

The Effective Knowledge Management In Local Brazilian Building Incorporation And Construction Enterprises

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Abstract– We display the Knowledge Management (KM) as a process, following a basic model based on seven dimensions. Our goal is to verify the level of effectiveness of KM in building incorporation and construction of enterprises located in Curitiba and its metropolitan area, Brazil. Therefore, we made a survey in a sample of local companies and analyzed the data using descriptive statistics. The results indicate the existence of processes and characteristics moderately associated with the KM, consistent with "Traditional Companies". We show a reference of where (in what dimension) and with which intensity the initiatives of the KM occur, allowing one to draw a profile of how knowledge is being managed by the contractors. The organizational culture dimension showed the greater effectiveness of KM, giving evidence that the organizational environment tends to be pleasant, prevailing freedom, trust and respect; fertile ground for the creation of knowledge.

Keywords– Civil construction, knowledge management, organizational processes and characteristics, seven dimensions of knowledge.

I. INTRODUCTION

The construction industry is basically formed by suppliers, services and project companies, all with a common goal: deliver products or services required for the construction process as a whole [1]. The construction is divided into three sub-sectors: edification (development and construction of buildings); heavy construction (infrastructure of transport, energy, telecommunications and sanitation); and industrial assembly [2].

The Brazilian construction companies have been seeking to implement practices that lead to Knowledge Management (KM) as a way to update and modernize the image of the sector in which they operate. The KM becomes important for the success of organizations, a key asset, the main material with which all companies work [3, 4 & 5]. The search for innovation through the adoption of more efficient production and management strategies makes the importance of knowledge and its management clear, in view of the challenges of the current environment of increased competition and of the changes from the consumer public to the private client, with greater demands and requiring an improvement in productivity and competitiveness [6]. The industry is placing great emphasis on improving the quality and productivity in view of the market competition coupled with the technological, informational and managerial developments [2].

Due to the size of the sector, its characteristics of intensive use of information, inefficient communication and low productivity, it is considered that the benefits of the integration of KM models to the processes of the construction industry would be significant [7]. The effectiveness of KM, however, represents a major challenge for a company, particularly for a construction company. The formalization of processes, management of resources (human, economic and physical) or the constant search for innovations and trends are processes that are involved in the theory and practice of KM in organizations [8]. The KM should therefore be considered a process that will add value to the products and final services of the organization, and, if structured and implemented, will compensate the investment employed to its achievement [4].

Thus, we do not question the fact that companies have adopted management models in order to obtain competitive advantage or even to merely remain in the market. However, the success of these models involves the way knowledge is being managed. After all, knowledge-creating companies are those that systematically create new knowledge, disseminate it across the organization and quickly incorporate it into new technologies and products [9].

Considering these assumptions, this work's goal is to verify the level of effectiveness of KM in Brazilian construction companies, specifically in enterprises of incorporation of real estates and of construction of buildings based in Curitiba and metropolitan area.

II. KNOWLEDGE MANAGEMENT AS A PROCESS

The authors may be divided as to how they approach the KM, conceptualizing it as a process, as management of intellectual capital, as a strategic resource, as a model, among others. Table 1 presents, in the organizational scope, some of these concepts and its approach.

Table 1– Concepts and approaches of knowledge management

AUTHOR	CONCEPT	APPROACH
Powell (1993) [10]	Integrated and structured way of managing the intellectual capital.	Management of intellectual capital
Petrash (1996) [11]	Providing the right knowledge to the right people at the right time, so that they can make better organizational decisions.	Tool for decision making
Hibbard (1997) [12]	Process of search and organization of collective expertise, anywhere it appears, and its distribution to where there is greatest return.	Search and organization of common expertise
Sveiby (1998) [13]	Art of creating value by leveraging intangible the assets of the organization.	Creating value to intangible assets
Davenport and Prusak (1998) [14]	Gathering processes that govern the creation, dissemination and use of knowledge to fully achieve the organizational goals.	Process
Beckman (1999) [15]	Formalization of experiences, knowledge and expertise, so that they become accessible to the organization, and this may create new skills, achieve superior performance, encourage innovation and create value for their customers.	Access to the organization
O'Dell and Grayson (2000) [16]	Obtaining the right knowledge, from the right people at the right time, helping people share and put information into action.	Strategy to put the information into action
Bukowitz and Williams (2002) [17]	Process to generate wealth from knowledge or intellectual capital.	Wealth generation
Salmazo (2004) [18]	Set of actions of an organization to create, acquire, share and use knowledge assets in order to assist in generating ideas, solving problems and making decisions.	Actions related to knowledge assets
Terra (2005) [9]	Use and combination of different sources and types of organizational knowledge, aiming to develop new skills.	Creation of new skills

In general, the authors listed in Table 1 attribute to KM the role of providing the conditions to guide, monitor and promote the knowledge and thus, generate benefits (tangible and intangible), including increasing business competitiveness. And this is achieved mainly through the adoption of models, the use of strategies, employing techniques and technologies, and through management of processes.

In this study, we adopted the process approach. KM is a process that aims to ensure and facilitate the creation, exchange and use of knowledge for the development of actions that will allow their acquisition, treatment, storage and exchange within an organization; in a way that they may be used to achieve continuous improvement and gain competitive advantage over their competitors [19].

In addition, each organization has a strategic goal, mission and vision of its own market, which makes them subject to the adoption of a peculiar model of knowledge management. Among these models we highlight what is proposed by Terra (2005) [9]. The next section presents the main features of this model.

III. MODELS OF KNOWLEDGE MANAGEMENT: THE SEVEN DIMENSIONS OF TERRA

Considering the multiplicity of objectives and purposes of organizations, seven KM models are noteworthy [20]. Such models and their characteristics are briefly described in Table 2.

Table 2– Models of knowledge management

MODEL	FEATURES
SECI model – Nonaka and Takeuchi (1997) [21]	Tacit and explicit knowledge interact through processes of socialization (S), externalization (E), combination (C) and internalization (I).
<i>Sense making</i> model of Knowledge– Cecez-Kecmanovic (2004) [22]	Considers that the knowledge can be individual, interpersonal, organizational and cultural, and that they interrelate with each other.
Knowledge Management Cycle models – Frank and Gardoni (2005) [23]	Allows the identification of the different cycles involved in knowledge activity, proposing a KM based on a structure useful for the control and investigation of the information flow and knowledge.
Organizational Knowledge Creation Process – Baskerville and Dulipovici (2006) [24]	Adaptation of the SECI Model. Presents a view that inserts the influence of consumers and strategic alliances in the knowledge creation process.
Model of Knowledge Integration for Decision Making in the Organization – Kwahk, Kim and Chan (2007) [25]	Proposes a model that influences in the decision-making process, based on the integration of individual and organizational knowledge.
New Knowledge Management Model– Firestone and McElroy (2005) [26]	Approach through which business processes, knowledge processes and KM interact to transform and improve the results of the organization.
Architecture Model of KM– Sharma and Gupta (2003) [27]	Aims to provide to the organization, a broader and more real vision about the importance of creating a relationship with consumers, making it thus more efficient to their demands.

SOURCE:adapted from Biz(2009) [20]

Terra (2005) [9], in turn, proposes another model, in which when managing knowledge, one should examine and organize key policies, processes and tools for a better understanding of generation, identification, validation, dissemination, sharing and use of strategic knowledge, to obtain economic outcomes and benefits to employees. The author suggests that the practice of KM is related to the capacity of organizations to develop specific abilities and innovative skills established from various sources and types of organizational knowledge. Thus, he concludes that the KM should not be treated separately in the organization, it should interact with business strategies, organizational processes and the external environment; it must be understood and implemented in a procedural way, following a model based on seven dimensions (Fig. 1).

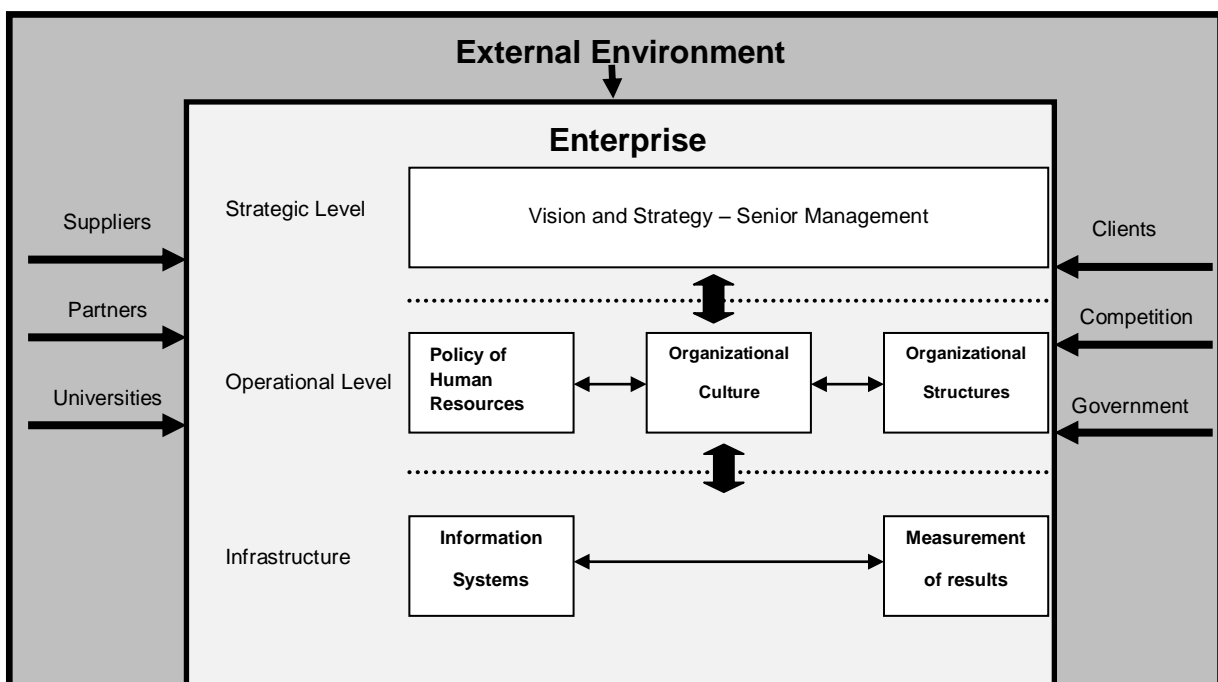


Fig. 1 – Seven dimensions of knowledge management

SOURCE: Terra (2005, p. 86) [9]

These dimensions allow a view of the position regarding the managerial practices that, in general, lead the company to an effective KM (Table 3).

Table 3 – Dimensions and main managerial practices

NUMBER	DIMENSION	MANAGERIAL PRACTICES
1	Strategic factors and senior management	<ul style="list-style-type: none"> • define the core competences and the areas of knowledge • create goals and a permanent sense of direction and urgency • encourage the sharing of information
2	Culture and organizational values	<ul style="list-style-type: none"> • develop creative environments and cultures • encourage individual creativity and the implementation of new ideas • provide relationships of trust • encourage dialogue • manage time resource • create workspaces or layouts that influence creativity, learning, and the environment for innovation in businesses
3	Organizational structure and processes	<ul style="list-style-type: none"> • develop hierarchical structures that overlap with the hierarchical bureaucratic structure • put learning in the context of projects and processes • foster communities of practice
4	Human resource management	<ul style="list-style-type: none"> • develop effective recruitment and selection processes; • train teams and individuals • encourage professional careers • create evaluation and reward systems
5	Information systems	<ul style="list-style-type: none"> • eliminate excess of information • ensure access and accuracy of information • develop categories and structures of information that make sense for the organization • provide information and knowledge through corporate portals • design and evaluate the usability of organizational systems • interconnect the human element with other management processes and tacit knowledge
6	Measuring results	<ul style="list-style-type: none"> • evaluate current accounting systems • measure the intellectual capital • measure results of KM initiatives
7	Learning with the external environment	<ul style="list-style-type: none"> • develop learning with customers • manage partnerships and alliances with other companies • network and learn with suppliers • attempt a systematic effort of benchmarking and competitive intelligence

SOURCE: elaborated by the authors based on Terra (2005) [9]

Terra (2005) [9], when analyzing the Brazilian organizations also identified three main groups of companies: small and delayed, traditional, and those that learn. The groups are formed from the management practices of organizations which are, respectively, less, moderately or more associated with the KM. The author characterized these three groups of companies as follows:

- i) Small and delayed: national capital; few market leaders; worst recent performance; small businesses; large concentration of companies in the services sector; knowledge intensive sectors; and, mostly, do not exert export activity;
- ii) Traditional companies: national capital (private and state), market leaders, large companies, traditional sectors;
- iii) Companies that learn: foreign capital, market leaders, best recent performance, large companies, knowledge intensive sectors, larger share of the revenue related to exports.

In the next section, we will make the contextualization of the KM in the construction environment. We present some studies on the subject that depict the panorama of how construction companies are managing the organizational knowledge.

IV. KNOWLEDGE MANAGEMENT IN CONSTRUCTION COMPANIES

The characterization of knowledge management in the context of this study is presented by showing the characteristics of the sector, the importance of knowledge management and the initiatives found in the literature.

4.1 Characteristics of the sector in Brazil

The companies in the construction sector, as a rule, have a traditional organizational structure whose hierarchy is vertical, with strength of decision making highly centralized and culture averse to change and innovation [28].

With regard to management processes and construction techniques, the sector is characterized by conservatism and traditionalism [5, 29 & 30].

One may frequently see, in one construction company, two or more teams develop similar works to solve similar problems, due to the fact that the knowledge belongs to each individual, and not to the organization as a whole, thus evidencing the need to create techniques to record and document this knowledge, which may accelerate and enhance new projects [2 & 4].

Despite the fact that the reality of the sector has recorded some changes, we observed that the decisions about the strategic direction of the construction companies are based more on intuition than on fundamental analysis, behold, they are guided by the fad or the perception of the entrepreneur, considering the high number of companies that do not use productive evaluation or planning [29].

The sector is also characterized by the intensive use of information, presenting inefficient communication and low productivity [3 & 31].

Regarding the organization of labor, it appears that outsourcing is a work process often adopted as an alternative to deal with the technological uncertainties [31 & 32].

4.2 The importance of managing knowledge

With regard to the KM, this is a recent need for construction firms, because without it, they are suffering the consequences of the limits imposed by the difficulties in: spreading knowledge throughout the company in line with customer requirements levels; follow the evolution of knowledge with the necessary speed to compete; organize and retain the knowledge accumulated throughout its existence in the company [33 & 34].

It is critical that companies store explicit knowledge (construction techniques, for example), however, to gain competitive advantage they need to capture and reuse tacit knowledge, because if this knowledge can, somehow, be captured and reused, it will reduce the waste caused by reinventing things already have been invented, and will improve the efficiency of processes [7 & 35]. The increase of pressure to reduce costs and time, the requirement to deliver the best projects and the ever-increasing struggle to overcome environmental challenges, made the effective use of the intellectual capital reach even higher levels of importance [7].

In a survey made in British engineering and construction companies, identified the main advantages of the implementation of KM in construction:

- i) Encourage continuous improvement (92.5%);
- ii) Share valuable tacit knowledge (88.7%);
- iii) Disseminate best practices (86.8%);
- iv) Respond quickly to customers (84.9%);
- v) Reduce rework (77.4%); and
- vi) Develop new products and services (58.5%) [36].

Another research, also with British engineering and construction companies, showed that about 40% of the respondents already had a KM strategy and another 41% wished to have a strategy within a year [37].

In Brazil, in the construction industry, which is competitive and subject to market uncertainties, there is little knowledge support and companies often lose much of their intellectual assets due, among others, to the high turnover of labor that creates an environment of job insecurity [38]. The author concludes that this environment of insecurity is one of the barriers to the sharing and dissemination of knowledge in construction companies.

On the other hand, in an international perspective, it is noted that the main barrier to KM in construction is the lack of standardized processes [37].

4.3 Knowledge management initiatives

One of the most studied knowledge management initiatives (highest number of publications) refers to the post-project evaluation [39 & 40]. Other authors relate another initiative with many publications: the sharing of knowledge resulting from the conjunction of contractual obligations and from the trust of the people to transfer the knowledge of the project [41 & 42].

In the United States, research in the construction sector have focused on all facets of the life cycle of the construction, which reflects the awareness that creation of knowledge is linked, among other things, to issues such as constructability, management of materials and project [43 & 44].

Anyway, two categories emphasize regarding the study of knowledge management in construction: knowledge management across projects and knowledge management between the companies involved [45].

The main challenges in building the KM were classified as follows [37]:

- i) Little time for implementation of KM initiatives and practices: the enterprises normally expect that their employees take over the responsibility of managing knowledge, in addition to their daily duties; which often means giving little, if any time to the KM. The accumulation of functions may withdraw the priority nature of the KM, unless the individual performance metrics are able to incorporate this priority [44];
- ii) Organizational culture: behavioral patterns can lead to isolation or lack of awareness of the collective, in addition to triggering internal competitions that undermine the efforts of sharing knowledge. A challenge for KM in construction is how to encourage people to willingly share knowledge [46 & 47];
- iii) Processes of nonstandard work: commonly occurs in large organizations that grow quickly without spreading their standard processes;
- iv) Low investment in management projects: the low profit margins of European construction companies and their conservative nature led to reluctance to invest in KM initiatives and infrastructure.

What companies have already realized is that the KM is not dependent on information technology only, because this ignores the sharing of tacit knowledge, the vital component of expertise of all organizations [48]. Some authors even attribute to the excessive emphasis on technological solutions the relatively high number of crashes of KM initiatives in construction companies [46].

The collaboration between teams and knowledge sharing in the construction sector are seen as priority in several research groups to minimize inefficient structures and processes and increase the added value to the project, work and operation, and between projects [49 & 50].

We believe that the work of Crema and Mendes Jr. (2005) [51] is the one that comes closer to the approach of this article. Their research was done in construction companies of small and medium size in Curitiba; as was ours. The authors classified the units of study from the perspective of the model of Terra (2005) [9] as "Traditional Companies" and profiled them as for their aspects of organizational learning. The possibility and the opportunity for participation of all employees provided by the construction companies, allowed to establish adherence in hierarchical levels in relation to practices of KM. They also found low levels of integration between the subcultures that make up the staff of these companies, showing that two major obstacles were communication and organizational culture. However, the survey revealed a high sense of trust between the company and the employees.

Fantinatti (2008) [38] undertook another study that has some resemblance with this paper. Through an exploratory case study made on a construction company of Campinas/SP, the author, using the techniques of gathering qualitative data, identified procedures of KM and showed the existence of a network of sharing and reusing knowledge.

V. METHODOLOGY

The research is characterized as quantitative, applied and with a descriptive focus. The target population were Brazilian enterprises of incorporation of real estates and of construction of buildings based in Curitiba and metropolitan area.

We opted for a non-probability sampling, selecting accessible individuals of the population (companies that returned the call of research), totaling 62 companies. In non-probabilistic techniques the individuals are selected according to criteria considered relevant to a particular object of investigation established inductively, thus, not all elements have a chance of being selected for the sample [52]. Thus, we selected 62 companies incorporation of real estate projects and construction of buildings, located in Curitiba and Metropolitan Region, Brazil.

To achieve the objective of this study, as a tool for data collection we applied a questionnaire, which was divided into two parts: (a) profile of the organization and the interviewee (8 open-ended questions and 8 closed multiple choice); (b) organizational characteristics and level of effectiveness of processes (49 multiple choice questions). In the "b" of the questionnaire organization's characteristics correspond to the variables "X" and processes the variables "Y". For the construction of this instrument we adopted the referential model of the seven dimensions of knowledge proposed by Terra (2005) [9] by contemplating a procedural approach of KM, because it is compatible with the Knowledge Creation Theory of Nonaka and Takeuchi (1997) [21] and because it presents a systemic vision of the organization, including with the integration of the external environment (partners, universities, suppliers, among others).

To measure the quantitative variables, check the level of intensity of the processes and the degree of agreement in relation to the assertive chosen by the respondents, we used two scales: semantic differential (variable "X") and increasing intensity (variables "Y"), both with 7 categories of answers.

The values correspondent to the processes were scaled as follows: (1) non-existent; (2) minimally developed (or in development); (3) undeveloped (or partially used); (4) developed (deployed and running); (5)

well developed (fully deployed and working);(6) very developed (working and fully stabilized);(7) highly developed (fully utilized with constant improvements).

The questionnaire was applied via an electronicsurvey, self administered, managed by the SurveyMonkey tool.The list of email addresses (over 1000) of the participating companies was obtained mainly by the Syndicate of the Construction Industry of Curitiba and Metropolitan Region, along with the *Conselho de Engenharia e Agronomia do Paraná* (CREA-PR) and before suppliers of the ERPsoftwarewith a specific module for the construction industry.

To validate the reliability of the research tool (reliability of internal consistency of the constructs: dimensions of knowledge), we used Cronbach's Alpha coefficient.This coefficient indicates the degree to which the questionnaire items are interrelated.

The constructs were analyzed as shown in Table 4.

Table4– Reference values for analysis of constructs

VARIATION ALPHA COEFFICIENT	STRENGTH OF THE ASSOCIATION
<0.6	Low
0.6 to <0.7	Moderate
0.7 to <0.8	Good
0.8 to <0.9	Very Good
0.9	Excellent

SOURCE: Hair Jr., et al.(2005, p. 200) [52]

We used the SPSSsoftware(StatisticalPackage for the SocialSciences)to perform statistical calculations.In Table 5 are the results of Cronbach's alpha coefficient, calculated for the seven dimensions of knowledge of Terra (2005) [9].

Table5 –Cronbach's Alpha Coefficient of Constructs

CONSTRUCT	ABBREVIATI ON	CRONBACH'S ALPHA	ASSOCIATIO N
Dimension 1 – Senior Management	D1	0.811	Very Good
Dimension 2 – Organizational Culture	D2	0.616	Moderate
Dimension 3 – Organization and Process	D3	0.761	Good
Dimension 4 – Human Resources	D4	0.866	Very Good
Dimension 5 – System Information and Communication	D5	0.873	Very Good
Dimension 6 – Measuring Results	D6	0.814	Very Good
Dimension 7 – Learning	D7	0.890	Very Good

The results suggest a moderate correlation in all constructs,which validates the tool of research.The acceptable value to admit a good internal consistency, based on Cronbach's alpha value, is of at least 0.60 [52].

The data collected through the questionnaire went through a process of codification and tabulation (descriptive analysis).To maintain the anonymity of the companies that participated in the research, we assigned to each of them an ordinal number from 1 to 62. Data were tabulated in rows (answers – intensity 1-7) and columns (variables "X" and "Y").For both we used the Microsoft Excel 2010software.To better see the results, we converted the tables into graphs.

To locate the center of the distributions (average level of intensity of the processes and characteristics), we used the arithmetic mean.The data, therefore, showed the degree of central tendency. As these measures in this study do not offer, a complete picture of the distribution of the sample, because there are many extreme points (answers 1 and 7 interspersed with other midlines), we also used measures of dispersion to describe the tendency of these answers of departing from the average.The calculation of the dispersion summarizes data, for it allows verifying whether the responses are consistent (little variation) and the prevailing situation is in the positive (top), negative (lower) edge of the scale, or even if the distribution is symmetric.In this study were used

four measures of dispersion: range, standard deviation, asymmetry and kurtosis. Data were analyzed as shown in Table 6.

Table6 – Reference values for data analysis

MEASURE	ESTIMATED VALUE	MEANING	ESTIMATED VALUE	MEANING
Standard deviation	<1	Coherent answers	> 3	High variability in responses
Asymmetry	> 1 or <-1	Substantially asymmetric distribution	0	Symmetric distribution
Kurtosis	> 3	Very sharp curve	<-3	Very flat curve

SOURCE: The authors based on Hair Jr. et al.(2005) [52]

To identify in which of the three clusters or groups defined by Terra (2005) [9] the surveyed companies were in, the scale (0-7) was fractionated into three parts (Table 7), to reveal a smaller, medium or larger association to KM.

Table7 – Identification of the clusters defined by Terra (2005) [9]

CLUSTER	DESCRIPTION	AVERAGE LEVEL PROCESS
small and delayed	Less associated with an effective KM	1.00 to 2.33
traditional enterprises	moderately associated with an effective KM	2.34 to 4.66
Companies that learn	More associated with an effective KM	4.67 to 7.00

SOURCE: Authors, based on Terra (2005) [9]

VI. RESULTS

In this section are shown the data analysis and the results. In section 6.1 we identified the sample. In section 6.2 we analyzed the responses of the questionnaire (descriptive analysis).

6.1 Profile of the organizations and the respondents

In the first part of the questionnaire we identified the sample (surveyed companies and respondents people). As far as the respondents, their characteristics (position / title, area and time of work in the company) were investigated. We note that most of them acting in engineering (50%) and work in the organization for up to one year (43%). Table 8 summarizes the characteristics of the organizations the surveys were held in (age of foundation, type of establishment and administration, number of employees, number of certificates and projects performed) and their outstanding works (in percentage).

Table 8 – Characteristics of the searched organizations

	CHARACTERISTICS	%
O R G A N I Z A T I O N	Foundation	• More than 13 years (68%)
	Constitution	• LLCs (92%)
	Administration	• Professional (42%) • Family (39%) • Mixed (8%)
	Number of Employees	• 20 to 99 (37%) • Up to 19 (29%) • 100-499 (8%) • Over 499 (15%)
	Certification	• None (65%) • 1 (19%)
	Projects Performed	• Over 100 (32%) • Less than 40 (57%)

We may extract from this first approximation that the majority of the surveyed organizations have more than 13 years of foundation (68%), are LLCs (92%), are managed by professionals (42%), are small and medium companies with up to 99 employees (37%), have no certification (65%), and have performed up to 40 projects (57%).

It should be emphasized that the sample has regular characteristics, that is, the majority are small and medium enterprises, constituted as associations of limited responsibility and administered by professionals. With regard to respondents, most of them engaged in engineering area and have worked in the organization for up to a year.

6.2 Descriptive statistics

First, using the SPSS software, we performed the calculation of the dispersion of responses. A preliminary analysis of these answers, considering the reference values of Table 6, reveals that:

- i) The mean values range between 2.16 and 5.11;
- ii) The standard deviation of the answers was similar (between 1.283 and 1.875) without great variability (>3) and with homogeneity of variances. Therefore, there are strong indications that the respondents understood the questions and were honest in their responses;
- iii) The majority of the values follow a nearly symmetric distribution (they are close to 0). Only two variables follow a substantially asymmetric distribution (> 1). No variable has value <-1 . The smallest negative value is -0.709 ;
- iv) There are not many sharp curves (> 3), neither many flat curves (<-3). The highest values are 2.034 and -1.375 . The vast majority of values follow a curve next to the normal (values close to 0).

Once the reliability of the responses was verified, we analyzed the processes and characteristics, in accordance with the seven dimensions proposed by Terra (2005) [9]. On Fig. 2 are displayed the general averages of each of the seven dimensions. On the abscissa are the categories (dimensions) and on the y-axis the corresponding averages.

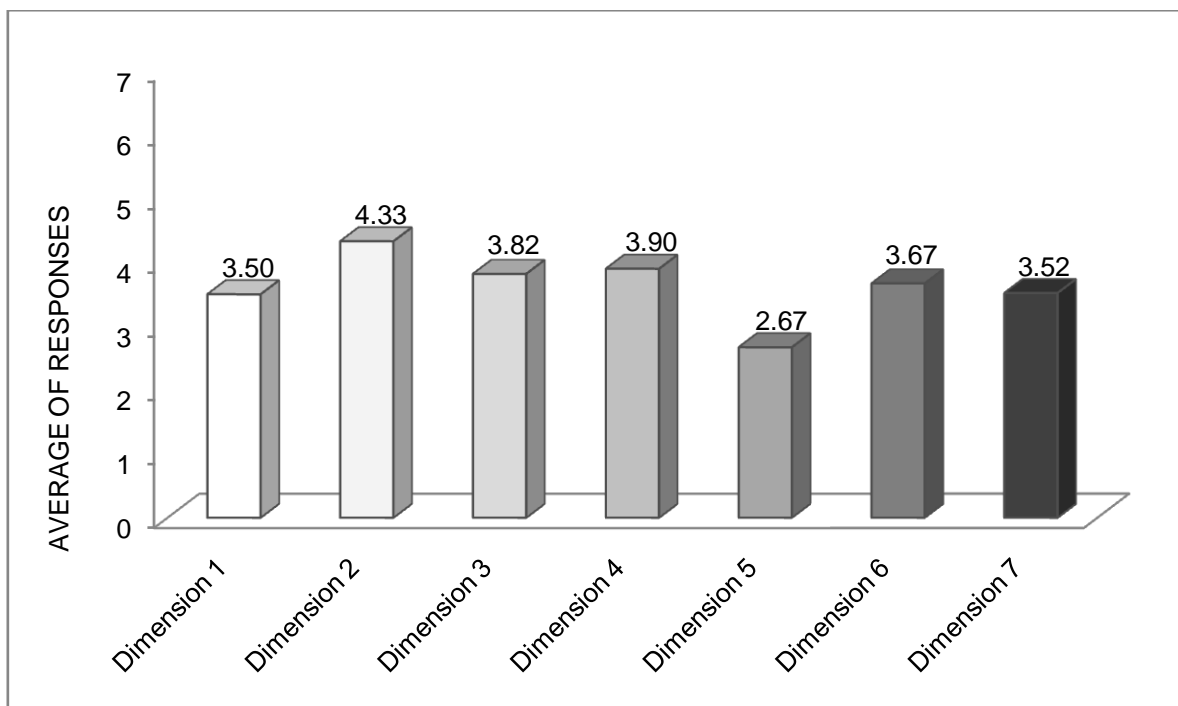


Fig. 2–Average of organizational processes and characteristics – seven dimensions of Terra (2005) [9]

Regarding **dimension 1**, we noticed that there is a high consensus on the existence of a strategic alignment; despite the respondents indicate that planning – both strategic and marketing– is not yet much used. This is another indication that the diagnosis of Tortato (2007) [29] is correct: most decisions about the strategic direction of the construction companies are mainly based on the intuition of the senior management, instead of on fundamental analysis, given the large number of companies that do not use the planning or production evaluation. In the perception of the respondents, disclosure of the strategy is not adequate, which serves as an indication that there are weaknesses or deficiencies in internal communication. The macro strategic decisions are not being passed on to the rest of the organization and there is not an adequate flow of

information. Weaknesses in this process reflect on the commitment of the employees, a factor of vital importance that decisively contributes to the achievement of the actions related to business strategies and the creation of knowledge. On knowledge creation the communication between individuals that hold knowledge is essential for comparison of ideas and experiences [53].

As to **dimension 2**, we perceived a feeling of (overall average 4.33) democracy, autonomy and interdepartmental interaction. The results of this dimension, therefore, reveal a fertile ground for the creation of knowledge.

The enterprises – **dimension 3** – present, from the point of view of the respondents, an organizational structure that tends more to the centralization of decision-making than for decentralization, with undeveloped planning processes. On the other hand, the feeling of the respondents is that the formalization of processes, the interaction between them and the time of execution of activities, show themselves developed, despite the fact that this perception decreases slightly in specific situations such as management of simultaneous works and in what relates to the planning, execution and control of activities of project execution. This finding goes against the survey results of Carrillo (2004) [37], which state that the main barrier to KM in construction is the lack of standardized processes.

In **dimension 4** we found that the processes of selection and management of employees are underdeveloped, and the career, rewards and retention plans of employees are minimally developed. Also with respect to employees, they have high level of versatility and their skills are continuously assessed, however, the amount of training and the levels of hierarchy are classified as medium. The management team, however, claims it knows about construction techniques and management methods. With respect to work processes, training and professional education, is evident a high concern of organizations as for the qualification and development of its employees. Although the overall average (3.90) indicates the existence of processes that are almost developed, we have a glimpse of the need for organizations to make their selection processes more rigorous and to reassess their wage policies (rewards, incentives, promotions, among others). These practices may bring, among other benefits, a decrease in costs of rehiring, increased motivation, involvement and commitment of employees, as well as help in retaining people and, consequently, the knowledge that they hold – one of the barriers (job insecurity) to the creation of knowledge signaled by Fantinatti (2008 [38].

For **dimension 5**, the partial averages indicate that the organizations moderately invest in information technology and also modestly seek to update them, but the control processes of user satisfaction and verification of information needs are minimally developed. Similarly, the processes of management of the installed systems are minimal. These results corroborate the studies of McDermott and O'Dell (2001) [46] who attribute the failure of KM initiatives in construction to the excessive emphasis on technological solutions. Thus, it ratifies the statement of Tiwana (2000) [48] that the KM does not only depend on Information Technology, but also on people, fundamental and indispensable elements to share tacit knowledge that cannot be neglected.

The processes of measurement – **dimension 6** – show themselves undeveloped (overall average 3.67). Even though the consensus points towards the existence of a developed process of financial control, in other questions (evaluation of performance, quality control and benchmarking) it leans towards the small development. Within the meaning of the respondents, regarding **dimension 7**, the organizations use, minimally, a survey of satisfaction of providers and procedures to enhance or develop external relations. There is, however, a sense of concern with the continuous improvement of services over competitors, despite processes related to adaptation and to monitoring the market being poorly developed. With regard to customers and suppliers processes are likewise undeveloped. This result demonstrates that firms learn little with the external environment (overall average 3.52).

Table 9 shows the intensity (minimum well-developed – according to the scale described in the previous section) of the main processes and/or characteristics related to the dimensions of knowledge, revealing the level of effectiveness of KM in the companies surveyed. It is noteworthy that we did not identify nonexistent (average ≥ 1 and < 2) very developed (average ≥ 6 and < 7) or highly developed (average = 7) processes and/or features.

Table9 – Level of effectiveness by dimension of key processes and features of knowledge management of the searched enterprises

DIMENSION	PROCESSES/FEATURES			
	Well developed (average ≥ 5 and <6)	Developed (average ≥ 4 and <5)	Undeveloped (average ≥ 3 and <4)	Minimally developed (average ≥ 2 and <3)
1		<ul style="list-style-type: none"> Strategic alignment 	<ul style="list-style-type: none"> strategic planning and <i>marketing</i>; dissemination of the strategy 	
2	<ul style="list-style-type: none"> interdepartmental interaction 		<ul style="list-style-type: none"> Democracy and autonomy 	
3		<ul style="list-style-type: none"> formalization of processes and interaction between them; time of execution of the activities 	<ul style="list-style-type: none"> project planning and construction management 	<ul style="list-style-type: none"> decentralization of decision-making power
4	<ul style="list-style-type: none"> company's concern for the improvement of work processes 	<ul style="list-style-type: none"> multi-skilling of employees; evaluation of the labor skills; knowledge about construction techniques and methods of management of the management team 	<ul style="list-style-type: none"> selection, management and amount of employee training; hierarchy level 	<ul style="list-style-type: none"> Plans of Career, rewards and retention of employees.
5			<ul style="list-style-type: none"> IT investment; update of IT solutions 	<ul style="list-style-type: none"> Control of user satisfaction; verification of information needs; management of installed systems
6		<ul style="list-style-type: none"> Financial control 	<ul style="list-style-type: none"> performance evaluation, quality control; benchmarking 	
7		<ul style="list-style-type: none"> company's concern for the improvement of projects/services in relation to competitors 	<ul style="list-style-type: none"> adequacy and monitoring of the market; relationship with suppliers and customers 	<ul style="list-style-type: none"> satisfaction of suppliers survey; procedures of enhancement of external relations

VII. CONCLUSION

Through the results presented in Figure 2 and in Table 10 we can observe the intensity of the main processes and/or the characteristics related to each of the seven dimensions of Terra (2005) [9], revealing the level of effectiveness of KM in the surveyed companies.

These results also provide a benchmark of where (in what dimension) and the intensity with which KM initiatives occur in researched construction companies, allowing to draw a profile that shows how knowledge is being managed by contractors.

The organizational culture dimension presented the processes and characteristics that are more associated with KM, giving evidence that the organizational environment tends to be pleasant, prevailing freedom, trust and respect, which resembles the finding of Crema and Mendes Junior (2005) [51].

The less effective dimension of KM regards information systems, mainly because the control processes of user satisfaction, management of installed systems and verification of informational needs are minimally developed. Construction companies in general emphasize technological solutions, but fail to assign equal importance to people, which is fundamental and essential for sharing tacit knowledge.

The surveyed companies have processes and characteristics moderately associated to KM (overall average 3.63), being, therefore, according to the classification of Terra (2005) [9], "Traditional Enterprises" (Table 7). Crema and Mendes Junior (2005) [51] obtained the same results when analyzing small and medium

construction companies of Curitiba. Therefore these companies still have a lot of improvements to make regarding processes and practices of KM, in order to be considered "Companies that learn".

This work serves as basis and/or reference to other studies directed at construction companies. The results of this research show – even in line with the international trend depicted by Carrillo (2004) [37] – the main challenges of KM in the researched construction companies: lack of time; organizational culture; and low investment in management of projects. With this, we have a reference of critical points that need to be overcome, towards an effective KM.

The results, in general, reveal the existence of informal and misguided initiatives and embryonic actions, that need improvement and formalization of processes and practices of KM, which, if formalized would allow a better performance for the companies.

We suggest as continuity and/or extension of this study:

- i) Increases the amount of samples or even diversify of the population, allowing broader generalizations;
- ii) Replicate the study with adaptations for the staff at the operational level, in order to confront the member's perceptions of various organizational levels;
- iii) Prepare, as pointed out by Carrillo (2004) [37], a management model adapted to the construction, which can be applied in order to enlighten and sensitize senior management to the importance of the KM, and provide continuous improvement and competitive advantage.

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