Structural Relationship among Intellectual Capital Dimensions

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Abstract—The purpose of this research is to address the degree of association among intellectual capital dimensions (human capital, structural capital and relational capital). For this reason, a quantitative methodology and a non-experimental design were used. Using Pearson correlation, structural equation modeling and linear regression we tested the study hypotheses. Through a sample of 103 companies from Cajeme, Mexico, a positive and significant association was found among intellectual capital dimensions, whose results provided empirical evidence that human capital can explain to structural capital and relational capital in organizations.

Index Terms—correlation, dimensions, intellectual capital, structural equation modeling.

1 Introduction

New changes are occurring in the world economy [1], which have made that intangible assets being considered as basic elements to generate a competitive advantage for the companies [2-5], where intellectual capital (IC) plays an important role [6-9].

IC is a term used to synthesize and evaluate the resources of the organization whose nature is intangible [10].

Although this view was originated from Penrose's approximations [11], as well as Machlup [12] and Drucker's work [13], today, the management of intangible assets is increasingly a necessity. Then, the industrial era is over and was supplanted by the knowledge era [9]. For this reason, managers in this new age must understand that compete with knowledge is the privilege of few [14].

Now, knowledge is the company's most important resource [4, 15]. Knowledge is an asset and, just as all assets, has to be managed, so whoever finds and controls them, triumphs (Stewart, 1998 [9]). Therefore, the management of intellectual capital is a necessity, because only 20% of the knowledge available to the company is used [8].

This is explained by The Resources-Based View (RBV) proposed by Barney [3], which argues that the intangible assets –as long as they are rare, valuable, inimitable and irreplaceable resources– can give the organization a sustained competitive advantage. In special, within The Knowledge-Based View (KBV) proposed by Grant [4], where knowledge is considered as a central resource, which is managed through intellectual capital [10].

The appearance of IC is considered as a product of the knowledge era [16]. This arose from the need to value companies through a more detailed way, going beyond the visible assets, until consider the relevance of the intangibles that the organization has to compete. It represents the fusion between two positions: management and knowledge measurement [15].

Within the principal antecedents of intellectual capital, is possible to highlight Müller's work (1779-1829), who wrote about a scientific and mental capital as a set of constructive powers of man, state and society [17]. Another of the pioneers of his study was Lawrence Dicksse, who was the first to mention the concept of intangible in the company in 1896 [18].

However –although its origins are located within the 19th century–, it was until the late 1950s and early 1960s that the study of intangible assets began to become relevant within organizations. Especially in the Penrose's work [11], where the intangible assets were conceived as generators of value in the organization. On the other hand, Machlup [12] y Drucker [13] argued the economic value of knowledge and, with that, the beginning of the knowledge society.

In that period –especially in 1969–, was when John Kenneth Galbraith called for the first time the intellectual capital as an intellectual action beyond knowledge or pure intellect [19]. However, the study of this variable received more attention until the beginning of the 1990s, with the Skandia model [6], which was the first of different models that have tried to explain this variable.

According to Roos, Roos, Dragonetti, and Edvinsson [15], no model is more important than the other when trying to explain intellectual capital, because of this it is necessary to consider them together. For this reason, within the different theoretical approaches that explain IC is possible to find different models such as *Balanced Scorecard* (Kaplan and Norton [20], *The Skandia Navigator* [6], *The Technolgy Broker* (Brooking [8]); *Western Ontario University Model* (Bontis, [7]), *Valoración y*

Gestión [Evaluation and Management] by Nevado and López [1], and *Intellectus Model* proposed by CIC (Knowledge Society Research Center) [21].

It is important to note that these models present their own dimensions to study intellectual capital. For example, Skandia [6] and Edvinsson [22] divide IC in client, financial, human, processes and renovation; Bontis [7], in human, relational and organizational; Brooking [8], in market, human, property and infrastructure; while Stewart [9], in human, technological, structural and client; Edvinsson and Malone (2001) [16], in human, clients, organizational and innovation; CIC [21] in human, organizational, technological, relational, business and social.

From the above, it is possible to observe that within the indicated models there is a certain consensus in the existence of three basic dimensions of intellectual capital: human, structural and relacional. However, it is still unclear how is he relationship between these dimensions. For example, within the approximations of Skandia [6], Edvinsson [22] and, Edvinsson and Malone [16], the relationship between these capitals is very close. Even, according to Bontis [7] and, Ahmad, Naji and Bontis [23], there is a mutual interdependence between these dimensions, which together, have an impact on performance.

Also, according to Edvinsson and Malone [16], and Stewart [9], not only is there a close relationship between the variables, but human capital is the basis for the development of structural and relational capital. For Bontis [24], too, there is a causal relationship between human, relational and organizational capital.

These theoretical postulates show the need for empirical evidence which provides information about the relationship among intellectual capital dimensions. This is why the following research questions are proposed: *How are intellectual capital dimensions associated with each other? How does human capital influence on structural capital?* and *How does human capital influence on relational capital?*

To answer the research questions the following hypotheses are proposed:

H_1: Intellectual capital dimensions are associated by a significant and positive way.

H_2: Human capital has a significant and positive influence on structural capital.

H_3: Human capital has a significant and positive influence on relational capital.

2 Intellectual Capital

2.1 Definition of intellectual capital

Intellectual capital may seem like a new approach, but in practice it has existed for years through common sense [22]. This theme has become more attractive for companies seeking to gain benefits through innovation and knowledge [25]. In essence, it is a term used to synthesize and evaluate those organization resources whose nature is intangible [10], which has caused controversy about this variable. Although there is no consensus on a definition fully accepted by the academic community about intellectual capital, different visions have emerged to try to conceptualize this variable.

According to Brooking [8] IC is the combination of intangible assets that belong to the company. Moreover, it is knowledge possession, applied experience, organizational technology, customer relationships and professional skills that give a competitive advantage in the market [16]. It includes information, intellectual property, knowledge and experience [7]; organizational processes, technologies, employee skills, as well as information about customers and supplies [9].

Therefore, IC is a term given to all intangibles, which allows organization management [8]. This can be used to create value, considering relationships with customers and partners, innovation, company infrastructure, and knowledge, as well as employee's skills and talents [15]; which is configured by everything within the company, in other words, its resources, intangibles processes, patents, customers, as well as tacit and explicit knowledge [26]. Consequently, it involves human, structural and relational capital [7], aspects that are described below.

2.2 Human capital

Human capital (HC) is very important for the organization, because it is a necessary resource for innovation and strategic change and, at the same time, has a great influence on how a company must be structured [27]. HC It is a combination of inherent genetics, education, experience, as well as life and business skills [28]. Moreover, represents value of knowledge and talent which are embodied or possessed by the people who conform the organization, Including values, attitudes, skills and abilities [29].

In addition to, Brooking [8] classifies HC into two types of assets: intellectual property and individual-centered. The first includes intellectual property assets, know-how, manufacturing secrets, copyright, patents and design rights, brands and services. These are the result of the mind but belong to the company and are protected by law, although varies by country. While human-centered human assets are based on the knowledge. They emerge from a more long-lived population with a greater demand of life quality and include collective experience, creativity, problem-solving ability, leadership, entrepreneurship and management skills. Furthermore, involve psychometric indicators about how individuals can perform in situations such as teamwork and stress.

2.3 Structural capital

Structural capital (SC) includes all non-human knowledge containers, which involves databases, process manuals, strategies, routines and analyzes that value the company [26]. It is important to emphasize that an organization with strong structural capital has a culture that allows people to perform tasks, fail, learn and try again [28].

Also, SC is the set of knowledge and intangible assets derived from the processes of action that are owned by the organization, which remains there when people abandon it. Even it is composed of organizational capital and technological capital. The first is associated with design, processes and culture; while the second type is linked to innovation, the use of technological endowment and its results [21].

2.4 Relational capital

Relational capital (RC) involves knowledge of market channels, customers, supplier relationships, and understanding of government impacts [26]. Among others, includes market orientations, customers, competitors and market learning systems. The essence of this capital is to relate outside and inside the organization [28].

RC can be defined as the set of knowledge that is incorporated into the organization and people as a consequence of the value derived from the relationships, which maintains with the agents of the market and the society in general. It also consists of social capital and social capital [30].

Social capital is the company's set of relations with the social agents that affect the integration, commitment, cooperation, cohesion, connection and social responsibility [31-32]. It consists of relations with public administrations (collaboration and participation in public management), media and corporate image (brand awareness); as well as environmental care, social relations and corporate reputation [30].

3 Method

3.1 Research approach and design

A quantitative approach was employed in this research because numerical data were used to test the study hypotheses [33]. It is also correlational because the association among intellectual capital dimensions was measured [34]. A transversal study was done because the information was collected only once in time; while that its design is not experimental since no manipulation of variables nor subjects was performed [35]. For the analyses and data processing, the statistical package for social sciences (SPSS, version 21) and structural equation modeling software (EQS, version 6.1) were utilized.

3.2 Study sample

In this study, a non-probabilistic sample was obtained for convenience, which was conformed by 103 companies from Cajeme, Sonora, México. Some of the main characteristics of these companies are shown in Table 1.

3.3 Measurement instrument

The general measurement instrument of the study was composed of a sociodemographic section and one instrument whose purpose to measure intellectual capital.

Table 1. Characteristics Of The Studied Companies ($N = 103$)

Characteristics	n	%
Size of the companies		
Micro	39	37.9
Small	32	31.1
Medium	12	11.7
Large	20	19.4
Market orientation		
National	79	76.7
International	10	9.7
Both	14	13.6
Activity of the companies		
Industry	22	21.4
Commercial	29	28.2
Services	52	20.5

In this case, a spanish version of a questionnaire to measure intellectual capital was used, which was based on Subramaniam and Youndt [36], and comprises 14 items answered using a Likert-type scale with five options to respond, ranging from 1 (*Strongly disagree*) to 5 (*Strongly agree*), where higher scores indicated higher levels of agreement.

Moreover, although in the original study the dimensions were called human capital, social capital and organizational capital [36], we chose to name them as human capital, structural and relational capital, as defined by Skandia [6], Bontis [7], Stewart [9], CIC [30] and, Edvinsson and Malone [16]. For this reason, the study variable was operationalized as is shown in Table 3.

Exploratory factor analysis was followed to measure the validity of the measurement instrument, using principal component analysis with Varimax rotation. Favorable values were found in the index Kaiser-Meyer-Olkin (0.834), Bartlett's test of sphericity ($X^2 = 1199.40$, gl = 276, $p < .001$), and factorial loads greater than 0.45 in all the questions [37-38]. Furthermore, all the items were grouped according to the dimensions proposed by the authors (see Table 2).

Moreover, it is important to mention that a reliability assessment of the variables of the measurement instrument and its dimensions was performed by means of the Cronbach's alpha coefficient, where all coefficients resulted above the normal levels of acceptance: human capital (α=0.823), structural capital (α=0.842) y relational capital (α=0.85) (see Table 3).

Table 2. Exploratory factor analysis ($N = 103$)

Items	Factor Loading			h^2
	1	*2*	*3*	
Qualified Employees	**.813**	.061	.142	.685
Employees are the best	**.698**	.266	.170	.587
Creative employees	**.826**	.044	.335	.797
Skilled employees.	**.587**	.209	.179	.420
Develop of new ideas	**.525**	.148	.517	.607
Use of patents	.055	**.752**	-.067	.573
Knowledge in databases	.131	**.830**	.136	.573
Organizational culture	.189	**.823**	.095	.573
Conversion of knowledge	.182	**.813**	.236	.573
Relationship between employees	.408	.179	**.653**	.624
Information sharing and learning	.300	-.061	**.771**	.688
Interaction and exchange of ideas	.293	-.051	**.760**	.666
Relationship with suppliers and partners	.046	.212	**.699**	.536
Applied knowledge	.114	.154	**.849**	.757

Note: Boldface indicates highest factor loading.
h^2 = communality

Table 3. Dimensions and Reliability ($N = 103$)

Variable	Dimensions	Elements	(α)
Intellectual capital	Human capital	5	0.823
	Structural capital	4	0.842
	Relational capital	5	0.85

Note. α = Cronbach's alpha coefficient.

4 Results

After obtain favorable results, both in the validity analysis –exploratory factorial analysis– and the reliability, Structural Equation Modeling (SEM) was performed. Using the EQS software, a standardized structural model was obtained through the three types of intellectual capital: human capital (HC), structural capital (SC) and relational capital (RC).

Figure 1 shows that the IC dimensions were significantly and positively associated. Moreover, adequate values were found in the adjustment measures of the structural model, through the indicators: X^2/gl, RMSEA, CFI, IFI y NNFI (see Table 4). These results coincide with those obtained by Pearson correlation in the relation between: HC-SC ($r = 0.369$; $p < .001$), HC-RC ($r = 0.617$; $p < .001$), SC-RC ($r = 0.267$; $p < .001$), as is shown in Table 5. In this way, the empirical evidence could support H_1.

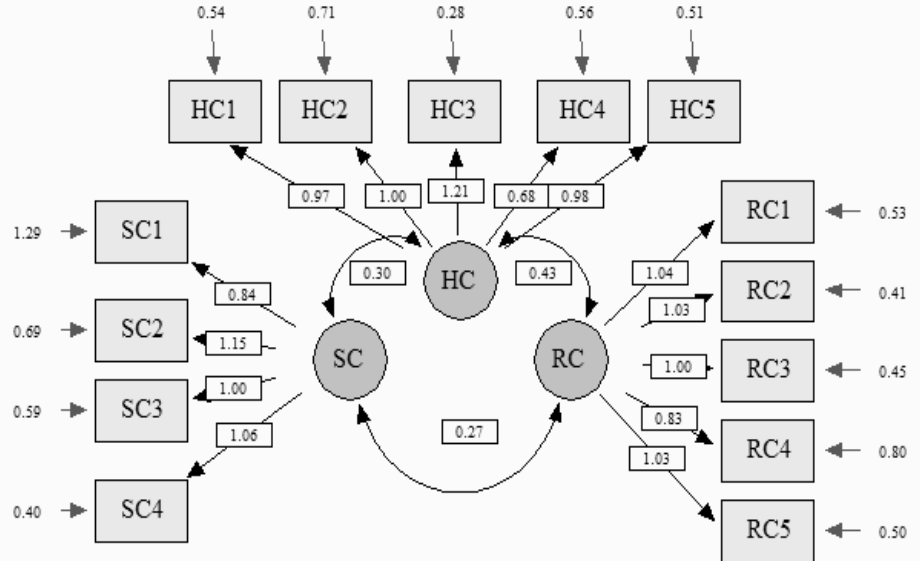

Fig. 1. Standarized structural model.

Table 4. goodness-of-fit indicator of the models for capital intellectual dimension (*N*= 103)

Indicator	Accepted value	Results
X^2		120.49
df		91
X^2/df	<3.0	1.324
RMSEA	0.06>RMSEA<1.0	0.083
CFI	>0.90	0.924
IFI	>0.90	0.926
NNFI	>0.90	0.903

Note. The accepted values were taken from Ho [34]

Table 5. Correlation of factors (*N* = 103)

Dimensions	1	2	3
HC	---		
SC	.369	---	
RC	.617	.267	---

Note. $p < 0{,}01$ (two tails).

On the other hand, linear regression was used to test H_2 and H_3, where we found that human capital influences structural capital and relational capital. In both cases, the effect was positive and significant; however, the explanation was 13% and 38% according to the statistic R^2 (see Table 6).

Table 6. Regression analysis considering to "human capital" as independent variable

Factor	B	SE	β	t	*p*
EC*	.511	.128	.369	3.990	.000
RC**	.666	.085	.617	7.871	.000

Note. *$R^2 = 136$; **$R^2 = 0.380$.

5 Conclusion

It is important to consider that the value of knowledge is in growth [15], because money has become dematerialized and intangible assets have become more valuable and powerful than natural resources, large factories or bank accounts [8]. Therefore, the study of intellectual capital has become increasingly important, especially within the Latin American context.

From a theoretical approach, according to Grant [4], KBV is based on the process of transfer, absorption capacity, appropriation, specialization and transformation of knowledge into products and services within the company. However, to be a reality, this requires intellectual capital, which through the development of human capital allows the transfer of knowledge through structural capital, and then, this can be reflected in the relationship that the company has with its customers, suppliers and society [19].

The results obtained with 103 companies from Sonora, Mexico, show that there is a significant relationship between the three dimensions of intellectual capital. This consistents with Skandia [6], Bontis [7], Edvinsson [22] and, Ahmad, Naji and Bontis [23]. In addition to, this empirical evidence shows that human capital –through the attitudes, knowledge and skills–, allows the development of structural and relational capital, as proposed by Bontis [7], Edvinsson and Malone [16], and Stewart [9].

Consequently, through Pearson correlation and structural equations modeling, the three hypotheses of study were sustained; however, the evidence found does not allow the generalization of the findings. Nevertheless, the most important thing of this study is that it showed how these capitals are associated from a structural perspective.

For future research, would be convenient to perform a validation study for the instrument proposed by Subramaniam and Youndt [36], in spanish version. This could favor the study of intellectual capital with Latin American organizations, because this instrument is short, easy to administer and clear; in addition, this showed adequate results within the exploratory factor analysis and structural equations modeling, as well as the level of reliability.

On the other hand, it is recommended to do a study with a larger sample within the Mexican context, where it also includes other intangible variables such as knowledge management, innovation, learning, organizational culture, and other intangible variables, in order to measure their association.

Considering that the principal limitation of the study is the size of the sample –103 companies–, because Jackson [39] recommends to have at least 200 subjects for the use of structural equations. However, according to Ho [34] there is still no consensus about the minimum sample to use this statistical technique. Therefore, for future re-

search it would be advisable to do the study with a larger sample, especially if the instrument will be validated.

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