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ORIGINAL ARTICLE

The impact of intellectual capital efficiency on value creation in video game industry—An evidence from Taiwan

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ABSTRACT

In light of the metaverse's vast expansion, it's a crucial intellectual platform that's transforming the video game industry and spurring creative innovation and technological advancement. Considering the distinctive niche that Taiwan occupies within the realm of the video game industry, this study uses a total of 11 video game companies in Taiwan as samples. The study spans a period of 16 years, from 2007 to 2022, and utilizes the random effect regression model for analysis. The study results illustrate that intellectual capital efficiency exerts varying contributions to the creation of value across different corporate value indicators within the video game industry. Among the factors, HCE, SCE, and CEE demonstrate the highest explanatory power for ROE, reaching up to 82.23%. Following this, they account for 73.57% of the variance in market share, but only a meager 13.67% for Tobin's Q. This study is the empirical evidence that different methods of measuring intellectual capital and various definitions of value creation in an industry may lead to divergent results and managerial implications in intellectual capital research. Hence, it is worthwhile for subsequent studies to continue clarifying and delving deeper into these aspects.

KEYWORDS

online game industry; intellectual capital; financial performance; firm value; VAIC™

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1. Introduction

As the global prevalence of hardware technology and the internet continues to grow, there has been a notable surge in the public's appetite for gaming entertainment (Marchand and Hennig-Thurau, 2013). This phenomenon has consequently led to the rapid expansion of the game industry on a worldwide scale. The burgeoning interest in gaming can be attributed to the accessibility and advancements in technology, which have significantly transformed the way people engage with interactive entertainment (Xi et al., 2022). Under the COVID-19 outbreak in 2020, consumer behavior and preferences have gradually changed, which has also brought good revenue to the video game industry (Citerne et al., 2023; Evenson et al., 2023).

Currently, the digital video gaming market is in the stage of continuous expansion and application of business opportunities, and the industry growth trend is constantly rising. It is one of the most noteworthy industries in recent years. According to Wijman (2022), the worldwide video game industry had a value of $184.4 billion in 2022, with approximately 3.2 billion players globally. The report further anticipates that by 2025, the international gaming market will yield revenues amounting to $211.2 billion.

Petrash (1996) advanced a model illustrating diminishing returns from financial capital juxtaposed with escalating returns from intellectual capital. This suggests that a consistent augmentation of intellectual capital might catalyze sustainable growth within business enterprises. While the gaming sector is distinctively knowledge-intensive, there is a conspicuous absence of academic exploration into the modalities of value creation within this domain (Marchand and Hennig-Thurau, 2013). Notably, research from the vantage point of intangible assets, especially intellectual capital, remains limited. Hence, this study endeavors to shed light on the pivotal elements underpinning value creation in this industry.

The trajectory of Taiwan's video gaming industry has evolved from the initial era of stand-alone games to subsequent phases of online, web-based games, culminating in the contemporary mobile gaming period. Remarkably, the proportion of gamers in Taiwan surpasses the global mean, and in terms of revenue, the nation's spending prowess ranks among the world's elite. The "2022 Mobile Game Market Report" (SensorTower, 2023) by research firm Sensor Tower identifies Taiwan as the fifth most significant mobile gaming market globally, trailing only the United States, Japan, China, and South Korea. This positioning is striking considering Taiwan's modest population of 23 million, underscoring its extraordinary gaming consumption intensity.

Despite its diminutive size, Taiwan boasts a robust ICT (Information and Communication Technology) infrastructure and operates within a liberal and democratic framework. This environment is enticing for global gaming giants. Prominent entities such as the American game developer Blizzard Entertainment and Korean game producer NCSOFT, with their respective offerings like "Battle" and "Paradise W", have elected to debut their products in Taiwan, subjecting them to preliminary testing before broader global releases. This preference underscores the global significance and representation of Taiwan's video gaming sector.

Drawing on the research of Blalock and Gertler (2004) and Moogk (2012), initiating sales in a smaller market offers the tangible benefit of risk mitigation. Companies can temper the up-front resource commitment until the product's viability is ascertained. Upon gleaning feedback and accruing experiential insights from preliminary marketing and sales endeavors, the gaming industry can then judiciously channel significant resources towards expansive global marketing campaigns. This iterative approach stands as a pivotal marketing strategy, especially in the high-stakes domain of video gaming.

This study aims to observe how intellectual capital efficiency creates different forms of business value, hoping to inspire the operational strategies in the gaming industry. We focus on the gaming environment in the iconic Taiwanese context. Try to answer three important questions: first, what defines intellectual capital in the realm of video games? Second, which aspects of this intellectual asset mainly impact corporate performance, market leadership, and Tobin's Q in the gaming sector? Finally, does the effectiveness of Intellectual Capital produce varying results based on different

value creation frameworks?

The contribution of this paper aims not only to address the research gap identified within the academic community, but also to provide valuable insights that can enhance decision-making and policy formulation for corporate practitioners and investors.

2. Literature review and hypothesis development

2.1. Value creation of the video game industry

Over the last three decades, the video game industry has emerged as a pivotal player in the global entertainment marketplace. Marchand and Hennig-Thurau (2013) delineate the primary business structures, interrelationships among stakeholders, and mechanisms that facilitate value creation and industry prominence. Beyond merely technological infrastructure, the process of value generation in the gaming arena shares intricate ties with other entertainment sectors, wherein societal influences shape individual consumer choices.

The distribution of market shares among game producers epitomizes oligopolistic tendencies. A select few predominant games command a lion's share of the aggregate market (Marchand and Hennig-Thurau, 2013). Clements and Ohashi (2005) illuminated the sway of the "installed base"—referring to the pre-existing console user pool—over game title proliferation. Their findings underscored that an expansive user base incentivizes developers to craft an increased array of titles for popular platforms, thereby enriching the diversity of accessible games.

Video games are susceptible to pronounced network effects. As the consumer cohort expands, the utility and allure of a video game offering grow correspondingly (Shankar and Bayus, 2003). Particularly pertinent to online gaming, the magnitude and caliber of the user community markedly influence the depth of player immersion and gratification (Marchand and Hennig-Thurau, 2013).

Ergo, dissecting the determinants of a dominant stance in the video game sphere can inform a recalibration of the industry's competitive edge, viewed through the lens of strategic foresight, resource allocation, innovative prowess, and stakeholder engagement. Such an analysis is pivotal in highlighting technological impediments and formulating responsive strategies.

Video games are dynamic forms of entertainment that operate on electronic equipment. According to the induction of scholars such as Xi et al. (2022) and Thomes (2015) based on the variations in platform mediums, video games can be divided into several categories: console-based games, handheld device games, arcade-style games, computer-based games, and games designed for mobile devices. Currently, the most flourishing type is the online game category. Its method of creating value is different from traditional stand-alone games. Users will create game value together with online game manufacturers through the process of participating in the game content.

Xi et al. (2022) in his aggregation of studies related to the gaming industry, pointed out that the emphasis of research on video games is progressively moving from areas such as education, information communication, and entertainment culture to matters of economics and industrial development. The multifaceted value of games in the realms of communication, education, and culture is readily apparent. Consequently, the game industry holds significant social external value in terms of its industrial worth. Hence, comprehending the intricate process of value creation within

the game industry warrants academic inquiry.

In Koster's (2018) comprehensive examination of the gaming industry over recent decades, he posed a salient question: which games yield the highest revenues per byte? Upon investigation, he identified three principal attributes that contribute to this high revenue yield. These include their status as evergreen games, their substantial dependence on robust community engagement, the significance of user-created content, and the requirement of player skill, akin to traditional sports.

Marchand and Hennig-Thura (2013) identified a scarcity of research on the value creation process within the video game industry. As a result, they proposed a conceptual framework to elucidate how value is generated in this industry. This framework encompasses various elements such as key industry stakeholders, products, and distribution channels, illustrating their interrelationships. The authors also expressed the hope that future scholars would apply this framework to identify potential avenues for further research, thereby addressing the existing academic gap in the understanding of value creation processes within the game industry.

On the other hand, some scholars have concentrated their efforts on determining whether event marketing can be advantageous for companies, potentially driving higher profitability (Szymanski et al., 1993), sales, or in conjunction with the intangibility and heterogeneity characteristic of a product (Schmitt and Zarantonello, 2013; Vila-López and Rodríguez-Molina, 2013).

Gaming is experiencing a state of transformation propelled by the rapid advancement of technology and substantial mergers (Insider Intelligence, 2023). The future value creation and development direction of the game company is oriented towards establishing a fan economy integrated with both virtual and physical elements, by connecting services under its group, including e-commerce, digital payment, digital distribution, digital publishing, and media. The gaming industry is undergoing a gradual expansion from its initial point, line, and surface, forming a larger digital industry chain and ecosystem.

2.2. The impact of intellectual capital on value creation in video game industry and hypothesis development

Drawing on the scholarly insights of Stewart (1999), Edvinsson and Malone (1997), and Smith and Parr (2000), intellectual capital can be dissected into three foundational constituents: human capital, structural capital (often termed organizational capital), and customer capital (alternatively known as relationship capital). In the dawning age of information, conceptualizing, evaluating, and quantifying intellectual capital emerges as a potent instrument for gauging the inherent value of enterprises. Edvinsson and Malone (1997) advocate that a genuine appraisal of corporate value can be distilled by rigorously evaluating intellectual capital. Osborne (1998) postulates that accountants ought to immerse themselves in the realm of intellectual capital, positioning it as a linchpin for furnishing a more precise valuation of enterprises anchored in accounting data.

Human capital encapsulates the strategic convergence of human resources within an organization, fostering alignment, and leveraging expertise to amplify business efficacy or elevate corporate value. Companies harness human capital by investing in employee development, refining their specialist know-how, acumen, and experience, all with an eye on engendering business value and bolstering organizational performance. Invariably, the full potency of human capital is realized when synergistically interwoven with structural and customer capital. This synergy crystallizes through

the dynamic processes of collective convergence, consensus forging, and the adept application of expertise. The primary aspiration of human resource strategies is the nurturing of employees, thereby augmenting their intangible reservoirs of knowledge, competencies, and experience, which in turn propels corporate performance and crafts tangible organizational value. Fey et al. (2000) underscore that the compensation packages extended to both managerial echelons and rank-and-file employees stand as pivotal facets of human capital, exerting a profound influence on organizational outcomes. Therefore, this study establishes Hypothesis H_1.

H_1: Human capital efficiency coefficient has a positive statistically significant impact on value creation in video game industry.

Structural capital, as elucidated by Stewart (1999), manifests its utility via the embedded infrastructure within an organization. Esteemed scholars such as Edvinsson and Malone (1997), Stewart (1999), and Sveiby (2001) emphasize that legacy organizations, buoyed by a protracted operational tenure, generally outperform their nascent counterparts in terms of effectiveness.

Structural capital derives its potency from the intrinsic organizational framework. Notably, the intensity of Research & Development (R&D) initiatives and the tally of approved patent rights frequently serve as surrogate metrics for gauging internal structural capital or what is occasionally termed "innovation capital". The seminal works of Edvinsson and Malone (1997), Stewart (1999), and Sveiby (2001) collectively corroborate the proposition that investments channeled into R&D or the acquisition of patent rights epitomize pivotal elements of structural capital with a substantial bearing on a firm's valuation. Legacy organizations, fortified by their extended operational trajectories, inherently exhibit enhanced stability compared to their fledgling counterparts. Such organizations, by virtue of their longevity, are adept at fostering robust external liaisons and collaborations. Furthermore, they invariably command a competitive edge in amassing a repertoire of patents, trademarks, brand equities, and intellectual property rights. Anchored in these insights, this research forwards Hypothesis H_2.

H_2: Structural capital efficiency coefficient has a positive statistically significant impact on value creation in video game industry.

Capital employed efficiency coefficient (CEE) encapsulates the quintessence of VAIC^{TM}, portraying the value augmentation incepted through shareholder equity investments. A resounding CEE is an emblem of corporate adeptness in harnessing shareholder capital to yield substantial profits.

A towering CEE is often emblematic of a corporate competitive edge. This is particularly pertinent in industries characterized by pronounced economies of scale, such as the video game domain. As the company's operational scale magnifies, the overarching costs associated with development and sustenance are apportioned across an ever-expanding user base, facilitating a decrement in per-unit costs. Such an economic dynamic endows the company with heightened competitive prowess and an expanded market footprint.

In the intricate tapestry of the gaming landscape, innovation reigns supreme. Companies with a stellar CEE are typically trailblazers, perpetually steering the helm of innovation. This innovative ethos equips them with the capability to incessantly unveil novel products and avant-garde features, tailored to satiate consumer appetites and carve a competitive niche in an industry rife with

contenders.

Moreover, in the gaming arena, companies that sport a commendable CEE are invariably recognized for their commitment to excellence. They curate top-tier products and services that resonate with gamers, fostering an ecosystem of trust and allegiance. This cultivated loyalty not only amplifies their market presence but also bolsters their competitive stature, enabling them to stay ahead in the dynamic world of video gaming. As such, this paper proposes Hypothesis H_3.

H_3: Capital employed efficiency coefficient has a positive statistically significant impact on value creation in video game industry.

3. Methodology

3.1. Research scope and framework

While scholarly pursuits related to the video gaming domain have seen an uptick, the quantum of academic focus it garners pales in comparison to other sectors (Marchand and Hennig-Thurau, 2013). Zhu (2020) attributed this oversight to the industry's pronounced reliance on process capital, its penchant for innovation, the inherent value addition, and its concentrated knowledge base. Compared to traditional manufacturing, its business model, marked by distinctiveness, presents inherent challenges for external comprehension.

In this study, the spotlight is trained on the gaming landscape within the emblematic Taiwanese domain. The research framework is shown in **Figure 1**. Our empirical methodology grapples with three salient queries: firstly, what constitutes intellectual capital within the video game milieu? Secondly, which facets of this intellectual reservoir predominantly influence corporate vitality, market dominance, and Tobin's Q within the gaming echelon? Lastly, does the efficiency of intellectual capital yield divergent empirical outcomes anchored to distinct paradigms of value genesis?

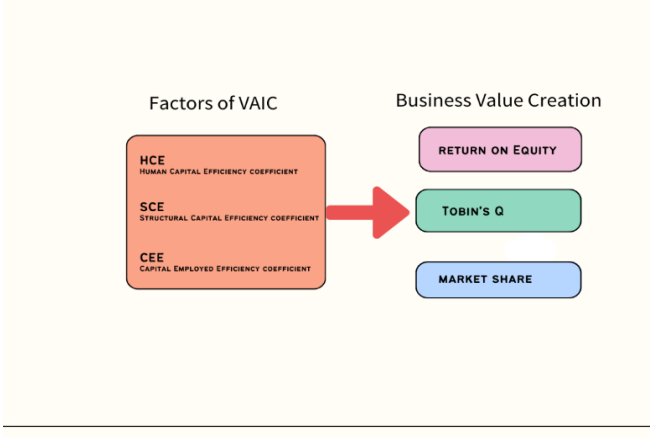

Figure 1. Research framework.

This inquiry delves deep into the quintessential role of value-added intellectual capital efficiency in the gaming realm, exploring its ramifications across three pivotal business value creation metrics: namely, a firm's fiscal performance (ROE), its marketing prowess, and intrinsic market value (Tobin's Q) (Agomor et al., 2022; Castro et al., 2021; Chen and Rahman, 2023; Suksarmrong et al., 2023).

Herein, ROE is positioned as a holistic metric assessing organizational vigor (Ali et al., 2022; Nguyen, 2023), market share signifies operational distinctiveness crucial for industry success, and Tobin's Q emerges as an indispensable tool for gauging a firm's intangible asset worth. Through this lens, the study aspires to elucidate how intellectual capital efficiency manifests varied business values, thereby informing operational strategies within the gaming industry.

3.2. Value added intellectual capital (VAIC™) of video game industry in Taiwan

The value added intellectual capital efficiency factor of intellectual capital (VAIC™) emerged from a model conceived by Pulic (2000), drawing inspiration from the categorization methodology heralded by Skandia. In contrast to traditional metrics which pivot around quantity, revenue, and profit, VAIC™ underscores the primacy of a novel evaluative paradigm tailored for the knowledge-driven economy. This new metric emphasizes the nexus between value creation and resource efficiency, effectively heralding a shift towards prioritizing quality, value, and efficiency in knowledge-centric enterprises.

VAIC™ serves as an astute analytical instrument, furnishing managers, shareholders, and other pertinent stakeholders with a lucid insight into a firm's adeptness at resource utilization for value augmentation. Firer and Williams (2003) delineated three salient rationales underscoring the adoption of (VAIC™):

1) It facilitates a homogenized and coherent platform, enabling apples-to-apples comparisons across multinational corporations and diverse industries (Pulic, 2000).
2) Rooted in certified financial data, VAIC™'s empirical foundation ensures its assessments are objective and subject to verification, bestowing it with an unmatched credibility (Pulic, 2000).
3) Its inherently intuitive conceptual framework not only enhances comprehension among a broad spectrum of stakeholders, but also renders its computational aspect relatively straightforward (Bornemann et al., 1999).

In essence, VAIC™ epitomizes a paradigm shift in corporate assessment, emphasizing the strategic leveraging of intellectual assets to drive enterprise value in our increasingly knowledge-oriented global economy.

The VAIC™ formula (Pulic, 2008) is as follows:

$$VAIC^{TM} = HCE + SCE + CEE$$

where:

VAIC™: Value added intellectual coefficient
VA: Value added = operating profit + employee costs + depreciation + amortization
HCE: Human capital efficiency coefficient = VA/total salary and wages
SCE: Structural capital efficiency coefficient = (VA – total salary and wages)/VA
CEE: Capital employed efficiency coefficient = VA/book value of the net assets

Pulic (2000) contends that a comprehensive measurement of intellectual capital's value and efficiency must encompass three integral facets: the efficiency coefficient of human capital, the efficiency coefficient of structural capital, and the efficiency coefficient of capital employed. VAIC™

offers businesses a lens to strategically marshal resources to engender optimal value addition, spotlighting the intricate interplay between value creation and resource deployment.

Figure 2 delineates the evolution of revenue and value-added (VA) for a cohort of 11 companies within the Taiwanese video industry spanning from 2007 to 2022—a 16-year trajectory. The graph, punctuated by orange bars, manifests a modest ascension in revenue. In juxtaposition, the blue VA bars sketch a pronounced V-shaped trajectory. A granular inspection of VA intimates an intensification of industry rivalry from 2011 to 2015, a period marked by the influx of nascent corporations and indie developers, culminating in market saturation and an escalation in user acquisition costs. It was only in the advent of 2016 that the industry exhibited signs of resurgence, subsequently registering consistent annual growth. Crucially, VA offers a more nuanced reflection of the collective contributions of the workforce and management towards value generation. This resonates with Pulic's (2008) discourse, which posits Value Added as a bellwether of entrepreneurial triumph, adeptly encapsulating both inputs and outputs.

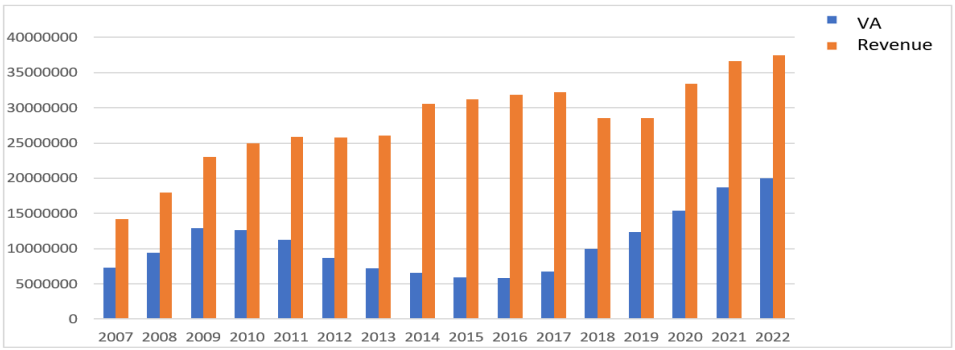

Figure 2. The revenue and value-added (VA) of Taiwan's video industry (2007–2022).

Figure 3 unfurls the yearly trajectories of HCE, SCE, and CEE for the representative 11 entities within Taiwan's video domain from 2007 to 2022. The visual representation underscores the disparate trends of these three indices. HCE's trajectory is characterized by a descent leading up to 2016, succeeded by a consistent ascent post-2016. In stark contrast, SCE exhibits pronounced volatility, reaching its zenith in 2020 amidst the onset of the COVID-19 pandemic. However, this spike was short-lived, with 2021 witnessing a precipitous decline, reverting to levels reminiscent of 2017.

3.3. Regression models

To guarantee the comprehensiveness of the data, the research timeframe incorporated the impacts of both the 2008 global financial crisis and the 2020 COVID-19 pandemic, with data collection spanning from 2007 to 2022. And the annual report data is used for a total of 16 years. The research sample is taken from the video game companies in Taiwan that have been listed on the Taiwan Stock Exchange or the OTC Center as the research object, a total of 11 companies, and a total of 176 sample observations.

This study characterizes the triadic indicators of corporate value creation—ROE, Tobin's Q, and each company's market share as the dependent variables and adopts the three dimensions of intellectual capital efficiency proposed by Public (2008)—human capital efficiency coefficient

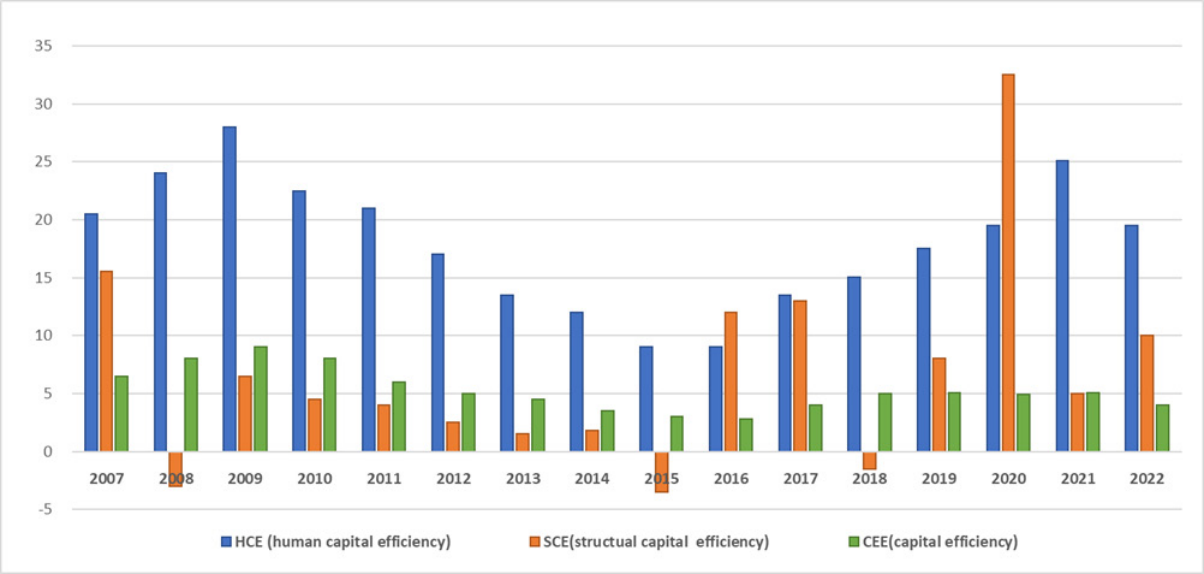

Figure 3. The annual index of HCE, SCE and CEE in Taiwan's video industry (2007–2022).

(HCE), structural capital efficiency coefficient (SCE), and capital employed efficiency coefficient (CEE)—as the independent variables.

Given that the data used in this study is an unbalanced panel data with time-related characteristics, there are differences between the independent and dependent variables across different years in the regression analysis. Therefore, it is necessary to control for the time effect when conducting the regression. Moreover, given the significant operational and business differences among the 11 firms, there is an implied need to control for firm heteroscedasticity during regression. Consequently, this study employs fixed effects and random effects for regression estimation with panel data.

The distinction between the fixed effects model and the random effects model is made using the Hausman test. The analysis for regression model is conducted using Python programming. The null hypothesis for the Hausman test is: H_0: Random effect model, with the alternative hypothesis being H_1: Fixed effect model. If the *p*-value of the Hausman test statistic is less than the significance level of 1%, it suggests rejecting H_0, indicating that the fixed effect model is more appropriate. Conversely, if the *p*-value is greater than the 1% significance level, it means that H_0 cannot be rejected, making the random effect model a better choice.

The three basic regression models were established as follows:

$$\text{Model I: } ROE_{it} = \alpha_{it} + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 LEV_{it} + \beta_5 ASSETS_{it} + \varepsilon_{it} \quad (1)$$

$$\text{Model II: } MS_{it} = \alpha_{it} + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 LEV_{it} + \beta_5 ASSETS_{it} + \varepsilon_{it} \quad (2)$$

$$\text{Model III: } TQ_{it} = \alpha_{it} + \beta_1 HCE_{it} + \beta_2 SCE_{it} + \beta_3 CEE_{it} + \beta_4 LEV_{it} + \beta_5 ASSETS_{it} + \varepsilon_{it} \quad (3)$$

where i is the 11 different online game companies, t is the period 1 to 16, α_{it} is the intercept term of the model, and ε_{it} is the error term of the i-th company in the period t. The dependent variables ROE, market share and Tobin's Q in the above three models are defined and calculated as follows:

1) ROE: return on Equity
2) MS: market share=$Revenue_i/\Sigma Revenue_i$
3) TQ: Tobin's Q = (market value of stock price + book value of liabilities)/book value of assets

(calculated by TEJ database)

Next, the independent variables of the explanatory models I–III are defined as follows:

1) HCE: Human capital efficiency coefficient. It comes from the human capital efficiency coefficient of value added intellectual capital, VAIC™ formula. (VA/total salary and wages)
2) SCE: Structural capital efficiency coefficient. It comes from the structural capital efficiency coefficient of value added intellectual capital, VAIC™. (VA – total salary and wages)/VA
3) CEE: Capital employed efficiency coefficient. It comes from capital employed efficiency coefficient of value added intellectual capital, VAIC™ formula. (VA/book value of the net asset)

In addition, several scholars (Ahn et al., 2006; Astianah and Aji, 2017; Brawn and Aleksandar, 2018) have identified debt and firm size (assets) as influential factors on firm value and performance. In the regression models, these two control variables are defined as follows:

1) LEV: Debt ratio = Total liability/equity.
2) Assets: The total assets on the balance sheet.

4. Findings

In this study, SPSS statistical software and Python programming were used to analyze the data of descriptive statistics, correlation and regression model of the research samples. This section is mainly divided into three subsections, the first subsection is the overall descriptive statistics; the second subsection is the correlation analysis; the third subsection is the three regression models analysis.

4.1. Descriptive statistics of the samples

Table 1 presents the descriptive statistics for the sample data encompassed in this study. The mean VAIC™ stands at 2.714, with the data displaying a rightward skew. This skew suggests that while a number of game companies efficiently harness resources to augment value, a considerable portion struggles in efficient resource utilization. The presence of negative values can be attributed to consistent losses experienced by some companies, resulting in negative VAIC™ figures.

Table 1. Descriptions statistics of the variables.

Variables	Min.	Max.	Average	Std.	Skewness	Kurtosis
VAIC™	–6.447	28.225	2.714	2.767	4.541	42.01
ROE (%)	–141.54	135.65	6.59	31.623	–0.639	4.5649
MS (%)	1.10	4.18	6.8	9.81	194.3	294.99
TQ	–0.07	12.61	2.46	1.869	1.837	5.198
HCE	–1.673	5.918	1.620	1.023	0.644	3.2261
SCE	–6.564	28.281	0.615	2.672	7.151	68.63
CEE	–0.614	1.559	0.480	0.311	0.069	2.0898
LEV (%)	9.2	345.8	63.8	61.873	2.16	5.37
ASSET	15,617	16,814,830	3,033,309	3,604,210	1.755	2.3354

** N = 173.*

The central measures for return on equity (ROE), Tobin's Q, and market share (MS) are 6.59%, 2.46%, and 9.81%, respectively. ROE's distribution leans leftward. Its minimum and maximum values depict a broad disparity, signaling the presence of substantial discrepancies in business performance amongst individual firms within Taiwan's video game industry.

A Tobin's Q value averaging at 2.46 signifies that the market perceives the company's assets' market value to be over twice the tangible assets' replacement cost. Such a high figure accentuates the market's valuation of the firm's intangible assets. It implies a robust market acknowledgment of the enterprise's intellectual capital, brand equity, or other non-tangible assets. This further indicates an investor sentiment that the company possesses noteworthy growth prospects.

Focusing on the three intellectual capital dimensions—human capital efficiency (HCE), structural capital efficiency (SCE), and capital employed efficiency (CEE)—all their mean values are positive. HCE and CEE data show a mildly positive skew. In contrast, SCE not only skews positively with a notable value of 7.151, but also presents a pronounced kurtosis. This intensified kurtosis suggests that SCE data points are largely concentrated around the mean, with fewer extreme values compared to a normal distribution. The data's distributional characteristics provide pivotal insights into the efficiency and variability of intellectual capital components within the Taiwanese video game sector.

In terms of control variables, the average assets of NT$3,033,309,000 (approximately US$101,110,300) indicates that there are differences in the business scale of the research samples; the average ratio of total liabilities to total assets (LEV) of sample companies is 63.8%.

4.2. Correlation analysis

Table 2 is the correlation coefficient table of the sample variables of this study. The table presents the two-tailed test of the Pearson correlation coefficient, analyzing three dependent variables, three independent variables and two control variables, totaling eight variables. Through the analysis of the Pearson correlation coefficient, the correlation between the variables is discussed. The correlation coefficients between variables are between 0.009 and 0.8671 in absolute value, and most of them belong to low-medium correlation.

Table 2. Correlation coefficient of the variables.

Variables	ROE (%)	MS (%)	TQ	HCE	SCE	CEE	LEV	ASSET
ROE (%)	1	0.2132***	0.230**	0.8576***	–0.2184***	0.7626***	–0.3056	0.2313***
MS (%)		1	–0.167**	0.2645***	–0.0373	0.1013	0.0446	0.8671***
TQ			1	0.193**	0.009***	0.261***	–0.289***	–0.190**
HCE				1	–0.1386	0.6845***	–0.2264	0.2966***
SCE					1	–0.1843**	0.1011	–0.0349
CEE						1	–0.0667	0.0200
LEV							1	0.0741
ASSET								1

*Note: *** 1% significance level; ** 5% significance level; * 10% significance level.*

4.3. Regression models results

In this section, we critically examine the impact of three principal independent variables: human

capital efficiency coefficient (HCE), structural capital efficiency coefficient (SCE), and capital employed efficiency coefficient (CEE) on a company's return on equity (ROE), market share, and Tobin's Q. Firstly, we utilized the test statistic from the Hausman test to determine whether the three regression models in this study should adopt a fixed effects or random effects model, with the results shown in **Table 3**. From the table, it can be observed that all three regression models in this study are better suited for the random effects model. **Table 4** presents the estimation results from the panel data regression using the random effect model.

Table 3. Hausman test of three regression models.

	Model I (ROE)	Model II (Market share)	Model III (Tobin's Q)
Hausman test statistic	4.6194	11.7707	7.0167
p-value	0.5934	0.0672	0.3193
Fixed or random effect model	Random	Random	Random

Table 4. The regression results (random effect model).

Dependent variables		ROE (Model I)			Market share (Model II)			Tobin's Q (Model III)			
		Coefficient	*t*-value		Coefficient	*t*-value		Coefficient	*t*-value		VIF
Constant		–35.192	–13.432	***	0.0066	0.5524		1.8755	4.459	***	6.061
Independent	HCE	16.091	10.403	***	–0.0081	–1.5826		0.1623	0.8672		2.439
	SCE	–0.6422	–1.6721	*	0.0003	0.0012		0.0773	1.6911	**	1.045
	CEE	39.311	8.1667	***	0.0425	2.3011	***	0.5999	2.0874	***	2.126
Control	D/E	–0.0077	–4.302	***	-9.00×10^{-8}	–1.4241		–0.0041	–1.7808	*	1.122
	ASSET	7.18×10^{-7}	2.0695	**	1.97×10^{-8}	12.085	***	-2.12×10^{-8}	–0.362		1.226
	F	156.12***			31.336***			4.7482***			
	Adj R^2	0.8223			0.7357			0.1367			

*Note: *** represents 1% significance level; ** represents 5% significance level; * represents 10% significance level.*

The variance inflation factor (VIF) serves as a diagnostic measure to assess multicollinearity. A VIF value exceeding 10 suggests pronounced collinearity amongst the independent variables, implying a high degree of correlation between them. As delineated in **Table 4**, the VIF values for each independent variable concerning the dependent variable remain below 5. This underscores that the degree of multicollinearity in the three regression models is negligible.

Model I, utilized to evaluate hypotheses H_1, H_2, and H_3, showcases commendable model fit (*F*-value is 156.12, *p*-value approximates 0), boasting an R-squared of 82.23%. The empirical evidence underpins significant interactions between the triadic efficiency metrics and the business performance indicator, ROE. Notably, both HCE and CEE of Taiwanese video game enterprises positively correlate with corporate ROE. Contrastingly, SCE negatively influences ROE. These outcomes partially validate Hypotheses H_1 and H_3 posited in this investigation. However, the empirical results diverge from Hypothesis H_2.

Model II delineates the dynamics between the three intellectual capital efficiency metrics and market share dominance. The regression statistics indicate a robust model fit (*F*-value is 31.336, *p*-value is close to 0), with an R-squared value of 73.57%. It was found that human capital

efficiency coefficient and market share of the company had a negative relationship with a coefficient of –0.0081. Although the coefficient did not reach statistical significance, it indicates that the human capital of Taiwan's video enterprises has a negative impact on market dominant. However, there is a positive relationship between capital employed efficiency coefficient and market shares, with a coefficient of 0.0425 ($p < 0.01$), indicating that the capital employed efficiency of Taiwanese video game industry companies has a positive relationship with company's market shares. In the Model II analysis, a clear consistency was solely observed with H_3. Intriguingly, HCE presented a negative correlation with market shares, which implies an inverse impact relationship. Conversely, SCE did not demonstrate any significant statistical relationship with market shares, contradicting H_2.

Lastly, Model III, purposed to discern the interplay between intellectual capital efficiency measures and Tobin's Q, presents a moderate model fit in comparison to its predecessors. The model statistics read as *F*-value: 4.7482 ($p < 0.01$), with an R-squared of merely 13.67%. Within this model's purview, both structural capital efficiency (SCE) and capital employed efficiency (CEE) demonstrates statistical significance in relation to the dependent variable (Tobin's Q).

5. Discussion

This research seeks to understand the mechanisms through which the Taiwanese video game industry leverages its resources to magnify business value. The study contemplates three key questions: firstly, it delves into the role of intellectual capital within the video game industry's paradigm. With the value-added (VA) considerably surpassing revenue, there emerges a significant variance. Moreover, VAIC^{TM} is identified as an invaluable tool for optimizing resource allocation and amplifying organizational value. Secondly, the study dissects the components of intellectual capital efficiency that most profoundly influence return on equity (ROE), market shares, and Tobin's Q in the video game realm. Lastly, it underscores how the interpretation of value added intellectual capital efficiency varies empirically based on the three distinct definitions of value creation employed.

5.1. The impact of HCE, SCE and CEE on value creation of ROE

ROE is indicative of an enterprise's capability to yield income from shareholders' investments, mirroring efficiency in capital utilization. Investment maestro, Warren Buffett, underscores ROE's utility in discerning an enterprise's vitality, making it a cornerstone financial metric in his valuation endeavors.

Model I's findings intimate that in the video game domain, both human capital efficiency (HCE) and capital employed efficiency (CEE) align positively with return on equity (ROE). However, structural capital efficiency (SCE) exhibits an inverse relationship with ROE. HCE's coefficient, standing at 16.091, elucidates its substantial marginal contribution to ROE. This underscores the video game industry's reliance on knowledge creation, rich in human-generated knowledge assets. Traditional financial statement structures, which classify operational expenditures, including wages, as deductions from profit, may not aptly convey the contributions of such intangible assets. This highlights the potential for a more encompassing representation of intellectual resources. In juxtaposition, SCE's negative coefficient of –0.6422 suggests that structural capital undertakings aren't instrumental in magnifying shareholder returns in this industry.

Concomitantly, the positive correlation of capital employed efficiency (CEE) with ROE, as evinced by Model I, signifies the paramountcy of efficient capital utilization in the gaming ecosystem. It underscores the significance of astute capital management, a facet often overshadowed in traditional financial delineations, meriting a meticulous intellectual capital scrutiny.

5.2. The impact of HCE, SCE and CEE on value creation of market shares

Market share, within the gaming ambit, quantifies an enterprise's sales fraction in relation to the industry's aggregate sales over a designated period. An expansive market share confers myriad advantages, from competitive supremacy to enhanced investor trust. Model II's analytics unveil a negative correlation of HCE with market share and a positive association with CEE.

Several hypotheses can elucidate HCE's negative tilt vis-à-vis market share:

1) Technology-driven nature: In video game companies, the application of innovation, automation, and digital technologies might be more decisive than manpower.
2) Product quality and service quality: Market share is largely dependent on the quality of products and services. If a company can provide excellent products and services, it may establish a position in the market, even with relatively fewer human resources.
3) Economies of scale: Economies of scale can reduce costs, increase efficiency, and enhance competitiveness. Consequently, enterprises within the gaming sector may prioritize scaling their operations as a strategic approach to enhancing market share, rather than exclusively depending on an increase in their workforce.
4) Branding and marketing strategies: Brand awareness and marketing strategies may have a larger impact on market share than manpower.

Furthermore, the positive association of CEE with market share underlines the quintessence of adept capital management in driving market presence in the gaming sector.

5.3. The impact of HCE, SCE and CEE on value creation of Tobin's Q

Model III's purview scrutinized the interplay between value added intellectual efficiency coefficients and Tobin's Q. The empirical tapestry reveals SCE and CEE both coefficient exhibiting a positive liaison with Tobin's Q, with HCE remaining statistically indifferent. Given Tobin's Q's calibration pivots on market valuation, an anticipatory metric, it's vulnerable to fluctuations influenced by diverse macroeconomic and microeconomic vectors. Consequently, VAIC™'s explanatory prowess for Tobin's Q is relatively subdued compared to its efficacy with ROE and market share, resulting in a modest explanatory power of 13.67%.

6. Conclusion

This research reveals that the efficiency of value added intellectual capital varies in its influence on value creation across different corporate value metrics in the video game industry. Notably, the indicators HCE, SCE, and CEE provide the most robust explanatory power for ROE, accounting for an impressive 82.23%. In sequence, they explain 73.57% of the variance in market share and a modest 13.67% in Tobin's Q.

Edvinsson and Malone (1997) insightfully posited that the conceptualization, assessment, and

measurement of intellectual capital emerge as potent tools for discerning the value of intangible assets in this digital era. Traditional financial statement metrics may present certain shortcomings, potentially leading to the misrepresentation of some corporate value components. Osborne (1998) contended that accounting professionals should immerse themselves in the realm of intellectual capital. This would empower conventional accounting practices to evaluate a company's genuine worth more accurately.

Our empirical findings underscore that the remuneration tiers for both managerial and non-managerial staff constitute a significant facet of human capital that profoundly influences organizational outcomes. Yet, within the consolidated income statement in financial documents, operational expenses, which encompass salaries and other workforce-related costs, are typically depicted as profit-diminishing entries. This representation, unfortunately, falls short in encapsulating the intangible benefits linked to human resources.

Another pivotal contribution of this investigation lies in its empirical demonstration that divergent methodologies of gauging intellectual capital, combined with assorted definitions of value creation, can culminate in varying outcomes and interpretive implications within intellectual capital scholarship. Consequently, there's an imperative for future research endeavors to elucidate and delve deeper into these nuances. Citing the work of Edvinsson and Malone (1997) as a reference, around 70% of the value of US publicly-traded firms, as measured by Tobin's Q, remains absent from their balance sheets. We contend that for contemporary, knowledge-centric entities, the proportion of corporate worth unreflected in financial documents might even surpass this estimation. The advent of the intellectual capital paradigm indeed ameliorates the inherent deficiencies of traditional accounting methodologies, allowing the outputs of knowledge-driven sectors to be rendered with enhanced clarity and coherence.

In light of these revelations, it's recommended that forthcoming scholarly endeavors employ alternative measurement paradigms to delve deeper into the pivotal determinants influencing the enterprise value within the video game sector. Such investigations could demystify the intricate processes underpinning corporate value creation.

Author contributions

Conceptualization, HHH and GYZ; methodology, HHH; software, HHH; validation, HHH, CYL and GYZ; formal analysis, CYL; investigation, CYL; resources, GYZ; data curation, GYZ; writing—original draft preparation, HHH; writing—review and editing, CYL; visualization, CYL; supervision, HHH; project administration, HHH; funding acquisition, HHH. All authors have read and agreed to the published version of the manuscript.

Data availability

All data underlying the results are available as part of the article and no additional source data are required.

Conflict of interest

No potential conflict of interest was reported by the authors.

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