Assessing the Intellectual and Knowledge Based Assets of Organizations: Case of Global Oil and Gas Operations Firms

Full Paper

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Abstract

Intellectual and knowledge based assets, as the elements of intellectual capital (IC) are key aspects of competitiveness in all types of firms in today’s knowledge economy. A huge portion of these assets are driven or supported by Information Systems (IS). The technological changes that occurred in the past few decades in how information is created, captured, and used in organizations has driven this paradigm shift in favor of those who capitalize on it the best. We examine to what level the top global oil and gas firms are using IC to gain competitiveness and how effective they are in doing so. The results indicate that higher levels of IC are associated with higher financial performance. By providing empirical evidence linking IC to performance, this research highlights the importance and need for developing IC within these organizations and the potential role of information systems and knowledge assets for achieving it.

Keywords

Intellectual capital, firm performance, oil and gas industry, calculated intangible value (CIV), information systems.

Introduction

As the world transitioned to a more knowledge based economy, intellectual capital (IC), or intangible assets have gained greater emphasis since 1990s (Edvinsson, 1997; Stewart, 1997; Sveiby, 1997), and continues to be an area that is being actively researched (Marr & Chatzkel, 2004; Secundo, et al., 2017). During the past few decades, we have transitioned from an industrial economy, where the business model was based mainly on exploiting the tangible resources, towards a knowledge based economy, in which the business is conducted by relying mostly on invisible, yet highly potent knowledge based resources. In this new paradigm, knowledge is viewed as a commodity, and the degree of interrelatedness between intangible and tangible resources has increased significantly. Information systems and technologies that enable this interconnectedness have tremendously improved this knowledge diffusion and dissemination.

The impact of IC on organizational performance has been widely theorized (Bontis, 1998; Nahapiet and Ghoshal, 1998) and empirically studied across many industries (Chen et al., 2005; Dženopoljac et al., 2016; Riahi-Belkaoui, 2003). However, most empirical studies have focused on the industries such as IT; financial firms and other service industries. IC in traditionally tangible asset intensive firms have not been adequately examined with some exceptions (Arslan & Zaman, 2015; Tosto & Nuttall, 2012). Given the volatile market conditions and the technological changes facing the oil and gas industry, this research focuses on better understanding the role of IC in this industry. Current literature suggests that knowledge, as a basis of competitive advantage among the innovative companies have become widely accessible and more complex. The contemporary firms that operate within this knowledge based economy are increasingly focusing on connections with its environment in order to gain and share knowledge. Having understood the reality that knowledge represents the main source of competitive advantage in modern business environment, companies must develop capabilities in identifying, measuring, and managing knowledge and knowledge based assets (Dobbs et al., 2015; MERITUM, 2002).
A recent study conducted by the consulting firm Ocean Tomo (2015) found that the contribution of intangible assets to market capitalization have been steadily increasing over the past several decades. In 1975, the proportion of intangible assets that contributed to the market capitalization of S&P 500 firms was only 17%. By 2015, this number has increased to about 87%. Implications of this for traditionally asset based industries, such as oil and gas, are huge. Though it is evident that IT, pharmaceuticals, and other financial and service firms rely heavily on intellectual assets to gain competitiveness, industries that are traditionally intensive with tangible assets, such as steel or oil and gas industries, have not placed similar emphasis on IC within their firms barring a few (Mkumbuzi, 2015) (for a discussion on IC in more asset intensive firms see Carrillo, 2004; Kujansivu & Lönnqvist, 2007 & Makki et al., 2009). This increasing trend in intangibles over the years is easily observed from the Figure 1.

![Figure 1. Proportion of Tangible and Intangible Assets in S&P500 Market Value (source: Ocean Tomo, 2015)](image1.png)

An important issue in this regard is an assessment of the nature of intangible assets. Contemporary strategic management theories, such as the resource-based view of the firm (RBV), have provided framework for better understanding the nature and importance of intangible assets in business success. RBV assumes that firms possess different types of resources, which are the basis for their competitiveness (Grant, 1991). Barney (1991) described enterprises as complex and heterogeneous entities characterized by their unique resource base. In this sense, particular resources may be of greater importance because of their potential to provide the firm with sustained competitive advantage. Resources that are valuable, rare, inimitable and non-substitutable have this potential. Often these resources are knowledge based and accessible only through the individual knowledge of employees (Muhammed et al., 2011). In this paper, we use a definition of IC that was given by Stewart (1997), which says, "IC is the sum of everything everybody in a company knows that gives it a competitive edge. Intellectual capital is intellectual material, knowledge, experience, intellectual property, information [...] that can be put to use to create wealth" (p.x). This knowledge is situated around organizational actors as human capital, or embedded in organizational systems and processes as structural capital. It is also embedded in the relationships between its customers and suppliers as customer or relational capital. The organizational inputs may be tangible assets like manufacturing plants, property, and materials, or intangible assets like patents, information, processes, software, and skills of people. Since all forms of intangible assets possess this knowledge whether in the tacit or explicit form, we refer to intangible assets and IC interchangeably to refer to the knowledge based assets that are not directly measurable and easily quantifiable (Bontis, 1998; Edvinsson, 1997; Hussi, 2004).

Information systems (IS) play a key role in creating a unique competitiveness within organizations, enhancing their IC both directly and indirectly (Sambamurthy et al., 2003). Directly, IS provides various
enterprise systems that institutionalize individual knowledge and automate processes. These range from ERP systems to various standalone and integrated systems within the organization. Indirectly, these systems have the potential to enable greater knowledge sharing and creation among the employees and thus contribute to the organizational knowledge assets.

Different “packages” of resources enable firms to implement different activities with different degrees of success from their competitors. Detailed analysis of the firm’s resources should offer a better understanding of the sources of competitive advantage (Bontis et al., 2015). This is why, within the RBV context, intangible resources are seen as the primary driver of above-average value creation. In this context, modern management principles and methods have transformed significantly because managing intangible resources is very different from handling of tangible ones. For example, in regards to the disclosure of IC, Mkumbuzi (2015) indicates that companies that are more intangible oriented, such as non-manufacturing companies, “are expected to apply unique and non-replicable IA [intangible assets] and IC in their operation” (p.152), compared to companies that are more tangible asset oriented, such as manufacturing firms. Mkumbuzi (2015) presents this within RBV and signaling theory. It is clear from Figure 1 that IC in the form of intangible assets has become more prominent than labor and capital as a fundamental resource competitiveness for contemporary organizations.

In this research, we conduct an exploratory analysis of whether increased performance of firms in a traditionally asset intensive industry, such as oil and gas operations, is associated with higher levels of IC as suggested by knowledge based economy business model that puts increased emphasis on intangible assets in value creation. We chose oil and gas operations firms due to the rapid market changes happening in this industry. A key assumption is that although this industry is seen as intensive with tangible assets, the companies would be forced to use their resources better to be competitive in such knowledge based economy. It is expected that firms with higher IC should be better performers in the current knowledge economy even within tangible asset intensive industry. We compare the levels of IC of high performing firms to low performing firms in this industry using a descriptive methodology and discuss some implications of the findings. We then indicate the limitations of this study and suggest some future directions.

Dimensions of intellectual capital

Early work in the area of categorizing IC(also referred to as intangible assets here) started with Karl-Erik Sveiby (1989), who asserted that IC in a company consists of internal structure (management systems, databases, business processes), external structure (relationships with external stakeholders), and competencies (individual experience, knowledge, and employee competencies). Throughout the last two decades, various categorizations of IC have emerged, trying to grasp every important intangible factor that aids to company’s value creation. For example, Hendriksen and van Breda (1992) consider that intangibles include traditional intangible assets (goodwill, brand names, and patents), and intangible assets with postponed effects (like, advertising costs, research and development expenditures, and training and development). Hall (1992) classified the intangible assets into those that can and cannot be separated from human resources. The overarching theme is that intangible assets are resources within organizations that are knowledge based and are not easily quantifiable as the tangible assets, which are physical, tradable and are usually listed on the balance sheet (Stewart, 2017).

Edvinsson (1997) and Bontis (1998) considered human capital (employee knowledge, experience, motivation, creativity, etc.), structural capital (corporate culture, information flows, databases, information systems etc.), and customer capital (possibility of capitalizing good relationships with customers) as the main elements of a firm’s IC. On the other hand, Lev (2000) had a slightly different perspective of IC elements. He categorized them into discovery, organizational practices, and human resources. When moving towards accounting area of intangibles categorizations, we come to an interesting categorization made by Schmalenbach Society (Schmalenbach Society, 2002), which divides intangible assets into innovation capital, human capital, customer capital, supplier capital, investor capital, process capital, and location capital. Finally, one of the most frequently used categorizations include human capital, structural capital, and relational capital (MERITUM, 2002).
Measures of intellectual capital

The significance and potential of IC is evident, but its immaterial nature makes it difficult to be financially assessed and valued. Thus, many different approaches to identifying, measuring, and disclosing IC have appeared. Special problem exists when trying to separate the effect of different elements of intangibles on performance since they are strongly interconnected. Different approaches to measuring arise from different IC’s categorizations. We can divide all approaches into four distinct groups (Roos et al., 2007): Direct Intellectual Capital Methods, Market Capitalization Methods, ROA Methods, and Scorecard Methods.

Direct methods of measurement include management’s direct involvement in identifying and evaluating the size and contribution of intangible assets to value creation. These approaches are individual, and are adjusted to the needs of the company itself and serve for internal reporting and planning. Market capitalization methods use company’s market value as the starting point for measuring intangible assets. The main hypothesis here says that company’s intangible assets are equal to the positive difference between its market value (market capitalization) and book value of assets. ROA methods include measurement of intangibles using the various forms of financial measures of success. Most widely used approaches in this group are Calculated Intangible Value (CIV), proposed by Stewart (1997), and Value Added Intellectual Coefficient (VAIC), proposed by Pulic (2000). Though widely used, these methods were found to have some flaws in measuring IC (Aho et al., 2011; Ståhle et al., 2011). Scorecard methods include preparing various scorecards with appropriate proxies for different elements of intangible assets.

CIV was introduced by Stewart (1997), as a measure of monetary value of IC. The measure was initially developed to analyze companies that mainly rely on intangible assets in their operations. The main assumption of the model is that above average returns earned by a company are created by its intangible assets, since the tangible assets are easily copied and used by competitors. In other words, if a company uses only tangible assets, it can only reach average returns in its sector/industry.

Since CIV attempts to measure the immaterial resources of a company, apart from goodwill and book value of intangible assets, the measure itself suffers from certain weaknesses as described in Aho et al. (2011). The mentioned criticism of CIV points to the fact that CIV is connected to all types of capital assets (physical, financial, combined physical and financial and intangible) and that it cannot only be related to company’s IC. The authors advocate that CIV should be seen only as a measure of financial efficiency derived from companies’ return on assets. CIV measures an overall financial performance in comparison with competitors within the same industry. However, being a broad measure of IC that can be calculated in a relatively easily way, using publicly reported financial data, we use CIV to measure the level of IC of the oil and gas firms. Measuring the level of IC and its contribution to value creation is extremely important since it enables the management of IC, development of strategic policies, and fostering communication with various stakeholders.

Data collection

The present study investigates the relationship between oil and gas companies’ efficient use of IC’s and financial performance of these companies. To investigate this we looked at the top global oil and gas firms listed in the Forbes Global 2000 list of 2016. Forbes 2000 is an annual ranking of world’s top firms based on various criteria such as market capitalization, sales, profits and assets. A total of 78 firms were listed in this ranking under oil and gas operations. Financial data about these firms for the period of 2011 to 2015 were then retrieved from the Thompson Reuters Eikon Datastream database for further analysis. Within this list, Cosmo Energy Holdings did not have complete data for the analyzed period, and hence was excluded from analysis.

Imported data were crosschecked for any inconsistencies such as differences in currencies and missing data. Other than Cosmo Energy Holdings, there were few missing data for the variables used in this study. The missing data were not clustered around any particular company or for a particular year given the fact that some companies started reporting their data later during the period of study due to being newly listed or being merged or acquired. Further, there were few (3 to 12 firms) and evaluated to possess no major issue.
Results and discussion

In order to measure the IC of the firms under consideration, we used Stewart’s (1997) CIV. The CIV is calculated in six stages. Initially, it is necessary to calculate company’s average pre-tax earnings for the last three years. Second step includes calculating average year-end tangible assets value of the company for the last three years, with book value of intangible assets subtracted from this amount. Third step is dividing the earnings with value of tangible assets in order to calculate the company’s return on tangible assets (ROA). Next, it is necessary to calculate the average ROA for the entire industry for the last three years. In fifth step, the “excess return” is calculated by multiplying industry ROA by the average year-end tangible assets of the company. Then, we should subtract the result from the pre-tax earnings of the company. In addition, we need to multiply this by the one less the three-year-average income tax rate of the company. Finally, we divide the after-tax value by the company’s cost of capital (weighted average cost of capital, WACC) (Kujansivu & Lönnqvist, 2007).

Traditionally, negative CIV’s are not calculated when the ROA of individual firms are less than the industry ROA. An argument for not considering the negative CIV’s is that firms cannot have negative IC (Ståhle et al., 2011). However, we did not exclude calculation of CIV for firms whose ROA was less than industry ROA since it would give a good indication of the trend within the firms regarding creation of IC. We also used yearly values rather than three-year averages of the parameters used for the calculation of CIV since our data was for five-year period from 2011 to 2015 and would mask important trend within this period if averages were used. CIV being a relative measure compared to the industry average, and an index of the level of IC rather than an absolute measure of it, provides a reliable analysis without any serious issues. Rather, it provides a more granular view of how companies manage their IC during this period. For example, in 2011, there were only two firms with negative CIV, but by 2015, that number had increased to 28. This may be caused by the loss in the value of IC of the firms due to their inability to adjust quickly to the falling oil prices during this period. This reveals an important characteristic of IC, which indicates that the value of IC is meaningful only in a relative context. Sustained future data on these firms can shed better light on how long firms take to adjust to such unanticipated external shocks.

We examined the list of firms to identify the best and worst performers based on the widely used financial and market measures of performance, such as return on invested capital (ROIC), return on equity (ROE) and market capitalization. The top 5 firms based on average ROIC and ROE over the period of 2011-2015 are shown in Figure-2. The best performers based on these measures were small or medium sized firms, with three of them (Oil & Gas Development, Novatek and Western Refining) in the top list based on both ROIC and ROE measures. The bottom five worst performers based on ROIC were also the firms who performed badly in terms of ROE (Figure 3). For the best performers, ROIC ranged from 0.442 (Novatek in 2011) to 0.064 (Novatek in 2014) with an average of 0.248 compared to the ROIC of worst performers that ranged from 0.105 (Apache in 2011) to -0.631 (Apache in 2015) with an average ROIC of -0.034. ROE for best performers ranged from 0.642 (Targa Resources Corporation in 2014) to 0.071 (Targa Resources Corporation in 2015) with an average of 0.329 compared to the ROE of worst performers that ranged from 0.172 (Apache in 2011) to -1.542 (Chesapeake Energy, 2015) with an average ROE of -0.094.

Another important measure that is used in the performance of firms is their market capitalization. This is also one of the dimensions used by Forbes to rank the firms. We examined firms that had the highest and lowest market capitalization for the period under study. The top five and bottom five firms based on this criteria is shown in Figure 4. We included only top and bottom firms in the above analysis so that any difference in IC between these firms will be more clearly visible and can be contrasted more effectively. Since this is an exploratory study, we also included only five firms at the end of each spectrum to keep the results more parsimonious.

Average CIV and the average ratio of CIV to market capitalization of these firms for 2011 to 2015 are shown in Figure 5. As expected, firms that performed better based on ROIC and ROE indicated better CIV. However, since larger firms may possess larger levels of CIV in absolute terms, we also examined the CIV for these firms in relation to their market capitalization (CIV/Market capitalization ratio indicated by line chart). This may provide a better indication on the relative efficiency with which IC is developed and used within a firm. Firms who performed better in terms of ROIC and ROE, performed better on this metric as well. This suggests that IC may be a key component contributing to the financial performance of
oil and gas firms. Figure 5 shows the average market capitalization, average CIV and average CIV/Market capitalization ratio for the top and worst performing firms.

Another interesting finding of this study is that, although the average CIV of top firms based on market capitalization is higher, small cap firms seem to be more efficient in using IC compared to their large cap counterparts based on average CIV to market capitalization of these firms. The finding is not surprising given the fact that smaller firms are more agile and responsive in a changing market environment. In Figure 5, most firms that had a positive CIV to market capitalization ratio were included in the worst performers list due to lower market capitalization. However, lower market capitalization does not
necessarily mean lower financial performance. These are younger firms that have greater potential to grow. In fact, two of the firms in this list (Targa Resources Corporation and Western Refining) were among the top performers based on ROIC and ROE.

![Figure 5: Average market capitalization (in billions of USD), CIV (in billions of USD), and average CIV/Market Capitalization ratio (line chart) of top and bottom performers.](image)

**Conclusion and future directions**

In this paper, we have investigated the level of IC in the global oil and gas industry and conducted a comparative study between the best and worst performers among them. We used the Forbes Global 2000 list to identify leading firms in this industry since their financial data are readily available. This study compared these firms based on commonly used financial performance measures such as ROIC, ROE and market capitalization. The level of IC in these firms was assessed based on Stewart’s (1997) CIV. Preliminary results indicate that high performing firms have higher levels of IC as measured by CIV compared to the low performing firms in the list. However, future research should investigate the relationships between IC and firm performance by applying more rigorous statistical tests, such as panel data regression. This research can also be extended to include other financial and market performance measures of firms, as well as for longer period.

There is dearth of empirical research in understanding the role of IC in the performance of firms even though we have clearly moved to a knowledge based economy. The few research studies that are available are often inconclusive. In order to make matters worse, the measurement of IC is also problematic due to the large number of measures in the literature - more than 42, according to Sveiby (2010). This gap is more evident in traditionally tangible-asset intensive industries, such as oil and gas. Hence, in order to gain a clearer understanding of the role of IC in this industry we have undertaken a more descriptive exploration of this relationship using financial and market data from these firms. Even though the trend seems to clearly indicate that IC is positively associated with financial performance of large, mid and small cap firms, the results should be interpreted with caution since the CIV comparison has been done only with the best and worst performers due to the scope of this paper. Further, this list only includes the top publicly traded firms and do not consider many other important firms in this industry that are private or state controlled.
During the period from 2011 to 2015, there has been a steady decline in profitability and market capitalization of many of the firms considered in this study along with a decline in the overall CIV. One of the key reasons for the broad decline has been the reduction in crude oil price during this period from nearly 95USD to about 35USD (West Texas Intermediate), peaking at about 113USD in 2011. Though not so drastic, there has also been a significant decline in the natural gas prices during this period. Even though such external events may influence the profitability of a firm, it can be argued that with the appropriate investments and exploitation of IC, firms can adapt and adjust their strategy and operations quickly and adeptly to overcome such challenges. Although all types of IC such as human, structural, and relational capital may be important for successful performance of a firm, it is likely that in certain situations, certain types of IC are more important. The inability of oil and gas firms to respond quickly to the price fluctuations may have been more due to the shortfall in structural capital more so than IC deficiencies in human and relational dimensions. Concepts such as Ubicomp can be successfully applied to integrate information systems to develop structural capital in oil and gas industry (Heyer, 2010). Holland et al., (2005) describe how BP uses multi-level enterprise management system to better connect to suppliers and other business partners that contribute to their relational and structural capital. Future research may investigate these possibilities, which are not possible with the current one-dimensional measure of IC using CIV.

It is interesting to note that both CIV and CIV to market capitalization ratio of all firms considered together have been declining steadily during this period. This may indicate the systemic inability of this industry to respond to such broad market based changes during the given time horizon. The general ability of the firms to capitalize on their intellectual capability may have a longer time horizon than the one-year period for which the CIV is calculated in order to respond to current challenges faced by the oil and gas industry. Future research may consider this aspect and may incorporate data for larger time horizon. In spite of this general trend, some firms (e.g., Surgutneftegias, ExxonMobil, Gazprom, Sinopec, SK Holdings, and Western Refining) seem to be coping with this change better than their counterparts as evidenced by relatively better performance and CIV. Findings of this research also contribute to the RBV literature by providing greater evidence that IC is gaining greater prominence as an important resource even in firms that traditionally valued tangible resources.

Appropriate use of information systems to improve IC capabilities could be an important way to achieve this competitiveness (Sambamurthy et al., 2003). For example, ExxonMobil uses high performance computing (HPC) capabilities to make better investment decisions such as for predicting reservoir performance in an efficient and timely manner (ExxonMobil, 2017). Others, like Western Refining, use information systems to improve management of maintenance and operations, thus embedding best practices, which may contribute to their IC (Invensys, 2017). A more in-depth investigation of how these companies succeed in such environment, how they create the IC necessary for their success, and the different types of IC they focus could be the topic of subsequent research. It is important that oil and gas industry pay attention to the important role of IC as they continue to face the market challenges and technological changes that are brought about due to the push for renewable energy. As Dobbs et al., (2015) indicate, one of the solutions to surviving in this new environment is by building intellectual assets of organizations.

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