it} + \varepsilon_{it}$
2	$ROE_{it} = \alpha + \beta_1 MVAIC_{it} + \beta_2 Size_{it} + \beta_3 Age_{it} + \varepsilon_{it}$
3	$ATO_{it} = \alpha + \beta_1 MVAIC_{it} + \beta_2 Size_{it} + \beta_3 Age_{it} + \varepsilon_{it}$
4	$ROA_{it} = \alpha + \beta_1 CEE_{it} + \beta_2 HCE_{it} + \beta_3 SCE_{it} + \beta_4 RCE_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} + \varepsilon_{it}$
5	$ROE_{it} = \alpha + \beta_1 CEE_{it} + \beta_2 HCE_{it} + \beta_3 SCE_{it} + \beta_4 RCE_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} + \varepsilon_{it}$
6	$ATO_{it} = \alpha + \beta_1 CEE_{it} + \beta_2 HCE_{it} + \beta_3 SCE_{it} + \beta_4 RCE_{it} + \beta_5 Size_{it} + \beta_6 Age_{it} + \varepsilon_{it}$

Notes: α is the constant; β is the slop of independent and control variables; ε is the error term; i is the firm, and t is the year the firm's data is used.

Research findings

Descriptive statistics

Table 4 demonstrates the results of the descriptive statistics for both dependent, independent, and control variables, showing the minimum, maximum, mean values, and standard deviation (S.D.). The mean values of ROA and ROE were 5.912 and 6.465, respectively, indicating that the profitability of Thai agriculture and food companies was relatively high. The mean ATO (1.100) indicates that these companies operate moderately efficiently. The value of the MVAIC coefficient for the agriculture and food companies ranged from -9.98 to 15.24, with an average of 3.155. The negative MVAIC value suggests that the costs incurred possessing IC are more than its contribution to the firm's value creation.

CEE, SCE, and RCE had averages of 0.282, 0.237, and 0.660, with an S.D. of 0.436, 1.729, and 1.815, respectively. The mean value of HCE (1.975) was the greatest compared with all IC components, indicating that human resources are crucial to agriculture and food firms in

creating value. In other words, the sample companies typically generated more value from human resources than physical and structural assets. Furthermore, it was noted that the total mean score of HCE, SCE, and RCE was 2.872, which is significantly greater than the average CEE of 0.282. According to the analysis, firms generate more value from IC and intangible components than from physical and financial components. The mean age value was 33.622 with a high standard deviation, indicating that age varies significantly across the sample companies. In addition, the mean values of size ranged from 13.92 to 20.27, with an average of 15.826.

Table 4 Descriptive statistics of the variables

Variables	Observation	Min	Max	Mean	S.D.
Dependent variables					
ROA	135	-30.520	22.390	5.912	7.825
ROE	135	-41.500	33.620	6.465	12.262
ATO	135	0.200	2.240	1.100	0.445
Independent variables					
CEE	135	-3.370	2.070	0.282	0.436
HCE	135	-7.670	13.810	1.975	2.292
SCE	135	-15.720	5.330	0.237	1.729
RCE	135	-10.800	9.290	0.660	1.815
MVAIC	135	-9.980	15.240	3.155	3.135
Control variables					
Size	135	13.920	20.270	15.826	1.350
Age	135	4.000	58.000	33.622	11.725

Correlation Analysis

The correlation analysis results in Table 5 indicate that MVAIC has a positive relationship with each component. MVAIC has the strongest correlation with human capital (r = 0.856), followed by correlation coefficients (r) of 0.312 (p-value<0.01), 0.308 (p-value<0.01), and 0.277 (p-value<0.01) with physical capital, structural capital, and rational capital, respectively. ROA and ROE were significantly associated, with a strong correlation of 0.916. This result is predictable because if one performance measure improves, another is likely to improve. Concerning firm efficiency, ATO positively correlates with both profitability measures (r = 3.333 and 0.327, respectively), and CEE (r = 0.377, p-value<0.01).

The VAIC model has been criticized for its computation of HC and SC. Ståhle et al. (2011) highlighted the flawless overlapping of HC and SC, resulting in the issue of multicollinearity between HCE and SCE. The current study's correlation coefficient between HCE and SCE was relatively low (r = 0.131), indicating that they do not reflect multicollinearity.

The results further demonstrate that MVAIC is positively associated with ROA and ROE yet remains insignificant with the firm’s ATO. Similarly, HCE and SCE have positively correlated with ROA and ROE. It is noteworthy that CEE indicates a substantial and positive

correlation with both firm profitability measures (ROA, ROE) and efficiency (ATO). Contrastingly, RCE is not correlated with any performance measures. According to Nimtrakoon (2015); Xu and Li (2019); RCE is recognized as a component that has fewer significant relationships with financial performance measures. The control variable, firm size, is positively associated with firm profitability measures (ROA, ROE), indicating that the larger the firm's size, the greater its profitability. On the other hand, size negatively correlates with ATO (r = -.257), indicating that the larger the firm's size, the lesser its efficiency will be. These relationships will be taken into account in the regression analyses.

Table 5 Correlation matrix

	MVAIC	**CEE**	**HCE**	**SCE**	**RCE**	**ROA**	**ROE**	**ATO**	***Size***	***Age***
MVAIC	1.000									
CEE	0.312**	1.000								
HCE	0.856**	0.247**	1.000							
SCE	0.308**	0.001	0.131	1.000						
RCE	0.277**	-0.014	0.032	-0.586**	1.000					
ROA	0.584**	0.544**	0.590**	0.219*	-0.040	1.000				
ROE	0.559**	0.576**	0.529**	0.180*	-0.050	0.916**	1.000			
ATO	0.075	0.377**	0.044	0.038	-0.054	0.333**	0.327**	1.000		
Size	0.410**	-0.016	0.430**	0.170*	0.007	0.200*	0.237**	-0.257**	1.000	
Age	-0.110	0.039	-0.090	0.000	-0.086	-0.077	-0.029	0.051	0.017	1.000

Note: The correlation is significant at the following levels: * 5%; ** 1%.

Regression results

Before performing the panel data regression, the heteroskedasticity was checked using the Breusch-Pagan-Godfrey test. In this study, the p-values were higher than 0.05, suggesting that residuals are distributed with constant variance. Furthermore, the Hausman test was employed to evaluate whether fixed effect regression (FE) or random effect regression (RE) should be used. As indicated by the high p-values (greater than 0.05) for all six models, RE rather than the FE is appropriate for examining further insights regarding the effects of IC on performance (Wooldridge, 2010). Durbin-Watson (DW) values ranged between 1.804 and 2.319; therefore, it is possible to ensure independence in the explicative variables; hence supporting autocorrection is not a serious concern. In addition, collinearity diagnosis was performed using the variance inflation factor (VIF) to detect possible correlations between explanatory variables. The VIF values of each model were between 1.022 and 1.620, indicating that multicollinearity was not an issue in the current study.

Table 6 presents the regression findings for Models (1)-(3), whereas Table 7 depicts the results for Models (4)-(6). F-values were significant for six models, in which all models demonstrated satisfactory goodness of fit (R^2 and adjusted R^2). Model (2) indicated that MVAIC could account for 32.7 percent of the variance in a firm's profitability, whereas Model (4) shows that the adjusted R^2 value increased to 52.3 percent. It further indicated that the four

components of MVAIC were more effective at explaining agricultural and food company profitability than the aggregate measure of MVAIC.

According to Models (1) and (2), MVAIC has a positive effect on agricultural and food firms' profitability (ROA, ROE), with adjusted R^2 values at 33.8 % and 32.7 %, respectively. Therefore, the empirical findings support H1a and H1b, demonstrating that firms with higher IC tend to have greater profitability. When viewing the coefficients of MVAIC in Models (1) and (2), firms that created MVAIC for one more unit increased ROA and ROE by 1.477 units and 2.215 units, respectively, confirming that IC plays an essential role in enhancing performance and creating wealth and value. However, MVAIC was found to have no significant influence on firm efficiency (ATO) in Model (3) that fails to support H2.

The regression findings for IC components and profitability are shown in Table 7. Three of the four MVAIC constituents, namely CEE (p-value<0.01), HCE (p-value<0.01), and SCE (p-value<0.10); significantly and positively affected ROA and ROE in Models (4) and (5), thereby supporting the H3a and H3b hypotheses. Models (4) and (5) provided adjusted R^2 values of 52.3 % and 50.9 %, respectively. The findings demonstrated that if firms generate CEE for an additional unit, their ROA and ROE increases increase by 7.328 and 13.123 units, respectively. Similarly, ROA and ROE should increase by 1.652 and 2.991 units, for every unit increase in HCE. Lastly, if firms generate SCE for an additional unit, their ROA and ROE should increase by 0.582 and 1.426 units, respectively. The results further demonstrated that agriculture and food companies could increase their profitability by investing in tangible assets (CEE), enhancing staff knowledge and skills (HCE), and developing systems and databases (SCE).

According to the results of Models (4) and (5), where ROA and ROE are the dependent variables, CEE is the most influential factor affecting company profitability, corroborating the findings of Phusavat et al. (2011); Tran and Vo (2018); Xu and Wang (2018); Xu and Liu (2020). The finding implies that the higher a firm's CEE, the more profitable it will be. Additionally, model (6) determines whether each IC component affects ATO. The results indicated that only CEE has a positive effect on ATO levels. A one-unit increase of CEE resulted in a 0.317 unit increase of ATO, more significant physical capital efficiency tends to have higher efficiency. The fourth component of MVAIC, RCE, shows the insignificant influence on all performance measures, consistent with the studies of Nimtrakoon (2015); Xu and Li (2019); Weqar et al. (2020). Concerning firm efficiency, size has a significantly negative impact (p-values<0.01), as shown in models (3) and (6). The results suggest that size damages a company’s efficiency (ATO). Age is one of the control variables in this study, which showed no significant association with any performance measurements (p-value>0.10).

Table 6 Regression results for MVAIC and ROA, ROE, and ATO

	ROA	**ROE**	**ATO**
Model summary	Model 1 (H1a)	Model 2 (H1b)	Model 3 (H2)
R^2	0.352	0.342	0.107
Adjusted R^2	0.338	0.327	0.086
F-statistic	23.817***	22.795***	5.234**
Durbin–Watson	1.900	1.804	2.319
Constant	3.088 (0.443)	-7.100 (-0.639)	2.665*** (5.736)
MVAIC	1.477*** (7.891)	2.215*** (7.490)	0.003 (0.169)
Size	-0.094 (-0.187)	0.356 (0.506)	-0.110*** (-3.783)
Age	-0.010 (-0.214)	0.017 (0.314)	0.002 (0.744)

Notes: The t-values are in parentheses. The asterisks indicate statistical significance at the following levels: * 10 %; ** 5%; *** 1%.

Table 7 Regression results for MVAIC components and ROA, ROE, and ATO

	ROA	**ROE**	**ATO**
Model summary	Model 4 (H3a)	Model 5 (H3b)	Model 6 (H4)
R^2	0.544	0.531	0.206
Adjusted R^2	0.523	0.509	0.169
F-statistic	25.546***	24.159***	5.553***
Durbin–Watson	1.899	1.918	2.209
Constant	2.632 (0.426)	-9.785 (-1.009)	2.545*** (5.626)
CEE	7.328*** (6.551)	13.123*** (7.453)	0.317*** (3.882)
HCE	1.652*** (6.032)	2.991*** (5.394)	0.016 (0.946)
SCE	0.582* (1.727)	1.426** (2.675)	0.024 (0.996)
RCE	0.026 (0.083)	0.379 (0.760)	-0.004 (-0.212)
Size	-0.067 (-0.172)	0.532 (0.863)	-0.102*** (-3.597)
Age	-0.033 (-0.718)	-0.012 (-0.180)	0.001 (0.502)

Notes: The t-values are in parentheses. The asterisks indicate statistical significance at the following levels: * 10 %; ** 5%; *** 1%.

Overall, the results indicate that IC positively impacts firm profitability. Firms with a higher degree of MVAIC will achieve higher performance. The findings suggest that the component-based IC model explicates better than the composite MVAIC model. The three components of MVAIC, CEE, HCE, and SCE were the most important value drivers according to their impact on firm profitability (ROA, ROE). However, in terms of efficiency, only CEE had a positive impact on ATO.

Discussion and conclusion

The current study aimed to investigate the effects and roles of intellectual capital in determining the profitability and efficiency performances of Thai listed agricultural and food companies. The author also tested the modified VAIC model, which extended the basic VAIC

model to overcome its limitations. The Public VAIC model provided a framework for measuring IC and its components and their impacts on performance. However, this model does not include RC, resulting in an overvaluation of capital-intensive firms. The study employs the MVAIC model with the introduction of RC, as suggested by Nazari and Herremans (2007); Vishnu and Gupta (2014); Ulum et al. (2014); Nimtrakoon (2015); Xu and Li (2019). Consequently, six regression models were proposed and empirically examined to analyze the effects of IC and its components on corporate profitability and efficiency.

The sample consisted of 45 listed agricultural and food enterprises operating in Thailand between 2017 and 2019. The MVAIC value had an average value of 3.155, which is greater than the Thai listed enterprises in the technology industry, where MVAIC = 2.404, based on data from 2011 (Nimtrakoon, 2015). Among IC efficiency values, HCE had the highest value average of 1.975 among all IC components, which is in line with the previous studies (e.g., Nimtrakoon, 2015; Weqar et al., 2020; Xu & Liu, 2020). Additionally, the total mean score of HCE, SCE, and RCE is greater than CEE. The finding indicates that firms generate more value from IC and intangible components than from physical and financial components.

The regression results revealed that MVAIC was positively associated with profitability (ROE, ROA) yet showed an insignificant influence on firm efficiency (ATO). Among MVAIC components, three of the four MVAIC constituents, namely CEE, HCE, and SCE, were significantly and positively associated with ROA and ROE. However, concerning firm efficiency, only CEE positively affects ATO. Unexpectedly, RCE had no significant influence on any of the performance measures. The findings also indicated that the component-based model explicates better than the composite MVAIC model. Among the MVAIC dimensions, CEE was the most significant contribution, as it improved both the profitability and efficiency of the sample Thai agriculture and food companies, similar to the study by Tran and Vo (2018); conducted within the Thai banking sector. Additionally, it is consistent with the study by Nimtrakoon (2015); capital employed continued to play a significant role in creating profitability and market performance in various ASEAN enterprises. Lastly, the results demonstrated that Thai listed businesses in the Agro and Food industry place a greater emphasis on the return of physical assets and a lesser emphasis on relational capital.

The findings suggest that agriculture and food enterprises could increase profitability by optimizing their physical, human, and capital assets, as these three positively correlated with ROA and ROE. They further indicate that investing in physical and non-physical resources, including systems, databases, software, and client relationships, is critical for profitability. Both physical capital and SC serve as a foundation for HC to operate effectively, as a well-trained and qualified workforce cannot accomplish its goals without the necessary infrastructure, processes, procedures, database, and routines (Mondal & Ghosh, 2012). Due to the prominent empirical findings demonstrating that companies can benefit from IC to increase their performance, this study can be seen as an addition to the existing literature that attempted to identify the drivers of successful businesses. It is in line with Nadeem et al. (2019); which

demonstrated that IC drives a business's success and allows a firm to gain a competitive advantage.

The MVAIC model is based on accounting data and does not focus on the firm's costs. Instead, it emphasizes the efficiency of resources that generate value for the organization. Therefore, firm managers or policymakers can utilize the MVAIC model to monitor and assess their assets and establish business plans to gain a competitive advantage (Appuhami, 2007). Moreover, a measurement of IC may be used to compare companies and find existing intellectual capital in firms, given the requirement for its disclosure (Jardon & Martinez-Cobas, 2021). From an accounting point of view, intellectual capital, like other resources of a corporate entity, should be recorded in financial statements (Roslender et al., 2006). Accountants may use the MVAIC model to report their IC performance to management. This study proposes that firms use this model to prepare and analyze financial statements and disclose IC. In addition, firms should make IC information available to users so that investors and shareholders may make better investment decisions and evaluate the firm's market wealth (Alipour, 2012). Increasing IC disclosure will create transparency between a business and its stakeholders and attract potential investors (Hatane et al., 2021).

This study, like any other, has limitations, which provide opportunities for future research. Since this study was conducted on a specific industry within a particular country, any generalization of the results must be made with caution. Future studies may be undertaken by utilizing various industries from various Asian countries. Furthermore, the lagged influence of IC components on company performance was not a consideration. Further research may be conducted to address this limitation.

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