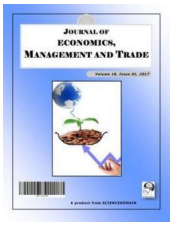

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Construction Firms' Intellectual Capital in Southeast Mexico

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Authors' contributions

This work was carried out in collaboration between all authors. Author RGSC directed the research project and wrote the first draft of the manuscript. Author ACCP wrote the protocol, conducted the field work and performed the statistical analysis. Authors JNZG and JAGF collaborated in the field work. All authors read and approved the final manuscript.

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ABSTRACT

Knowledge is currently an important element for most companies and constitutes an intangible asset that can generate profits and competitive advantages. Intellectual Capital is conformed with the accumulation of explicit knowledge that is generated from capitalization of knowledge and experiences of the company's personnel. In the construction industry, this capital has not been given enough importance, so its potential has not been fully exploited; the lack of memory in construction firms causes that in many occasions the same project's errors are repeated out in another one, and this derives in profit loss. The aim of this work was to measure the Intellectual Capital of a leading construction companies group in the southeast of Mexico, to assess their weaknesses and good practices. The methodology consisted in the application of a questionnaire to employees at operational and managerial levels; this instrument was organized into two sections, one to measure Human Capital and another to measure Structural Capital, and was developed based on a system of indicators that have already been used in other industries internationally. Results showed that most of their Intellectual Capital is made up of the skills, knowledge and

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experience of their staff and it is not appreciated that they are carrying out sufficient actions to convert such knowledge into organizational knowledge, so these firms could lose competitiveness in globalized market.

Keywords: Construction; intellectual capital; knowledge management; construction firm; competitiveness.

1. INTRODUCTION

In today's dynamic and globalized economic environment, knowledge has become an important element for organizations; so, the value of companies no longer corresponds only to the sum of their tangible assets (real estate, furniture, money, etc.), but also includes their Intellectual Capital [1].

Intellectual Capital is defined as the accumulation of explicit knowledge that can generate profit and competitive advantages for the company [2]. It is composed of three main elements: Human Capital (the people in whom the experience, skills and abilities reside); Structural Capital (infrastructure, procedures and policies); and Relational Capital (relations with customers and suppliers) [3].

Currently the companies that have a dominant position in the market, give great importance on capitalization of experiences that are generated in development of their businesses or projects; and are aware that accumulated knowledge of their employees and organization, will allow the formulation of better action plans in the future [4].

In accordance with the above, companies, in addition to managing their tangible assets, require managing knowledge through the generation of learning environment that encourage the creation, increase, use and reuse of knowledge [5]. The fundamental objective of knowledge management is seeking to increase the Intellectual Capital of the company, managing the capabilities of problem solving that allow it to generate sustainable competitive advantages over time [6].

One of the first assessment systems of Intellectual Capital, and perhaps the best known, is Skandia Navigator, developed by the Swedish insurance company of the same name. It is composed into five dimensions: human, financial, relative to processes, relational, and relative to innovation and development. This system has shown its effectiveness in mature companies that already have a culture of knowledge management; It is important to pointed out that many of its indicators are obtained from the accounting reports, which means that the firm has already achieved the transformation of knowledge into tangible assets [7].

Evidence has been found about knowledge management having a positive relationship with quality management, because some actions are common to both [8]. The ISO 9001 standard (which determines the requirements for a quality management system) makes explicit mention of knowledge as a transcendental resource, and defines the requirements necessary for its management; so, any organization that wants to be certified must demonstrate how it manages its knowledge, and how it plans to incorporate the knowledge that it does not yet have and will need [9].

Authors found only one antecedent about the study of Intellectual Capital in the southeast of Mexico. It was a study involving 20 companies of diverse industrial branches; It was reported that these companies are mainly knowledge consumers, but these companies do not turn its knowledge into an explicit form. It was also concluded that the most successful companies focus on innovation, but with little or no knowledge assimilation [10].

Knowledge management has been widely applied in many industries, however, in the construction sector its adoption has been very slow, so its potential has not yet been fully exploited. It is very common that the lack of memory in the construction firms causes that same errors are repeated from one project into another, which causes cost overruns and loss of profit. Research carried out in construction firms have shown that their practices for the processing, capture and storage of knowledge are modest, and that they do not manage to convert experiences into tangible benefits. These results suggest that the loss of knowledge is a threat to their permanence in the market [11].

It is pertinent to note that the execution of construction projects requires the participation of

large number of people and various organizations, so that the accumulation of knowledge becomes an even more difficult task, especially in the absence of good coordination between the work teams [12]. For all the above, it is important that construction firms consider knowledge management and generation of Intellectual Capital as important challenges they must face, to remain effective in an increasingly competitive market.

The objective of this work was to assess the Intellectual Capital of a group of mature construction firms in the southeast of Mexico, to identify their weaknesses and recognize their good practices.

2. METHODOLOGY

The unit of analysis was the medium or large size construction firm that is operating continuously in the State of Yucatan, Mexico. The criterion for classifying the size was taken from the National Institute of Geography and Information Statistics [13], based on the number of permanent employees.

The sample was non-probabilistic and consisted of five construction companies that are considered leaders in the region, based on their age in the market and relevance of the projects they have carried out. In accordance with the above, the sample included firms with the desirable level of maturity to study Intellectual Capital. Henceforth these companies will be referred to as follows: company A (large size with 36 years old), company B (large size with 26 years), company C (large size with 39 years), and company D (large size with 30 years) years) and company E (medium size with 16 years).

In this study, the Intellectual Capital of the firms was assessed through two components: Human Capital and Structural Capital; Relational Capital was omitted because of the difficulty of measuring it in a first study. The assessment instrument used was developed based on the system of indicators proposed by Manzari et al. [14] for Intellectual Capital assessment in any kind of industries. Being this a first exploration in the region to the phenomenon studied, the instrument was not normalized, so in quantitative terms its results are not susceptible to be compared with other studies.

For the assessment of Human Capital, three factors were considered: Motivation, which included 14 indicators; Competencies, which included 11 indicators; and Experience and knowledge, which included 9 indicators. While for the Structural Capital two factors were considered: Knowledge infrastructure, which included 7 indicators; and Processes and routines, which included 8 indicators. In this way, the instrument was made up of a total of 49 indicators, which are listed in Tables 5 to 9 (in the Results section).

The instrument was applied to both operational and managerial staff, and provided information about the interviewees and about the construction firms. In this study, 41 people of operational level and 15 of management level participated, making a total of 56 people, which were distributed evenly among the five companies. Both, people and firms were guaranteed of confidentiality for provided information.

Based on employee responses, each indicator was assigned a Likert scale rating with values from 1 (very low or zero presence of the indicator) to 5 (optimal presence of the indicator). For this, each indicator was defined with five values for its scale; for example, for the indicator Induction to the organization, the scale was defined as follows: 1, if less than 20% claimed to have had this activity before starting to work in the company; 2, if between 20 and 40% affirmed it; 3, if between 41 and 60% affirmed it; 4, if between 61 and 80% affirmed it; and 5, if between 81 and 100% affirmed it. In accordance with the above, for each indicator a rating was assigned to each company; and, in the same way, a grade to the entire group of participants in the study.

The score of each factor was calculated by means of the quotient between the sum of the ratings assigned to its indicators, between the maximum value that this sum could reach (if all the ratings had been 5); and this quotient was multiplied by 100 to convert this score to units with a scale of 1 to 100.

For example, for the Motivation factor of the operating personnel of company A, the sum of the ratings of its 14 indicators was 31, with 70 being the maximum possible value (5 x 14); therefore, the score assigned to this factor was 44 (see Table 3 in the Results section).

Based on the previous scores, each factor was associated with a qualitative level on a scale that

Table 1. Qualitative scale of factor level assessment

Level	Scale	Description
Lowest	0-20	Present at a very low level or not present at all.
Low	21-40	Present only in some departments.
Medium	41-60	Present, but not at the organizational level.
High	61-80	Present, but still with deficiencies in its implementation.
Highest	81-100	It has reached a high level of development and implementation.

defined as shown in Table 1. This scale was based on the theory that defines the levels of intellectual capital management [15].

Intellectual Capital was calculated by means of the weighted average of its two components, considering the following weights: 0.40 for Human Capital and 0.60 for Structural Capital. This weighting was defined considering that obtaining structural capital necessarily implies carrying out planned management actions, while part of the human is possible to obtain it in a fortuitous manner.

3. RESULTS

The distributions of the main characteristics of the 56 employees participating in the study are presented in Table 2: Seniority in the company, gender of the person and their academic training.

Table 2. Distributions of the characteristics of the people who made up the sample

Seniority	%	Gender	%
<5 years	41	Female	21
5-10 years	25	Male	79
11-15 years	16	**Academic level**	**%**
16-20 years	11	Postgraduate	14
21-25 years	5	Graduate	73
>25 years	2	Undergraduate	13

For each of the five firms participating in the study, Table 3 presents the scores (on a scale of 1 to 100) of the three components of Human Capital: Motivation, Competencies, and Experience and knowledge; the score of the operating personnel, of the management personnel and the score of the total of the participating employees of each company is presented separately.

In the same table, for each factor, the score of the group that includes all the companies is presented in the penultimate column; and in the last column, the qualitative level associated to each factor, according to the scale defined in Table 1. In the last row, the Human Capital scores were calculated for each company are presented, which were included in a range of 62 to 74, and correspond in all cases to a high level; The calculated score for the entire sample is also presented, which was 65 and corresponds to the same level.

Analogously, in Table 4, for Structural Capital, construction firms and complete sample scores are presented, as well as the levels of the factors. According to these results, the Structural Capital scores for the five construction firms were in a range of 35 to 69, distributed among the low, medium and high levels; it is also observed in this table that the score calculated for the whole sample was 40 and it was located on the border between the low and medium levels.

Based on the results of Tables 3 and 4, the score for the Intellectual Capital of each company was calculated, according to the weighting explained above. In Fig. 1 these scores are presented, with those of their respective human and structural components.

On the other hand, considering in a single group the 56 people who participated in the study, they were qualified from the different indicators that made up each factor (in a scale of 1 to 5). Tables 5, 6 and 7 present scoring for the Human Capital factors; It is observed that some indicators of Motivation and Competence factors only applied for operative personnel. Analogously, tables 8 and 9 present the scoring that correspond to the Structural Capital factors.

In the last two rows of these tables, the general factor score (in a scale of 1 to 100) and qualitative level associated with each factor are presented. It can be observed that general scores calculated by each factor match with those presented in Tables 3 and 4, which were calculated by each construction firm.

Table 3. Human capital score by construction firm

Factors	Personnel	Construction firms						Level
		A	B	C	D	E	All	
Motivation	Operative	44	51	63	60	63	56	Medium
	Managerial	49	75	78	58	60	68	High
	Total	43	57	70	61	61	57	Medium
Competencies	Operative	67	65	67	76	56	64	High
	Managerial	44	88	64	60	60	64	High
	Total	64	67	69	75	58	64	High
Experience and knowledge	Operative	89	78	87	76	71	80	High
	Managerial	69	89	84	82	80	84	Highest
	Total	89	87	87	82	76	80	High
Human Capital	Operative	64	63	71	69	63	65	High
	Managerial	55	82	78	67	67	73	High
	Total	62	68	74	71	64	65	High

Table 4. Structural capital score by construction firm

Factors	Personnel	Construction firms						Level
		A	B	C	D	E	All	
Knowledge infrastructure	Operative	40	51	60	54	46	43	Medium
	Managerial	37	57	60	63	63	51	Medium
	Total	40	51	54	54	51	46	Medium
Processes	Operative	30	75	83	48	30	35	Low
	Managerial	33	63	80	68	50	53	Medium
	Total	30	70	83	55	33	35	Low
Structural Capital	Operative	35	64	72	51	37	39	Low
	Managerial	35	60	71	65	56	52	Medium
	Total	35	61	69	55	41	40	Low

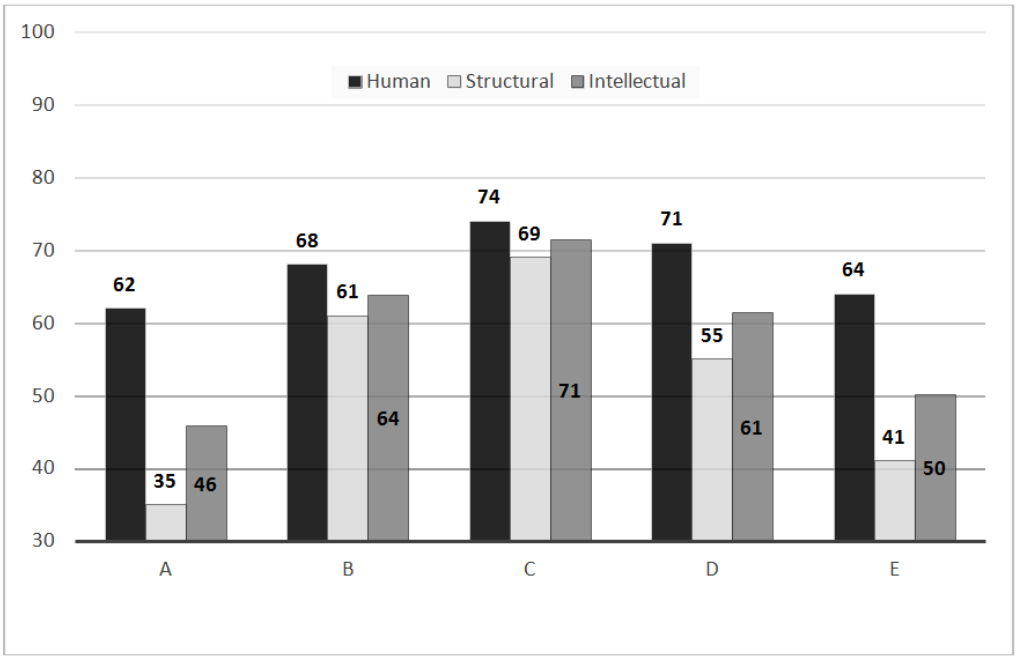

Fig. 1. Intellectual Capital scores and its human and structural components of construction firms

Table 5. Scoring for indicators of motivation factor for complete sample

Indicators	Motivation		
	Operative	Managerial	Total
Personnel voluntary resignation	3	3	3
Wages	1	1	1
Additional compensations	2	3	2
Incentives	3	4	3
Equity	5	5	5
Commitment with the company	2	3	2
Identification with the company	1	2	1
Knowledge of organization culture	2	3	2
Rotation opportunity	3	4	3
Perception of the organizational climate	4	4	4
Employee satisfaction	4	4	4
Utilization of staff capabilities	3	3	3
Fixed / temporary personnel relationship	4	5	5
Retention of key personnel	2	-	2
Overall score	56	68	57
Level	Medium	High	Medium

Table 6. Scoring of the factor indicators competencies for the complete sample

Indicators	Competencies		
	Operative	Managerial	Total
Recruitment policies	2	2	2
Flexibility to staff	3	4	3
Attraction of talented people	5	-	5
Learning capacity	3	-	3
Proactive ability	3	-	3
Entrepreneurship	3	-	3
Responsibility	4	-	4
Outstanding performance	3	-	3
Induction to the organization	2	3	2
Utilization of personnel capacity	3	3	3
Sensitivity	4	4	4
Overall score	64	64	64
Level	High	High	High

Table 7. Scoring for experience & knowledge factor indicators for complete sample

Indicators	Experience & knowledge		
	Operative	Managerial	Total
Average age of the workforce	4	4	4
Education	4	5	4
Average duration of the staff	4	5	4
Years of experience	3	4	3
Knowledge transfer	5	5	5
Reflection on previous experiences	5	5	5
Organizational learning	4	4	4
Computer skills	4	3	4
Training and qualification	3	3	3
Overall score	80	84	80
Level	High	Very High	High

Table 8. Scoring for knowledge infrastructure factor indicators of complete sample

Indicators	Infrastructure		
	Operative	Managerial	Total
Available software	4	3	3
Knowledge center	4	3	4
Information Systems	1	3	1
Organizational Learning	2	3	3
Patents	1	1	1
Innovation	2	3	3
Research projects	1	2	1
Overall score	43	51	46
Level	Medium	Medium	Medium

Table 9. Scoring for process & routine factor indicators of complete sample

Indicators	Process & routine		
	Operative	Managerial	Total
Organizational flexibility	5	5	5
Procedures	1	2	1
Productivity index register	3	3	3
Quality improvement	1	1	1
Organizational culture implementation	1	2	1
Organizational structures	1	3	1
Strategic plan	1	3	1
Mission & vision	1	2	1
Overall score	35	53	35
Level	Medium	Medium	Medium

4. DISCUSSION

According to the obtained results, indicators that could be considered as weaknesses of the Human and Structural Capital of the companies studied were identified. For the above, the indicators with values of 1 or 2 were considered as weaknesses, which means that they are present in the organization at a low or null level.

Regarding Human Capital, Motivation was the factor that obtained the lowest score in four of the five organizations studied (see Table 3). Six indicators of this factor were considered as weaknesses: Wages, Additional compensations, Identification with the company, Commitment to the company, Knowledge of organizational culture and Retention of key personnel. It can be seen that among these indicators are those that are related with monetary perceptions and retention of personnel in companies, which seems to be resulting in employees not identifying much with them and, therefore, not show a high commitment. In the same Table 3 it can be seen in Motivation factor, the employees with management position had higher scores than the those with operative positions. This can be attributed to the fact that the management positions receive greater economic incentives and have had greater opportunities growing up in the organization.

These results on Motivation are consistent with those obtained by Solís et al. [16], who studied the job satisfaction of professional construction employees in the same region of Mexico. The main conclusions of this research were that the managerial staff is more satisfied with their work than the operative one; that the wage levels of the employees of the construction organizations are, in general, unsatisfactory; and that these companies do not generate work environments that positively influence the behavior of their employees.

The next factor of Human Capital with lowest scores in all companies was the Competencies. Two indicators of this factor were considered as weaknesses: Recruitment policies and Organization induction. These indicators describe the way companies choose and host the employees they hire; the results showed that the most common practice is to hire people recommended by other employees or known people, and that no actions are planned to communicate their organizational culture to new

employees. The latter can also explain, in part, because employees do not identify much with the company in which they work.

The fact of hiring workers by personal recommendation could have the advantage of being able to access first-hand information about some aspects of a person's behavior or competencies. However, this is not a professional way of managing Human Capital, and it is likely that some important steps are missed, such as the work position analysis and description, and the description of the candidate. Some authors have emphasized the importance of using prediction models of the candidate's performance based on some dimensions of personality, such as openness to new experiences, responsibility, cordiality, emotional stability and extroversion [17]. On the other hand, the way in which the new employee is hosted into a company has an immediate impact on their level of satisfaction and should have an impact on the company's results. Some benefits of labor induction are: identification with the organization, understanding of what the company expects from the new employee and a better acceptance of their colleagues [18].

Experiences and knowledge was the factor of the Human Capital with the highest score in all the studied organizations, and it had not indicators that could be considered as a weakness. The data collected on the seniority of employees in their companies were distributed approximately uniformly: 41% with less than 5 years old, 25% between 5 and 10 years and 34% with more than 11 years (see Table 2). It is likely that the balance between up-to-date knowledge and professional experience is making this factor a strength in the studied organizations.

Regarding Structural Capital, the Knowledge infrastructure factor had the lowest score in three of the five organizations (see Table 4). Three indicators of this factor were considered as weaknesses: Research projects, Patents and Information systems. These indicators are related to the lack of generation of new knowledge and obtaining exclusive rights for new products or technologies that can be exploited commercially; as well as the lack of integral information systems in organizations.

The construction Gross Domestic Product (GDP) represents approximately 11% of world GDP [19], and in most countries this activity is one of the most contributing to GDP. However, the construction sector is recognized as one of the least investing in research and innovation, with only very large organizations considering technology research as a strategy. The above has resulted in the construction traditionally having a low productivity; for example, it has been reported that construction in Spain has 30% less productivity compared to other manufacturing industries [20]. On the other hand, related to the lack of information systems in construction organizations, some studies have concluded that they have a considerable delay in the use of information and communication technologies [21].

Two of the five companies obtained their lowest Structural Capital score in the Processes and routine factor. Five indicators of this factor were considered as weaknesses: Procedures, Quality improvement, Organizational culture implementation, Strategic plan, and Mission and vision. In general, it was not observed that companies used procedure manuals; that they had systems of continuous improvement of quality and strategic plans; and that his employees knew the mission and vision of the organization. The previous weaknesses show that the studied companies have an organization that, although it has allowed them to maintain a leading position in the region, it is very likely that in a more globalized environment they will be uncompetitive, for these reasons they would have to improve in quality, productivity and incorporate technological innovation [4].

In general terms, the results of the study showed that the studied organizations had a medium level in Intellectual Capital, conformed with a high level in Human Capital and a medium level in Structural Capital. The results of a similar study conducted in Malaysia [11] showed that construction companies have a storing knowledge practice that was rated as high, while the dissemination and application of it was rated as low; these authors conclude that knowledge management is done informally.

Some authors have emphasized the importance of comparing firms with those of similar functionality that have the best operational practices; this benchmarking system would allow them to improve in the performance of their operations in the short term [22].

In the present study company C was that it had the best scores in the two components of Intellectual Capital (see Fig. 1). Below is a

Table 10. Good practices related to the intellectual capital observed in company C

Indicator	Good practice
Incentives	Granting special permits. Additional economic remunerations. Additional holiday days.
Perception of the organizational climate	Opening attitude on the part of the high commands.
Utilization of staff capabilities	Advance recruitment of personnel aligned with the future growth of the organization.
Key personnel retention	Freedom in decision making. Flextime. Annual salary increases.
Education	Postgraduate financing. Flexibility of schedule to continue studying.
Training and qualification	Organize diploma courses on decision making.
Organizational learning	Permanent update of the procedure manuals.
Procedures	Permanent update of administrative procedures.
Organizational culture implementation	Place posters in strategic sites. Annual meetings. Economic benefits for compliance. Evaluations carried out by specialized personnel.

brief description of this company and some characteristics of the employees interviewed:

Company C is a large organization and is 39 years old dedicated to the execution of building projects. It is organized with a general management and four managements (operations, construction, accounting and marketing).

In the research, 12 employees were interviewed: eight operatives and the four managers (one of them with a master's degree). Ten men and two women (both at an operational level, with a degree). All with permanent employment in the company. Six with ages between 25 and 35 years old, and six with ages between 36 and 55 years. Seven with less than 5 years in the company, three with seniority between 5 and 10, and two with seniority between 15 and 25. Five with professional experience between 1 and 5 years, four with experience between 10 and 20 years, and three with experience between 21 and 30 years.

According to the previous data, the organization has a good combination of young professionals in full (50%) and mature professionals (50%); in terms of professional experience, it has a uniform distribution that ranges from young people who are starting their careers to mature people who have already lived approximately two thirds of their career; and has a majority group (58%) that have recently joined the company.

This company, according to its scores, had high level in the three factors of Human Capital; in Structural Capital it had a very high level in one factor and a medium level in the other. In general, its Intellectual Capital was high, and according to what was observed, the staff was proud to work for this company, committed to its vision and without the intention of causing voluntary resignation.

Table 10 lists the good practices that were identified in company C, and that make it stand out from the rest.

5. CONCLUSIONS

According to the indicators and scales system used, all the organizations studied showed an acceptable Human Capital level and a poor Structural Capital level. The main strengths of these organizations were the good levels of knowledge and experience from employees, which is a good starting point to begin with Intellectual Capital management.

Likewise, the study identified great opportunities for organizations improvement, based on their main weaknesses observed, which the following were:

a) For Human Capital management: Improve the recruitment system, based on merits, instead of relying on recommendations; improve induction programs to the

organization for new employees; increase salary levels, both to improve employee satisfaction, and to encourage the retention of outstanding staff.

b) For Structural Capital management: participate in research projects jointly with universities; standardize their processes, recording the results in manuals; increase the use of information systems; promote the organizational culture; implement systems of continuous quality improvement; and establish the strategic plans of the organization.

In general, it is not appreciated that organizations are carrying out sufficient planned and systematic actions for turning out personal knowledge into organizational knowledge. It can be concluded that if the companies studied (and other similar ones) do not begin to manage the knowledge they generate, they will have few opportunities to compete successfully with companies with greater Intellectual Capital, when the market in which they participate becomes more open and globalized.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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