Available online at
http://myjms.mohe.gov.my/index.php/JEEIR

JEEIR

e-ISSN: 2289-2559

Journal of Emerging Economies & Islamic Research 11(1) 2023, 15 – 40.

Journal of Emerging Economies and Islamic Research

Is intellectual capital measurement matters in the profitability of technology firms in Malaysia? Investigating the moderating effect of human capital efficiency

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ARTICLE INFO

Article history:
Received 10 November 2022
Accepted 25 December 2022
Published 31 January 2023

Keywords:
MVAIC Model
Profitability
Human Capital Efficiency
Technology Sector
Malaysia

DOI:
10.24191/ jeeir.v11i1.20695

ABSTRACT

This study investigates the relationship between intellectual capital and profitability of technology firms in Malaysia, while considering the moderating effect of human capital efficiency. Intellectual capital is measured using the Modified Value-Added Intellectual Coefficient model (MVAIC), and profitability is proxied by return on assets (ROA) and return on equity (ROE). The MVAIC model comprises four dimensions: human capital efficiency (HCE), structural capital efficiency (SCE), relational capital efficiency (RCE) and capital employed efficiency (CEE). The study uses panel data analysis based on usable data of 32 technology firms listed on the main market of Bursa Malaysia and covers a period of seven years from 2013 to 2019. The empirical findings suggest that intellectual capital has a significant effect on profitability, whereas HCE and CEE positively influence the profitability of technology firms. However, SCE and RCE reveal an insignificant association. Nevertheless, human capital moderates positively the impact of SCE and RCE on profitability and improves the explanatory power of the model. The findings confirm that intellectual capital is a key driver of profitability, and therefore, firms and the government should invest in developing intellectual capital for enhanced profitability and economic growth. The study investigates one country and one industry, thus, limiting the generalization of the findings.

1. Introduction

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In the past two decades, Malaysia has increasingly evolved into a knowledge-based economy. The technology-intensive environment has created a situation in which investments in human resources, research and development, information and communications technology, and advertisements have become important to improve a firm's competitive advantage and ensure its economic prosperity. In this context, firms feel an increasing need to invest in intangibles that are generally not expressed in the balance sheet, but on which the firms' potential performance is focused. In today's dynamic and challenging era, knowledge is a vital re source in the knowledge-based economy. Therefore, intellectual capital investment is especially critical to firms pursuing productivity and efficiency gains (Forte et al., 2017). Intellectual capital has been identified as the main factor responsible for the performance of knowledge-intensive organisations such as banks, financial institutions, and technology firms (Serenko et al., 2009). As the economy grows and evolves, scholars argue that inimitable and non-substitutable resources will become a source of competitive advantage, a source of value creation, and act as a driver for firm growth, which ultimately enhances firm performance, and these two characteristics are abundantly available in intellectual capital (Ousama et al., 2019; Ozkan et al., 2017; Ting et al., 2020; Tiwari & Vidyarthi, 2018; Tran & Vo, 2018; Soewarno & Tjahjadi, 2020).

Three primary intellectual capital components have been agreed upon by many researchers after years of research (Maji & Goswami, 2016), and previously, these components were given various names (Agostini et al., 2017). However, recently the mutually agreed names are human capital, structural capital, and relational capital (Ting et al., 2020). In view of the importance of intellectual capital, numerous studies have attempted to shed light on the association between intellectual capital and firm performance. The research focus is divided into two dimensions, namely, the aggregate effect and the separate effect of intellectual capital and, and how each dimension influences firm performance (Ousama et al., 2019; Ozkan et al., 2017; Ting et al., 2020; Tiwari & Vidyarthi, 2018; Tran & Vo, 2018; Soewarno & Tjahjadi, 2020). Empirically, the Value-Added Intellectual Coefficient (VAIC) and Modified Value-Added Intellectual Coefficient (MVAIC) models are widely employed to measure the relationship between intellectual capital and firm performance (Tran & Vo, 2018). Although the importance of intellectual capital seems to be theoretically supported (Soewarno & Tjahjadi, 2020), particularly in financial institutions involving banks and finance, the empirical findings show inconsistent results, for instance, in the technology industry (Dženopoljac et al., 2016; Nimtrakoon, 2015). Concerning this, the inclusion of a moderating variable such as human capital efficiency may further strengthen the connection between intellectual capital and firm performance (Tiwari & Vidyarthi, 2018).

Malaysia is in a group of high-income markets with strong digital technology adoption. In 2018, the digital economy contributes 18.5 % to Malaysia's GDP, and it is projected to meet a 20% target by 2020 (Department of Statistics Malaysia, 2019). In this context, considering the significance of the technology sector to Malaysia's growth, this study contributes to the body of knowledge in three ways. First, most prior empirical studies employed VAIC model to measure intellectual capital efficiency, which focuses more on HC (Human Capital) and SC (Structural Capital), but RC (Relational Capital) receives little or no attention. As such, this study will concentrate on the multidimensional nature of intellectual capital through the use of MVAIC Model. The use of this model will provide a more comprehensive analysis of intellectual capital efficiency in Malaysian technology firms. Second, the research setting, which is technology firms in Malaysia, is a knowledge-intensive industry that is rarely investigated. Therefore, it will provide insights into the level of adoption of intellectual capital and its correlation to profitability, and it will extend the existing literature on intellectual capital by attempting to identify the drivers of growth among technology firms in developing countries such as Malaysia. Third, this study introduces a moderating variable into the models while measuring the efficiency of intellectual capital components on profitability. The application of moderating variables in the intellectual capital literature is still in its infancy, thus making a novel contribution into the research (Tiwari, 2022). Moreover, introducing the moderating variable would improve the explanatory power of regression models and expand comprehension of the relationship among variables. Therefore, this study aims to provide an in-depth analysis of the connection between intellectual

https://doi.org/10.24191/jeeir.v11i1.20695

capital and performance, particularly profitability, and aims to achieve three objectives, namely to investigate the aggregate impact of intellectual capital on profitability, to examine the separate effect of intellectual capital on profitability, and to determine the moderating role of human capital in the relationship between intellectual capital and profitability.

The paper is organised as follows. Section 2 provides a literature review and the research hypotheses. Subsequently, section 3 presents the data and methodology of the study. Section 4 provides findings and analysis. Finally, in section 5, the conclusion is presented.

2. Technology sector

2.1 Overview of technology sector in Malaysia

ASEAN is projected to be the fourth-largest economy globally by 2030, with its digital economy expected to expand 6.4 times from USD$31 billion (RM130 billion) in 2015 to USD$197 billion by 2025, as anticipated by the Economic Research Institute for ASEAN and East Asia (New Straits Times, 2020). According to the World Bank, Malaysia is a high-income market with a robust adoption of digital technology, ranking higher than approximately one-third of Organisation Economic Cooperation and Development (OECD) countries. As a rising Asian economic powerhouse, Malaysia aims to establish technology-driven, high-tech production-based model, and it has aggressively implemented business-minded projects and guidelines to encourage higher foreign direct investment.

The Malaysia Digital Economy Corporation (MDEC) has been leading the country's was founded in Multimedia Super Corridor initiatives since its establishment in 1996. Currently, MDEC is a body under the Ministry of Communications and Multimedia Malaysia (KKMM), and it has favorably managed Information and Communications Technology (ICT) and digital economy growth in Malaysia for nearly 25 years. MDEC has also launched the Global Growth Acceleration (GGA) program to promote high-potential Malaysian-based tech firms to accelerate globally, leading the Global Acceleration and Innovation Network (GAIN) projects covering cloud computing, artificial intelligence (AI), Internet of Things (IoT), e-business, bitcoin, cybersecurity, unmanned aircraft, robotics, and fintech. The GAIN projects aim to act as a catalyst to steer the growth of Malaysian tech firms to become big brands, eventually creating further Malaysian tech industry icons (New Straits Times, 2020).

Malaysia is strategically located with easy access to other countries and boasts stable facilities, digital accessibility, and enjoys economic prosperity. ICT is the country's primary growth market, rising at an Annual Average Growth Rate (AAGR) of 9.0% over seven years. The government of Malaysia has launched several strategies to accelerate the tech industry, including fostering business technology adoption and supporting digital entrepreneurship, which have started paying off. According to the Department of Statistics Malaysia, the digital economy contributed 18.5% to the nation's GDP in 2018 and is projected to meet a stretched 20% target by 2020.

In 2018, the digital economy contributed RM267.7 billion to the country's GDP, a 6.9% increase from 2017. ICT added 18.5% to GDP, consisting of the ICT industry's Gross Value Added (GVAICT: 12.6%) and non-ICT industry's e-commerce (5.9%), as shown in Figure 1. GVAICT rose by 6.1% to RM182.4 billion in 2018, with the ICT services sector leading with a 43.2% share, followed by ICT manufacturing with 34.1%. Telecommunications was the main driver in ICT services sector, while electronic parts and boards, networking devices, and consumer electronics supported ICT manufacturing (Department of Statistics Malaysia, 2019). The number of jobs in the ICT industry increases to 1.12 million people, with a 2.6% growth compared to 1.09 million in 2017. ICT manufacturing occupied 37.0%, followed by ICT services (28.2%) and ICT trade (20.9%).

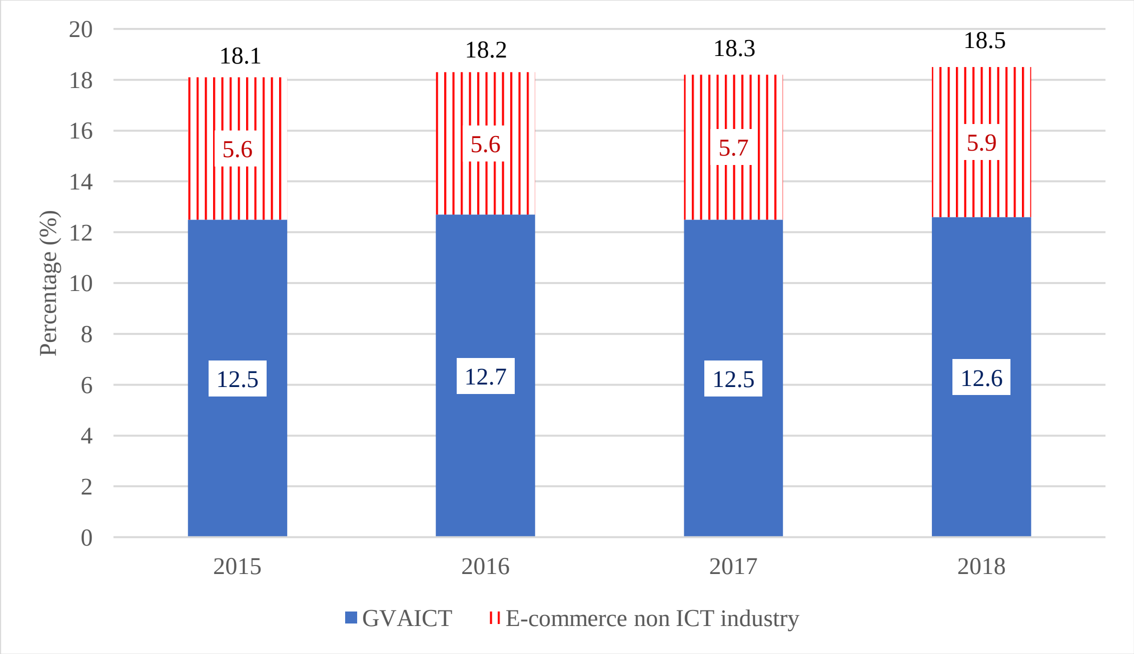

Figure 1. ICT Contributions to Economy. Source: Department of Statistics Malaysia (2019).

Despite its successes, Malaysia lacks the scale of its neighbor, Indonesia. The country faces various challenges, such as talent growth, digitalization of traditional sectors, and other obstacles. In response, the government introduced the national policy on Industry 4.0, known as Industry Forward (Industry4WRD), in October 2018 to promote innovation and productivity (Ministry of International Trade and Industry, 2020). The Industry4WRD Policy objectives are based on three major principles: Attract, Create and Transform. These principles aim to attract stakeholders to adopt Industry 4.0 applications and technologies, create a comprehensive environment to promote the market implementation of Industry 4.0, and enable a systemic transition of the manufacturing sector to improve productivity, cost efficiency, technology applications, innovation potential, local technology creation, and the development of highly competent employees. The implementation of Industry4WRD would enable business, particularly small and medium-sized enterprises (SMEs), to increase efficiency and productivity, thereby remaining essential and competitive at domestic and international level. The Industry4WRD policy would also promote the production of Malaysian goods and services using advanced technology-based manufacturing capabilities (Ministry of International Trade and Industry, 2020).

In light of Malaysia's aspiration to become a digital economy, a study of intellectual capital in this industry appears to be both appropriate and appealing. By incorporating intellectual capital management, the industry can move in the right strategic direction, uphold its future, engage in technology upgrades, and consequently enhance profitability and productivity. Moreover, firms' abilities to manage intellectual capital efficiently and effectively can be measured through intellectual capital influence on firms' performance. This study aims to fill the void in the intellectual capital literature by addressing the lack of evidence supporting the efficiency of intellectual capital and its influence on firms' performance in the technology sector in Malaysia.

https://doi.org/10.24191/jeeir.v11i1.20695

2.2 Empirical reviews

2.2.1 Intellectual capital and firm performance

This study focuses on the digital economy and the technology industry in Malaysia, which has grown significantly due to rapid technological advancements. The technology industry in Malaysia is a primary growth market with an Annual Average Growth Rate of 9.0% over seven years. To further accelerate its growth, the government of Malaysia has launched several strategies, including fostering business technology adoption and supporting digital entrepreneurship. However, the technology industry in Malaysia faces both internal and external factors, such as talent, legislation, economies of scale, and a lack of technological innovation. The shortage of intellectual workers and the lack of emphasis on digital literacy and innovation result in a less adaptive workforce to the fast-evolving economy. As a result of the lack of attention to innovation, automation, digitization, and technology, Malaysia has yet to acquire a developed industrial nation status. The knowledge-based economy relies on knowledge, information, and highly skilled workers as a requirement for businesses and government sectors. Intellectual capital is a collection of intangible and knowledge-based assets that include employee competencies (human capital), the processes and procedures produced in its system (structural capital), and the value associated with its relationships (relational capital). Firms in knowledge-intensive industries have a significant need for, and benefit more from intellectual capital. Thus, intellectual capital efficiency, comprising human capital efficiency, structural capital efficiency, relational capital efficiency, is a significant determinant in the sustainable firm success of the technology industry.

The financial industry, including banks, insurance companies, and brokerage firms, has been extensively researched regarding the impact of intellectual capital on firm performance. This is due to their focus on utilizing knowledge to enhance their performance (Dženopoljac et al., 2016; Vishnu & Gupta, 2014). For example, Al-Musali and Ismail (2016) investigated 214 commercial banks listed in Gulf countries from 2008 to 2010 and found a positive correlation between intellectual capital efficiency and performance. Tiwari and Vidyarthi (2018) studied 663 banks in India over seven years from 1999 to 2015, and discovered a positive association between intellectual capital and firm performance. Tran and Vo (2018), Ousama et al. (2019), and Soewarno and Tjahjadi (2020) conducted similar studies on banks in Thailand, Islamic banks in Gulf countries, and Indonesian banks, respectively, and all reported a positive and significant relationship between intellectual capital and firm performance. However, empirical research has shown inconsistent results, particularly in the technology industry (Soewarno & Tjahjadi, 2020). Additionally, technology firms have not received much attention in the literature on intellectual capital. Nimtrakoon (2015) investigated 213 technology firms across five ASEAN countries and found a positive impact of intellectual capital on firm performance, indicating intellectual capital may be a future indicator of firm performance. In contrast, Dženopoljac et al. (2016), found no significant association between intellectual capital and firm performance based on an examination of 13,989 technology firms in Serbia from 2009 to 2013. Ting et al. (2020) also reported similar empirical evidence in their analysis of the relationship between intellectual capital and firm performance in technology firms in Taiwan, based on data from 6,408 firms over twelve years, from 2006 to 2017. Table 1 summarizes the literature review conducted on the knowledge-intensive industry over the six-year period, from 2015 to 2020.

https://doi.org/10.24191/jeeir.v11i1.20695

Table 1. The impact of intellectual capital on firm performance on knowledge-intensive industry using VAIC/MVAIC models

No	Authors	Year	Country/Region	Knowledge-Intensive Industry	Observation	Year of Observation	Research Focus	Impact (+ or -)
1	Nimtrakoon	2015	ASEAN Countries	Technology Firms	213	2011	Profitability and market value	+
2	Al-Musali *et al.*	2016	Gulf Countries	Listed commercial banks	214	2008-2010	Profitability	+
3	Dženopoljac *et al.*	2016	Serbia	ICT sector	13,989	2009-2013	Profitability and productivity	-
4	Meles *et al.*	2016	United States	Commercial banks	40,000	2005-2012	Profitability	+
5	Singh *et al.*	2016	India	Public and private sector banks	100	2007-2011	Profitability	+
6	Irsyahma & Nikmah	2017	Indonesia	Banking sector	60	2011-2014	Profitability and market value	+
7	Nawaz & Haniffa	2017	Asia, Europe, and Middle-East	Islamic financial institutions (IFIs)	320	2007-2011	Profitability	+
8	Ozkan *et al.*	2017	Turkey	Banking sector	440	2005-214	Profitability	+
9	Murugesan *et al.*	2018	India	Private sector banks	210	2007-2017	Revenue growth and profitability	+
10	Tiwari & Vidyarthi	2018	India	Public and private sector banks	663	1999-2015	Profitability	+
11	Tran & Vo	2018	Thailand	Listed banks	320	1997-2016	Profitability	+
12	Buallay	2019	Gulf Countries	Islamic and Conventional banks	295	2012-2016	Profitability and market value	+
13	Ousama *et al.*	2019	Gulf Countries	Islamic banking industry	93	2011-2013	Profitability	+
14	Soewarno & Tjahjadi	2020	Indonesia	Public listed banks	114	2013-2017	Profitability, productivity and market value	+
15	Ting *et al.*	2020	Taiwan	Listed electronic firms	6,408	2006-2017	Firm efficiency and sales growth	-

Note: The content is from the study, however the format of the table is adapted from Xu & Li (2019, p.491).

2.2.2 The separate effect of intellectual capital components and firm performance

The aforementioned studies have utilized either the VAIC model or the MVAIC model to assess the efficiency of intellectual capital. The VAIC model is comprised of three pillars: human capital efficiency (HCE), structural capital efficiency (SCE) and capital employed efficiency (CEE). On the other hand, the MVAIC model includes HCE, SCE, CEE, and relational capital efficiency (RCE). This study utilizes the MVAIC model due to its inclusion of RCE, which provides a more comprehensive measure of intellectual capital. The existing literature on intellectual capital examines both the aggregate effect and the separate effect of intellectual capital on firm performance. Scholars argue that investigating the impact of each component of intellectual capital on firm performance is necessary because investors place different emphasis on each component of intellectual capital, and each component appropriate investment to accumulate intellectual capital efficiency (Nadeem et al., 2017). The effect of intellectual capital components, namely human capital, structural capital, relational capital, and capital employed (a component of VAIC/MVAIC model) is mixed and inconclusive. Nawaz and Haniffa (2017) applied the VAIC model to 320 Islamic financial institutions across Asia, Europe and Middle East, and their findings reported different degrees of value creation capability of the three components of intellectual capital. They observed that theIslamic financial institutions tended to generate efficiency from human capital and capital employed rather than structural capital. Research by Ozkan et al. (2017) based on 440 banks inTurkey documented similar empirical findings. However, the study of Tiwari and Vidyarthi (2018) which drew from Indian banks, revealed different results. They reported that structural capital is the most efficient value driver for Indian banks, and their analysis failed to note any significant association between human capital, capital employed and firm performance. Tran and Vo (2018), using VAIC model, compared performance of intellectual capital components and firmperformance of 320 listed banks in Thailand. They observed that human capital has a major impact on firm performance in relation to structural capital and capital employed. In a study of the impact of intellectual capital components on profitability, productivity and market value, using 114 Indonesian banks, Soewarno and Tjahjadi (2020) found a significant link between structural capital and profitability. Human capital is noted to be superior in creating value for banks' productivity and market value. However, capital employed is observed to be the leadingvalue driver for firm performance measured through profitability, productivity, and market value.

2.2.3 The interaction effect of human capital efficiency on intellectual capital performance and firm performance

Numerous scholars have asserted that human capital plays a vital role in the value creation capability of firms (Nawaz & Haniffa, 2017; Ozkan et al., 2017; Tran & Vo, 2018; Soewarno & Tjahjadi, 2020). Conversely, Tiwari et al., 2018 posited that structural capital has a significant impact on business performance. Additionally, the findings of Scafarto et al. (2016) indicated a positive influence of relational capital on firms' performance. However, other studies revealed that human capital may have an indirect effect on firm performance through its positive impact on structural capital and relational capital (Scafarto et al., 2016; Sardo et al., 2018). Scholars have argued that a cause-and-effect relationship exists between human capital and other components of intellectual capital, and these interactions ultimately affect firm performance. Scafarto et al. (2016) suggested that human capital, structural capital, and relational capital alone are insufficient to deliver superior performance; instead, their interactions with other components of intellectual capital are required to leverage the firm's overall intangible value. Similarly, Sardo et al. (2018) claimed that the interaction between human capital, structural capital, and relational capital can create synergy for intellectual capital efficiency. Furthermore, Tiwari and Vidyarthi (2018) stated that the inclusion of a moderating variable in the relationship between intellectual capital components and firm performance would increase the explanatory power of the regression models. Therefore, this study seeks to contribute to the literature by measuring the moderating role of human capital in the relationship between intellectual capital and firm performance. Table 2 summarizes the separate effects of intellectual capital components on firm performance in previous studies.

https://doi.org/10.24191/jeeir.v11i1.20695

Table 2. The separate effect of intellectual capital components on firm performance

No.	Authors	Intellectual Capital Components	Firm Performance			
			ROA	ROE	ATO	PBV
1	Nawaz & Haniffa (2017)	Human Capital	S	-	-	-
		Structural Capital	NS	-	-	-
		Capital Employed	S	-	-	-
2	Ozkan et al. (2017)	Human Capital	S	-	-	-
		Structural Capital	NS	-	-	-
		Capital Employed	S	-	-	-
3	Tiwari & Vidyarthi (2018)	Human Capital	NS	-	-	-
		Structural Capital	S	-	-	-
		Capital Employed	NS	-	-	-
4	Tran & Vo (2018)	Human Capital	S	-	-	-
		Structural Capital	NS	-	-	-
		Capital Employed	NS	-	-	-
5	Soewarno & Tjahjadi (2020)	Human Capital	NS	NS	S	S
		Structural Capital	S	S	NS	NS
		Capital Employed	S	S	S	S

Note: ROA is Return On Asset, ROE is Return on Equity, ATO is Asset Turn Over, and PBV is Price to Book Value, NS is not supported, S is supported. Source: The Content is from the study; however, the format of the table is adapted from Soewarno & Tjahjadi (2020, p.3).

In conclusion, Table 1 and Table 2 above provide a comprehensive summary of studies that have explored the impact of intellectual capital on firm performance. From the analysis, several research issues concerning the study have been identified, summarized, and outlined. First, there is a significant gap in the literature regarding the impact of intellectual capital on profitability of technology firms, particularlyin Malaysia. Second, limited studies have investigated the moderating role of human capital in the relationship between other components of intellectual capital and profitability. To the best knowledge of the researcher, this relationship has received little research attentionin the case of Malaysia. Therefore, the outcome of this study aims to address this research gap.

2.3 Hypotheses development

The research hypotheses are formulated based on theoretical literature and findings from prior empirical studies (Ousama et al., 2019; Ozkan et al., 2017; Soewarno & Tjahjadi, 2020; Ting et al., 2020; Tiwari & Vidyarthi, 2018; Tran & Vo, 2018). Table 2.4 summarizes the expected effects of intellectual capital and its components on profitability.

Table 3. Hypotheses framework

Variables of Interest	Expected Signs from Literature Review	Sources
MVAIC	+ve	Nimtrakoon (2015) Tiwaro et al. (2018)
HCE	+ve	Nawaz et al. (2017); Ozkan et al. (2017); Tran et al. (2018); Soewarno et al. (2020)
SCE	+ve	Tiwari et al. (2018); Soewarno et al. (2020)
RCE	+ve	Tiwari et al. (2018)
CEE	+ve	Nawaz et al. (2017); Ozkan et al. (2017); Soewarno et al. (2020)

Based on the mainstream literature on intellectual capital and profitability, the hypotheses of the study are formulated as follows:

Hypothesis 1: A higher value of intellectual capital leads to higher profitability.

Hypothesis 2: Values of HCE, SCE, RCE, CEE impact profitability positively
2a: A higher HCE value leads to increased profitability.
2b: A higher SCE value leads to increased profitability.
2c: A higher RCE value leads to increased profitability.
2d: A higher CEE value leads to increased profitability.

Hypothesis 3: HCE moderates positively the relationship between SCE, RCE, CEE, and profitability.
3a: HCE moderates the link between SCE and profitability in a positive manner.
3b: HCE moderates the link between RCE and profitability in a positive manner.
3c: HCE moderates the link between CEE and profitability in a positive manner.

2.4 Research framework

Figure 2 depicts the conceptual framework of this study, which illustrate the relationship between intellectual capital on profitability, and the moderating effect of human capital efficiency on this relationship. The framework is grounded in resource-based, resource-dependency and learning organization theories.

The resource-based view theory emphasizes the importance of valuable, rare, inimitable, and non-substitutable firm resources in creating sustainable competitive advantage through value creation strategies. Three broad classifications of such resources are human capital, structural capital, and relational capital, which proxy variables for intellectual capital and its components measured using the MVAIC model. The second theory that supports the relationship between intellectual capital and profitability is organizational learning theory (Njuguna, 2009). This theory recognizes the process of continuous learning within the firm that drives innovation in products and processes, enabling the firm to better understand external changes such as shifts in customer demand. Hence, linking this theory with intellectual capital is essential in enhancing profitability. The third theory is resource dependency theory which considers the entity as an open system that relies upon the opportunities in the external environment (Salancik & Pfeffer, 1978). To understand an entity's performance of, it must be aware of its ecological surroundings. By incorporating human capital efficiency as a moderating variable, this theory can be linked with external resources like human resources of the firm (Smitri & Das, 2018), ensuring efficient management of the relationship with the external environment.

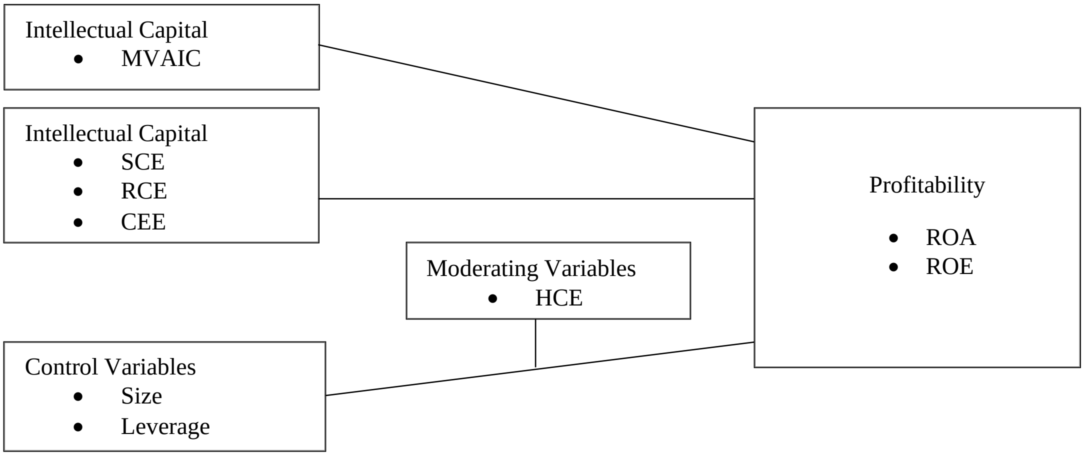

Figure 2. Research framework

3. Data and methodology

3.1 Data

A total of 40 technology firms are listed on the main market of Bursa Malaysia. However, for the purpose of this analysis, usable data was obtained from 32 firms through their respective websites. The data was collected over the period 2013 to 2019. Firms with missing data, as indicated in the studies conducted by Smriti and Das (2018), Chowdhury et al. (2018), and Ting et al. (2020), were excluded from the sample. This resulted in a final observation of 224 (i = 32 firms, t =7 years).

3.2 Measurement of variables

Dependent variables: The present study focuses on two proxies for firm profitability, which serve as the dependent variables. The first proxy is the return on assets (ROA), which measures the firm's profitability relative to its total assets and is computed as the ratio of net income to total assets. The second proxy is the return on equity (ROE), which is an essential financial indicator for the owners of the firm, and is calculated as the ratio of net income to equity.

Independent variables: Several scholars have categorized intellectual capital into various types, with Stewart (1997), Bontis (1998), and Sveiby (1997) classifying it into customer, structural, and human capital. Pulic (1998) introduced the value-added intellectual coefficient (VAIC) model to measure intellectual capital performance, categorizing it into human capital, structural capital, and physical capital. VAIC remains constant regardless of stakeholder beliefs, as stakeholders are the central driving force behind profit maximization (Forte et al., 2017). VAIC assesses the cumulative revenue generated by stakeholders, making it suitable measure to examine the impact of intellectual capital on firm performance, as proven by Meek and Gray (1988). The most widely accepted methodology of intellectual capital is capital employed efficiency (CEE), human capital efficiency (HCE), and structural capital efficiency(SCE), as evidenced by the present literature.

One of the many advantages of the VAIC methodology is its clarity and regulation in determining intellectual capital, which provides a more accurate and valid measure of intellectual capital based on audited financial statements (Al-Musali & Ku Ismail 2016; Nimtrakoon, 2015; Pulic, 2004). Additionally, it is easy to obtain an intellectual capital connection over cross-sections and estimating the efficiency of each resource included in value (Chen et al., 2005; Hang Chan, 2009; Soetanto & Liem, 2019). Furthermore, firms can use VAIC to measure their intellectual capital performance regardless of management rules (Nimtrakoon, 2015). However, VAIC has limitations, with the primary constraint being its failure to cover relational capital (RC), which is crucial in the concept of sustainable development (Ståhle et al., 2011; Vishnu & Gupta, 2014). To address this issue, several scholars have added relational capital efficiency (RCE) and reconstructed the initial VAIC model with the modified value- added intellectual coefficient (MVAIC) model (Nimtrakoon, 2015; Sardo & Serrasqueiro, 2017; Soetanto et al., 2019; Vidyarthi, 2019; Vishnu & Gupta, 2014; Xu & Wang, 2019). A firm's progress is significantly linked to its relationship with external stakeholders, such as government and customers, relational capital is an essential resource that can help create and maintain such connections, drives sustainable development (Bontis, 1998; Vidyarthi, 2019).

In this study, the MVAIC model was used to measure intellectual capital and its components, namely human capital, structural capital, relational capital, capital employed. The higher the value of MVAIC, the higher the value creation capability of the firm. MVAIC is calculated as the sum of Human Capital Efficiency (HCE), Structural Capital Efficiency (SCE), Relational Capital Efficiency (RCE) and Capital Employed Efficiency (CEE) and mathematically expressed as: $MVAIC = HCE + SCE + RCE + CEE$. To calculate efficiency scores using MVAIC model, the value added (VA) must be established using the equation: $VA = OP + EC + D + A$, where OP isoperating profit, EC is employee costs, D is depreciation, and A is amortization. $HCE = VA / HC$,human capital (HC), which represents the investment made by the firm on its employees, including salary, wages and incentives. This ratio measures the contribution made by every unit of money invested in human capital to the value-added in the firm, indicating the value added by the human resources employed by the business (Joshi etal., 2013). $SCE = VA – HC / VA$, SCE indicates the proportion of total VA accounted by structural capital. SCE shows how much of the firm's value creation is generated by the structural capital (Joshi et al., 2013). $RCE = RC / VA$, relational capital (RC) is the marketingcost of firms. This ratio gives the contribution made by every unit of relational capital to the value-added in the firm (Ulum et al., 2014). $CEE = VA / CE$, capital employed (CE) representsthe total assets of the firm (Ulum et al., 2014). CEE is a measure of physical capital. This ratiogives the contribution made by every unit of physical capital to the value-added in the firm.

Moderating variable: This study aims to investigate the moderating impact of HCE on other components of MVAIC, namely SCE, RCE, CEE. Prior research has indicated that HCE has a direct or indirect influence on other components of MVAIC. However, the use of moderating variables in the intellectual capital literature is still in its early stages (Tiwari & Vidyarthi, 2018; Tiwari, 2022). As a result, this study introduces three interaction terms, namelyHCE*SCE, HCE*RCE and HCE*CEE, to assess the joint effect of two explanatory variables on the dependent variables (Sardo et al., 2018; Scafarto et al., 2016; Tiwari & Vidyarthi, 2018).

Control Variables: To ensure the reliability and validity of the findings, two additional control variables, firm size, and leverage, were included in the analysis based on previous research (Sardo et al., 2018; Scafarto et al., 2016; Soewarno & Tjahjadi, 2020; Tiwari & Vidyarthi, 2018). The study by Nimtrakoon (2016) revealed that intellectual capital and profitability are likely to rise with an increase in firm size. The study suggested that firm size, calculated using the natural log of total assets, may affect a firm's intellectual capital because larger firms with more resources are more likely to generate or create a higher intellectual capital than smaller firms. Scafarto et al.(2016) proposed that firm size is utilized to control the impact of size on wealth creation due to scale economies, monopoly power, or bargaining power. Ozkan et al. (2017), Soewarno and Tjahjadi (2020), and Tiwari and Vidyarthi (2018) used firm size as a control variable and discovered an insignificant effect of firm size on profitability. Meanwhile, Nawaz and Haniffa (2017) found critical connections between size and profitability. In addition to firm size, a firm'sleverage, calculated using total debt over total assets, affects profitability. Ozkan et al. (2017) and Tiwari and Vidyarthi (2018) found

https://doi.org/10.24191/jeeir.v11i1.20695

a negative association between leverage and profitability, whereas Dzenopoljac et al. (2016) and Soewarno and Tjahjadi (2020) discovered a positive relationship between leverage and profitability. Therefore, to mitigate the influence of firm size and leverage on the relationship between intellectual capital and profitability, firm size and leverage were added as control variables. The natural logarithm of total assets was used to measure firm size, while leverage was calculated as total debt over total assets. The following table summarizes the variables and measurements employed in this study.

3.3 Estimation method

The research regression models consist of the full model and partial models, stated as follows:

$FP_{it} = f\,(MVAIC, \text{firm size, leverage})$

This study proposes three models to meet the research objectives. Model 1(a) and 1(b) examinethe impact of intellectual capital using MVAIC model on profitability.

a. $ROA_{it} = \beta_0 + \beta_1 MVAIC_{it} + \beta_2 Size_{it} + \beta_3 Lev_{it} + \varepsilon_{it}$
b. $ROE_{it} = \beta_0 + \beta_1 MVAIC_{it} + \beta_2 Size_{it} + \beta_3 Lev_{it} + \varepsilon_{it}$

Model 2 (a) and 2 (b) examine the separate effect of MVAIC components (HCE, SCE, RCE, and CEE) on profitability.

a. $ROA_{it} = \beta_0 + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 RCE_{it} + \beta_4 CEE_{it} + \beta_5 Size_{it} + \beta_6 Lev_{it} + \varepsilon_{it}$
b. $ROE_{it} = \beta_0 + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 RCE_{it} + \beta_4 CEE_{it} + \beta_5 Size_{it} + \beta_6 Lev_{it} + \varepsilon_{it}$

Model 3 (a) and 3 (b) investigate the moderating effect of HCE on the relationship between SCE, RCE, CEE and profitability.

a. $ROA_{it} = \beta_0 + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 RCE_{it} + \beta_4 CEE_{it} + \beta_5 HCE_{it} \text{ x } SCE_{it} + \beta_6 HCE_{it} \text{ x} RCE_{it} + \beta_7 HCE_{it} \text{ x } CEE_{it} + \beta_8 Size_{it} + \beta_9 Lev_{it} + \varepsilon_{it}$
b. $ROE_{it} = \beta_0 + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 RCE_{it} + \beta_4 CEE_{it} + \beta_5 HCE_{it} \text{ x } SCE_{it} + \beta_6 HCE_{it} \text{ x} RCE_{it} + \beta_7 HCE_{it} \text{ x } CEE_{it} + \beta_8 Size_{it} + \beta_9 Lev_{it} + \varepsilon_{it}$

The above are panel regression equations, the double subscript attached to each variable indicate that these equations are different from a purely time-series or cross-section regression (Singla, 2020). Here, *i* denotes the cross-sectional dimension, *t* represents the time-series dimension, β is constant over time and specific to an individual firm *i*. $\beta_1 \ldots\ldots \beta_9$, are the coefficients of explanatory variable and ε is an error term.

4. Findings and analysis

4.1 Diagnostic tests

In a quantitative analysis, it is crucial to examine the data properties prior to final analysis (Smriti and Das, 2018; Tiwari, 2022). Panel data can suffer from econometric problems such as stationarity, multicollinearity, heteroscedasticity, and serial correlation. To address these issues, this study performed several tests. Firstly, the Levin, Lin and Chu (LLC) test (Levin et al., 2002) was used to confirm the stationarity of the data. The results indicated that all variables were stationarity at levels, which suggested that the series were integrated at order zero, I(0). The LLC test results are presented in Table 5. Secondly, as there are more than two explanatory variables in the regression models, the data may suffer from the

https://doi.org/10.24191/jeeir.v11i1.20695

problem of multicollinearity. This study used Pearson correlation matrix and variance inflation factor (VIF) to examine the presence and severity of multicollinearity. The analysis based on Pearsoncorrelation matrix is presented in table 6. The results indicate the presence of high correlationbetween variables. To mitigate the multicollinearity effect, the variables are separated into model 1 and model 2. Further, the results of VIF values are below 2 confirming the data do notsuffer from multicollinearity issue. Third, the diagnostic checks of heteroscedasticity and serialcorrelation tests are performed after obtaining an appropriate model through pool ability test. The testing of heteroscedasticity and serial correlation are essential in panel data analysis. Thisis because the presence of heteroscedasticity and serial correlation problem would affect the reliability of the model regressions. In order to identify the presence of heteroscedasticity in the data, modified Wald test for groupwise heteroscedasticity in fixed effect regression model was employed. The assumption of the problem lies in the p-value, if the p-value is lesser than 0.05 ($p<0.05$), than reject the null and conclude there is a heteroscedasticity problem (variances are not constant). The results are presented in Table 6. Fourth, to detect if the data has serial correlation problem, Wooldridge test for autocorrelation test was employed. Similar with heteroscedasticity, the assumption of the problem lies in the p-value, if the p-value is lesser than 0.05 ($p<0.05$), than reject the null and conclude that the data has first-order autocorrelation. The results are presented in Table 7.

Table 5. Results of the LLC panel unit root test at levels

Variables	Technology
HCE	21.4562*** (0.0000)
SCE	9.5058*** (0.0000)
RCE	1.1e+02*** (0.0000)
CEE	1.0e+02*** (0.0000)
MVAIC	21.8102*** (0.0000)
ROA	24.9918*** (0.0000)
ROE	27.7222*** (0.0000)
SIZE	1.6e+02*** (0.0000)
LEV	9.7109*** (0.0000)
HCE*SCE	20.5641*** (0.0000)
HCE*RCE	12.9251*** (0.0000)
HCE*SCE	20.5641*** (0.0000)

Note: Values in parentheses are p-values. ***, ** and * indicates rejecting the null hypothesis of non-stationery at the 1%, 5% and 10% at level, respectively. N/A indicating data not available.

https://doi.org/10.24191/jeeir.v11i1.20695

Table 6. Results on heteroscedasticity test

Industry	Model	1(a)	1(b)	2(a)	2(b)	3(a)	3(b)
Technology	Heteroscedasticity Test	2.4e+05	86844.87	58996.71	66725.99	93712.48	1.8e+05
	p-value	(0.0000) ***	(0.0000) ***	(0.0000) ***	(0.0000)***	(0.0000) ***	(0.0000) ***

Note: Values in parentheses are p-values. ***, ** and *, rejecting the null hypothesis indicating the presence of heteroscedasticity problem at the 1%, 5% and 10% at level, respectively.

Since the p-value is <0.05, reject H0. The variances are not constant, and there is a heteroscedasticity problem. Thus, the problem is corrected using robust standard errors.

Table 7: Results of Serial Correlation Test

Industry	Model	1(a)	1(b)	2(a)	2(b)	3(a)	3(b)
Technology	Serial Correlation Test	0.119	0.589	0.009	0.014	0.158	0.125
	p-value	(0.7322)	(0.4486)	(0.9260)	(0.9077)	(0.6936)	(0.7261)

Note: Values in parentheses are p-values. ***, ** and *, rejecting the null hypothesis indicating the presence of serial correlation problem at the 1%, 5% and 10% at level, respectively.

Since the p-value is >0.05, the findings support H0. This means no serial correlation problem.

4.2 Descriptive analysis

Descriptive statistics are shown in Table 8. The mean value of ROA and ROE is 0.0427and 0.0530 respectively, suggesting that the sample firms are able to generate profit during theperiod of the analysis. The mean value of MVAIC 3.4778 is the second highest value among the variables after firm size. It indicates that the firms produced an average value of RM3.4778for every RM1 invested showing that intellectual capital plays an important role and is a significant contributor in creating wealth. HCE is an indicator of value added by the human resources, a HCE of 2.963 means for every RM1 invested, the firms created RM2.693 from itshuman capital. Following, SCE of 0.4622 indicated that for every RM1 invested, the firms created RM0.4622 from its structural capital to create value. In terms of RCE, RCE of 0.0626 means for every RM1 invested, the firms created RM0.0626 from its relational capital. Next, CEE of 0.2601 which indicated that for every RM1 invested, the value created from physical capital is RM0.2601. CEE is an indicator of efficiency in generating value from physical capital. It shows that technology firms are efficient in managing both, intellectual capital and physical capital, in creating values.

https://doi.org/10.24191/jeeir.v11i1.20695

Table 8. Descriptive analysis for technology industry

Industry	Variables	Mean	Min	Max	Std.Dev.
Technology	HCE	2.6930	-3.50938	27.8748	3.5604
	SCE	0.4622	-7.1952	5.8058	0.7995
	RCE	0.0626	-0.73443	1.4853	0.1918
	CEE	0.2601	-0.49849	0.5563	0.1564
	MVAIC	3.4778	-6.07903	29.0658	3.7650
	ROA	0.0427	-0.7519	0.3580	0.1416
	ROE	0.0530	-1.0532	0.4651	0.2078
	SIZE	5.3100	0	6.2660	0.7841
	LEV	0.3013	0	0.6792	0.1440
Number of observations: 224					

4.3 Correlation analysis

Table 9 represents analysis from Pearson's correlation coefficient matrix. The correlation values indicated significant positive associations between only several pairs of variables. The correlation value indicated significant positive associations between only several pairs of variables. As expected, MVAIC has significant positive correlations with firm's financial performance, ROA and ROE. It implies that firms with greater intellectual capital efficiency have higher financial performance. Specifically, MVAIC is significantly and positively related to ROA ($r=0.4031$, $p<0.0000$) and ROE ($r=0.3840$, $p<0.0000$), indicating a strong relationship between value efficiency and financial performance. Regarding the components of MVAIC, HCE and CEE, both exhibited significant positive correlations with firm's financial performance, ROA and ROE. CEE has the strongest correlation with ROA ($r=0.6811$, $p<0.0000$) and ROE ($r=0.6464$, $p<0.0000$). Meanwhile, HCE is moderately correlated to ROA ($r=0.3878$, $p<0.0000$) and ROE ($r=0.3668$, $p<0.0000$). It is noted that MVAIC has significant positive relationships with the components of intellectual capital except RCE. MVAIC has the strongest association with HCE ($r=0.9826$, $p<0.0000$), followed by its relationship with SCE ($r=0.3353$, $p<0.0000$), but is weakly correlated with CEE ($r=0.1236$, $p<0.0001$). ROA and ROE are found to be significantly associated with each other with strong a correlation of 0.9752 ($p<0.0000$). Size has a weak but positive and significant association with financial performance measures, ROA and ROE at correlation values of 0.2079 and 0.2194 respectively ($p<0.0000$). However, leverage, the other control variable, has no association with ROA and ROE. Size and leverage recorded a significant positive correlation, but it is a weak association ($r=0.2903$, $p<0.0001$).

Several correlation coefficients values above 0.80 are noticed between HCE and MVAIC (0.9826), MVAIC and HCE*SCE (0.9814), MVAIC and HCE*CEE (0.8714), HCE and HCE*SCE (0.9995), HCE and HCE*CEE (0.8708). Correlation coefficient values above 0.8 indicates a multicollinearity problem (Gujarati et al., 2012). Therefore, HCE and MVAIC are separated into model 1 and model 2. Meanwhile, MVAIC, HCE*SCE and HCE*CEE are separated into model 1 and model 3. Further, the values of variance inflation factor (VIF) are computed to test the presence of multicollinearity and the mean values of VIF for models 1 and 2 are 1.18 and 1.32. The results suggest that a multicollinearity problem between explanatory variables, using a cut-off factor of 10 and below, is weak or non-existent (Tran & Vo, 2018).

However, for model 3 with interaction variables HCE*SCE, HCE*RCE and HCE*CEE, El-Bannany (2002), Tiwari and Vidyarthi (2018), and Tiwari (2022) argue that since the correlation is less than 0.99, multicollinearity should not be considered a serious problem. They cited Neter et al. (1985) who stated that while some or all independent variables in multiple regression are correlated among themselves, this does not inhibit our ability to obtain a good fit in general, nor does it affect inferences about mean responses, as long as these inferences are made within the region of observations. Further, Allison (2012) stated, if we specify a regression model with x, z and xz, both x and z are likely to be highly correlated. However, there is no serious concern of multicollinearity because the p-value for xz is not affected by the multicollinearity.

https://doi.org/10.24191/jeeir.v11i1.20695

Based on the above argument, it is therefore assumed that multicollinearity has no adverse consequences on model 3.

Table 9. Pearson correlation matrix of study variables for technology industry

Variables	HCE	SCE	RCE	CEE	MVAIC	ROA	ROE	SIZE	LEV	HCE*SCE	HCE*RCE	HCE*CEE
HCE	1.0000											
SCE	0.1629**	1.0000										
RCE	-0.0502	-0.5147***	1.0000									
CEE	0.1176*	-0.1188*	-0.0766	1.0000								
MVAIC	0.9826***	0.3353***	-0.1091	0.1236*	1.0000							
ROA	0.3878***	0.0393	-0.0050	0.6811***	0.4031***	1.0000						
ROE	0.3668***	0.0429	0.0234	0.6464***	0.3840***	-0.0179	1.0000					
SIZE	0.2344***	0.1121*	0.0285	0.2509***	0.2573***	0.2079***	0.2194***	1.0000				
LEV	-0.1505**	-0.0972	0.1179*	-0.1423**	-0.1629**	-0.2469***	-0.2253***	0.2903***	1.0000			
HCE*SCE	0.9995***	0.1611**	-0.0516	0.1115*	0.9814***	0.3876***	0.3667***	0.2093***	-0.1588**	1.0000		
HCE*RCE	-0.0972	0.0403	0.6747***	-0.2763***	-0.0605	-0.0994	-0.0445	0.0471	0.1768***	-0.0992	1.0000	
HCE*CEE	0.8708***	0.2085***	-0.1488**	0.2708***	0.8714***	0.4360***	0.4122***	0.1802***	-0.2436***	0.8696***	-0.1771***	1.0000
Number of observations: 224												

Note: ***, ** and * indicate that correlation is significant at the 0.01, 0.05 and 0.1 level respectively.

4.4 Hypothesis testing

There are three main hypotheses developed based on previous research. The first hypothesis is concerned with intellectual capital and profitability, that is a higher value of intellectual capital leads to higher profitability. The second hypothesis is to examine the separate impact of intellectual components on profitability. It is hypothesized that higher values of HCE, SCE, RCE, CEE impact profitability positively. The last hypothesis is to investigate the moderating effect of human capital efficiency on other components of intellectual capital on profitability and the moderations are hypothesized as HCE moderates positively the relationship between SCE, RCE, CEE and profitability. The study does not apply pooled OLS because unobserved effects would result in inefficient estimators. Therefore, fixed effect and random effect models were employed to account for differences across the sample firms. Then, a Hausman test was performed to determine the model estimators. The results show that model 1 and model 3 were estimated using the random effect model while model 2 was estimated using the fixed effect model. Each hypothesis testing is elaborated as follows.

Hypothesis 1:

Table 10 presents the regression results of models 1(a) and 1 (b). The reliability of regression model 1(a) is examined through the values of R2 of 0.2107 and Wald Chi-Sq of 68.61 ($p<0.0000$) which indicate that 21.07% of possible variation in the ROA is explained by the variables in model 1(a) and is statistically significant. MVAIC with the coefficient of 0.0170 is found to be positive and significantly associated with

ROA. The findings imply that as MVAIC increases by RM1, ROA increases by RM0.017. Unexpectedly, size is insignificantly associated with ROA, and leverage is significant but negatively associated with ROA. Concerning model 1(b), the value of R2 is 0.1959 with Wald Chi-Sq of 49.92 ($p<0.0000$) indicating that the variables in model 1(b) are capable of explaining approximately about 20 percent of the variation in the firms' ROE and statistically significant for prediction. MVAIC is positively and significantly associated with ROE. The coefficient is 0.0217, which implies that as MVAIC increases by RM1, ROE increases by RM0.0217. It is noticed that leverage is significant but negatively associated with ROE, while size is insignificantly associated with ROE. The findings support H1, confirming that firms with greater MVAIC, irrespective of size and leverage, tend to have higher profitability.

Table 10. Regression results of model 1

Model	1(a)	1(b)
Variables	ROA	ROE
Cons	-0.0313	-0.0747
t-value	(-0.21)	(-0.43)
MVAIC	0.0170***	0.0217***
t-value	(3.94)	(3.84)
Size	0.0131	0.0235
t-value	(0.59)	(0.66)
Lev	-0.1815***	-0.2412***
t-value	(-2.31)	(-1.34)
R-Sq	0.2107***	0.1959***
Wald Chi-Sq	68.61	49.92
p-value	(0.0000)	(0.0000)
N		224

Note: ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The t-values are stated at robust standard error. N is number of observations.

Hypothesis 2:

Table 11 presents the regression results of models 2(a) and 2(b). Concerning model 2(a),the value of R^2 is 0.5441 with F-value of 69.89 ($p<0.0000$), indicating that the variables in themodel is capable of explaining about 54 percent of the variation in the firms' ROA and the model is reliable for prediction. Two components of intellectual capital, HCE and CEE, are found to be positively and significantly associated with ROA with the coefficient values of 0.0086 and 0.6284, respectively. The findings imply that as HCE and CEE increase by RM1,ROA increases by RM0.0086 and RM0.6284 respectively. SCE is significantly but negatively associated with ROA while RCE is insignificantly associated with ROA. Size is negatively correlated with ROE, while leverage is significantly but negatively associated with ROA. The regression result for model 2(b) reveals that the overall model is reliable with R2 of 0.4695 and F-value of 43.08 ($p<0.0001$), suggesting that the model is able to explain about 46.95 percent variation in the firms' ROE and the model is statistically significant for prediction. Two components of intellectual capital, HCE and CEE, are positively and significantly associated with ROE with the coefficient values of 0.0096 and 0.8804. The findings imply that as HCE and CEE increase by RM1, ROE increases by RM0.0096 and RM0.8804 significantly. Both SCE and RCE are negatively associated with ROE. Size is negatively correlated with ROE, while leverage is significantly but negatively associated with ROE. The findings support H2a and

https://doi.org/10.24191/jeeir.v11i1.20695

H2d, confirming that firms with greater HCE and CEE tend to increase profitability. However, the findings do not support H2b and H2c, since SCE and RCE are found to be negatively associated with profitability.

Table 11: Regression results of model 2

Models	2(a)	2(b)
Variables	ROA	ROE
Cons	-0.0474	-0.0892
t-value	(-0.76)	(-0.91)
HCE	0.0086***	0.0096***
t-value	(2.77)	(2.22)
SCE	-0.0099***	-0.0202
t-value	(-0.72)	(-0.72)
RCE	-0.0179	-0.0466
t-value	(-0.35)	(-0.43)
CEE	0.6284***	0.8804***
t-value	(6.64)	(6.00)
Size	-0.0073	-0.0068
t-value	(-0.53)	(-0.31)
Lev	-0.1721***	-0.2133***
t-value	(-1.99)	(-1.28)
R-Sq	0.5441***	0.4695***
F-stat	69.89	43.08
Sig F-stat	(0.0000)	(0.0000)
N	224	

Note: ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The t-values are stated at robust standard error. N is number of observations.

Hypothesis 3:

Table 12 presents the regression results of models 3(a) and 3(b). The fit of regression model 3(a) is tested through the values of R^2 of 0.5899 and Wald Chi-Sq of 527.67 (p<0.0000),suggesting that 59 percent of possible variation in the ROA is explained by the variables in model 3(a) and the model is reliable for prediction. This model investigates the moderating roleof HCE. For the interaction effect, only HCE*SCE is found to be positively and significantly associated with ROA with a coefficient of 0.5637. As for HCE*RCE and HCE*CEE, both areinsignificantly associated with ROA. Size has a positive and significant association with ROA.However, leverage is negatively associated with ROA. The regression result for model 3(b) reveals that R^2 = 0.5626 and Wald Chi-Sq = 332.95 (p<0.0000), suggesting that the model is able to explain approximately about 56 percent variation in the firms' ROE. As for the moderating role of HCE, HCE*SCE and HCE*RCE are found to be positively and significantlyassociated with ROE. However, HCE*CEE is negatively associated with ROE. Size has a positive and significant association with ROE while leverage is significantly but negatively associated with ROE. The findings support H3a and H3b, confirming that HCE moderates SCEand RCE. However, the findings do not support H3c since HCE does not moderate CEE.

Table 12: Regression results of model 3

Models	3(a)	3(b)
Variables	ROA	ROE
Cons	-0.0105	-0.0347
t-value	(-0.18)	(-0.62)
HCE	-0.5547***	-0.7611***
t-value	(-3.52)	(-3.44)
SCE	-0.0062	-0.0147
t-value	(-0.68)	(-0.82)
RCE	-0.0174	-0.0598

t-value	(-0.49)	(-0.78)
CEE	0.6376***	0.8860***
t-value	(9.48)	(8.14)
HCE x SCE	0.5637***	0.7732***
t-value	(3.64)	(3.54)
HCE x RCE	0.0422	0.1371**
t-value	(-0.59)	(-0.43)
HCE x CEE	-0.0040	-0.0051
t-value	(0.07)	(0.19)
Size	0.0876***	0.1210***
t-value	(3.63)	(3.25)
Lev	-0.1483***	-0.1954***
t-value	(-1.58)	(-0.99)
R-Sq	0.5899***	0.5626***
F-stat	527.67	332.95
Sig F-stat	(0.0000)	(0.0000)
N	224	

Note: ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level respectively. The t-values are stated at robust standard error. N is number of observations.

4.5 Discussion

The study's first research objective is to examine the effect of intellectual capital on profitability of technology firms. The MVAIC model was employed to measure intellectual capital, while ROA and ROE served as proxies for profitability. The empirical findings of the study support H1, revealing a significant positive relationship between MVAIC and the profitability of technology firms in Malaysia, as indicated in models 1(a) and 1(b). Therefore, managers of technology firms should recognize the importance of utilizing intellectual capital to enhance their profitability by gaining a better understanding of intellectual capital and putting in greater effort on its management. This is particularly important as Malaysia is currently operating in a knowledge-based economy, where firms' reliance on intellectual capital as a source of competitive advantage is greatly emphasized. These results align with prior research findings (e.g., Al-Musali & Ku Ismail, 2016; Nimtrakoon, 2015; Ousama et al., 2019; Ozkan et al., 2017; Xu & Li, 2019), indicating that firms with higher levels of intellectual capital exhibit higher profitability. However, the coefficient values are relatively low (0.0170 and 0.0217), suggesting limited investment in intellectual capital by technology firms in Malaysia. Therefore, it is crucial for firms to invest adequately in intellectual capital to promote growth and seek favorable government policies for the development of intellectual capital in the technology sector (Tiwari, 2022).

The second research objective is to examine the separate effects of HCE, SCE, RCE and CEE on profitability. By measuring the relationships between the components of MVAIC and profitability, the results in models 2 (a) and 2 (b) show that both HCE and CEE have a significant positive impact on the profitability of technology firms. The significant and positive relationship between human capital and profitability suggests that an increase in HCE has a positive impact on profitability, thus endorsing the resource-based theory. This finding is essential for stakeholders who consider investment in employees as expenses (Firer & Williams, 2003; Nadeem et al., 2017). Therefore, firms should focus on employees and formulate strategies related to the training and development of human resources. Although both HCE and CEE were positively and significantly correlated with profitability, CEE recorded a higher efficiency level. As the technology sector in Malaysia is still developing, the findings of the study suggest that profitability is primarily driven by CEE, which is consistent with the studies of Chowdhury et al. (2018) and Ozkan et al. (2017). Therefore, the findings of the study suggest that both, physical capital and human capital affect profitability, and the utilization of intellectual capital is still at a low level, endorsing the resource-based theory. This is consistent with the findings of Firer & William (2003) and Nadeem et al. (2017) who argued that physical capital has always been a significant factor influencing the profitability of the firms in emerging markets. However, it was noted that for both models, SCE and RCE had a negative and insignificant association with profitability, indicating that structural capital efficiency and relational capital efficiency have no impact on firm profitability. The result is consistent with the studies by Nawaz and Haniffa (2017) and Ozkan et al. (2017). It indicates that firms in the technology sector cannot fully harness the potential of structural capital and relational capital to maximize stakeholder value.

From the above findings, it can be concluded that firms in the technology sector produce substantially more value from human capital and capital employed. The findings imply that firms place a great emphasis on human capital, suggesting that they invest in employee training programs to enhance employee skills and expertise.Additionally, firms in the technology sector also create value by focusing on capital employed, as capital employed is determined by the usage of tangible assets. Nonetheless, the findings of the study suggest that the resource- based theory alone is insufficient to explain the relationship between the components of Intellectual capital and firm profitability. These findings partially support H2 and partially endorse the resource-based theory.

The final research objective of this study is to investigate the moderating effect of HCE on the relationship between SCE, RCE, CEE, and profitability. After adding interaction variables to the components of MVAIC, the result showed that HCE*SCE had a positive and significant association with ROA, and both HCE*SCE and HCE*RCE had positive significant associations with ROE, indicating that HCE positively moderates the effects of SCE and RCE. However, the relationship between HCE*CEE was insignificant, partially supporting H3. These findings suggest that employee knowledge is a valuable asset of human capital that can be used to foster innovation, improve process, and develop patents, thereby, supporting the organizational learning theory. Furthermore, in line with the resource dependency theory, Smriti and Das (2018) supported Nadeem et al. (2017) argument that firms, as an open system, depend on external opportunities such as the changes in customer demand to enhance profitability. Therefore, the significance of the interaction variables implies that the organizational learning theory and the resource dependency theory complement the resource-based theory in creating value for firms. These findings are consistent with Tiwari (2022) and Sardo et al. (2018) studies, which found that human capital efficiency positively moderates the relationship between structural capital efficiency and profitability, and between relational capital efficiency and profitability, respectively.

As indicated by the R2, the study yielded several noteworthy findings regarding the model explanatory power. Notably, the R2 value of model 3 surpassed that both model 1 and model 2, which suggests that the incorporating a moderating variable into the models increases their explanatory capacity, thereby lending support to the use of interaction variables. Additionally, the regression results revealed that when investigating the impact of intellectual capital on profitability of technology firms, ROA should be prioritized over ROE, given that the R2 values of ROA models are comparatively higher. Similar findings have been reported by Clark et al. (2011), Tiwari & Vidyarthi (2018) and Vishnu & Gupta (2014).

Regarding the two control variables in the study, namely leverage and firm size, the analyse indicated that the coefficient values of leverage were negative but significant across all the models, implying that leverage has an inverse relationship with profitability. This pattern aligns with the pecking order theory, which posits that the higher the profitability, the lower the leverage ratio of the firm. Accordingly, technology firms prioritize internal funding first, followed by new equity, and lastly debt when considering sources of financing. Notably, the coefficient values for firm sizes in models 1(a) and 1(b) were positive but insignificant, while those models 2(a) and 2(b) were negative and insignificant, indicating that firm size, regardless of whether it is big or small, does not influence profitability. However, the introduction of interaction variables in model 3 yielded significant positive relationships between firm size and profitability.

https://doi.org/10.24191/jeeir.v11i1.20695

5. Conclusions

The present study provides theoretical and managerial implications based on its findings. Theoretical contributions include the use of the employs MVAIC model, which incorporates relational capital along with human capital and structural capital. While prior research has focused primarily on the latter two, the inclusion of relational capital provides a comprehensive measurement of intellectual capital in the context of Malaysia. Additionally, this study examines the moderating effect of human capital on the relationship between intellectual capital and profitability of technology firms, which is an understudied area in Malaysia. The findings emphasize the importance of resource-based theory in explaining the positive impact of firms' resources on profitability, and the study also employs organizational learning and resources dependency theories to explain the exclusive nature of intellectual capital and its components in increasing firms' strategic management and profitability.

Several managerial implications arise from the study. The findings suggest that physical capital is still relevant in today's knowledge-based economy and contributes significantly towards growth and profitability. Therefore, managers should focus on optimizing the utilization of physical assets to achieve a high level of profitability. Human capital is another significant component of intellectual capital that has a positive impact on the profitability of technology firms. As such, managers should invest in strengthening the personnel structure and provide continuous training to enhance human capital. The study also finds that structural capital and relational capital, when acting independently, do not create value. However, their impact on profitability is contingent upon the level of human capital investment. When firms invest in human capital, they are better places in establishing and maintaining relationships with key stakeholders, leading to enhanced profitability.

This study has some limitations that future research could address. First, the study's generalizability is limited to a single industry and country. Future research could use data from multiple countries and industries for better generalization. Second, the study focuses solely on the intellectual capital framework using the MVAIC model. Future research could expand on this framework by incorporating research and development, risk management, management control system, and strategy development.

https://doi.org/10.24191/jeeir.v11i1.20695

Acknowledgements

The authors would like to express their gratitude to IPSIS, Universiti Teknologi MARA, Malaysia, for their valuable support in completing this research project. Additionally, the authors would like to extend their thanks to the IJEER's editorial team and reviewers for their assistance and valuable feedback. The kindness and competence of everyone involved have significantly contributed to the success of this study. Lastly, this research project was conducted as part of Shaira Arwine's MSc thesis under the supervision of Dr Hapsah S. Mohammad.

Conflict of interest statement

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of any conflicting interests.

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Shaira Arwine Shairi carried out the research which includes the technical computations, wrote the paper, assisted in preparing the manuscript formatting. Hapsah S. Mohammad supervised the research progress and approved the article submission. Both authors discussed the results and contributed to the final manuscript.