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A SURVEY OF IT USE BY SMALL AND MEDIUM-SIZED CONSTRUCTION COMPANIES IN A CITY IN BRAZIL

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SUMMARY: *The potential contribution of information technology to improving the competitiveness of small and medium sized enterprises (SMEs) in the State of Parana has been recognized. However, fulfilling this potential has been problematic. In this context, this paper sets out to measure the capacity of Brazilian civil construction companies in the town of Ponta Grossa – Paraná to use IT. The methodological approach consists of a quantitative research study comprising a review of the literature and case studies. The theoretical foundation is based on concepts of competitive strategy, the management of knowledge, competitiveness, the alignment of IT and the value chain. Information on the companies studied was gathered which demonstrates how the factors mentioned in the literature all over the world are understood by the companies studied as being inhibiting. The results indicate what factors inhibit adopting IT and describe the practical experience of the civil construction industry in planning and control. Moreover, it was observed that, in general, the SMEs surveyed have a reasonable perception of the importance of IT for their organizations. The results presented illustrate the concepts presented in the review, as well as the influence of what has been learned as to how innovation has been developing and as to the role of IT. The study concludes by pointing the way forward as to the possibilities for further research on the issues tackled in this paper.*

KEYWORDS: *Information Technology, small and medium-sized construction companies, administrative management of building sites.*

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1. INTRODUCTION

Against a complex backdrop to society and the corporate world where social and economic phenomena that have global outreach are responsible for changes in the business environment, Information Technology (IT) is a reality that can contribute to increasing the level of companies technological development. Therefore, starting out from this understanding, it is possible that IT can be used as a valuable strategic resource by companies, and will have a direct impact on increasing their in-house potential.

On the other hand, research studies such as those by (Rivard, 2000, Irani et. al.,2003, Love et. al.,2005) show that when construction companies set up IT in their building systems, they come up against a series of

difficulties in their efforts to consolidate the use of IT. In addition, deficiencies in information and the lack of integration among the actors involved in the construction process contribute to information systems being regarded as falling short of expectations. This is what has been reported in the literature as being some of the difficulties these companies face.

Therefore, on emphasizing the difficulty of implementing IT, another relevant observation concerns the inclusion of new processes that require adjustments to be made to companies information systems. In many cases this inclusion is not always perceived by companies, which may aggravate their resistance to innovation.

The theoretical basis that underpins the study includes work on the management of knowledge, competitive strategy (Porter and Millar, 1985; Mintzberg et al., 2003); on learning, knowledge creation in the company (Nonaka and Takeuchi, 1995), on the role of IT in organizations and as a support to decision-making (McFarlan, 1984), and the approaches presented in the literature review on the subject of IT.

Decision-making also involves a cycle and it is of extreme importance that appropriate quality information is at hand in all phases of the cycle as shown in Figure 1.

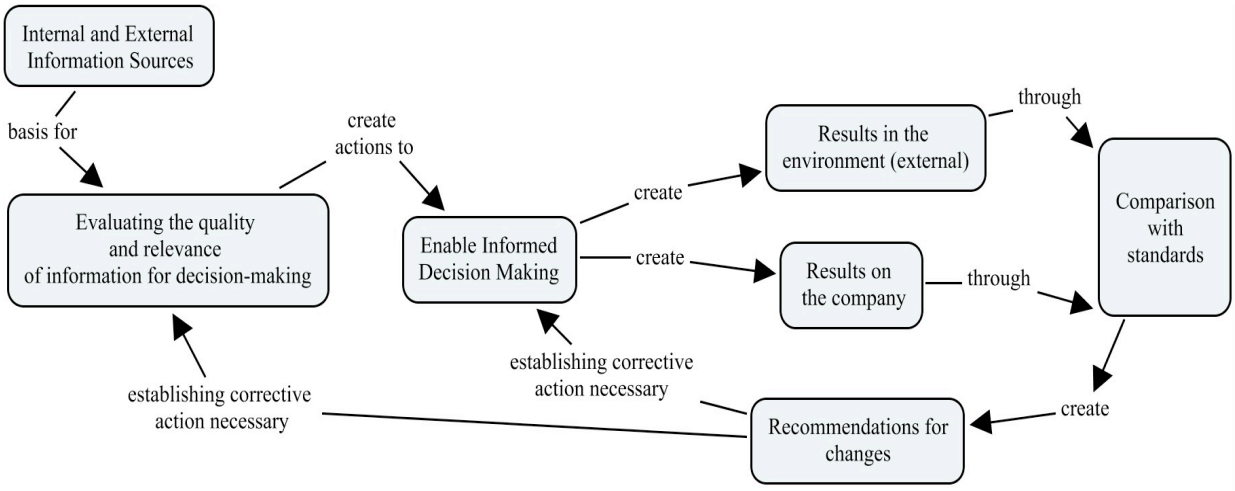

FIG.1: Cycle of decision making adapted from Turban (2008)

In fact due to the increase in competition, it has become vital to improve decision-making abilities at all levels and in the cycle of business activities. However, it may very often be appropriate or necessary to use decision making models. The models allow simulations to be made of what might occur if certain variables were to act in a given way.

According to Nonaka and Takeuchi (1995), "the information provides a new point of view on the interpretation of events or goals, which makes visible previously invisible meanings or provides unexpected connections" and Malhotra, (2009) adds, "information is the raw material for the creation of knowledge".

Information Technology could be the means by which such information is provided to support the decision process. Therefore, in order to contextualize an understanding of role of Information Technology for construction companies, discussion is needed on some critical factors in the construction industry, such as competitive strategy, the management of knowledge and competitiveness, and to relate these to Information Technology (IT).

2. INFORMATION TECHNOLOGY IN THE ORGANIZATION

With regard to the advances in IT, there are several IT evaluation methods available to aid organizations to achieve the strategic performance they desire. Through these, the performance level of the organization can be obtained. Assistance via computational means is relevant in order to perform simulations of performance related to the management of enterprises, and thus strategic solutions close to ideal parameters can be obtained and errors in planning and in carrying plans out can be reduced as can problems that are involved in the process of managing.

The diagnosis provided by Information Technology is a cornerstone for all and every management task because a company needs to take note and be fully aware of how it functions; in other words, how its operations its business and its activities are conducted, and what its organizational culture is.

2.1 Competitive Strategy

According to Porter cited by Mintzberg et al. *(*2003), business strategy should be about deliberately choosing a different set of activities so as to deliver a unique mix of values that should consist of a company positioning itself differently from its rivals.

For Ansoff et al. (1991) competitive strategy is directed towards company actions in given areas of the business with the clear objective of increasing market share. Therefore, organizations have been investing their resources in various sectors with the target being competitiveness, including in IT matters.

2.2 Management of knowledge

Studies set out different approaches to the issues of knowledge and the dynamics of innovation, among which attention is drawn to Nonaka and Takeuchi (1995) who present the concept of "the spiral of creating knowledge". This spiral represents the creation of knowledge within organizations through the flow of tacit knowledge (what we know implicitly) and explicit knowledge (that which is transmitted in formal language). In the flow of information between the tacit and explicit, the authors classified four quadrants: socialization, externalization, combination and internalization. For these authors, information should be a message aimed at preparing the person who receives it in order to make a difference in his or her perception. Thus, within this context, information is a flow of messages, while knowledge is created by this very flow of information, and this flow is linked into the beliefs, values and commitments of those who possess such information.

In their research Bukowitz and Williams (1999) concluded that the management of knowledge and learning must meet clear and specific goals, by keeping the focus on knowledge and not on the data and information. They suggest a typology that emphasizes the ability to transmit knowledge where explicit knowledge is that which individuals are able to express quite easily and implicit knowledge is that which the individual is unable to articulate and, therefore, useful management information.

Table 1 summarizes the relationship between data, information and knowledge, as defined by Davenport and Prusak (1998).

TABLE 1. Relationship between data, information and knowledge adapted from (Davenport, T and Prusak, L, 1998)

Data	Information	Knowledge
Simple observations about the state of the world	Data endowed with relevance and purpose	Valuable information of the human mind. (reflection, synthesis, context)
Highly structured	Requires unit of analysis	Difficult to structure
Easily obtained by machines	Requires consensus on the meaning	Difficult to capture on machines
Often quantified	Necessarily requires human mediation	Often tacit
Easily transferable	Necessarily requires human mediation	Difficult to transfer

Table 1 starts from the premise that the management of knowledge is a system of corporate management. Thus, the management of knowledge should be approached as a management concept rather than as a technological tool. Therefore, it should be seen as a personal ability such as the skill, experience, reasoning or intelligence of an individual, always within a context. That is, when information is applied, it turns into knowledge, and becomes one of the organization's assets and stops being a support for taking decisions. Given the needs of information and a technological tool to implement the management of knowledge, IT has an important role in that process.

2.3 Competitive and IT

IT has been changing the way businesses compete. And according to the study by McFarlan (1984), there are five basic principles that should be taken together so as to assess the impact of IT in organizations:

1. Do you think that IT can create barriers to market entry?
2. Do you think that IT can change the basis of competition?
3. Do you think that IT can change the relationship with suppliers?
4. Do you think that IT can change the relationship with clients?
5. Do you think that IT can create opportunities for new products?

According to this author, if the answer to one, or more, of the questions is yes, then it is evident that IT is a strategic asset for the company.

Porter and Millar (1985) claim that IT can create competitive advantage by lowering the costs of value-added activities and can also change the end-goal of competitiveness and generate new types of businesses. Thus, IT can influence competitive factors other than those of price-cutting and making differential offers for the same or a very similar range of products or services offered by competitors. Porter and Millar (1985) state that the set of five competitive forces in an organization determines the intensity of competition as well as that of profitability, and the force or the most pronounced forces predominate when strategies are being formulated. According to Drucker (1990) what matters is not the tool, but the concept behind it.

Carr (2003), on the other hand, questions the strategic importance of IT and claims it is becoming increasingly a commodity, the costs of which will fall rapidly to ensure that new resources are shared quickly but the very fact that this includes so many of a company's functions indicates that this will entail a major consumption of corporate investment.

For Turban et al. (2008), environmental, organizational and technological factors are creating a highly competitive scenario in which clients are the main focus. Companies that are at the cutting edge have been designed on an infrastructure of information.

2.4 The role and methodologies of IT in evaluating organizations

The function of IT is to identify, develop and set up technologies and information systems that support business communication and the exchange of ideas. This prompts people to unite and to take part in groups. It also makes it possible to regenerate informal networks for acquiring and exchanging knowledge, as well as to facilitate the sharing of problems, perspectives, ideas and solutions during day-to-day work.

There are several evaluation models for determining the position of IT in an organization. Nolan (1979) put forward, after studying the process of computerization in companies, a classification into four stages of the evolution of computerization, later expanded to six stages: initiation, contagion, control, integration, data administration and maturity. Rockart (1979) presents a model for the critical success factors (CSF) and provides an analysis of the company's information systems based on the critical factors for the success of the business.

Another important model, the one highlighted in this paper is the eclectic model drawn up by Sullivan (1985), which relates the guidelines and methodologies used by businesses to the levels of "infusion" and "diffusion" of technology and information systems already set up in a company.

According to Sullivan (1985) the conclusion to be drawn is that companies are moving towards the environment of the information age. In this environment, the planning of information systems should be focused on strategic issues based on information about services, organizational transformations, administration and on developing an overall IT architecture.

Models include: the Intensity Matrix on Products by Porter and Millar (1985); the Stages of Decentralized IT by Donovan (1988); the relationship between the use of IT and Financial Indicators developed by Mahmood (1993); classic case studies of the success of Strategic IT Systems in accordance with competitive forces by Porter and

Millar (1985) and Eardley et al. (1996); the Performance of IT and the Company, as per the environmental, strategic and administrative context, arising from IT investments by Li and Ye (1999).

Jiang and Klein (1999) presented a model for the diagnosis of IT that is founded on three aspects. The first is to identify a criterion using models already developed, with the objective of determining the company´s real need for information and the strategic relevance of IT. The second is to quantify a criterion for developing information. And the third is to evaluate project proposals based on the criteria quantified.

2.5 The alignment of IT

An important aspect to guarantee a strategic role of IT in construction industry, such as in any industry, is the alignment between IT and the business strategy.

Among models for analyzing the strategic alignment of IT are those put forward by Lederer and Mendelow (1986), Venkatraman and Henderson (1993), Willcocks and Lester (1997). All these models point to companies lack of skill in this area, in most instances beginning with failures to align business strategies with IT strategies.

For Venkatraman and Henderson (1993), there is no ideal model for implementing the alignment between IT strategy and business strategies, but there are models that can provide support for such implementation.

Studies (Chan et al.1997; Chan,2002), show that the alignment models are interchangeable with each other, as they explore and strongly reinforce the various success factors of strategic alignment. The strategic alignment generates a convergence between business strategies and IT strategy aimed at achieving competitive advantage for the company. Thus, formulating and implementing strategies at the various levels of the company require that the concepts of strategy and alignment be interdisciplinary and become a part of the organizational culture.

3. EVALUATION OF IT IN CIVIL CONSTRUCTION

Formulating a methodology for assessing the performance of IT in organizations has been a challenge for many researchers (M. Fischer and J. Kunz, 2004; El-Mashaleh and O'Brien, 2004; Love et al. 2005; Fagundes et al. 2005, Issa et al. 2007), it was observed there is a major concern with the use of information technology that can be related to the civil construction sector. Thus, it was observed that the large variety of surveys and places surveyed demonstrates the relevance of the topic as they all seek to identify what characterizes the use of IT by the civil construction industry. However, it is recognized that because this is a relatively new topic, there are still many gaps to be filled by further research.

O'Connor and Yang (2003) identified that the success of a project is related to the level of IT use. The authors approach the issue of IT by means of statistical methods and found that there is a statistically significant correlation between the use of IT and projects being successful.

Shang et al. (2004) presented the basic principles for formulating IT and the norms for construction which are divided into three levels: the basic norm, the standard for the norm and the specialized norm. The basic norm defines the terms of the general expressions for signposting information in the management of construction; the standard for the norm reflects the particular demand and the technical requirements relating to each sector for the use of IT in planning the construction; the specialized norm details IT techniques generally applied in various sectors of the construction.

Rivard et al. (2004) conducted an exploratory study of the best practices in the use of IT in architectural civil engineering companies and in companies of contractors and in construction management in Canada, and provided qualitative information for each case study, with comparisons between the technologies used in each company surveyed. IT can be a trap if misused. There is a systematic method for analyzing the entire cycle of best IT practices. In case studies, the authors highlight negative impacts of IT within the general characteristics of each company.

Olugbode et al. (2007) conducted an exploratory study and described in their article a case study undertaken in an organization with the goal of achieving strategic sustainable development by adopting IT. The authors concluded that success in using IT in an organization can be attributed to the support of senior management, to there being appropriate software packages and integration by means of information systems.

Towards this end, Stewart and Mohamed (2003) cited by Jaafar et al. (2007) conducted an empirical and descriptive investigation on the application of information technology (IT) and information systems (IS) in the construction industry, concluding that they generate recurring problems in the construction industry. According to these authors, the construction industry is still slow to incorporate innovations in IT/ IS, such as: e-commerce, e-conferencing, intranets, and business to business B2B, mainly due to the limited planning of organizations.

In their study Ekholm and Molnár (2009) found through case studies that ICT practices are key and relevant factors to increasing the efficiency of quality in the construction industry. The authors report that although ICT has a crucial role in efficiency and quality, the study reveals that there are hardly any ICT practices in the industry. According to the authors, the current business model for the construction industry does not have instruments to create a process for coordinated information and the sector has difficulty in managing competences for working with processes and products in a structured way. According to the authors, a set of actions is needed at the sector level to develop a framework for the management of integrated information in the process of traditional construction.

It is observed that all IT principles and the methods of analysis presented earlier, even with different degrees of detail, emphasize the relevance of a comprehensive approach, by analysing all IT stages. Moreover, some approaches further emphasize the importance of assessing the inter-relationships of IT with the production of building works and with the company's culture.

3.1 IT Scenarios in civil construction

IT, when it makes use of microcomputers, has been fostering a new infrastructure for developing production activities in a company, leading, to some extent, to changes in the work process.

According to Scheer et al. (2007), using IT has impelled advances in the production chain of the sector such as there being more integrated, objective and flexible processes, thus enabling the efficient use of capital, labor and resources. From the literature it is possible to find many studies on the use of IT in construction industry.

Chien and Barthorpe (2010) conducted a research study into small and medium-sized construction companies, the headquarters of which were in Taiwan and discuss the challenges that the sector faces in order to use IT. The results of the research demonstrate that the organizational structure of SMEs has technological aspects that can bring the use of IT to maturity, although there are still factors which inhibit the adoption of IT. The authors conclude that the investment in adequate IT is less than 1 million dollars which corresponds to around 0.1% of the volume of business of the SMEs and the main problems are the workers' lack of familiarity with the system, the fact that data that can be altered in transit and software problems.

Erdogan (2009) presents a comprehensive study on various scenarios undertaken in order to identify the trends that the construction industry may well face regarding Information and Communication Technology ICT. He describes the scenario for 2030 based on a review of previous research studies and the application of a questionnaire underpinned by four forces that drive change: society, technology, processes and geography. Environmental issues and policies are discussed. These scenarios indicate what the tendencies are of the behavior of civil construction industries in the world and the impacts of ICT. The authors foresee that in 2020 the focus will be on implementing laws and norms. And in 2030, there will be greater regulation of the use of ICT in terms of planning, deadlines and interventions in the economic plans of countries, which consequently will have a direct effect on civil construction.

In their paper, Sorensen et al (2009) identified the user needs in relation to construction management through virtual models and RFID. Sorensen et al. (2009) applied a contextual method for design that was useful in the research process and in developing IT prototype systems for managing building works. Based on a case study carried out in Ramboll and Aalborg in Denmark, it was possible to verify the great potential of using cell phones. These may be important for introducing RFID into civil construction besides collaborating with the principle of lean construction e.g., the combination of RFID and the use of GPS that help to track and locate machines and materials. The authors developed a prototype for the management of building works to assist projects in real time, in quality and in inventory management with the aim of providing greater integration between the office and the construction site. However, the prototype presented in the study conducted by the authors is a preliminary one and needs to be implemented and validated by large-scale testing. Thus, the authors hope that the prototype can serve as a basis for developing the management of building sites at a distance.

Persson et al. (2009) conducted an exploratory study in Swedish companies and discuss the processes, products and environment of IT involved in constructing industrialized pre-fabricated homes. The objective of the study was to identify critical aspects of the management of information. Thus, companies must describe the processes, the products and their variety and thus manage strategic information. In their conclusions, the authors present results and show that the companies need a better understanding of the requirements for industrialized construction in terms of IT.

Shih et al. (2006) in their research conducted in Thailand developed monitoring by image of the building site using a system of data management, deemed PIDMS, to organize information. The approach of the study used VR technology to build a panorama based on the system of monitoring the building works by means of a remote site, using a set of panoramic cameras. The management of the building works is accessed through the Internet, which allows a communication platform to be formed between the parties involved in the project, management and implementation process. Thus, the management of the building works is conducted by real-time monitoring of the construction sites. Communication via the Internet allows daily records to be sent, such as images, text and numerical data. Thus, the PIDMS increases the efficiency and effectiveness of supervision, and the authors, in their conclusions, propose that a future study could include video segmentation and the connection between 3D images and attributes.

Samuelson (2008) developed a survey in Sweden and Finland over a period of nine years on IT in the construction sector and described the most significant results. The goal was to collect information on the experience of companies with regard to the use of IT and to compare the data with the research developed by Samuelson (1998a) and Samuelson (1998b) and describe the direction that companies are following in the use of IT. The methodology is quantitative and as the target population covered a large number of people, five broad categories were considered: architecture, technical consultants, contractors, owners and materials industry. To collect data the researcher used a questionnaire sent to companies through the Internet. The author had to make adjustments to the questionnaire to maintain the objectivity of the questions while making them easy to answer. As a conclusion of the study it appears that the handling and use of CAD is fully integrated into the business environment and a software-based CAD increased significantly between the architects and technical consultants. The research also concludes that the use of project webs and electronic trade in the construction industry is well known in the construction environment, but their use is still low. Investments in IT are concentrated on well-tried techniques that support companies in the business, and at the top of the list at the moment are mobile solutions.

In research conducted by Samuelson (2008) it is clear that companies with an IT background understand their business processes and have scanned the components of these processes well enough to recognize what can be handled by a service provider and what needs to be kept in company.

Caron (2007) conducted a survey by e-mail and phone on the use of information technology in design offices in southern Brazil in the metropolitan region of Curitiba. The study was based on several surveys on the use of IT in other countries such as Australia, China, United States, Canada, Singapore, Hong Kong, Saudi Arabia and the Nordic countries. Based on surveys, he collected information 86 architectural and engineering offices aimed at presenting an overview of IT use by these professionals. The statistical method presented in the paper was by cluster analysis (cluster analysis). The study indicates that extranets and 3D CAD were used by a few architectural firms which demonstrated under-utilization of IT resources by the offices studied. He concludes by recommending investment in knowledge of new technologies and creating actions to combat the lack of culture in the use of IT in project offices

Scheer et al. (2007) discuss the use of IT in Brazil. According to them, the country faces specific restrictions, not only in infrastructure but also related to cultural and economic differences. Moreover, according to Scheer et al. (2007), in Brazil most civil engineering firms are small and medium-sized companies with limited budgets and expertise. Thus, most of the market will be outside the regulatory context, and, therefore, these companies are not concerned with quality and productivity. On the other hand, the study highlights that only a small number of large civil engineering firms have begun using information systems IS/IT, due to the financial investment which is still high and the time that needs to be spent on implementing them. The conclusion of the study is that it is possible to improve the application of IT in construction companies by means of organization and discipline in companies. Furthermore, as per Scheer et al. (2007), in the current scenario, the lack of protocols and norms for proceeding with IT result in repetition, dispersal and the waste of efforts by different companies.

It can also be said that the cultural barrier and the often confusing terminology of the industry make it difficult to organize the data. To all this is to be added the low levels of education of the manual laborers, and because of this the dream of an integrated building site seems a distant reality.

On the other hand, the focus of the software developers and researchers is increasingly aimed at systems for managing building sites and for the management of companies. .

The software packages for modern management in the construction industry can be defined as having three characteristics: projects, management of construction works and the management of companies. However, there are software project management programs that are web-based.

Among the software programs that simulate IT conditions for the modern management of a building site, there is (ToCEE, 2009) - Towards a Concurrent Engineering Environment in the Building and Engineering Structures Industry, a project under the responsibility of the European Union, the objective of which is the dynamic exchange of information to support a virtual engineering environment using IT tools to control and manage processes.

The advantage of using computerized systems is precision and speed, as long as they are programmed according to the characteristics of a particular project and the data are constantly kept up-to-date. This may well be how most processes in the future will be forecast.

Coming at the problem form a different direction, Nascimento and Santos, (2003) assess the effectiveness of IT as a tool to leverage the business even with moderate investment. The study was conducted in a construction company which has three offices in São Paulo and one in the city of Manaus. In this study, the authors analyzed the scenario of using IT based on theoretical models put forward by Rockart (1979) the focus of which is on the Critical Success Factors, which are held to be "the limited number of areas in which the results, if satisfactory, ensure successful competitive performance for the organization". And based on McFarlan (1984) who enables visualizing how IT relates to the strategy and operation of the company's business. The model analyzes the impact of current and future IT applications on business, by setting out four quadrants, each representing a situation for the company: Support, Factory, Transition and Strategic. In this study, the authors realized that the company's organizational structure is of the functional type and, despite there being an IT department in the company, there is no-one specifically in charge of strategy in the IT area and there is no provision for adopting any Integrated Management System (ERP - Enterprise Resource Planning).

Also according to Nascimento and Santos (2003), the company used IT only to design and produce electronic documents by using text-editing programs, electronic spreadsheets and CAD programs. Therefore, although the company works hard on projects, IT tools were rarely used to manage them. The authors concluded that although the use of IT in the company is important for its business success, there is no formal methodology for either feasibility analysis or, risk assessment or evaluating applications.

4. CIVIL CONSTRUCTION IN BRAZIL

The Brazilian civil construction industry consists of several interconnected complex activities through diversification of products and processes with different degrees of originality, associated with different types of demand.

In Brazil, the construction industry itself is classified into the following subsectors: (a) Building Materials, (b) Other materials, (c) Machines and equipment, (d) Construction (buildings, heavy construction), (e) Services (Projects of engineering and architecture) (FIESP, 2009).

Construction in Brazil is responsible for a significant share of Gross Domestic Product - GDP, this being 11.9% of GDP (FIESP, 2009). Table 2 represents the share in percentage of GDP in the subsectors

TABLE 2. Involvement of subsectors in GDP of the construction (FIESP, 2009)

Activity	Share in GDP
Building materials	4.8%
Other materials	0.8%
Machines and equipment	0.3%
Construction (buildings, heavy construction),	5.5%
Services (Projects of engineering and architecture)	0.5%

The construction industry plays an important role in the Brazilian economic scenario being responsible for major changes in the structure of the country. This statement is justified by the Annual Survey of Construction Industry - PAIC held by the Brazilian Institute of Geography and Statistics – IBGE. PAIC aims to identify the basic structural characteristics of the business segment of the construction activity in the country and its changes over time, through annual surveys, taking as its basis a random sample of construction companies, which allows the expansion of its scope to the universe of construction companies. The survey provides an important source of statistical information about the sector, providing to government and companies private contribution for planning and to general users, information for the sectorial studies. Thus, according to PAIC (2008) the construction sector in Brazil accounts for salary expenses of US$ 14.57 billion, corresponding to an average of 2.6 times the minimum wage and 5.1% of Gross Domestic Product - GDP. The GDP of the construction industry according to the value added at basic prices of the country as a whole, released by the IBGE (2008) was US$ 118.17 billion dollars. The study of PAIC (2008) indicates that in the Brazilian southern state of Parana there are 2733 companies but only 2249 are active and this represent a total of 6.4% in Brazilian GDP that year. However the main problem in the state was the lack of manpower, this obstacle continues today in 2010. Yet companies are gradually solving the problem by investing amounts in skills that should be maintained next year due to new technologies, widespread urbanization, expansion of public goods and collective consumption, and globalization itself that redefines the functions of various economic and social spaces. In relation to the current stage of construction companies which are active in the construction business in the city of Ponta Grossa in Paraná, the state which is the objective of this study, the economic, political and social changes that are occurring in the country mean that companies face a new Brazilian reality. This is one which significantly modifies the levels of competitiveness adopted, thus requiring companies to achieve new standards of quality, from organizational strategies, as well as the restructuring of corporate management policies based on more effective participation in the productive process. The search for better business results using information technology is a basic premise for survival in a competitive market.

5. RESEARCH METHOD

The methodology used to analyze the use of information technology IT in the civil construction industry was exploratory and based on the quantitative approach by means of field research conducted and a case study that used interviews and a questionnaire to be completed by respondents who are engineer directors of the companies selected.

The type of industry chosen for the study is the Buildings subsector of construction companies.

The criterion to conduct the study was used in accordance with guidelines from the Brazilian Chamber for the Construction Industry - CBIC (2003) that adopts the concept of number of workers employed to define the size of companies operating in the civil construction industry. The use of such criterion is justified because this is regarded as the most important one in most legislation, and by official bodies and research institutions in the country.

The stratification of companies per numbers employed is equal to that adopted by other institutions such as the Brazilian Service to Support Micro and Small Enterprises - SEBRAE. The levels of the classification of company size as per the number of employees are (CBIC, 2003):

a) up to 19 employees – Micro companies;

b) 20 to 99 employees - Small companies;

c) 100 to 499 employees - Medium companies;

d) more than 500 employees - Large companies.

The survey was conducted in small and medium-sized construction companies in the town of Ponta Grossa - Paraná. The data were collected from December 2009 to February 2010 from the sample selected to represent the target population.

The population of companies for this study was obtained from the authority that deals with the accreditation of engineering professionals – the Regional Council of Engineering and Architecture of Parana - CREA-PR, which provided a list of civil engineering companies held in its records, which were operational during 2009. Prior to

this, 30 randomly chosen companies served as a starting point for data collection and a pre-test of the questionnaire.

This is a non-probabilistic sample, for convenience. The selection of these companies for analysis was carried out using a reasonable criterion, based on the principle that the companies have the characteristics and profile of civil construction ones in the town and region as per the classification of CBIC (2003). There were 143 companies on the listing provided by CREA-PR. From this list, 66 companies were disqualified because they were of the Subsector of Building Materials subsector and 26 companies were disqualified because they were of the Heavy Construction subsector. Thus, the universe resulted in 51 companies that are of the Buildings subsector.

Figure 2 shows the structure of the methodology of the study for the diagnosis of the use of information technology in civil construction.

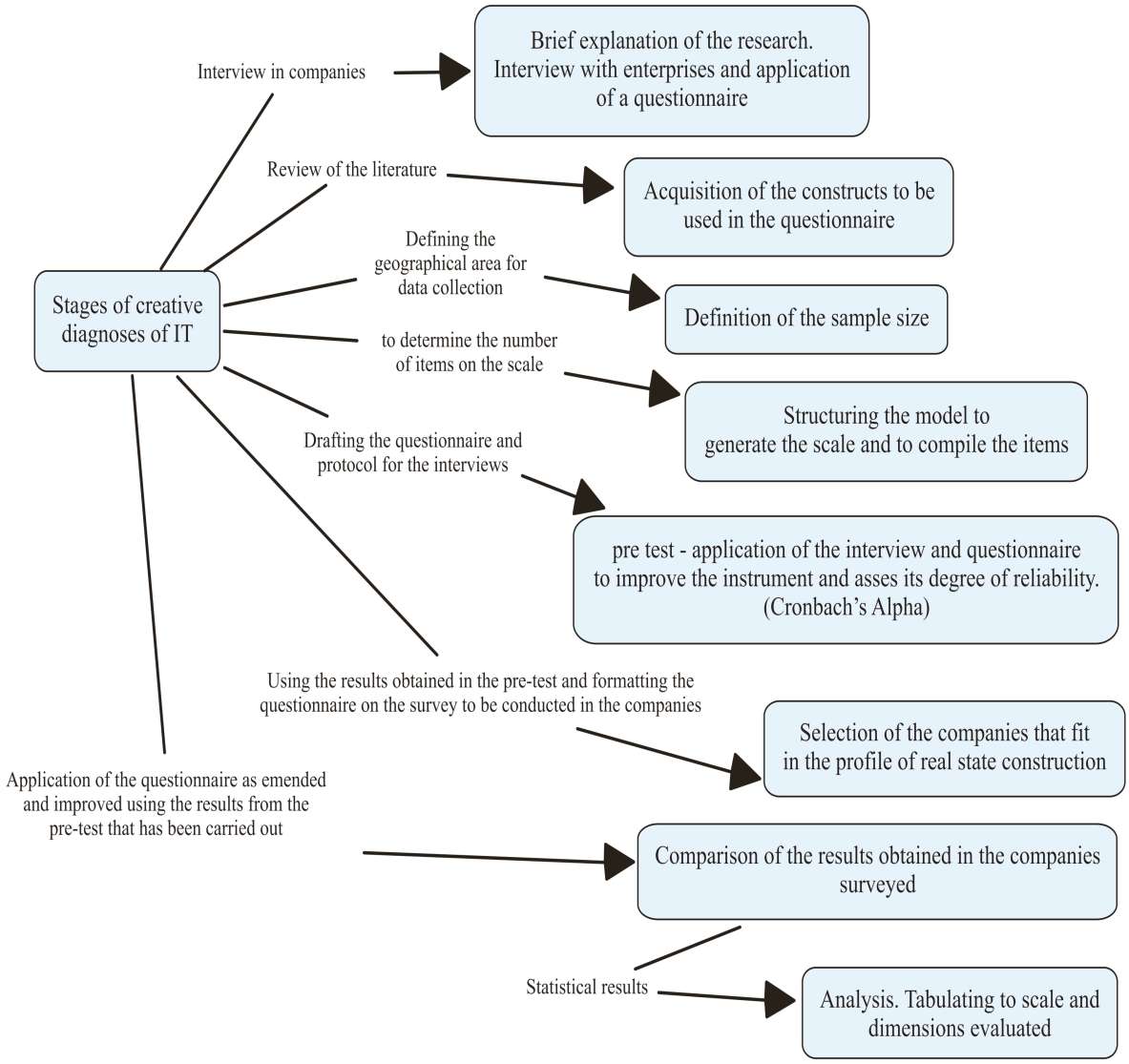

FIG. 2: Real estate construction

We have chosen to use the Likert scale because it allows a series of statements related to the object under research and they represent various assertions about a subject and the scale gives directions about the attitude of the answers for each statement,which can be positive or negative.

The respondents not only say whether they agree or disagree with the statements, but also report what their degree of agreement or disagreement is. There is a number assigned to each response, which reflects the direction of the attitude of the respondent in respect of each affirmation. The sum of scores for each statement is given by the total score of each respondent's attitude towards that statement. Therefore, on the Likert scale, the answers for each item vary according to degree of intensity. This scale has ranked categories, evenly spaced and the same number of categories in all items is widely used in organizational research (Brown, 2000, Hair Jr. et al. 2000, Morales, 2003).

Therefore to ensure more reliability in the process of data collection and to ensure that no-one had any doubts about how to complete the questionnaire to be applied in the test, a pre-test questionnaire was applied focusing on issues of objectivity, the ease of giving answers, the adequacy of formatting and layout.

The questionnaire consisted of 43 questions that measured the study dimensions on the characteristics of the company's IT structure, resources, perception, IT problems, administrative and technological management and commitment to the use of IT. Each dimension was evaluated by a set of variables as shown in Table 3.

TABLE 3. Dimensions and characteristics evaluated

Focus área	Features / tendency
Structure of IT	Infrastructure (software, hardware, technology, data management ....)
Resources	Human, physical, financial
Perception	Impact of IT on business (beliefs, attitudes, intentions, values, vision, fears), behavior, recognition of opportunities, desire to be entrepreneurial
IT problems	Security, customization, barriers, limitations, shortcomings, failures.
Administrative management and technology	Planning (setting goals, finding information, continuous planning, ongoing monitoring), organization, barriers, control, competitive intelligence, benchmarking (going beyond the measures and understanding the "how"), dynamic technology management (the company's response to the introduction of new technologies), technology already stabilized (management of company resources for more efficient use of well-established technologies).

Source: Compiled by the authors

Tables 4, 5 and 6 summarize the theoretical basis of the issues and the classification of size and evaluation.

TABLE 4. Theoretical basis of the structure of the questionnaire – Overall Dimension IT

CODING Dimensions and characteristics evaluated	OVERALL DIMENSION OF IT	REFERENCE
Structure Q1 and Q2	1. Name of the company 2. What is the total number of microcomputers that your organization has?	(Alter, 1998)
Structure Q3	3.How many people use a computer to perform their tasks?	(Benamati and Lederer, 1998)
Structure Q4	4.Which sectors or departments are assisted by IT?	Interview
Structure Q5	5. IT in the company is available to: 1.Single users 2. Multiusers	(Oz, 2000)
Structure Q6	6. Are the computers networked?	(Oz, 2000)
Structure Q7	7. Who is connected?	Interview
Structure Q8	8. What kind of network does your organization use?	(O'Brien,2001)
Structure Q9	9. How many employees have access, in the company, to the Internet (www and email)?	(O'Brien,2001)
Structure Q10	10. How does the company use the Internet?	Interview
Structure Q11	11. What information system is used by the company?	Interview Samuelson (2008)
Structure Q12	12. If you have answered question 11with integrated management systems, check what type (s) system (s) is (are) deployed in the company.	Interview Samuelson (2008)
Structure; Resource Q13	13. If you have answered question 11 with isolated management systems, mark what type (s) of system (s) is (are) set up in the company.	Interview Samuelson (2008)
Resource Q14	14. Approximately what was the annual budget for IT in your organization last year?	Interview

Structure; perception Q15	15. Are the hardware resources (hardware, network, speed, etc.) currently available in the company sufficient to promote the required competitiveness of the company?	(Day and Wensley, 1988)
Structure; perception Q16	16. Are the software features (programs) currently available in the company sufficient to promote the required competitiveness of the company?	(Benamati and Lederer, 1998)
Structure; perception Q17	17. Is there a willingness by the company to train staff to use IT, i.e. does the company provide courses, training etc. to empower employees?	(Davenport, T and Prusak,1998,Laudon and Laudon,2000)
Commitment Q18	18. How many employees were trained to operate / work in computer systems over the last year?	(Cornella,1994)

TABLE 5. Theoretical basis of the structure of the questionnaire – Technical Dimension IT

CODING Dimensions and characteristics evaluated	**TECHNICAL DIMENSION OF IT**	**REFERENCE**
Resource Q19	19. The company does not clearly identify which one (s) problem (s) is/are to be resolved by IT.	(Laudon and Laudon,2000)
Resource Q20	20. Ignorance of ITs available and the benefits that new ITs can bring to company (difficulty in staying informed about new IT).	(Benamati and Lederer, 1998)
Problem; Resource Q21	21. Are ITs very complex and difficult to learn, that is, is there interface not user- friendly?	(Laudon and Laudon,2000, O'Brien,2001)
Resource Q22	22. There is a lack of human resources to operate the ITs. (The company has few employees, often performing various activities, without specific technical knowledge in IT.)	(Cornella, 1994)
Administrative management and technological commitment; Resources Q23	23. The company knows how to give training to employees to use the IT available. (with adaptation)	(Davenport, T and Prusak,1998)
Resource Q24	24. Is the cost of software or hardware high?	Interview (Samuelson, 2008)
Administrative management and technological commitment; Resources; IT Problems Q25	25. Does the implementation of IT take more time and money than originally planned?	(Laudon and Laudon,2000)
Perception; Resources; IT Problems Q26	26. Does IT not increase productivity?	(Davenport, T and Prusak,1998)
Structure; Resource Q27	27. Which Tools (programs) do the company use?	Interview (Samuelson,2008)
Structure; Resource Q28	28. What are the management tools that the company uses?	Interview
Commitment Q29	29. For what business function does the company use the tools selected in the previous question (28)?	Interview (Samuelson,2008)
Perception; Resources; IT Problem Q30	30. Do ITs not increase the sales and/or not reduce costs but just automate existing processes?	(Laudon and Laudon,2000)
IT Problem; Resources Q31	31. Difficulties in adapting IT to the company's needs. (Lack of compatibility between what the company needs and what the software offers. The information and knowledge that are available through IT to managers are not timely, are of low quality or do not satisfy the needs.)	(Benamati and Lederer, 1998)
IT Problem; Administrative and technological management	32. It is difficult to spread the use of new ITs between the collaborators (suppliers, customers, etc.). And get their commitment.	(Benamati and Lederer, 1998)

Q32		
Administrative and technological management Q33	33. Lack of nearby reference point on the use of IT. (There is no company that can be visited to verify the benefits arising from the use of IT).	Interview
Administrative and technological management Q34	34. Lack of a clear policy for adoption / modification of IT. (There is no standard procedure on adopting / changing IT in the company.).	Interview
Resources Q35	35. Lack of technical support in the region (vendors who provide guidance / assistance)	Interview
Adm. Manag.; IT Problem Q36	36. Difficulty of preparing the environment for IT. (Operational difficulty of the company to prepare staff and the physical environment for new ITs.)	Interview

TABLE 6. Theoretical basis of the structure of the questionnaire – Cultural Dimension IT

CODING Dimensions and characteristics evaluated	**CULTURAL DIMENSION OF IT**	**REFERENCE**
Perception Q37	37. Is there resistance from employees?	Interview
Perception Q38	38. Is there resistance to the use of IT by engineer managers of the building site?	Interview
Commitment Q39	39. Does the company not have a policy of motivation, remuneration and assessment that encourages and rewards an individual's active stance in the process of adoption/ modification of IT?	(Davenport, T and Prusak, 1998)
Perception Q40	40. The company prioritizes efforts for ITs. (The IT are not seen as critical factors - for decision-making tools such as generators or product / process innovation - to achieve a competitive advantage.) (Adapted)	(O'Brien,2001)
Administrative and technological management Perception Q41	41. Does the adoption/modification of IT lead to change in the structure of the organization. (Amendments to the power and decision structure, changing routines and administrative procedures, modifies the organizational chart etc.).?	(Laudon and Laudon, 2000, O'Brien,2001)
Administrative and technological management Perception Q42	42. The adoption / change of a new IT requires changes in the bases of the company's relationship with its collaborators (suppliers, customers etc.).	Interview (Samuelson,2008)
Perception Commitment Q43	43. The new ITs require a process of continuous learning and dynamic work systems, thus demanding greater effort and individual responsibility. (The adoption of IT requires staff to develop new competences.)	(O'Brien,2001) Interview

Source: Compiled by the authors

6. RESULTS

Analysis of the items was conducted first by considering the total sample. Subsequently the companies were grouped so as to demonstrate how the factors mentioned in the literature were understood by the companies of the region under study, as being potentially restrictive.

In the analysis of the data, the Cronbachs α was calculated to check the internal consistency (reliability) of the scale of the instrument applied in the companies.

According to Kline (1998) there is no standard value such that the Cronbachs α is considered good. Hair et al. (2005) consider a value of less than 0.6 is low and one of between 0.6 and 0.7 moderate. Morales Vallejo et al. (2003) regard Cronbach alphas below 0.6 as questionable.

However, Kline (1998) states that if alpha is less than 0.5, it may be that if it has 50% of the variance observed, this is due to random error. In the light of these arguments, this paper therefore opted for a value of between 0.6 and 0.7 or higher: $\alpha \geq 0.65$

The processing of data using Minitab 15 software licensed to Federal University of Technology of Paraná- Ponta Grossa UTFPR - PG showed that the total Cronbach α and that of each construct reached the level deemed "very good" as a result of the option for α used by the researcher, as per the classification of Hair et al. (2005). The value of α for the total scale reached the level of α = 0.6854. This total value indicates that the companies that answered the questionnaire were consistent in their responses, and thus gave values very close to the items within each construct. Tables 7 and 8 show the results per construct.

TABLE 7. Cronbach alphas for total scale and construct

TECHNICAL DIMENSION OF IT			
Reference	**Coding**	**Enunciation**	**Values**
(Laudon and Laudon, 2000)	Q19	Resources	0.7073
(Benamati and Lederer, 1998)	Q20	Resources	0.6652
(Laudon and Laudon, 2000, O'Brien, 2001)	Q21	IT Problem: Resources	0.6726
(Cornella, 1994)	Q22	Resources	0.6402
(Davenport, T and Prusak, 1998)	Q23	Administrative and technological management	0.7117
(Samuelson, 2008)	Q24	Commitment	0.6788
(Laudon and Laudon, 2000)	Q25	Resources	0.6528
(Davenport, T and Prusak, 1998)	Q26	Resources	0.7090
(Laudon and Laudon, 2000)	Q30	Administrative and technological management	0.6653
(Benamati and Lederer, 1998)	Q31	Commitment	0.6435
(Benamati and Lederer, 1998)	Q32	IT Problem	0.6658
Interview	Q33	Perception: Resources	0.6679
Interview	Q34	IT Problem	0.6791
Interview	Q35	Structure: Resources	0.6569
Interview	Q36	Structure: Resources	0.6530

TABLE 8. Cronbach alphas for total scale and construct

CULTURAL DIMENSION OF IT			
Reference	**Coding**	**Enunciation**	**Values**
Interview	Q37	Commitment	0.6496
Interview	Q38	Perception: Resources	0.6386
(Davenport, T and Prusak, 1998)	Q39	IT Problems	0.7004
(O'Brien, 2001)	Q40	IT Problems	0.7154
(Laudon and Laudon, 2000, O'Brien, 2001)	Q41	Resources	0.6945
(Samuelson, 2008)	Q42	IT Problems	0.6650
(O'Brien, 2001)	Q43	Administrative and technological management	0.6864

To facilitate the preparation of tables, the items were all coded. The list of codes is given in Table 5 and Table 6

TABLE 9. Descriptive statistics

TECHNICAL DIMENSION OF IT							
Reference	**Items**	**Average**	**Standard Deviation Σ**	**Coefficient of Variation**	**Minim**	**Maxim**	**Range**
(Laudon and Laudon, 2000)	Q19	3.667	0.887	24.19	1	5	4
(Benamati and Lederer, 1998)	Q20	3.725	1.078	28.95	1	5	4
(Laudon and Laudon, 2000, O'Brien, 2001)	Q21	2.980	1.257	42.17	1	5	4
(Cornella, 1994)	Q22	3.784	1.346	35.58	1	5	4
(Davenport, T and Prusak, 1998)	Q23	2.765	0.862	31.19	1	4	3
(Samuelson, 2008)	Q24	3.980	0.969	24.35	1	5	4
(Laudon and Laudon, 2000)	Q25	3.333	1.227	36.82	1	5	4
(Davenport, T and Prusak, 1998)	Q26	3.863	0.980	25.38	2	5	3
(Laudon and Laudon, 2000)	Q30	2.804	1.386	49.43	1	5	4
(Benamati and Lederer, 1998)	Q31	3.137	1.114	35.51	1	5	4

(Benamati and Lederer, 1998)	Q32	3.745	1.146	30.6	2	5	3
Interview	Q33	3.922	1.055	26.91	1	5	4
Interview	Q34	3.980	0.927	23.29	2	5	3
Interview	Q35	3.902	1.118	28.66	1	5	4
Interview	Q36	3.627	1.232	33.97	1	5	4

TABLE 10. Descriptive statistics

CULTURAL DIMENSIONS OF IT							
Reference	**Items**	**Average**	**Standard Deviation Σ**	**Coefficient of Variation**	**Minim**	**Maxim**	**Range**
Interview	Q37	3.235	1.,335	41.28	1	5	4
Interview	Q38	2.647	1.560	58.93	1	5	4
(Davenport, T and Prusak, 1998)	Q39	2.373	1.356	57.15	1	5	4
(O'Brien, 2001)	Q40	3.078	1.278	41.52	1	5	4
(Laudon and Laudon, 2000, O'Brien, 2001)	Q41	3.706	1.331	35.92	1	5	4
(Samuelson, 2008)	Q42	3.922	1.093	27.86	2	5	3
(O'Brien, 2001)	Q43	3.824	1.072	28.03	2	5	3

As can be seen in Tables 9 and 10, the averages ranged from 2.3 to 3.9 and the standard deviations from 0.8 to 1.5 but appeared not to compromise most items, which would lead to their elimination. It was then decided to continue the analysis by using the arithmetic mean of the responses on an interval scale of 1-5 and to regard the factors with an average equal to or greater than 3 as a potentially inhibiting factor as to the use of IT in the company.

The mean length of time of the companies activity in the construction market was 20 years. The Internet was available in 100% of the companies. As for the structure and perception, 15.68% of the respondents stated the availability of hardware was insufficient to carry out activities and 33.3% of the respondents perceived the software resources made available to perform the activities as being insufficient.

The results obtained in the general dimension of information technology show that the existing IT structure in the companies serves 85% of the administrative sector such as for: purchasing, accounting, finance, human resources; and technical matters like: production, management of and actual work on the building sites. IT was available on a multi-user basis in 67% of the companies and 66.8% of PCs were on a wireless LAN (WLAN) at an average of 4 computers per WLAN.

The use of Information Technology, the object of this paper, has permeated almost all functional areas of the companies surveyed. The most visible part of this was in the automation of jobs in the office and at building sites which serve internal and external clients. The technology of the automation of job and service posts included the use of various types of telecommunication systems, such as word processing, electronic spreadsheets, computer graphics and electronic mail (e-mail) used for contact with clients, finding out about new products, purchasing/ procurement and the management of building sites.

When asked about the use of IT tools of integrated management systems between the office and the building site such as the Management Information System, SIG in Portuguese, Managing customer relationships - CRM, Supply Chain Management - SCM, Business Intelligence, Balanced Score Card - BSC, Electronic commerce - e-Commerce, 86.3% of the companies responded that they did not use any of these tools and 13.7% replied that they use SIG and CRM. The network operating system most widely used among the companies surveyed is Microsoft Windows and the development tools for activities related to engineering are Volare, Archi CAD, Auto CAD, Corel Draw, Access, Excel, Ms Project, High IQ.

In the interviews with the SMEs, some of the managers stated that the reasons why they had difficulty in using IT in the company more intensively for the administrative management of the building sites was to do with the low level of education and skills of the group involved, and the fact that companies do not have the resources to have highly-skilled professionals implement criteria or indicators of IT management. Other factors mentioned in

the interviews included: high staff turnover and the lack of reliable data from the sector to allow comparisons. One possible explanation for these perceptions is that, in their organizational structure, the SMEs have technological issues about improving their competitive performance, in accordance with the indices cited by Ribault et al. (1995) and yet have better skills when it comes to changes and maturing IT.

An evaluation was conducted of the data for evaluating the degree of diffusion of the companies regarding the use of IT as per the model given by Sullivan (1985) and based on studies by Costa et. al. (2006).

In studies of Costa et. al. (2006) the metric was used as the empirical relationship between the number of computers and number of employees provided by the companies. Therefore, companies that had a relationship with a value greater than 0.5 corresponds to a ratio of 1 computer to 2 employees were considered to be high diffusion ones and those with a value less than 0.5, low diffusion ones. However, it is notable that there have been significant advances in the use of IT over time. Thus, the metric used in this study was based on the universe of 51 companies studied which had a total of 263 computers and 282 employees working in the domestic business environment, where the ratio of computers per employee generated an empirical index of 0.9. Thus, companies that were associated with a value exceeding ≥ 0.9 were characterized as having more than two employees per computer and were considered high diffusion ones, the others as low diffusion ones.

The test result showed that 75% of companies surveyed have high diffusion while, in 25% of companies, diffusion is low.

To identify companies with respect to their level of infusion, the criteria adopted were those used for evaluating the average of responses to the following questions: Q37. Is there resistance from employees? Q38. Is there resistance to the use of IT by engineer managers of the building site? Q39. Does the company not have a policy of motivation, remuneration and assessment that encourages and rewards an individual's active stance in the process of adoption/ modification of IT? Q40. The company prioritizes efforts for ITs. (The IT are not seen as critical factors - for decision-making tools such as generators or product / process innovation - to achieve a competitive advantage.), Q41. Does the adoption/modification of IT lead to change in the structure of the organization? (Amendments to the power and decision structure, changing routines and administrative procedures, modify the organizational chart etc.) Q42. The adoption / change of a new IT requires changes in the bases of the company's relationship with its collaborators (suppliers, customers etc.).

The average of responses to questions Q37 to Q42 of all companies was 3.0. Thus, companies that were associated with a value exceeding ≥ 3.0 were considered high infusion ones, the others, low infusion ones.

The results show that 35.29% of the companies have high infusion and 64.71% companies, low infusion. This indicates that although companies make use of computers in all sectors of the business, IT is not internalized in the companies in terms of impact, importance and significance.

It is not enough for a company to have a formatted IT structure, it needs to be well formatted, i.e., to comprise a computerized system for transactions and accounting, which contains the commercial part of the transactions; a network that connects all the key people; and a server for exchanges. It is important to stress that, within the context of competitive and strategic thinking, it is essential to think about automating processes by using IT better (intranets, extranets), management of the workflow process and to introduce the redesigned process in the organizational structure of business.

It is very clear from the results of this study that the companies have an IT infrastructure that is satisfactory to its users, a large majority of whom consider that the hardware and software resources made available by the companies are sufficient to carry out their activities.

Taking as a starting point the statistical treatment of the data, Table 11 was drawn up and shows the situation of the SMEs in relation to several factors.

Data are discrete within a range of 1 to 5 inclusive. This includes the extremes (1 and 5) and the average was rounded to the nearest interval.

TABLE 11 – Arithmetical mean of the technical and sociocultural factors

Factors that are Inhibitors - Descending Order	Values
Use of management tools in the company	1.1
Underestimate the potential of IT for giving a competitive edge - hardware deployment	1.2
Financial investment in IT	1.3
Underestimate the potential of IT for giving a competitive edge - Software Deployment	1.3
Investment in the preparation of the annual physical environment and employees	1.4
Obstacles in the way of training for the company's employees	1.6
Lack of a Policy for motivation and rewards	2.4
Resistance from the field engineers	2.7
ITs do not increase sales / reduce costs	2.8
ITs are very complex	3.0
The company knows how to give IT training targeted on the sector	3.0
Lack of priorities in the efforts to use IT	3.0
Big difficulty in adapting IT to the companies´ needs.	3.1
Resistance from older employees	3.2
ITs require more time and $ than planned	3.3
Difficult to prepare the company environment for IT	3.6
IT does not identify the problem	3.7
IT causes structural changes in the company	3.7
Ignorance about the ITs that are available	3.7
Difficulty in spreading IT among the actors and collaborators in the industry	3.8
Absence of HR to operate ITs	3.8
Need for new professional profile	3.8
Increased productivity	3.7
Lack of technical support in the region	4.0
Causes dependence on IT suppliers	4.0
Absence of reference sector companies that use information technology efficiently and effectively	4.0
Lack of IT usage policies that target the construction industry	4.0
Costs of software and hardware	4.0

Source: Data from the authors' survey of construction companies - Ponta Grossa – Paraná

From the analysis of Table 11, it appears that SMEs have restrictive results / inhibitors for the use of IT in the company on 19 factors in which the arithmetic mean of the scale adopted of 1 to 5 is equal to or greater than 3. This gives strong evidence that companies do not measure important indicators on the quality of the product, the IT structure, resources, perception, IT issues, technological administrative management and commitment.

It is important to point out that, although the directors do not see complexity in IT matters such as restrictive factors on using them, they consider that the new ITs need a new profile and training and that this is a potentially restrictive element to adopting ITs and changing them, which indicates a certain degree of incoherence.

Another relevant point emphasized in the interviews with directors of the company is that, initially, all of them say that they apply measurement criteria. However, during the interview when evidence for this was requested, it was noted they do not have any. Only two SMEs have data that are used for product quality. It is important to stress that if the directors do not have measurements performed, it is very likely that they will have difficulty managing IT matters.

The study shows that there is dependence between variables considered to be strongly inhibiting for the use of IT in the company and others that, in the perception of the directors, have not reached the band deemed as inhibiting (**mean = 3**).

Table 12 shows the variables in which a strong dependency was identified with the variable of "cost of software and/or high cost of hardware", which is one of the variables that has the greatest inhibitory force.

TABLE 12. Comparison of the variable of the technical dimension of IT - Resources "Cost of software and high cost of hardware" with other variables

Variable crossover	IT dimension	Classification	Level of dependency	Qui2	Degree of freedom	p-valor
ITs require more time and $ than planned	Technique	Administrative Management Technology; Commitment; IT Problems	Management Technology; Commitment; IT Problems	13.385	50	1,000
Lack of technical support in the region	Technique	Administrative Management Technology;	High	12.241	50	1,000
Lack of Policy for use of IT to the construction industry	Technique	Administrative Management Technology;	High	10.432	50	1,000
Difficulty in adapting IT to business needs	Technique	Administrative Management Technology; IT Problems	High	14.050	50	1,000

Although there are cross variables that were not considered strong inhibitors, such as the variable "ITs are very complex" and the variable "they do not increase sales / reduce costs," it is observed that there is a correspondence between these and the perceived cost of software and/or high cost of hardware.

7. DISCUSSION

Suggestions will be put forward for mitigating the problems encountered in the analyses noted above regarding the use of information technology as a strategic tool in successfully managing an engineering company.

The most problematic pieces of evidence encountered in the course of the interviews were: a) SMEs are unaware of measurement criteria and indicators for IT, with no alignment for continuous improvement; b) SMEs are not aware of the need to know and apply IT measurement criteria and indicators; c) SMEs are unaware of methodologies for applying criteria and IT performance indicators.

The solutions to the problems raised should be discussed between universities, trade unions, CREAs, and organizations that support SMEs such as SEBRAE so that the management of knowledge and IT is made feasible.

The maturity process of the company and generating knowledge creation through groups with the aim of discussing improvements so as to modernize SMEs should be accelerated.

Meetings with entrepreneurs from SMEs are suggested through the associations of architects and engineers to present and discuss successful cases of applying criteria, indicators and forms of maturity in the use of IT.

Technical visits, sponsored by the organizations mentioned above so that entrepreneurs can be exposed to good business management practices should be encouraged.

Creating networks to integrate organizations, the goal of which is to create local networks of SMEs in the construction industry should also be encouraged. Thus, by being part of the network, SMEs will stop acting as small individualized businesses and will start to act as integrated systems of SMEs. Thus, SMEs can overcome problems such as a lack of: knowledge about artificial intelligence, expert knowledge, generating and disseminating knowledge, innovation , IT and other knowledge, where applicable

With regard to the factors of the "need for a new professional profile" and the "absence of HR to operate ITs", educational measures, consultations and training geared to aspects of transition or change in IT are needed. Thus this would significantly minimize the resistance from staff and a culture of motivation and reward policies could be developed, provided that the companies visualize the advantages and benefits that could arise through the efficient and effective use of IT.

It was observed that the SMEs surveyed have in general a reasonable perception of the importance of IT to their organizations.

The financial and policy factors contain the factor considered the greatest inhibiting medium for using IT of all the factors considered (cost of software /high cost of hardware) and (the lack of a policy for using IT targeted on the construction industry) and that is present in any dimension that is considered.

The study also shows there is dependence between variables considered inhibitors, and others that, in the perception of the respondents, did not reach the band considered an inhibitor (**mean = 3**).

Another observation made during the research is that most SMEs believe that the main source of knowledge that they can have at their disposal is their own companies. However, it is emphasized that the intellectual capital of companies is sometimes scattered around, lost in the labyrinths of the company, disorganized or often inaccessible. A well-managed information system open to all would go a long way to minimizing these problems and to ensuring that the intellectual capital of the company was constantly available and should be drawn on and kept up-to-date .

The SMEs also understand that among the management tools for promoting the dissemination of knowledge, the most common one is the one that allows knowledge that is “in the heads" of people to be shared. It is this which is an indicator of the importance correctly attributed by top management to people.

8. FINAL CONSIDERATIONS

The conclusion brings up reflections on the reason which led the researchers to conduct this study. Thus, researchers sought to understand how Information Technology IT is being used and applied in small and medium-sized companies in the field of civil construction in civil construction companies in an environment of the private sector. Characteristics were identified with the support of the specialist literature and the practices experienced in public agencies and private companies in the sector of the civil construction.

As a result of applying the diagnostic of the use of IT in a company, it was possible to find evidence that, in civil construction SMEs, the needs for improvement are those set out in summarized form in the item on discussion.

It is believed that, from the analysis of the research results, there is the feeling that IT tends to grow in geometric progression among companies in the civil construction segment. However, for IT to happen in fact, there is a gap that should be filled, namely: the top management of companies in the engineering segment should be alert to the real importance of IT in business. IT should be understood as a necessary and continuous practice for differentiation with regard to planning, behavior, recognition of opportunities, and the desire to be entrepreneurial, customization, competition and not just to be understood as a set of tools to acquire operational data from within and without the company. The company should transmit these data to other people and processes, both within the organization and outside it.

As to a general conclusion, the research indicates that many companies still are not aware of the benefit that the full use of IT can bring to their business and still need methodologies to plan and decide on how best to exploit this potential, and thus to regard IT as having tools that can support management as well as performing routine transactions quickly.

The authors do not claim to have exhausted the subject nor that this paper presents definitive solutions, but rather they do see the need for further exploratory studies with a larger number of companies, aiming to test the diagnosis of IT use, and test hypotheses put forward in this preliminary investigation.

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