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An assessment of Structural (organizational) and Relational Capital Indicators in Knowledge- Intensive Industries: Evidence from Pharmaceutical Industry

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ABSTRACT

During the last decade, intellectual capital (IC) and intangible assets has been widely considered as a critical tool to deliver successful business in an intensive- knowledge environment. Accordingly, the main goal of this paper is therefore to develop and prioritize the most important indicators of structural and relational capital in knowledge-based industries. Based on an extensive literature review, a valid and reliable questionnaire was designed. In order to data gathering, it was sent out to participants from both academic and university who qualified well in pharmaceutical practice. In order to exact prioritization of indicators, fuzzy TOPSIS technique as a MADM model was used. The fuzzy TOPSIS results revealed participants show high concerns especially about positive climate, ratio of investment in R&D and numbers of R&D projects regarding to structural capital, while considering the relational capital, more attention was paid to customers and strategic cooperation such as alliances and licensing.
Keywords: Intellectual capital, Structural capital, Relational capital, pharmaceutical industry

1. INTRODUCTION

In the current economy, the industrial development model has become knowledge based and innovation intensive (Seleim et al., 2004). Accordingly, the increase of the knowledge-based economy and society has been attributed to the importance of intellectual capital (IC) as a key resource for obtaining firm’s sustained competitive advantages (Mehralian et al., 2012). The intangible assets and intellectual capital (IC) are increasingly overcoming traditional valuating tools, such as land, property and capital assets, and are becoming the determinants and foremost sources of company success (Drucker, 1993), as a result, company valuation is beyond the ability of conventional accounting methods.

It is often discussed that companies in today’s new economy do not initially invest in fixed assets, but in intangibles, since these are today’s value drivers. Among these intangible assets intellectual capital (IC) has an important role. Because of the investments in IC, its volume necessarily increases and the measurement of IC becomes an important issue given the direct and indirect advantages that can be gained from it. Some of these advantages may consist of the added value of the knowledge that is processed, the learning process included in the measurement of IC (Roos, 1997), its strategic power (Bontis, 2001), the optimal exploitation of limited resources and its usage as a motivational factor (Edvinsson, 1997). However, despite the difficulties connected to IC evaluation, there are several logical reasons (discussed in the literature) for companies to disclose information on IC (Bruggen et al., 2009).

Ultimately, the purpose of this study therefore is to develop and prioritize the most important indicators of structural and relational capital in knowledge- based industries. As mentioned earlier, pharmaceutical companies have all the features of knowledge-based environments. Accordingly, we have focused on pharmaceutical industry as the best example to manifest knowledge based environment, moreover, Bollen et al. (2005) asserted that the pharmaceutical industry combined all relevant four components of IC, the latter not always being present in other knowledge- intensive industries. Remaining of paper consist of 3 sections. In Section 2 literature review is discussed, followed by section 3 which presents study design and methodology. Section 4 describes the data analysis, and section 5 contains conclusion, implications and limitations of this study.

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2. Intellectual capital concept

Intellectual capital is generally recognized as an intangible asset of a company that is difficult to evaluate by conventional financial report. Although it normally cannot be identified from traditional financial statements, relevant parties have usually taken such expanding investments. To date, researchers have proposed a wide scope of definitions and perspectives on intellectual capital. De Pablos (2002) addressed that IC is the sum of the hidden resources of the company not fully captured by the conventional accounting system. Edvinsson and Malone (1997) assert intellectual capital as the value of intangible assets accumulated by the company. This value was equal to the difference between corporate market and book value (Bontis, 2001; Edvinsson and Malone, 1997). Stewart (1997) explained intellectual capital as the intellectual material composed of knowledge, information, intellectual property, and experience, by which wealth could be created.

In addition, researchers have decomposed and conceptualized intellectual capital in order to obtain a better description of it. While, Brooking (1996) addressed four components of IC, including marketplace-related, mind-related, organization-related and human-related capital, many researchers describe IC from the perspectives of human capital and structural capital (Bontis et al., 1999; Edvinsson, 1997; Sveiby, 1997). Edvinsson and Malone (1997) defined IC as the sum of knowledge and capabilities of employees in a company. So, IC is considered as the portion of a firm's competitive strength derived from its components consists of human capital, structural capital, and customer capital. Due to our concentration on structural and relational capital as key components of IC and intangible assets in this paper, the next part tries to explain more regarding of these capitals.

2.1. Structural capital

Structural capital (SC) comprises mechanisms and structures, which support employees. In fact, they are the companies routines and convert individual human assets into group assets. Edvinsson and Malone (1997) explained SC as everything that "supports employees' productivity" or "everything that gets left behind at the office when employees go home". In contrast to human capital, SC can be owned by the company and therefore can be traded. Bontis (1998) stated that SC comprises mechanisms and structures of the organization that support employees in their performance, whence, also overall business performance. Structural capital including the non-human storehouses of knowledge in firms that are existed in systems, databases and programs (Edvinsson and Malone, 1997). Unlike human capital, SC is an intangible asset that can be traded, reproduced and shared within the firm. In fact, specific structural capital elements can be legally protected in the form of patents and trademarks as a result of investment in research and development (Roos et al., 1997). Finally, in this manner, structural capital can be considered as the skeleton of a firm because it provides the tools and architecture for retaining, packaging, reinforcing, and transferring knowledge along the business activities (Cabrita and Bontis, 2008).

2.2. Relational capital

Until now, relational capital remains underexplored, at least, relative to the way and depth of the other two previous types of IC. This may be due to the fact that relational capital has probably the most complex and divers nature due to all the kinds of intangible assets. Anyway, an additional effort should be done, because, as Acedo et al. (2006) remark, one of the most effective developments of the resource-based view (RBV) will be the 'relational one'. From the knowledge-based perspective of the firm (Kogut and Zander, 1993), it has been highlighted that firms are social entities that retain internal and external knowledge which lies at the core of firm survival and success. Now, when describing relational capital, we have to focus on how firms can absorb, exploit and explore new knowledge from its environment to obtain and sustain competitive advantage positions. Besides other classifications related to relational capital, Bontis (1996) also expands the concept of 'client or customer capital' to include all the external relationships of the firm (e.g. suppliers, allies, trade unions, etc.).

Summary, relational capital could be critical for making decisions about how to exploit the current firm knowledge base and also about detecting market trends and 'technological opportunity'. Therefore, relational capital could be considered as a close relative to the well-known notion of 'dynamic capabilities' reposed by Teece et al. (1997).

2.3. Intellectual capital evaluation

There is no globally accepted IC evaluation method among the 34 methods recognized in the relevant literature (Sveiby, 2010), nevertheless several substantial studies have been done by researchers (Bontis, 1998; De Pablos, 2002; Bollen et al., 2005; Sharabati, et al., 2010; Huang, et al., 2011) in order to evaluate IC and maybe its impact on firm's outcomes. So, despite the difficulties connected to IC evaluation, there are several logical reasons for companies to disclose information on intellectual capital. (i) The reduction of information asymmetry between a company and external users of information is one main reason for voluntary IC disclosure. According to Andriessen (2004), information asymmetry may make misallocation of capital; (ii) the weak of traditional financial accounting, therefore IC disclosure can help to enhance the value relevance of financial reports. Undoubtedly, investors have difficulties in appropriately assessing firm value for resource allocation through financial statements that do not disclose IC. Furthermore, managers may find it difficult to assign relevant intangible investments needed for the company's operations. As a result, the providing of relevant information to managers and other users of financial statements can become pivotal; (iii) companies are also interested in evaluating IC information to establish trustworthiness with employees and other stakeholders (Bruggen et al., 2009). The dissemination of trust is one of the most important factors in the company's long-term growth strategies because it creates stakeholders' higher commitment to the company future, especially in turbulent times (Prusak and Cohen, 2001); (iv) finally, considering the company's market value, Edvinsson (1997) addressed that in a major proportion of well established companies such as Intel and Microsoft, there are remarkable differences between market values and book values, and furthermore, a cross-sectional study determined that the discrepancy between market value and book value reached 30- times in pharmaceutical companies, in which intellectual capital plays an key role in company valuation (Liao et al., 2010).

2.4. The important role of IC and intangible assets in the pharmaceutical industry

Considering all the features of knowledge-based companies, pharmaceutical companies are widely accepted as such companies. Knowledge is developed mainly in own research departments or is bought from other companies, and it also is considerably protected by intellectual property rights (IPR). Knowledge is sold to other companies and – most important – there is a continual and critical need to develop new knowledge in order to have successful products in time to the market (Alpkan et al., 2010). This signifies that the way pharmaceutical companies develop and apply knowledge will have a large effect on their economic success. Pharmaceutical companies are dependent extensively to capital and they also intend to invest large amounts of money, while the returns will only come after years of research and development. Inevitably, investors are looking for indicators of "good-knowledge-handling" in order to guaranty their investment (Boekestein, 2006).

Summary, Daum (2005) concluded pharma industry is a great source of intellectual capital, since this industry is research-intensive, highly innovative, and well-balanced in its use of IC and technological knowledge (Hermans and Kauranen, 2005). Pharma industry is extensively dependent on its intangible assets as a key source for innovation (Huang, 2011). Pharmaceutical industry, therefore, can be considered as an ideal candidate for analyzing IC component (Bollen et al., 2005). Furthermore, Intellectual capital was proposed to measure future value and tacit value of a firm (De Pablos, 2002), particularly important for firms in knowledge-based environment such as the pharmaceutical industry.

2. MATERIALS AND METHODS

This study used a developmental process that employs a set of procedures similar to perceptual mapping. This process involves several phases of data collection and sequenced data analysis. The four phases of the development process include:

(1) generation of critical elements;
(2) expert review and questionnaire development;
(3) data collection; and
(4) data analysis.

Phase 1. In the first phase, this study developed an initial questionnaire with detailed elements of structural and relational capital indicators. In accordance with intellectual capital theory in pharmaceutical environment (Sharabti, et al., 2010), main factors in structural capital were categorized into (i) systems and programs (ii) research and development (iii) intellectual property rights, meanwhile relational capital consists of (i) strategic alliances, licensing and agreements (ii) relation and knowledge about partners, suppliers and customers. The items of this study were originated from both the previous literatures (Bontis, 1998; Seleim et al., 2004; Bollen et al., 2005; Sharabati, et al., 2010, Liao et al., 2010) and expert's opinions.

Phase 2. In the second phase, the preliminary questionnaire was further refined by experts. The validity of a measure refers to the extent to which it measures what is intended to be measured. Validity is not evaluated numerically, it is subjectively judged by the researchers (Kaplan, 1987). Eight experts who qualified in field of pharmaceutical practice, six of them were from pharmaceutical practice, one in a pharmacy school, and one in a business school, were participated. The participants suggested adding and omitting some parts of questionnaire. Finally, all the pretest participants expressed strong agreement with the face validity of the questionnaire. The expert-refined questionnaire includes 25 indicators both from structural and relational capital. Besides the face validity, factor analysis (i.e. Pearson's principal component analysis) was tested with and without rotation (i.e. Varimax rotation with Kaiser normalization). All variables and sub-variable items were confirmed valid due to their factor loading values exceeded than 0.5. The internal consistency of a set of measurement items refers to the degree to which items in the set are homogeneous. Internal consistency can be estimated using a reliability coefficient such as cronbach's alpha (Saraph, 1989). It was calculated in this research around 0.92. Ultimately, the questionnaire was finalized, then ready to be delivered. It is important to note that just 3 of 25 items among structural and relational capital indicators had standard deviation exceeding 1.

Phase 3. During this phase, the questionnaire is scored on a scale ranging from 1 (least important) to 5 (most important). In order to participate in this study, our inclusion criterion was being as a manager in pharmaceutical practice for at least 5 years. The questionnaire was sent out to managers from 17 pharmaceutical companies and 3 school of pharmacy, finally, 108 questionnaires were returned.

3. DATA ANALYSIS AND RESULTS (PHASE 4)

Data for this study were collected using a self-administered questionnaire that was distributed to both industry and university experts. Questions also included demographics such as educational level, work place and experience which are shown in Table 1. In order to prioritize indicators, fuzzy TOPSIS technique as an algorithm of Multiple Attribute Decision Making (MADM) was used.

Table 1. Demographics of the respondents

Workplace		**Experience**		**Educational Level**	
	Frequency		Frequency		Frequency
University	25	Between 6 to 10 years	31	BS	5
				MS	28
		Between 11 to 15 years	25		
				Pharm D	62
Industry	83				
		Between 16 to 20 years	26		
				PhD	23
		More than 20 years	26		
Total	108		108		108

4.1. Result of fuzzy TOPSIS

Natural language to express perception or judgment is always subjective, uncertain or vague. Such uncertainty and subjectivity have long been handled with probability and statistics (Wang and Chang, 2007). Since words are less precise than numbers, the concept of a linguistic variable approximately characterizes phenomena that are too cumbersome or poorly defined to be described with conventional quantitative terms (Herrera and Herrera-Viedma, 2002). To resolve the ambiguity and subjectivity of human judgment, fuzzy sets theory was introduced to express the linguistic terms in decision making (DM) process (Wang and Chang, 2007). The TOPSIS method was firstly proposed in 1981. The basic concept of this method is that the chosen alternative should have the shortest distance from the positive ideal solution and the farthest distance from a negative ideal solution. A positive ideal solution is a solution that maximizes the benefit criteria and minimizes cost criteria (Karimi et al., 2011); whereas, a negative ideal solution maximizes the cost criteria and minimizes the benefit criteria. Therefore, the fuzzy TOPSIS method is proposed, in which the weights of criteria and ratings of alternatives are evaluated by linguistic variables represented by fuzzy numbers to deal with the deficiency in the traditional TOPSIS. This paper presents an extension of the TOPSIS method proposed by Chen et al. (2006). The related algorithm can be described as follows:

Step 1: A committee of the decision-makers is formed fuzzy rating of each decision maker. $D_k = (k = 1,2,\ldots,k)$ can be represented as triangular fuzzy number $\tilde{R}_k = (k = 1,2,\ldots,;)$ with membership function $\mu_{\tilde{R}_k}(x)$

Step 2: Criteria evaluation is determined.

Step 3: After that, appropriate linguistic variables are chosen for evaluating criteria and alternatives.

Step 4: Then the weight of criteria are aggregated. The aggregated fuzzy rating can be determined by:

$$\tilde{R} = (a, b, c), k = 1,2,\ldots, k.$$

$$\text{where }, a = \min\{a_k\}, b = \frac{1}{k}\sum_{k=1}^{k} b_k, c = \max\{c_k\} \qquad (1)$$

$$a_{ij} = \min_k \{a_{ijk}\}, b_{ij} = \frac{1}{k}\sum_{k=1}^{k} b_{ijk}, c_{ij} = \max_k \{c_{ijk}\} \qquad (2)$$

Then, the aggregated fuzzy weight ($\tilde{w}_{ij}$) of each criterion are calculated by:

$$(\tilde{w}_{ij}) = (w_{j1}, w_{j2}, w_{j3}) \qquad (3)$$

Where $w_{j1} = \min_k \{w_{ik1}\}, w_{j2} = \frac{1}{k}\sum_{k=1}^{k} w_{jk2}, w_{j3} = \max_k \{w_{jk3}\}$ (4)

Step 5: Then the fuzzy decision matrix is constructed.
Step 6: The above matrix is normalized.
Step 7: Considering the different weight of each criterion, the weighted normalized decision matrix is computed by multiplying the importance weights of evaluation criteria and the values in the normalized fuzzy decision matrix.
Step 8: the fuzzy positive ideal solution (FPIS,A*) and fuzzy negative ideal solution (FNIS,A*) are determine by:

$$A^* = (\tilde{V}_1^*, \tilde{V}_2^*, \ldots, \tilde{V}n^*), \qquad (5)$$

$$A^- = (\tilde{V}_1^-, \tilde{V}_2^-, \ldots, \tilde{V}_n^-) \qquad (6)$$

Where, $\tilde{V}_j^* = \max_i \{V_{ij3}\}$ and $\tilde{V}_j^- = \min_i \{V_{ij1}\}$

$i = 1,2,\ldots,m; \qquad j = 1,2,\ldots,n$

Step 9: Then, the distance of each alternative from FPIS and FNIS are calculated by:

$$d_i^* = \sum_{j=1}^{n} d_v(\tilde{V}_{ij}, \tilde{V}_j^*) \quad i = 1,2,\ldots,m \qquad (7)$$

$$d_i^- = \sum_{j=1}^{n} d_v(\tilde{V}_{ij}, \tilde{V}_j^-) \quad i = 1,2,\ldots m \qquad (8)$$

Where $d_v(\ldots)$ is the distance measurement between two fuzzy numbers?

Step 10: A closeness coefficient index (CCl) is defined to rank all possible alternative. The closeness coefficient represents the distance to the fuzzy positive ideal solution (A*) and fuzzy negative ideal solution (A^-) simultaneously. The closeness coefficient of each alternative is calculated by:

$$CC_i = \frac{d_i^- i}{d_i^* + d_i^-}, \ i = 1,2,\ldots, m \qquad (9)$$

Step 11: According to the closeness coefficient, the ranking of the alternative can be determined.

Table 2. Language terms

Very low	**1**	**(0,0.1,0.2)**
Low	2	(0.1,0.25,0.4)
Medium	3	(0.3,0.5,0.7)
High	4	(0.6,0.75,0.9)
Very high	5	(0.8,0.9,1)

In order applying fuzzy TOPSIS, We have converted the language terms to fuzzy numbers according Table 2, and its results are shown in Table 3and 4.

Table 3. Rank of fuzzy TOPSIS for structural capital

Structural Capital indicators	Important level	Distance from positive deal	Distance from negative ideal
Open and positive climate	0.663	0.011	0.021
Ratio of investment in R&D	0.622	0.012	0.02
Numbers of R&D projects	0.596	0.013	0.019
Existence of active intranet	0.571	0.013	0.018
Management information systems (MIS)	0.536	0.015	0.017
Importance of National brand	0.518	0.016	0.017
Numbers of scientific data base	0.491	0.016	0.016
Importance of patent	0.473	0.018	0.016
Number of specific software	0.463	0.017	0.015
Numbers of PCs	0.433	0.019	0.014
Numbers of scientific publications	0.429	0.020	0.013

According to Table 3, open and positive climate shows the high priority followed by ratio of investment in R&D and numbers of R&D projects, in opposite, the numbers of scientific publications manifest the least priority based on fuzzy TOPSIS technique. This may result from low interest of practitioners to publish without having any application in their practice, while R&D structure as an important component of technological capital in knowledge-based environments was placed near the top of ranking.

Table 4. Rank of fuzzy TOPSIS for relational capital

Relational Capital indicators	Important level	Distance from positive deal	Distance from negative ideal
Mutual trust with customers	0.76	0.007	0.022
Customer's satisfaction	0.71	0.009	0.021
Extent of relationship with public institution (diabetic association, ect.)	0.643	0.011	0.019
Numbers of customers	0.632	0.011	0.018
Number of strategic cooperation (alliances, licensing and agreements)	0.628	0.011	0.019
Average period of relationship with customers	0.622	0.011	0.017
Numbers of R&D contracts for product development	0.602	0.012	0.018
Numbers of customer's complaints	0.562	0.013	0.017
Number of transferred technological knowledge	0.545	0.014	0.016
Number of distribution channels	0.542	0.014	0.016
Number of suppliers	0.489	0.016	0.015
Extent of attendants in scientific convention	0.482	0.015	0.014
Numbers of new investors	0.407	0.017	0.012
Number of co-publication with academic centers	0.371	0.018	0.011

As depicted in Table 4, customer's perspectives are placed in superior levels of table according to fuzzy TOPSIS. Furthermore, pay attention to public institutions needs and commitment to strategic cooperation like alliances, licensing and agreements could show the high priority among relational capital indicators.

5. DISCUSSION

Present study has developed a valid tool for measuring and evaluating of intellectual capital especially for the knowledge- intensive environments like pharmaceutical and bio pharmaceutical industry. Experts confirmed 42 important and relevant items to this issue from a primary questionnaire.

Considering the structural and relational capital as two major components of IC (Wu et al., 2008) and knowledge productivity (Huang et al., 2010), the competitive position of companies is heavily dependent on systems and programs which provide positive climate for the scientists in order to be creative and innovative (Sharabati et al., 2010). Regarding to structural capital, fuzzy TOPSIS's result show that much concern is paid to positive climate, ratio of investment in R&D and numbers of R&D projects which reflect the meaningful position of systems and programs beside the technological capital in such environment. According to Subbanarasimha and Ahmad (2003), among the resources which a firm uses, technological knowledge (R&D activities) is an imperative one as it can help firms both attain, and sustain their competitive advantage. Furthermore, Cabrita and Bontis (2008) pointed out if a company has good systems, database, patents, trademarks, routines and procedures (as parts of the structural capital) it would be promising of efficient running of the company performance.

Though the relational capital dimension is divers and including suppliers, competitors, investors, and collaborators, but its primary attention in this study is customers and strategic cooperation such as alliances and licensing. Considering the key role of it, Seleim et al. (2004) addressed customer’s satisfaction as a critical component of relational capital. In addition, kennedy (1998) proposed that customer’s loyalty gives an indication of how stable the customer base is, and also maintainable customer relationships is therefore key factor in the competitive advantage of a company. According to numbers of R&D contracts for product development, our result was consistent with the findings of Maurer and Ebers (2006) that pharma companies are interested in collaborating with parties enabling their R&D, particularly scientific centers. Related to number of strategic cooperation (alliances, licensing and agreements) as an indicator which refers to the acquisition of new knowledge from other firms, some studies indicate that by considering aforementioned strategy in R&D industries, knowledge can be transmitted (Navaretti and Tarr, 2000). The good position related to extent of relationship with public institution is in turn with recent study (Aras et al., 2011) which has addressed the influence of corporate social responsibility on IC components.

8. Conclusion

From a strategic point of view, IC is becoming a critical one for a firm’s long-term productivity and performance in the knowledge-based environment, and it is widely accepted that knowledge make capabilities for firm to innovate, as well as its performance. Furthermore, firm performance is clearly connected to its IC ability to utilize knowledge resources in an effective manner (Subramaniam and Youndt, 2005). Therefore, in order to measure and report the IC, firms would require a number of indicators which able to evaluate the intellectual resources of the firm. Finally, regarding to structural and relational capital, it can be summarized that customers and collaborators play a key role in relational capital, since the concentration on aforementioned issues show the willingness of such firms to accelerate their own research through external collaborations.

In spite of some existing limitations, the tool for measuring and evaluating of intellectual capital constructed in this study has a number of new contributions and applications. First, the measurement is not only suitable for evaluation of a company’s development but also present a basis for further academic research. Second, the development of this tool can support the inadequacy of tangible asset evaluation of companies in emerging industry or with primary activities in R&D. Third, investors can apply this measurement for evaluation of the future value of such companies; it also is able to give venture capitalists a set of relatively objective indicators of the status of firms and their future trends in different development stages in an emerging industry. Finally, in light of this distinction, IC measurement can also be used as a quality management tool for corporate performance using concepts adopted from existing quality management technologies, such as ISOs, capability maturity model (CMM), and total quality management (TQM), in organizational or process improvements (Lee and Chang, 2006). Appropriate application of this tool in quality management can significantly help organizations in improving efficiency and achieving goals (Daily et al., 2006).

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