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INTELLECTUAL CAPITAL EFFICIENCY AND ITS DETERMINANTS

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This study applies a two-stage approach to examine intellectual capital efficiency and its determinants. In the first stage, we evaluate the intellectual capital efficiency of 25 Malaysian software companies by using the data envelopment analysis (DEA) approach. Our findings show that the sample companies have to first improve their technical efficiency, and subsequently scale efficiency. We also provide some information on how much and in which types of intellectual capital an inefficient software company needs to improve. In the second stage, we run ordinary least squares and Tobit regression analyses to examine determinants of intellectual capital efficiency. Sales growth appears to have a significantly positive influence on intellectual capital efficiency. This study may provide some information for software managers to improve their efficiency in intellectual capital management.

Keywords: intellectual capital, data envelopment analysis, efficiency

INTRODUCTION

Since 1980s, a firm's intangible assets, i.e. the various components of a firm's intellectual capital, have been increasingly used in scholarly investigations. In Malaysia, the government has embarked on a mission to develop a knowledge-based economy through the 2002 Knowledge-Based Economy Master Plan. The plan highlights a few strategies to accelerate the transformation of Malaysia into a knowledge-based economy (Economic Planning Unit, 2001). It is designed to enable Malaysia to achieve sustainable economic growth so that we would no longer have to depend solely on capital or physical assets investments.

According to Zéghal and Maaloul (2010), citing the Organization for Economic Cooperation and Development (OECD, 2008), many industries that invest in intellectual capital are growing and competing with physical and financial capital investments. Since the software industry is a knowledge-intensive industry with significant intellectual capital, the development of new software depends on key intellectual inputs such as human structural capitals. Hao (2010) corroborates that technology-oriented software industry has intangible information and therefore needs to understand the mechanics of intellectual capital management efficiency and its determinants.

Igel and Islam (2001) state that the majority of Malaysian software companies have achieved competitive advantages in quality, efficiency, innovation, and responsiveness to customers, focusing largely on customer-needs, people management, and technology. They, however, also note that rapid technological development and human resources are constraints that limit the growth and development of Malaysian software companies. Their findings suggest that intellectual capital plays an important role in the Malaysian software companies' value creation efforts in today's challenging business environment. Therefore, the industry provides us with an appropriate setting to examine intellectual capital management efficiency for the purpose of this study.

We opine that managing intellectual capital efficiently is the key to sustaining a company's competitive edge. As documented by Kujansivu (2009), intellectual capital management should focus on managing and transforming various intangible resources for the creation of values or their maximisation. Following prior studies (for example Wu et al., 2006; Lu et al., 2010; Yang and Chen, 2010; Lu and Hung, 2011), we employ data envelopment analysis (DEA) to evaluate the intellectual capital efficiency management of the Malaysian software industry. Specifically, we utilise the Value Added Intellectual Coefficient (VAIC^{TM}) developed by Pulic (2000) to gauge intellectual capital value because this variable is superior in terms of its practical validity (Clarke, Seng and Whiting, 2011; Mehralian et al., 2012). VAIC^{TM} has been widely found in intellectual capital literature (for example, Tseng and Goo, 2005; Ting and Lean, 2009; Young et al., 2009; Laing, Dunn and Hughes-Lucas, 2010; Phusavat et al., 2011; Rehman, Ilyas and Rehman, 2011). According to Chan (2009), this method offers many advantages to the researcher including objectivity, relevance, usefulness, comparability, simplicity, reliability and consistency with all major definitions as it does not undermine the importance of human capital.

The first stage of analysis in this study is to evaluate the efficiency of Malaysian software companies in managing intellectual capital while in the second stage, we run both ordinary least squares and Tobit regressions to identify the determinants of intellectual capital management efficiency. To the best of our knowledge, there is no research that has examined the effects of a firm's characteristics on intellectual capital management efficiency. Therefore, this study aims to provide such evidence by investigating a sample of Malaysian software companies. For our regression analysis, we apply the ordinary least squares method, following Banker and Natarajan (2008), and Tobit regression, following Barros, Barroso and Borges (2005).

This study makes several important contributions to existing literature on this area. Firstly, we are able to identify companies that are efficient in intellectual capital management. Hence, other software managers can use these companies as benchmarks to improve their own efficiency in managing their intellectual capital. Secondly, we provide potential improvement with regards to potential reduction in intellectual capital investments. Third, we adopt an innovative two-stage approach: in the first stage, we examine intellectual capital management efficiency and, in the second stage, the estimated efficiency score is regressed in relation to firms' characteristics.

LITERATURE REVIEW

Intellectual Capital

The worth of a company lies not in bricks and mortar, but in its intangible asset, which is its Intellectual Capital, that is hidden behind the company's book values (Edvinsson and Malone, 1997). This implies that intellectual capital is the reason why companies' market values are considered to be higher than their book values. Specifically, intellectual capital is the difference between the market value and book value of a company (Roos et al., 1998), due to the fact that traditional accounting systems are inadequate to capture the true value created by intellectual capital. This may result in poor resource management and lead to underutilisation of the intangibles (Pulic, 2000). Therefore, efficient management of the intellectual capital is important for companies to achieve good corporate performance and to sustain growth in this challenging knowledge-based era (Marr, 2007).

There are numerous definitions of intellectual capital available in literature. A general definition is that intellectual capital refers to intangible assets that create values for future benefits of an organisation. Chong (2008) has offered this view on intellectual capital after compiling a listing of 30 definitions and indications from literature covering the period between 1991 and 2004.

Stewart (1991), in his report in Fortune Magazine, points out that intellectual capital includes patents, processes, management skills, technologies, information about customers and suppliers, and old-fashioned experience, of which when added up together strengthen a company's competitive edge in the marketplace. In another study, Stewart (1997) argues that intellectual capital covers various aspects of intellectual material such as knowledge, information, intellectual property, experience that can be put to use to create wealth. Edvinsson and Malone (1997) claim that intellectual capital is the possession of the knowledge, applied experience, organisational technology, customer relationships, and professional skills that give companies a competitive edge in the market. In a similar vein, Lynn (1998) describes intellectual capital as knowledge that is transformed to some items of value to the organisation; specifically, the creation of sustainable values within a company when information is organised into knowledge, and knowledge is transformed into intellectual capital. Bose and Thomas (2007) conceptualise intellectual capital as the knowledge capability of a company to convert knowledge, skills and expertise into assets that can become profitable, while Hsu and Fang (2009) summarise intellectual capital as the total capabilities, knowledge, culture, strategy, process, intellectual property, and relational networks of a company that create value or competitive advantages and help a company achieve its goals.

Overall, intellectual capital may be summarised as the accumulation of all the intangible assets or knowledge that include intellectual property (like patents and trademarks), intellectual resources (for example, customer relationship), and intellectual capabilities and competences (for instance, employees' professional skills). When the above-mentioned knowledge is transformed efficiently, companies gain competitive advantage that is sustainable, suggesting that intellectual capital drives performance and value creation (Roos and Roos, 1997; Bontis, 1998).

Intellectual Capital Measurement and Efficiency

According to Bontis (2001), it was Skandia who delivered the first intellectual capital report to convey supplementary information in measuring knowledge assets in 1994. Since then, much research has been devoted to explore new measurement methods (for example, Brooking, 1996; Stewart, 1997; Roos et al., 1998; Pulic, 2000).

There is a list of 42 methods for measuring intangibles (Sveiby, 2010). Specifically, the methods can be classified into four measurement approaches, namely: (1) direct intellectual capital (DIC) methods like Technology Broker (Brooking, 1996), (2) market capitalisation methods (MCM) like Calculated Intangible (Stewart, 1997), (3) return on assets (ROA) methods such as VAIC^{TM} (Pulic, 2000) and (4) scorecard methods (SC) like Skandia Navigator^{TM} (Edvinsson and Malone, 1997) and intellectual Capital-Index^{TM} (Roos et al., 1998). Each of these approaches offers different advantages and disadvantages. It is, thus, not surprising that Lu et al. (2010) claim that there is no best or consensus solution for intellectual capital measurement.

However, VAIC^{TM} is a well-known and widely used method among currently available methods (Rehman, Ilyas and Rehman, 2011; Young et al., 2009) because it is capable of fully evaluating intellectual capital within a company (Young et al., 2009; Phusavat et al., 2011). Chen, Cheng and Hwang (2005) who investigated the relationship between value creation efficiency and firms' market valuation and financial performance used VAIC^{TM} as the efficiency measure of intellectual capital of 4254 Taiwan listed companies from 1992 to 2002. The findings support the hypothesis that firms' intellectual capital had a positive impact on market value and financial performance. In other words, firms with greater intellectual capital perform better in terms of profitability and revenue growth. By regressing lagged independent variables, the study also concludes that intellectual capital efficiency is related to future profitability.

Shiu (2006) also applied VAIC^{TM} to measure the "value creation" efficiency of a company. The scholar investigated 80 Taiwan listed technological firms based on their special attribute of being intelligent-intensive. The regression results demonstrate that capital employed efficiency (CEE) and human capital efficiency (HCE) have a significantly positive effect on profitability whereas structural capital efficiency (SCE) has a negative effect. The results for VAIC^{TM} document that value creation efficiency increases profitability and market valuation but decreases productivity. Tan, Plowman and Hancock (2007) also employed Pulic's framework to investigate 150 public listed companies in Singapore from 2000 to 2002. The findings show that intellectual capital, return on equity (ROE) and future company performance were positively related. Besides, the results also conclude that the contribution of intellectual capital to company performance differs according to the nature of the industry.

VAIC^{TM} is the sum of value creation efficiency of the physical capital and intellectual capital (human capital and structural capital). One of the main advantages of VAIC^{TM} is that it identifies weak areas that require intervention (Pulic, 2000). Moreover, VAIC^{TM} is superior in terms of its practical validity because the model can be derived using quantitative data from audited financial statements (Clarke, Seng and Whiting, 2011; Mehralian et al., 2012). Furthermore, VAIC^{TM} is an intellectual capital measurement method that is characterised by its high objectivity (Mehralian et al., 2012). In this study, we also employ VAIC^{TM} to estimate the value of intellectual capital.

As for measuring intellectual capital efficiency, several studies have utilised DEA such as Leitner et al. (2005) who demonstrate the usefulness of DEA in evaluating and benchmarking the efficiency of intellectual quantitatively and comprehensively. Using Austrian universities as sample, the findings show that DEA is useful in distinguishing between efficient and inefficient universities departments. Thus, they argue that DEA can be applied to evaluate intellectual capital efficiency in various organisations and industries. Wu et al. (2006) used DEA and Malmquist productivity index (MPI) to examine the efficiency in intellectual capital management of 39 Taiwanese integrated circuit design companies in view of the significant role of intellectual capital efficiency in achieving a competitive advantage. Lu et al. (2010) developed an innovative two-stage transformation process by employing the multiple input output concept under DEA to examine both the intellectual capital capability and intellectual capital efficiency of Taiwanese semiconductor companies. In the first stage, the study evaluated intellectual capital creation from internal and external resources. In the second stage, intellectual capital efficiency was measured based on how the output from the first-stage transformation process transform into tangible and intangible values for the sample companies. Yang and Chen (2010) employed DEA and principal component analysis (PCA) to analyse the efficiency of intellectual capital management of 62 Taiwanese public-listed companies in the integrated circuit design industry.

Following prior studies, we also use DEA to measure the process of intellectual capital efficiency. Our study differs from previous studies in terms of DEA input variables where VAIC^{TM} is used as inputs that represent intellectual capital.

Determinants of Intellectual Capital Performance

El-Bannany (2008) tests on the determinants of intellectual capital performance in UK banks and indicates that investment in information technology systems, bank efficiency, barriers to entry, and efficiency of investment in intellectual capital variables have significant impacts on intellectual capital performance. Singh and Mitchell Van der Zahn (2008) evaluate intellectual capital from a different perspective. They investigated the association between intellectual capital disclosure levels of 444 Singapore listed initial public offerings and find that ownership retention, proprietary costs, and corporate governance structure are the three determinants of intellectual capital disclosure.

In Malaysia, Norman, Mara Ridhuan and Mohamat Sabri (2009) assert that a high degree of family ownership implies a high probability of opportunistic behaviour where family members pursue their objectives at the expense of value creation activities. Therefore, the authors agree that family ownership appears to have a negative effect on intellectual capital performance in the Malaysian Exchange of Securities Dealing and Automated Quotation (MESDAQ) market between 2005 and 2007. Siti Mariana, Rohaida and Nurul Huda (2012) conclude that age, size, director ownership and growth are the factors affecting intellectual capital disclosure in 150 listed companies in Malaysia. Azwan et al. (2012) studied 130 companies in the technology and industrial products sectors of Bursa Malaysia that went through an initial public offering between 2004 and 2008. Their results provide evidence that board size, board independence, age, leverage, underwriter and listing board significantly influence the extent of intellectual capital disclosure in an initial public offering prospectus. These studies, mainly, focus on the determinants of intellectual capital disclosure. On the other hand, this study looks at the determinants of intellectual capital management efficiency. It is hoped that the findings of this study can serve as an indicator in assessing the antecedents of intellectual capital efficiency in Malaysia.

DATA COLLECTION AND METHODOLOGY

Data Collection

We obtained data from the annual reports of the sample companies that are available publicly. Our sample is made up of Malaysian public-listed software companies in 2010. After deleting sample companies with missing data, we were left with a final sample of 25 companies. Our sample is representative of the Malaysian software industry because the total assets of the companies account for approximately 94% of that of the 29 initial sample companies.

Research Methodology

DEA, developed by Charnes, Cooper and Rhodes (1978) and extended by Banker, Charnes and Cooper (1984), is a widely used linear-programming-based composite tool. DEA, a mathematical technique comparing multiple inputs and outputs of decision-making units (DMUs) for measuring relative DMUs' efficiency, allows the identification of benchmarking. Instead of using merely uni-dimensional ratios and other individual financial variables, intellectual capital indicators such as human capital and structural capital can be accommodated so that possible interactions between them can be captured to derive efficiency scores using DEA. Moreover, DEA approach provides added information that complements the analysis of traditional financial ratios especially when two or more ratios provide conflicting interpretations (Feroz, Kim and Raab, 2003).

Specifically, a DEA study aims to project the inefficient DMUs onto the production frontiers, whereby we can opt for either input-oriented or output-oriented direction. The former refers to the objective to proportionally reduce the input amounts with the output amounts held constant at the present level, and the latter focuses on the objective to proportionally reduce the output amounts with the input amounts held constant at the present level. Since software managers have the discretion to determine the input amounts (intellectual capital and physical capital), but not the output amounts (Tobin's Q and ROE), this study applies the input-oriented model.

The Charnes, Cooper and Rhodes (1978) (CCR) model is the most basic DEA model. The CCR model is assumed to be under constant returns to scale (CRS) of activities. However, the CRS assumption is not appropriate if not all companies are operating at the optimal scale. The Banker, Charnes and Cooper (1984) (BCC) model overcomes this problem, allowing for variable returns to scale (VRS). Assume there are n DMUs (DMU_1, DMU_2, …, and DMU_n) with s different outputs and m different inputs. DMU_j (j = 1, 2, …, n) consumes amount x_{ij} (i = 1, 2, …, m) of input i to produce amount y_{rj} (r = 1, 2, …, s) of output r. The linear programming in the envelopment form of an input-oriented BCC model to evaluate the efficiency of DMU_0 is shown as follows:

$$Min\, z_0 = \theta - \varepsilon(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+)$$

Subject to:

$$\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = \theta x_{io},\ i = 1, 2, ..., m;$$

$$\sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ = y_{ro},\ r = 1, 2, ..., s; \qquad (1)$$

$$\sum\nolimits_{j=1}^{n} \lambda_j = 1;$$

$$\lambda_j, s_i^-, s_r^+ \geq 0,\ j = 1, 2, ..., n.$$

where z_0 is the efficiency score for DMU_0, λ is the weight assigned by DEA. DMU_0 is considered as BCC-efficient efficient if and only if $z_0 = 1$ and the slack variables, s_i^- and s_r^+, are equal to zero. The CCR model differs from the BCC model in which the former is without the additional constraint, the convexity condition $\sum\nolimits_{j=1}^{n} \lambda_j = 1$.

Using the same data, the dual (multiplier) form of the BCC model in Equation (1) can be used in the following form:

$$\text{Max } z_0 = \sum_{r=1}^{s} u_r y_{ro}\ u_o$$

Subject to:

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} - u_o,\ j = 1, 2, ..., n; \qquad (2)$$

$$\sum_{i=1}^{m} v_i x_{ij} = 1$$

$$v_i \geq 0,\ u_r \geq 0,\ u_o \text{ free in sign}$$

where u_r is the output weight and v_i is the input weight. u_o is the condition $\sum_{j=1}^{n} \lambda_j = 1$ in Equation (1). Using $(\hat{x}_o, \hat{y}_o)$ as the coordinate point that corresponds to multiple inputs and outputs for DMU$_o$ on the efficiency frontier, a researcher can identify one of the three situations for returns to scale (RTS) for the BCC model: (1) Increasing RTS (IRS) prevails at $(\hat{x}_o, \hat{y}_o)$ if and only if $u_o^* < 0$ for all optimal solutions; (2) Decreasing RTS (DRS) prevails at $(\hat{x}_o, \hat{y}_o)$ if and only if $u_o^* > 0$ for all optimal solutions; and (3) Constant RTS (CRS) prevails at $(\hat{x}_o, \hat{y}_o)$ if and only if $u_o^* = 0$ for at least one optimal solution.

Figure 1 provides a graphical illustration of measuring input-oriented efficiency using a single input and a single output. Assume that there are five DMUs, A, B, C, D, and E. Ray 0BC is the CRS frontier (the CCR model). The BCC model or VRS frontier consists of the line connecting A, B, C, and D. For instance, the CCR efficiency of DMU E is calculated as PQ/PE. The other 4 DMUs (A, B, C, and D) that lie on the frontier are considered as operating at efficiency. With respect to RTS, IRS prevails at any point on line AB, while DRS prevails at any point on line CD. Any DMU that lies on the CRS frontier is operating at CRS.

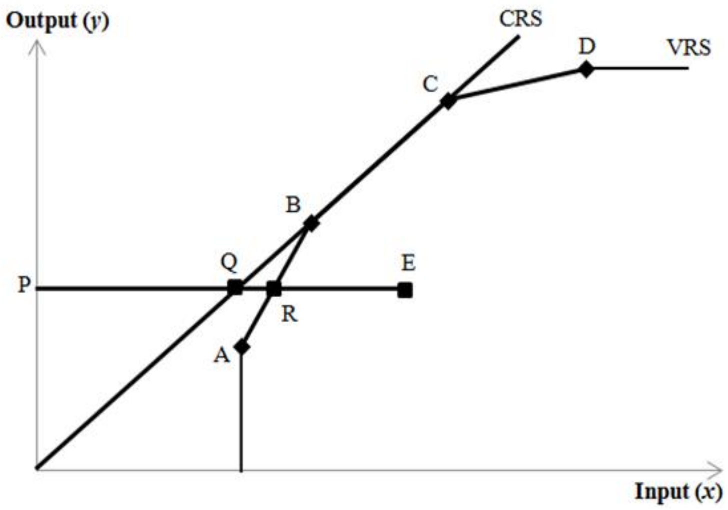

Figure 1: Graphical illustration of the BCC model and the CCR model.

The outcome of the BCC model represents pure technical efficiency (PTE), while that of the CCR model reflects technical efficiency (TE) of the target DMU. Dividing TE by PTE, the scale efficiency (SE) can be obtained. The SE represents the proportion of inputs that can be further reduced after pure technical inefficiency is eliminated if scale adjustments are possible (Hung and Lu, 2007; Hung, Lu and Wang, 2010).

Both TE and PTE values lie between 0 and 1, while SE has a value less than or equal to 1. A value of 1 for either TE or PTE means that the target DMU is efficient. If a DMU is efficient under both the CCR and BCC models, it is operating in the most productive scale size or constant returns to scale size (Cooper, Seiford and Tone, 2006). A DMU with efficiency score less than 1 is considered inefficient.

Input and output variables

As for the DEA model, the input variables are made up of the items of VAIC^{TM}, namely CEE, HCE, and SCE. Note that VAIC^{TM} = HCE + SCE + CEE, where CEE is an indicator of value added (VA) of capital employed; HCE indicates VA efficiency of human capital, whereas SCE represents VA efficiency of structural capital. The alphabetic formula of calculating intellectual capital performance is as follows:

CEE = VA/CA

HCE = VA/HC

SCE = SC/VA

VA = operating revenues – operating expenses

CA = the book value of net assets

HC = total salaries and wages

SC = VA – HC

Following Lu et al. (2010), the output variables used in this study are the intangible value and tangible value. We use Tobin's Q of a DMU as at year end to proxy for intangible value. Tobin's Q is defined as the ratio of market value to the book value of total assets. The ROE, calculated as the ratio of net income to stockholders' equity, is used to proxy the tangible value. Table 1 presents the descriptive statistics of both inputs and outputs for our sample. On average, the software companies have greater HCE, followed by SCE and CEE.

Table 1: Descriptive statistics (N = 25 companies)

Variable	Mean	Standard deviation	Minimum	Maximum
CEE	2.86	0.63	0.07	3.40
HCE	23.79	5.00	0.09	26.52
SCE	19.39	5.40	0.23	35.47
Tobin's Q	3.14	3.14	0.87	16.52
ROE	3.74	0.80	0.17	4.40

EMPIRICAL FINDINGS

Efficiency Analysis

Table 2 presents the efficiency scores of the sample companies. The overall average values of technical efficiency (mean TE = 0.948), pure technical efficiency (mean PTE = 0.951), and scale efficiency (mean SE = 0.997) suggest that managers of software companies are inefficient in managing intellectual capital due to the technical problem and not the scale problem. In other words, the companies are on average 94.8% to 95.1% as efficient as the benchmark companies. Therefore, managers should first attempt to improve their technical efficiency, and subsequently scale efficiency. The findings show that 80% of the software companies are inefficient in transforming intellectual capital into tangible and intangible values. In other words, five companies are relatively efficient (efficiency score = 1.000), based on both the CCR and BCC models.

Of particular concern are the results obtained from our analysis on Green Packet Berhad, which shows 0.681 for technical efficiency and 0.689 for pure technical efficiency. These results show that this company is far lagging in managerial efficiency as compared to its counterparts, even though they operate in the same kind of environment. Moreover, we also examined the condition with respect to the returns to scale of the software companies. An untabulated results show that all the companies operate at constant returns to scale technology, implying that the inefficient companies should reduce in size to increase efficiency.

Potential Improvement in Intellectual Capital Efficiency

In this study, we also conducted slack analysis to find potential improvement steps that inefficient software companies can take in future. Table 3 provides information on how much and in which types of intellectual capital an inefficient software company needs to improve, particularly by decreasing specific intellectual capital amounts.

In percentage terms, the "Potential Improvement" column shows the potential reduction in intellectual capital amount that an inefficient software company needs to undertake to become efficient. For example, CBSA Berhad should reduce its CEE by 4.0%, HCE by 5.6%, and SCE by 17.9%. By reducing those three intellectual capital amounts, it can become as efficient as its benchmark company. Such findings indicate that inefficient companies do not fully utilise or over-utilise their intellectual capital. On the whole, the results in Table 3 indicate that the inefficient companies should spend most of their time in reducing their SCE.

Determinants of Intellectual Capital Efficiency

A two-stage procedure involving DEA followed by ordinary least squares regression analysis yields consistent estimators of the regression coefficients (Banker and Natarajan, 2008). Explanatory variables used in this study are independent from the efficiency scores obtained in the first stage, whereby we estimate the following equation:

$$EFF_{it} = \beta_0 + \beta_1 SG_{it} + \beta_2 SIZE_{it} + \beta_3 LEV_{it} + \beta_4 TANG_{it} + \beta_5 CF_{it} + \beta_6 LIQ_{it} + \varepsilon_{it} \qquad (3)$$

where *EFF* is the efficiency scores obtained through the input-oriented BCC model under the assumption of variable returns to scale. Sales growth (*SG*) is the growth of sales. Firm size (*SIZE*) is the natural logarithm of a company's total assets. Leverage (*LEV*) is the ratio of total debt to total assets. Tangibility (*TANG*) is the ratio of fixed assets to total assets. Cash flow (*CF*) is the ratio of net cash flow to total assets. Liquidity (*LIQ*) is the ratio of current assets minus inventory to current liabilities.

Table 2: Efficiency scores of the 25 software companies

		TE	PTE	SE
1	CBSA Berhad	0.957	0.960	0.997
2	Excel Force MSC Berhad	0.957	0.961	0.996
3	Green Packet Berhad	0.681	0.689	0.988
4	Willowglen MSC Berhad	0.946	0.948	0.998
5	Ariantec Global Berhad	0.943	0.947	0.996
6	Asdion Berhad	0.933	0.934	0.999
7	Cuscapi Berhad	0.941	0.943	0.997
8	CWorks Systems Berhad	0.969	0.973	0.996
9	DSC Solutions Berhad	0.976	0.984	0.992

(continued on next page)

Table 2: *(continued)*

		TE	PTE	SE
10	eBworx Berhad	0.956	0.956	1.000
11	Eduspec Holdings Berhad	1.000	1.000	1.000
12	Elsoft Research Berhad	0.965	0.967	0.998
13	Extol MSC Berhad	0.967	0.971	0.996
14	Fast Track Solution Holdings Berhad	1.000	1.000	1.000
15	Green Ocean Corp. Berhad	0.954	0.954	1.000
16	Infortech Alliance Berhad	0.969	0.973	0.996
17	I-Power Berhad	1.000	1.000	1.000
18	M3 Technologies (ASIA) Berhad	0.949	0.949	1.000
19	mTouche Technology Berhad	0.913	0.913	0.999
20	N2N Connect Berhad	0.976	0.979	0.997
21	Nova MSC Berhad	1.000	1.000	1.000
22	Rexit Berhad	0.956	0.959	0.997
23	SMR Technologies Berhad	0.949	0.966	0.982
24	TechnoDex Berhad	1.000	1.000	1.000
25	The Media Shoppe Berhad	0.838	0.840	0.998
	Overall mean	0.948	0.951	0.997

Table 3: Potential improvement for the 20 inefficient software companies

	PTE	Potential Improvement (%)		
		CEE	HCE	SCE
CBSA Berhad	0.960	–4.0	–5.6	–17.9
Excel Force MSC Berhad	0.961	–4.0	–8.6	–19.6
Green Packet Berhad	0.689	–32.0	–31.1	–31.1
Willowglen MSC Berhad	0.948	–5.2	–6.1	–15.4
Ariantec Global Berhad	0.947	–5.3	–6.6	–21.3
Asdion Berhad	0.934	–6.6	–10.6	–9.7
Cuscapi Berhad	0.943	–5.7	–6.1	–20.5
CWorks Systems Berhad	0.973	–2.7	–7.4	–18.5
DSC Solutions Berhad	0.984	–1.6	–5.6	–30.2
eBworx Berhad	0.956	–4.4	–6.8	–4.4

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Table 3: *(continued)*

	PTE	Potential Improvement (%)		
		CEE	HCE	SCE
Elsoft Research Berhad	0.967	–3.3	–7.2	–10.6
Extol MSC Berhad	0.971	–2.9	–6.9	–18.2
Green Ocean Corp. Berhad	0.954	–4.6	–10.1	–4.6
Infortech Alliance Berhad	0.973	–2.7	–6.7	–19.0
M3 Technologies (ASIA) Berhad	0.949	–5.1	–7.2	–7.1
mTouche Technology Berhad	0.913	–8.7	–8.7	–12.8
N2N Connect Berhad	0.976	–2.1	–5.7	–15.2
Rexit Berhad	0.956	–4.1	–6.6	–19.2
SMR Technologies Berhad	0.949	–3.4	–6.4	–53.4
The Media Shoppe Berhad	0.838	–17.9	–16.1	–22.2

Table 4: Pearson correlation matrix

	EFF	*SG*	*SIZE*	*LEV*	*TANG*	*CF*
SG	0.097					
SIZE	–0.600***	–0.046				
LEV	–0.458**	0.011	0.414**			
TANG	–0.418**	0.059	0.194	0.504**		
CF	–0.273	0.220	0.066	0.023	–0.214	
LIQ	0.190	–0.145	–0.032	–0.286	–0.168	–0.378*

Note: *, **, and *** denote the statistical significance at the 10%, 5%, and 1% level, respectively.

Table 4 reports the Pearson correlation coefficients. *EFF* are negatively correlated with four firms' characteristics, namely *SIZE*, *LEV*, *TANG*, *CF*, and *LIQ*; and *EFF* is positively correlated with *SG* and *LIQ*, respectively. As other correlation coefficients are generally lower than 0.505 and the untabulated VIF values are all less than 1.7, we summarise that there is no multicollinearity problem for multivariate analysis[1]. We conduct our ordinary least squares regression analysis by employing White (1980) heteroskedasticity-robust econometrics techniques. The results are shown in Table 5.

Table 5: Regression analysis

Variable	OLS		Tobit	
	Coefficient	p-value	Coefficient	p-value
Intercept	1.2718***	0.000	1.2718***	0.000
SG	0.0049**	0.025	0.0049**	0.013
SIZE	–0.0282**	0.041	–0.0282**	0.030
LEV	–0.0367	0.388	–0.0367	0.733
TANG	–0.1470*	0.069	–0.1470*	0.066
CF	–0.1746**	0.046	–0.1746**	0.036
LIQ	–0.0001	0.403	–0.0001	0.769
Adjusted R^2	0.449			
F-value	4.264***			
Log-likelihood			44.724	

Note: *, **, and *** denote the statistical significance at the 10%, 5%, and 1% level, respectively.

The model appears to fit the data well, with highly significant F-statistics. All of the explanatory variables are negatively related to efficiency scores, with the exception of the coefficient on *SG*. *SG* is significantly and positively related to *EFF*, suggesting that the greater the growth in sales is, the better the intellectual capital efficiency will be. Among the negative coefficients, *LEV* and *LIQ* do not reach conventional significance level. In summary, most firms' characteristics exercise negative influence on intellectual capital efficiency.

Also shown in Table 5 are the results of Tobit regression. As a robustness check, in line with Barros, Barroso and Borges (2005), we estimate Equation (3) using Tobit regression. The results of Tobit regression are similar to those of ordinary least squares regression.

DISCUSSIONS

In today's challenging business environment, a software company has to efficiently manage its intellectual capital in order to gain competitive advantage. Our analysis on efficiency reveals that most companies have achieved efficiency on the scale front but not technical front, implying that scale efficiency is not a problem to them. Hence, we argue that the focus should be on their managerial skills and reduction in overinvested or underutilised intellectual capital to improve efficiency. This suggestion should augur well for inefficient software companies to become as efficient as their benchmark companies. The results also show that 20 companies have underutilised their intellectual capital to some extent during the period because they have too many employees or have plenty of idle time in terms of their structural capital usage.

In our regression analysis, it can be noted that sales growth can improve intellectual capital management efficiency of software companies in Malaysia while the other characteristics contribute negatively to this. This is probably due to sales growth serving as a motivational factor for employees to work harder and smarter; thus efficiency is achieved. Other characteristics like firm size, tangibility, and leverage will put a company in greater risk and thus, there is less initiative to invest and efficiently manage its intellectual capital. The results of our Tobit regression further corroborate the findings of our ordinary least squares regression.

In summary, Malaysian software companies should fully utilise their intellectual capital, especially human capital and structural capital and improve efficiency through greater managerial skills and best-practice initiatives. This is achievable if the companies continue to recruit and retain experienced and high-calibre employees. Additionally, they should also continue to invest in structural capital or new technology, and at the same time ensure that the capital is fully utilised and managed efficiently.

CONCLUSIONS

This study first examines the intellectual capital efficiency of Malaysian public-listed software companies by using a combination of VAIC^{TM} and DEA methodology. The findings reveal that our sample companies have greater HCE compared to SCE and CEE. From our efficiency analysis, we determined that 20 out of the 25 sample companies are not efficient in transforming their intellectual capital into tangible value and intangible value. To become efficient, we suggest that they reduce their investments in SCE because the move will provide the opportunity for the greatest potential improvement. In the second stage, we ran regression analyses to examine determinants of intellectual capital efficiency. Among the six explanatory variables (i.e. firms' characteristics), only sales growth is significantly and positively related to intellectual capital efficiency, indicating the importance of sales growth.

There are some limitations in this study. For instance, we are unable to specify the role of managers in influencing the efficiency because we rely on secondary data. Besides, the findings are specific to a relatively small sample of Malaysian software companies and therefore cannot be generalised beyond this, unless further studies are undertaken. Future studies may employ different DEA method to study intellectual capital efficiency and future researchers can regress intellectual capital management efficiency scores on other explanatory variables such as corporate governance components.

NOTE

1. A VIF greater than 10 is considered a rule of thumb for harmful multicollinearity (Kennedy, 1998).

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