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Full Length Research Paper

Perceptions of accounting professionals about the influence of information technology in their individual work process

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The continuous flow of technological innovations, combined with the changes that occur in accounting practice is changing the organizational environment and the people involved. Accounting professionals use IT to be able to make reliable and timely information available to managers, supporting the decision making process. This investigation aims to identify the perceptions of accounting professionals from the State of Paraná, Brazil about the use of IT in their individual activities. Data collection was done with an online questionnaire. 362 responses were obtained, validated by Factor Analysis and submitted to reliability testing with Cronbach's Alpha coefficient. The research findings reveal that users indicate higher benefits in Productivity, moderate benefits in Management Control and Customer Satisfaction, and less intense benefits in Innovation. With respect to the participation of accounting professionals in the three levels of decision-making, Cluster Analysis revealed the formation of five respondent groups: Interns, Operational Supervisors, Department Heads, Vice-Directors and General Directors.

Key words: Information technology, accounting, work process, benefits, productivity.

INTRODUCTION

The continuous flow of technological innovations, together with changes in accounting practices induces changes in the organizational environment and in the

Behavior of workers, particularly accounting professionals. Fetzner and Freitas (2007) argue that information technology (IT) is one of the determining factors

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of organizational transformation by providing innovative technological solutions since the middle of the twentieth century. According to the authors, IT has brought about technological innovations that enable organizations to reach higher standards of performance and competitiveness, thus its contribution is widely acknowledged.

Davenport (1998) points out that managers must adopt a holistic approach in order to reap the benefits of intensive investments on technology. Such approach has been called information ecology, which emphasizes an encompassing view of the information environment, taking into account the corporate values and beliefs about information (culture); the way people use information and what they do with it (behavior and work process); the pitfalls that may hinder information exchanges (politics); and which information systems are properly implemented (technology).

Thus information ecology is not concentrated on technology, but rather on the way people create, distribute, understand and use information, highlighting the importance of the human factor for the success of IT. For Santana (2004), the human element stands above the technology, taking responsibility for the interaction with all the other components. Hence technology will be neither functional nor useful unless human interaction is fully accomplished. In this view, organizations are composed by a set of activities, not necessarily computer-supported, conducted by people. Accounting (as a business language) and its practitioners play a highly visible role in this context, with significant consequences that transcend the corporate world to reach all society.

Continuous upgrading of technical skills is a major requirement for accounting professionals to perform competently their activities. That enables them to be adequately prepared to supply relevant and timely information as required by managers. Laudon and Laudon (2007) point out that since the 1950s, accounting was one of the first area to use computers in companies. Ever since, the reliance of accountants on IT to perform their activities has been growing, particularly within large corporations. Information is an essential input to corporate managers, thus accounting has a central role as primary supplier of information about business transactions and events. The role of the accountant is highlighted by being among the workers that use IT intensively to perform their tasks (Borinelli, 2006). The relevance of IT impacts on their professional practice is acknowledged by AICPA (2011), which has recently stated that the ability to use IT efficiently and effectively is one of the major competences needed by accounting professionals.

In this context, the understanding of the impacts of IT on organizations and on the professional activities of individual workers, in this case accounting professionals, constitutes a challenging and promising research opportunity. Torkzadeh and Doll (1999) argue that the study of IT impact on organizations is a wide and multifaceted field

that provides research opportunities and significant challenges.

Antonelli et al. (2010) used data from international publications to investigate thematic and methodological trends on research about the impacts of IT in organizations across publications from 2005 to 2009. One of the findings is that only two among 38 articles studied IT impacts at the individual level, suggesting a dearth of research of this kind. The results are similar to other studies from the 1990s, such as the one by Torkzadeh and Doll (1999), which reported a number of broad-ranging surveys, but not specifically focused on personal aspects of work.

Individual-level study of IT benefits is particularly relevant because (1) the accounting professional depends strongly on IT to develop its personal and professional competences; (2) the need to focus on the human factor on IT-related studies; and (3) the lack of such studies with a focus on the individual level, and specifically, on accounting professionals. Within the proposed framework, this study is oriented by the following research question: what are the perceptions of accounting professionals about the influence of information technology on their individual work process? Consequently, the objective of the investigation is to identify the perceptions of accounting professionals about the influence of information technology on their individual work process.

The paper is divided into five sections, including this introduction. The following sections present the theoretical empirical foundations and a description of the methodology. The fourth and fifth sections present respectively the results and conclusions.

Benefits of information technology on individual work

Lucht et al. (2007) classify the work of Torkzadeh and Doll (1999), which proposed to measure the impact of IT on individual work, as ground-breaking. Torkzadeh and Doll (1999) propose a framework to measure the impact of IT on individual work on the basis of four constructs: (i) Productivity, (ii) Innovation, (iii) Customer Satisfaction and (iv) Manager Control. The constructs proposed by them are aligned with the organizational objectives that drive companies to invest in technology, per Laudon and Laudon (2007). The Productivity and Manager Control constructs are aligned with: (i) operational excellence, which seeks superior levels of efficiency and performance; the innovation construct is linked to the objective (ii) creation of new products, services and business models; and the Customer Satisfaction construct is related to the objective (iii) closer relationship with customers and suppliers. These connections show that organizational benefits are similar to individual ones, and that individual-level studies may display similarities with organization-level studies.

Torkzadeh and Doll (1999) collected data about the

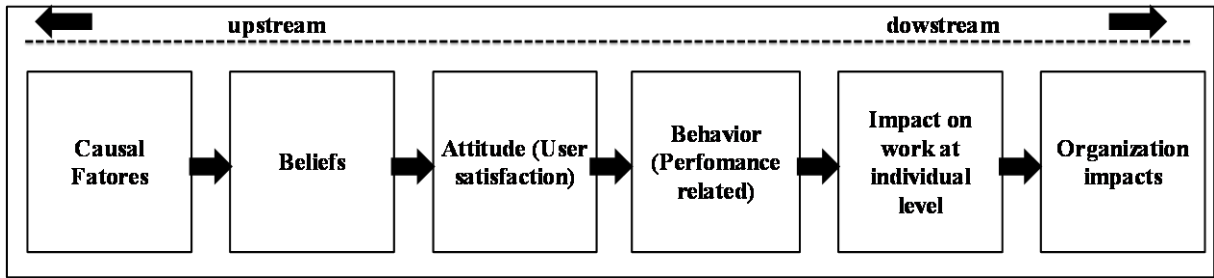


Figure 1. System of value chain. Source: adapted from Torkzadehand Doll (1999).

Table 1. Definition of constructs in the work process framework.

Construct	Definition	Supporting literature
Task Productivity	Degree of improvement in user production by unit of time	Braverman [2], Curley and Pyburn [7], Hirschheim and Farduhar [24], Kraemer and Danziger [30], Liff [32], Sulek and Maruchek [43], Weick [54] and Zuboff [55]
Management Control	Degree to which the application helps to control work process and performance	Braverman [2], Hirschhorn [26], Kraemer and Danziger [30], Shaiken [51] and Zuboff [55]
Task Innovation	Degree to which the application helps users to create and experiment new ideas in their work	Curley and Pyburn [7], Davis [11], Harvey <i>et al.</i> [22], Hirschhorn [25], Larson and Fielden [31], Long [33] and Zuboff [55]
Customer Satisfaction	Degree to which the application helps users to create value for internal or external customers of the organization	Curley and Pyburn [7], Filiatrault <i>et al.</i> [17], Harvey and Filiatrault [21], Harvey <i>et al.</i> [22], Hirschhorn [25, 26], Schlesinger and Haskett [47]

Source: adapted from Torkzadeh and Doll (1999).

perception of IT users to measure its impact on their professional activity. Pereira (2003) argues that such strategy is based on the individual cognitive process that uses a personal framework for understanding the outside world. The cognitive process is based on the behavioral theory of management, represented in the work by Torkzadeh and Doll (1999) as a “system to value chain” to explain the relationship between the use of IT and its impacts (Figure 1). For the authors, IT impact is a central concept that comprises downstream effects and, therefore, to study individually the human element is a direct reflection that the use of technology precedes organizational effects.

The analysis of IT impacts on individual work as an antecedent of organizational impacts was studied by DeLone and McLean (1992). The understanding of those authors, based on research findings, reinforces the relevance and importance of investigating the relationship of IT with the individual level, more specifically in the accounting area.

In order to develop a framework to measure the impacts of IT on individual work, Torkzadeh and Doll (1999) divided the extant literature into two groups: the industrial and the post-industrial model. In the first one, technology was used to produce impacts on productivity and on manager control, replacing human work. In the post-industrial model, the focus was sustained by productivity and managerial control, yet technologies began to be seen as drivers of innovation and customer satisfaction.

The authors produced definitions for the four constructs about the impact on individual work, which describe “how” is the impact of an application on the individual within the organizational context. The application is defined as the use of IT to perform the work. The definitions and supporting literature are described in Table 1.

Torkzadeh and Doll (1999) composed 39 Likert-type questions with a five-point scale to capture individual perceptions related to IT impact in the four proposed

dimensions. For the initial validation of the instrument, they conducted a pilot study for verification of unidimensionality, reliability, concision and simplicity of factor structure, using Factor Analysis. As a result, the final version of the questionnaire contained twelve questions to evaluate IT impact on individual work. The authors subsequently applied the final version to a sample of 409 users distributed among 18 organizations of several areas of activity and sectors.

Later, Torkzadeh et al. (2005) conducted a study with the purpose of re-validating the instrument developed by Torkzadeh and Doll (1999). A new validation approach was proposed, using confirmatory techniques and factorial invariance tests. Data were collected from two samples – IT users in the United States and Mexico – with respondents from different managerial roles in the hierarchy of the organizations. The study results provided evidences that the four initial constructs measure adequately the impact of IT on individual work. Reliability coefficients were high and the factorial invariance tests showed that, in general, the evaluation model is invariant considering the countries under study and the levels of management.

The authors have indicated that the proposed framework should be confirmed, with replication to test its stability and to develop standards to evaluate specific applications. To that end, there are some studies that replicate Torkzadeh and Doll's (1999) framework, including: (i) the study of Maçada and Borenstein (2000) that measured user satisfaction among users of a Decision Support System and concluded that the four dimensions of the model are sufficient to analyze a public organization prototype, and (ii) Lunardi et al. (2004), that evaluated the Enterprise Resource Planning system in a federal university hospital, employing the user satisfaction metrics.

METHODOLOGY

A survey was undertaken with the application of the instrument developed by Torkzadeh and Doll (1999). According to Babbie (2001), a survey is designed to achieve three main goals: to describe, explain and explore. Hence this study seeks to measure, using an ordinal scale, the degree of intensity of the benefits of TI on professional activities from the perspective of the users themselves. Following the criteria laid out by Hair Jr. et al. (2005), this research is classified as quantitative and descriptive.

Torkzadeh and Doll (1999) point out that, as a result of the collection of several responses from a great variety of applications and organizations, the results may be generalized. For this study, the selected population comprises the accounting professionals of the state of Paraná, Brazil.

The instrument for data collection has twelve questions replicated from the instrument developed by Torkzadeh and Doll (1999). They are Likert-type questions, with five levels that range from "1" (very low) to "5" (very high) to measure the perception of the intensity of TI benefits on the work of the individual. Seven other questions, divided into two groups, were used to characterize

the respondent. The first group is related to the IT application, with three assertions that verify: (i) whether the application is in its implementation phase, so that if the answer is positive, the impact is expected to be lower than if it is not in the implementation stage; (ii) whether the application is part of an ERP or not, considering that previous studies indicate that ERP brings significant changes in its environment, such as reported in the study by Newman and Westrup (2005), which concluded that the rise of ERP systems constitutes a fundamental change for accountants; (iii) what is the main function, or functions that are performed by the application that is most used by the professionals. The second group of characterization questions includes four assertions related to the respondent, in order to investigate: (i) age of respondent; (ii) duration of employment in the current organization; (iii) education background; and (iv) what is the intensity of the professional decisions, considering the three levels of decision making: operational, tactical and strategic. Therefore, the survey questionnaire comprises twelve Likert-type questions to measure the benefits of TI on the work of the respondents, and seven questions to characterize their profile, for a total of nineteen questions.

At the time of the survey, there were 20,228 accountants and 10,355 accountant technicians in the state of Paraná, totaling 30,583 licensed active professionals, according to data from the State Accounting Council – *Conselho Regional de Contabilidade do Paraná - CRCPR* (2011). The Council, as well as a company association – *SESCAP-PR (Sindicato das Empresas de Serviços Contábeis e das Empresas de Assessoramento, Perícias, Informações e Pesquisas no Estado do Paraná)* and a women's accounting association – *IPMCONT (Instituto Paranaense da Mulher Contabilista)* sent e-mail messages to their membership lists introducing the research, asking for their cooperation and including a link to the electronic questionnaire. It should be noted that only accounting professionals with registered e-mail addresses in the above mentioned organizations were invited to take part in the survey.

The electronic questionnaire was made available on the Qualtrics® software platform for web data collection. The e-mail messages to potential respondents were sent by the institutions in the following dates: (i) CRCPR on 7/14 and 7/28/2011; (ii) SESCAP-PR on 8/4/2011 and (iii) IPMCONT on 7/11 and 7/29/2011. The period for data collection ended on 8/17/2011. A total of 362 valid responses were received, excluding questionnaires that were incomplete or that had taken less than five minutes to be completed. Data treatment was initially done with descriptive and univariate statistical techniques, followed by multivariate techniques, including Cronbach's Alpha, Exploratory Factor Analysis and Cluster Analysis.

RESULTS AND DISCUSSION

The study results are described in four parts. The first is about sample characteristics, and the second deals with the validation and analysis of Torkzadeh and Doll's (1999) instrument. The third phase used Cluster Analysis to identify respondent groups in terms of their intensity of decision-making by organizational level. The last part related the survey results with sample characteristics, in addition to a Cross-tabs analysis to locate important characteristics among the sample clusters.

Sample characteristics

The following characteristics were observed after the

Table 2. Comparison of Cronbach's Alpha coefficient among work process studies.

Construct	Cronbach's Alpha test coefficients		
	Current Research	Pereira (2003)	Torkzadehand Doll (1999)
Productivity	0.88	0.74	0.93
Managerial Control	0.89	0.82	0.93
Innovation	0.88	0.80	0.95
Customer Satisfaction	0.89	0.81	0.96
Total	0.94	0.82	0.92

Source: calculated from survey data.

verification of the 362 valid questionnaires:

The functions of the IT applications used by respondents in the sample are essentially linked to their professional formation. The Accounting function has the largest share with 86 percent, followed by Fiscal and Payroll, with 70 percent and 56 percent respectively;

2. The software programs used by the majority of accounting professionals are fully implemented (74 percent of the cases), so it is possible to assume that those applications are fully functional;

3. With respect to ERP systems, 43 percent of the respondents informed that the software program is integrated with ERP, 30 percent do not use it and 27 percent were not able to answer the question;

4. The age of the respondents was also analyzed, indicating that 66 percent are in the 19 to 35 age group, indicating a predominantly young sample;

5. Among the respondents, 19 percent (70 people) have been "up to one year" in the organization, so those may not be fully adapted to the managerial practices, processes and technologies that are used. Within the interval of two to four years, there are 37 percent (135) of the respondents; 21 percent are in the organization for "more than ten years"; 14 percent (51) between five and seven years, and 8 percent (30) between eight and ten years. The data show a small percentage of workers in the five to ten-year employment period;

6. The education background of the respondents comprises in the majority (i) accounting technicians and (ii) accountants, but it also includes other backgrounds.

Validation and analysis of the work process instrument

For validation of the instrument, the reliability scale using Cronbach's Alpha was applied, with subsequent validation using confirmatory factor analysis (CFA) to confirm the theoretical sustainability of the replicated survey. The following parameters were used for the operationalization of factor analysis.

Method of factor extraction

The principal components model was used with the goal of determining only the linear components within the data and how the variables may contribute to each component (Field, 2009);

Criteria for the extraction of the number of factors

The *a priori* criterion was used, which according to Hair et al. (2005), is applied when the researchers knows the number of factors before performing factor analysis;

Rotation of factors

The option was for Equamax orthogonal rotation, with the objective of minimizing the number of factors needed to explain each variable, and allows to maximize variable explanation within a single factor, while also ensuring that factors remain non-related (Hair et al., 2005; Field, 2009).

The Cronbach's Alpha test was done initially for each assertion and subsequently for each construct. The analysis took into account the assumptions of each coefficient, so that there was no correlation with negative values. Table 2 details the coefficients for Cronbach's Alpha test and compares them with previous studies. The total coefficient for this survey (0.94) is greater than the previous ones, showing that the results are acceptable and the model reliability is verified. The results for the individual constructs are also satisfactory, and confirmatory factor analysis could then be performed.

The results of the confirmatory factor analysis for the work process survey were consistent and precluded new analyses, that is: (i) the communality table did not display any indicator with low explanatory power; (ii) the correlation matrix did not indicate any high correlations among the indicators; (iii) the KMO test, which indicates data adequacy from the factors derived from CFA was

Table 3. CFA of work process survey.

Rotated Component Matrix ^a		Component			
Theoretical Construct	Question	Factor 1	Factor 2	Factor 3	Factor 4
Productivity (Factor 3)	Q01			0.724	
	Q02			0.731	
	Q03			0.830	
Managerial Control (Factor 2)	Q04		0.733		
	Q05		0.791		
	Q06		0.755		
Innovation (Factor 1)	Q07	0.839			
	Q08	0.790			
	Q09	0.770			
Customer Satisfaction (Factor 4)	Q10				0.706
	Q11				0.751
	Q12				0.763

^aExtraction Method: Principal Component Analysis. Rotation Method: Equamax with Kaiser Normalization. Rotation converged in 9 iterations. Source: calculated from survey data.

0.94, a highly adequate value to perform CFA; (iv) Bartlett's test of sphericity, which indicates the existence of adequate relations among the indicators for application of CFA, was satisfactory, and (v) the anti-image matrix, which indicates the explanatory power of the factors in each of the variables under analysis, returned values above 0.91 in its lower diagonal area, which denotes a high explanatory power for all variables.

The four factors that were obtained from the instrument advanced by Torkzadeh and Doll (1999) exhibit a 81.86 percent explanatory power, distributed among the four generated factors, which, after Equamax rotation, explain respectively 21.01, 20.6, 20.54 and 19.7 percent respectively. Table 3 shows the load distribution of the variables among the four factors. These results are similar to previous studies (Torkzadeh and Doll, 1999; Pereira, 2003), which supports the applicability of this instrument for measuring IT impacts in the context of accounting professionals in Brazil.

Table 4 shows the means of answer frequencies by question and factor. All questions received the same minimum and maximum values (1 and 5) and the means were between 3 and 4 in the response scale. Some values for the means are near 3, indicating an IT impact of "neither low nor high"; others are near 4, suggesting a greater intensity ("high"). The ones with higher evaluations (near value 4 in the scale) are for the Productivity factor, followed by Management Control. The construct that is nearest to 3 in the scale is Customer Satisfaction, and Innovation displays the lowest

evaluation. This order remains the same when the analysis is done by factor, indicating the absence of disparity among assertions in each factor.

The results of the study by Torkzadeh and Doll (1999) with IT users in the United States were compared to the findings of this survey. It should be noted that other previous studies (Pereira, 2003; Ferreira and Ferreira, 2008) also confirmed Productivity with the highest impact on Work Process and Innovation with the lowest value. The results show that Productivity presents a significant benefit in most environments and professions, including accounting professionals. On the other hand, Task Innovation remains as a benefit that is more "restricted" to IT professionals. This comparison also suggests that the benefits that are perceived by accounting professionals are not unlike users in general, considering that the study by Torkzadeh and Doll (1999) used a broad and diversified sample.

In order to verify whether the differences among the factor means in Table 3 are statistically significant, firstly data normality was analyzed with the Kolmogorov-Smirnov test. At a 5 percent significance level for all factors, the null hypothesis (H0) was accepted, reporting non-normality of the data with the following results: for Factor 1, $D(362) = 0.186$, $p < 0.05$; Factor 2, $D(362) = 0.176$, $p < 0.05$; Factor 3, $D(362) = 0.116$, $p < 0.05$; and for Factor 4, $D(362) = 0.167$, $p < 0.05$. Hence it was necessary to use a non-parametric technique to evaluate the differences between factor means.

The application of the non-parametric test Kruskal-

Table 4. Descriptive analysis of Work Process survey instrument and comparison with previous study.

Factor	Question	Analysis by question		Analysis by factor		Results by assertion from Torkzadeh and Doll (1999)		
		\bar{x}_s^*	S**	\bar{x}_p^{***}	S**	\bar{x}_s^*	S**	
Work Process (WP)	Factor 3 (Productivity)	Q01	3.90	0.95	2.98	0.66	3.70	1.20
		Q02	3.88	0.97			3.50	1.30
		Q03	3.95	0.99			3.50	1.30
	Factor 2 (Management Control)	Q04	3.55	1.00	2.72	0.66	3.20	1.40
		Q05	3.56	0.94			2.90	1.40
		Q06	3.62	0.96			3.10	1.40
	Factor 1 (Innovation)	Q07	3.12	0.99	2.47	0.72	2.30	1.30
		Q08	3.02	1.02			2.20	1.30
		Q09	3.11	1.00			2.40	1.20
	Factor 4 (Customer Satisfaction)	Q10	3.72	0.93	2.67	0.62	3.20	1.40
		Q11	3.51	0.96			3.10	1.30
		Q12	3.60	0.86			3.20	1.40

\bar{x}_s^* : simple means; ** S: standard deviation; \bar{x}_p^{***} : weighted average calculated by weighing each assertion with its factor load. Source: calculated from survey data.

Wallis, with Monte Carlo extraction since it was a large sample (Field, 2009), enabled the comparison of two or more sample groups of unpaired data, in this case the four factors. A significance level of 5 percent was used with the null hypothesis of non-existing statistically significant differences between the sample means, which was rejected, proving statistically the existence of difference between means [$H(3) = 130,00, p < 0.05$].

The following phase was the application of *post hoc* hypothesis testing to verify which of the means were statistically different. The Mann-Whitney hypothesis test was chosen, with application of Bonferroni correction in all effects, with a significance level of 0.0083 (0.05/6). The null hypothesis of equality of means was accepted for just one effect, from Factor 2 with Factor 4, which represent the Managerial Control and Customer Satisfaction respectively. Therefore, it is possible to affirm that the benefits of IT on the individual work of accounting professionals are greater in the aspect of Productivity (Factor 1), moderate in Managerial Control (Factor 2) and Customer Satisfaction (Factor 4), and lower in Innovation (Factor 3).

Cluster analysis

In order to provide a taxonomic description of the data for exploratory purposes, one assertion of the characterization questions sought to clarify the level of intensity of decision-making in the professional activity of the respondents within three levels: operational, tactical and

strategic (Moritz and Pereira, 2006). The cluster analysis was used to classify the sample according to their organizational hierarchy level, measured by an adapted Likert scale with six points [(0) no decision making; (1) very few; (2) few; (3) neither few nor many; (4) many and (5) very many]. This type of exploration was undertaken in the study by Torkzadeh et al. (2005), in which the sample was divided into two groups, "top management" and "lower management".

The frequency analysis began with eight clusters, which were gradually reduced (Figure 2). In the process, it was observed that one of the groups with 44 respondents would not group with others, and its grouping occurred only in the analysis involving four clusters, with another cluster with 67 respondents. This result led to a descriptive analysis of cluster to verify whether the means of decision-making within the group with 67 respondents were similar to the ones in the group of 44, so that they could be joined. In those two groups, similar means were observed at the operational and strategic levels, but they were quite different in the tactical level (3.39 and 0.23). That result led to the option of choosing five clusters to represent the study sample.

The variance analysis ANOVA was used for cluster interpretation. According to Field (2009), this hypothesis test is used to analyze situations in which there are several independent variables. For the ANOVA application, the Tukey post-hoc hypothesis test was used for multiple comparisons, indicated when sample sizes are the same, in addition to its control over Type I errors. The analysis of the results of the Turkey test enabled to

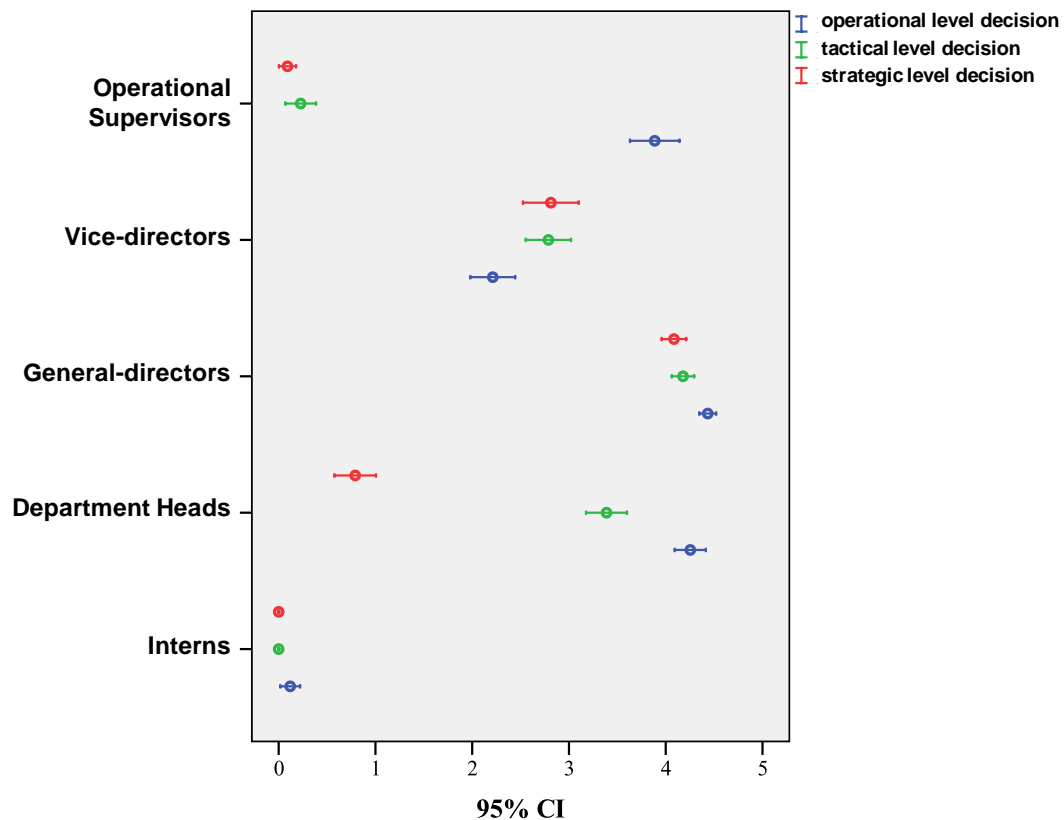


Figure 2. Clusters and their decision-making levels. Source: developed from survey data.

nominate the five clusters (Figure 2). The first group are the so-called “Interns”, referring to users that rarely make decisions in the operational, tactical or strategic levels. The “Department Heads” are those who commonly make operational decisions, sometimes tactical and rarely strategic. Those who are intensely involved in decisions in the three levels are denominated “General Directors.” Those that make mid-level decisions in the three levels are called “Vice-Directors.” The last group is characterized by making only operational decisions, the “Operation Supervisors.”

Relations of the instrument with sample characteristics

At this stage, the resulting factors from the replicated instrument (Torkzadeh and Doll, 1999) were cross-tabulated with sample characteristics. After sample stratification, the means for each one were calculated and analyzed as to whether the differences among them were statistically significant. For that, in the comparison between up to two groups, the Mann-Whitney test was used; for more than two, the non-parametric Kruskal-

Wallis test was applied; when a statistically significant difference was found, the Mann-Whitney test was applied to verify in which group was the difference found in the previous test. A 5 percent significance level was used in all tests, and the Bonferroni correction was used when the sub-sample was deemed large (Field, 2009).

Table 5 compares the factor means with sample characteristics. The first relationship refers to benefits of IT applications that are fully implemented or not. It should be noted that in all factors the test shows the existence of statistically significant differences. Therefore, it can be affirmed that fully implemented applications are more helpful for accounting professionals in the aspects of Productivity, Manager Control, Innovation and Customer Satisfaction. This supports the findings of the study by Ferreira et al. (2002): in the process of implementing a technology, there is an operational lag caused by low utilization of software resources, implying lower benefits to users.

Another analysis focused on whether IT applications are part of ERP systems. The importance of this assertion is related to many studies that report benefits from this type of technology, such as the one by Newman and Westrup (2005), which suggests that the use of ERP

Table 5. Relationship of factors in the instrument with characterization questions.

Factor (construct)	(a) Implementation			(b) ERP system			(c) Age group (years)			(d) Duration of employment (years)		
	Yes	No	MW*	Yes	No	MW*	Up to 30	More than 30	MW*	Up to 1	More than 2	MW*
F3 (Productivity)	3.09	2.66	≠	3.02	2.90	=	2.93	3.03	=	2.91	3.00	=
F2 (Manager Control)	2.82	2.43	≠	2.82	2.58	≠	2.65	2.78	=	2.64	2.74	=
F1 (Innovation)	2.57	2.18	≠	2.55	2.34	≠	2.38	2.55	=	2.25	2.52	≠
F4 (Customer Satisfaction)	2.80	2.31	≠	2.71	2.65	=	2.61	2.73	=	2.54	2.70	≠

*MW = Results of Mann-Whitney tests. Source: calculated from survey data.

Table 6. Relationship among instrument factors and clusters.

View	Factor (construct)	Means from cluster answers					Result of Kruskal- Wallis test
		Intern	Department Head	General Director	Vice-director	Operation Supervisor	
WP	Factor 3 (Productivity)	2.92	2.95	3.21	2.63	3.05	≠
	Factor 2 (Manager Control)	2.53	2.77	2.92	2.47	2.66	≠
	Factor 1 (Innovation)	2.32	2.39	2.75	2.22	2.36	≠
	Factor 4 (Customer Satisfaction)	2.61	2.63	2.89	2.40	2.63	≠

Source: calculated from survey data.

systems produce fundamental changes for accountants. Along the same lines, Turban et al. (2004) mention that ERP systems provide solutions that improve efficiency, quality and productivity, thus enhancing business performance and customer satisfaction. The results of Mann-Whitney hypothesis tests (Table 5) indicate that the benefits of ERP systems are notable only in Manager Control and Innovation, while for Productivity and Customer Satisfaction there are no significant differences in comparison with applications that are not connected with ERP technology.

As far as age group is concerned, statistically significant differences were not found in any factor. On the other hand, for the duration of employment in the current organization there were significant differences (Table 5). It becomes evident that the perceived benefits in the Innovation and Customer Satisfaction constructs are higher for workers with a longer employment period (more than two years) and lower for those who have been in the company for a shorter period (up to one year).

The final relationship under analysis relates the five clusters with the factors from Torkzadeh and Doll's (1999) instrument. Statistically significant differences were found

with the application of the non-parametric Kruskal-Wallis test (Table 6).

Due to the existence of statistically significant differences in Table 6, it was necessary to apply the Mann-Whitney hypothesis test to verify the differences. It should be noted that a significance level of 0.005 (0.05/10) was used for the Mann-Whitney test due to the Bonferroni correction. Table 7 shows the results.

The highest contrasts among IT benefits are related to *cluster comparisons*: (i) General Director with Vice-director (3 – 4) display different IT benefits in all factors, and the General Director cluster shows greater benefits in all of them; (ii) Department Head with General Director (2 – 3) show differences, except in Productivity and Manager Control, which are similar; (iii) lastly, there is a difference only in the Productivity factor when comparing the Department Head with the Vice-director cluster (2 – 4) and the Vice-director with the Operation Supervisor (4 – 5), so that Vice-directors supposedly occupy tactical-level positions and enjoy lower benefits in their productivity compared to the others.

A number of cross-tabulations were also undertaken. Firstly, the number of employees was analyzed together with clusters. It was found that Interns, Vice-directors

and Directors predominate in smaller firms (up to 19 employees). In the larger organizations (more than 50 people), the most common groups are the Operations Supervisors and Department Heads, and this probably relates to the fact that such companies usually are structured with more departments and supervisors of production units on the factory floor.

The second cross-tabulation investigates the relation between clusters and age of respondents. The age group from 26 to 30 years corresponds to Vice-directors, and from 31 to 40 years, to Department Heads. The General Directors, and again the Vice-directors, are concentrated in the 41 to 45 age group; lastly, the Interns, above 46 years. With the exception of the respondents above 46 years, the results denote the importance of professional experience (represented by age group in this analysis) for tactical and strategic jobs.

The last cross-tabulation relates the clusters with the professional experience of the respondents. It was found that people who make few tactical and strategic decisions have little professional experience, such as the interns and the Operation Supervisors, while more experienced people hold decision-making positions, such as the Director and Vice-Director, as it would be expected.

CONCLUSION

The main focus of this investigation was the perception of accounting professionals in Paraná regarding the use of IT in their individual professional activity. For such, the instrument that measures the relation of IT in the Work Process was replicated (Torkzadeh & Doll, 1999). In the validation of the instrument, its twelve assertions were associated to the factors as proposed by the theory, which confirms the model's robustness. It was confirmed that the benefits of IT are stronger in the Productivity construct (2.98); moderate and equal to each other (statistically) in Managerial Control (2.72) and Customer Satisfaction (2.67); and in last place, in Innovation (2.47).

The fact that the Productivity variable occupies the first place demonstrates the automation of several tasks that were done manually some time ago, such as the keying-in of fiscal and accounting records that today are generally done online. This reality is verified in accounting offices where workers attend to an ever-growing number of customers, as a direct consequence of automation. On the other hand, intense use of IT creates a technological dependence, in such a way that a system malfunction can cause a sudden drop in productivity levels. That said, it is valid to point out the importance of the productivity/IT paradox as a topic for future research, since Productivity is the foremost factor in the work process.

In second and third place, the benefits in Management

Control and Customer Satisfaction are noticeable. In the Management Control variable, the benefits are clearly visible in the substitution of digital storage media for paper, or the improvement in data processing capabilities, creating internal control mechanisms that can influence the behavior of workers, thus increasing the likelihood of reaching corporate objectives. This can be seen in the current accounting environment, where great amounts of information are stored in computational systems that control the performed tasks, such as work-time control, cost spreadsheets emitted on a per-client basis, document control, financial control, among others. Post-industrial concerns can be verified in the Customer Satisfaction variable, a consequence of the rise in competition and increasing customer demands. This has forced companies and professionals to see their customers in a different way, adapting themselves to suit their needs and offering better service as well as competitive prices. The accounting context is no exception; using IT, professionals in the field can obtain information and submit reports quickly, which allows them to ensure greater customer satisfaction. It should be pointed out that, in Managerial Accounting, the tools that are used to generate useful information for the company use IT massively, such as, for instance: simulations, Economic Value Added (EVA®), Economic Management, etc., highlighting once more the importance of IT in this construct. On the other hand, it appears that Brazilian tax bureaucracy impacts Customer Satisfaction negatively, in such a way that the accounting professional is often seen merely as a performer of tax-related activities (Merlo and Pertuzatti, 2005).

On a lower level, the support of IT for the creation and experimentation of new ideas, represented by Innovation, indicates the need for accounting professionals to practice problem-solving skills more intensely, as well as their ability to learn and innovate. The possible causes of Innovation's position seem to result, firstly, from the accumulation of the accounting professional's responsibilities in "reports" for the government and Brazilian regulations, which "freeze" procedures, reducing the likelihood that professionals will experiment with new ideas; secondly, the "turnkey" information systems used in accounting are rigid and not amenable to user adaptations and modifications, in contrast with the post-industrial model.

The characterization questions made it possible to sketch out a profile of the sample, which essentially comprised accountants whose professional practice is closely related to their technical background. They are responsible for diverse tasks within their department and have a close relation with their technical formation, and because of it they use ERP technology to a great extent. The intensity of their three levels of decision-making (operational, tactical and strategic) was the subject of

analysis. Because of the disparity among the answers, Cluster Analysis was employed to classify the respondents in five profiles according to the intensity of their decision-making on the three levels.

Some analyses were carried out to generate speculations about the sample. It was verified, effectively, that users with partially implemented solutions reported fewer benefits of IT usage on all four research constructs. This information is fundamental to guide future research, so that researchers should consider this variable in their work. In contrast with previous studies (Shang and Seddon, 2002; Newman and Westrup, 2005), for the theoretical constructs Productivity and Customer Satisfaction, it was found that ERP systems did not bring more benefits than other kinds of systems, that is, the technology in itself does not imply benefits in work process efficiency or the approach to the customer.

The benefits of IT within the five clusters were evaluated. Considering the hierarchical positions defined by the decision-making level of the respondents, it was observed that jobs that are apart from each other, such as Intern and Vice-director or Intern and Department Head, exhibit statistically similar benefits. On the other hand, hierarchically close jobs such as Director and Vice-Director were the opposite, with totally divergent benefits. These findings reveal that the benefits of IT do not follow hierarchical lines, so that a corporate position does not necessarily derive similar benefits to another position with similar characteristics.

Cluster analysis also revealed that the respondents who make the most corporate decisions were between 41 and 45 years old. The adage that older professionals are more experienced and thus make more decisions was not totally confirmed by this study, since the professionals who least make decisions are the oldest, that is, Interns are more common in the over-46 age group. However, in the analysis of professional experience period, it was found that, in general, the more experienced individuals are, the more decisions they make. These findings reveal the need for future research to characterize respondents not only by age but also by professional experience.

The limitations of these study include: (i) the use of a non-probabilistic sample, which precludes precision estimates and generalization of results; (ii) the findings are specific for accounting professionals; (iii) the study focuses on the perceived relation of IT with the work of accountants from the viewpoint of the individual professional, so the organizational perspective falls out of the scope of this study; (iv) as a geographic delimitation, the research population comprises professionals with registered e-mail addresses in CRCPR, SESCAPP and IPMCONT; and (iv) lastly, as a temporal delimitation, the study was restricted to a predetermined time frame during 2011.

Nevertheless, taking into account the research findings

as well as its limitations, it may be suggested for future studies: (i) as it was limited by a non-probabilistic method, a replication of the instrument is suggested with a probabilistic sample; (ii) replication of this study with a larger sample, and/or with accounting professionals in other regions and countries, so that a comparison and verification of differences and similarities is possible; (iii) application of instrument with other types of professionals (such as managers, engineers, economists and others) with the purpose of comparing the impacts of IT among them.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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Full Length Research Paper

Criteria for the selection of architects by first- time clients

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The purpose of the research is to answer two questions: Which factors do individual clients consider when selecting an architect for the first time? How does the importance attached to these factors vary with the procurement method? These questions are answered in a questionnaire survey of recent clients of architects who commissioned architects for residential projects in Lagos, Nigeria. The respondents were asked to rate the importance of certain criteria in their selection of architects. A principal component analysis of the variables investigated reveal that the factors that define the selection criteria used by these clients are responsiveness, perceived professional competence, personality and prominence of the architect. Other factors are acquaintance with the architect and the budget of the client. The most important factor for each procurement method was identified. Only the factors within the control of the architect are considered in this study. The study identified areas that are most important to clients, which architects could improve on to enhance their chances of reaping from the new housing market. The findings of this study suggested areas that architects could improve on to improve their chances of selection by clients in search of residential architectural services.

Key words: Architectural Service, Individual Client, Nigeria, Residential Client, Service Provider Selection.

Introduction

Customers and clients constantly make decisions as to which product or service to purchase respectively. The difference between a client and a customer, according to Bailey (2000) is that while a client is one to whom professional services are rendered; a customer is one who buys goods and services. With architects, the client is the owner of the project who requires the services of an architect. Like every other professional service, intangibility, heterogeneity and simultaneity of production and consumption often characterize architectural services (Kugyte and Sliburyte, 2005). This suggests that the client may not be able to assess the attributes of the

service before purchase as is possible with products. In addition, the prospective client may not be able to compare alternatives as alternatives are not easily identified, coupled with the fact that the criteria for evaluation are not easily determined. This is because clients of architects may be non-professionals, unfamiliar with construction works. The decision is even more complex when one considers that fact that clients may also depend on the architect to define the problem as well as advice. The choice of an architect is however of utmost importance because it often affects the outcome of a building project.

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Architects provide services for both the public and the private sector. The public sector clients are usually more organized, using a given set of criteria, often documented, in selecting architects to provide services for them. This is because there are often written guidelines used in the selection of service providers. In addition, the public sector often invites persons who are knowledgeable in the service to be procured to participate in the selection process. In fact, scholars have suggested that the selection of service provider in the public sector is often based on a pre-qualification process, which is mostly based on the professional competence of the provider (Sporrong, 2011). Within the private sector, private organizations may also be more organized than their individual counterpart. The implication of this is that architects may be able to position themselves to attract commissions from the public and private organization sector because their requirements are known. There is however need to acquire knowledge on the criteria considered by individual clients when selecting their architects so as to enable the architect to rightly position to attract commissions from these clients.

When an individual client approaches an architect for the first time, it may be that such a client is embarking on a building project for the first time or the client had reasons to change architect. Whichever the case, the client is approaching a person whose capability cannot be judged from previous contact and experience. The case of individual clients who seek architects for residential projects presents an opportunity for this study. The reason for this is that housing is an essential need of man. As such, the growing housing supply deficit (UN-HABITAT, 2006) coupled with the ever-rising cost of rent, has led to the increasing craving for house ownership. Ownership of personal houses may however not be the only reason why clients may approach an architect for residential project services. Investments in rental properties, especially much sought after apartment buildings, also necessitate commissioning of architects. This, coupled with other anecdotal evidence suggests that this category of clients will constitute most of the clients that will approach the architect for the first time.

While it is a fact that these clients approach the architect, little is known about the factors considered in selecting such. An article by American Institute of Architects (2008) suggested that clients tend to select architects that they like and trust. This is coupled with the fact that scholars have also opined that private sector clients often start their selection of professional service provider, such as the architect, from the recommendation of friends and family (Duhan, Johnson, Wilcox and Harrell, 1997). This probably suggests that some relational and personality criteria may be important in helping a client choose which architect to work with. These were however opinions, not backed with empirical data. Literatures exist based on empirical data which investigated the criteria used by clients in selecting professional

service providers (Razzouk, Seitz and Webb, 2004; and Araloyin and Olatoye, 2011). There are also empirical studies carried out to determine the criteria used in selecting architects by real estate developer clients (Cheung, Kuen and Skitmore, (2002). Very little is however known about the factors which are considered when individual clients select their architects especially for residential projects. More important to this study are the factors that these individual clients will consider when they attempt to commission an architect they are working with for the first time. The study therefore aims at investigating the criteria used in selecting architects by first-time clients in search of architectural services for residential projects. This study answers two questions: First, which factors best describe the criteria used by first-time clients in selecting architects? Second, how does the importance attached to the factors differ with nature of service to be provided? The findings may indicate the major concerns of this category of clients, which may contribute to the teaching and practice of architecture and position the profession to reap from the ever-increasing housing market.

LITERATURE REVIEW

The process of selection of professional service providers often poses its own difficulty. This is because, compared with products, services are intangible, often involve the participation of clients and the clients are often inexperienced in the process of service production. The process of service provider selection however determines whether the architect acquires new clients or not. Knowledge of the factors considered may therefore be important for the sustenance of professions, as it will inform practice and education.

For an individual approaching an architect for the first time, there are different ways such an approach is made possible. This may be by the recommendation of mutual acquaintance or the client may personally know the architect. It is also possible that the prospective client had seen a likeable building prompting such clients to seek out the architect (Chappell and Willis, 2000). The architect that is commissioned to undertake a residential project may be involved in all aspects of the work including design and administration of the construction project. This may be because the client may have limited knowledge to execute the job. The level and scope of involvement of the architect in the administration of the construction may however differ. While some architects design and supervise, clients may request others to construct, raise funds, or even entirely manage the project, from resources to work force to schedule. The services required may therefore vary from design, design and construct, project management to renovation. One may therefore expect that the criteria that the client will use in selecting an architect will depend on the type of

service required. Such service- related criteria, which first- time clients consider, are however little documented.

There have been several studies on the criteria used in selecting professional service providers. In the context of clients of international accounting firms, Scott and Walt (1995) found that the most important selection criteria were accessibility to key staff, ability to offer personal service and reputation for fast and efficient service were the most important choice criteria given by respondents. Razzouk, Seitz and Webb, (2004) also found that clients rated reputation as well as the interpersonal skill of the physician high as criteria which influenced their selection of doctors. Reputation was also a major criterion in the selection of banks (Almossawi, 2001) and real estate agents in Lagos, Nigeria (Araloyin and Olatoye, 2011). In summary Kugyte and Sliburyte, (2005) listed three categories of service provider selection criteria which are used by clients of professional service firms and which are within the control of the service firms. These include pre-purchase knowledge (referred to as search- based criterion), experience/ relational aspects and credence criteria. The foregoing however suggests that the most important criteria may vary.

Within the construction industry, studies on clients selection of service providers have often been focused on contractor services (Zavadskas and Vilutiene, 2006; Holt, 2010). There are also some studies, which focused on the selection of architects. The criteria for selection of architects found in these studies were diverse. Day and Barksdale (2003) in their qualitative study found that the capability (likelihood that the service provider will conform to contractual agreements); chemistry (the providers' understanding of client needs and interest); and the perceived competence of the service provider influenced the choice of architectural and engineering service provider. The findings of the study by Cheung, Kuen and Skitmore (2002) also show that real estate developer clients in Hong Kong rated professional qualification/ experience of the architects and consultancy fees high as criteria for selection of architects. They however rated reputation of the architect low as a criterion. This probably suggests that within the construction industry, the pre-purchase knowledge and relational criteria are highly rated as criteria for selection of service provider. Cheung et al also found that the relative importance of the criteria varied with the project type. This suggests that project types should be the basis for the investigation of architect selection criteria. For this reason, this study considers only residential projects. Repeat clients may re-commission an architect for a new project because of their satisfaction with previous projects. When a client approaches an architect for the first time however, such clients may have had to compare architects on other factors other than their actual capabilities. It is also important to note that the ability to attract new clients may contribute to an architect's practice sustenance. This study therefore builds on previous studies by

investigating the criteria used by clients in selecting an architect that they have never commissioned before. The set of criteria that are important will give an idea of what is important to the clients. They also represent the clients' concerns for the particular project types.

For the profession of architecture, there have been attempts at defining the criteria used by clients in selecting architects. American Institute of Architects (AIA) (2008) for example identified the approaches used in the selection of architects. These include value- based; cost-based; qualification- based and direct hire approaches. Although clients may use a blend of the categories, it was noted that one criterion is likely to be more important to different categories of clients or for different services.

Previous literatures have mostly concentrated on Qualification- Based Selection (QBS) (Sporrong, 2011). This is probably because the public sector, which is more investigated mostly adopt this approach since there is often a written process. AIA suggested that the criteria that are considered for QBS are the competence of the architect in the project type, demonstrated by projects of similar scope and complexity, experience of the architect, reputation of the architect and understanding of client needs. Summarized in Kugyte and Sliburyte, (2005)'s terms, these are pre- purchase knowledge and credence criteria. This suggests that the relational criterion is played down in QBS. However, Sporrong (2011) noted that opponents of QBS have stated that its use is based on subjective criteria which prevent new firms with limited experience from obtaining contracts. It will appear that inexperienced clients will not use this criterion as AIA suggested that clients who have many projects use this approach. Another approach used by architecture clients is value- based selection. The requirements for value-based selection are often capacity of the architect for innovation, experience and commitment to the client's interest. This is because the client's predominant interest is in design. AIA suggested that this is the approach used by most in-experienced clients, who this study focuses on.

Cost-based selection has as criterion the cost of the service. According to AIA (2008), this is the approach mostly used by private sector clients. Projects that cost-based selection may be often used for commercial facilities and industries. This approach can be used with qualification approach, before or after cost has been considered. Sporrong was however of the opinion that once price is introduced as a criterion; the selection becomes biased in favour of lowest fee. It will also appear that a focus on value excluded cost- based selection as AIA noted that clients that rely on value are less likely to rely on cost- based selection. This is probably because clients who seek innovation have to be willing to pay for it. Direct hire on the other hand may be based on the reputation of the architect, previous professional relationship with architect, personal relationship and the recommendation of a friend, former client or

another architect. Little evidence exists on the empirical basis of these criteria. It may therefore be enlightening to examine the selection criteria as well as the importance attached to the criteria by architecture clients using empirical data. For this reason, this study explores the selection criteria used by first-time clients in the selection of architects for residential projects.

RESEARCH METHODS

The sample survey approach was considered appropriate for this study since the aim is to gain an understanding of the factors considered by first-time clients in selecting architects for their residential projects. The study was carried out in this city between March and December 2011. Firms were used in generating client lists. This is because Nigeria has no register of clients of architects which may have constituted the sample frame for the study. However, architectural firms often keep a list of clients. As such, the clients is presumed to be more likely robust with firms of architects than with individual architects. At the time of the survey, around 44% of registered architectural firms in Nigeria were located in Lagos. From the list of architectural firms registered to practice in Nigeria (ARCON, 2010), 213 out of the 613 registered architectural firms were in Lagos. Using the formula derived by Frankfort-Nachimias and Nachimias (1992), a sample size of 137 was obtained. The 137 architectural firms were approached to provide their list of clients but only 44 agreed to participate out of the 137 approached. The other firms were skeptical about giving out a list of their clients. The firms were asked to give their first-time residential client list in the last two years. Four private individual clients who commissioned the architects for residential project for the first time were randomly selected from each client list. It is important to mention that obtaining clients list from the architectural firms ensured that only the owners of the building projects who had direct contact with the architects were chosen.

Quantitative data were used in this study. For this purpose a questionnaire was drafted with the aid of ten potential clients of architects. This was to ensure that issues that were important to clients who commission architects are considered. The questionnaire was preferred because it afforded the opportunity to have uniform criteria for measuring the subjective perceptions of the respondents. The questionnaire comprised two sections. The first included question on the nature of service for which the architect was commissioned. This gave an idea of the service procurement method used. The second part of the questionnaire measured the criteria used by the clients in selecting architects. To measure the subjective judgment of the respondents in the selection of architects, the respondents were asked to indicate the relative importance of the criteria in selecting architects on the scale of 1 (incompletely irrelevant) to 5 (very important).

This ensured that the respondents were able to weigh the factors and rate according to the relative importance attached to each. The questionnaire was based on only factors, which the architect can control to enhance chances of being selected.

In the survey proper, 176 clients drawn from the list of 44 architectural firms were sampled with the questionnaires administered to them. Forty-four of these clients declined to participate, leaving 132 participants in the survey. Due to the terrain of Lagos and wide areas covered, fifteen field assistants were used in the administration and retrieval of the questionnaires. However, 93 and 29 of the questionnaires were administered by physically and electronically through e-mail by the researchers, respectively. The electronic mail approach was adopted because some of the clients were out of Lagos State and it was easier to reach them by mail, while a few others, although within Lagos opted to fill the

questionnaires electronically. A total of 125 questionnaires representing about 94.70% of the distributed questionnaires were returned. This may have been so because the clients who declined to participate from the initial 176 were not approached with the questionnaires. Since the first aim of the study is to define the factors used by first-time clients in selecting architects for their residential projects, a principal component analysis was carried out. To determine how these factors varied with the nature of service obtained (procurement method), the overall ranking of the mean weights of the factors based on the procurement method was explored. This analysis was also adopted by Songer, Moleenar and Robinson (1996).

RESULTS

From the results, most of the first-time clients (48%) engaged architects for just design services (Table 1). A slightly lower percentage (40%) engaged architects for design and construction project, while 7.2% of the clients engaged the architects for renovation services. Equal percentages of clients (2.4%) engaged the architect for project management and construction. To obtain the dimensions, which describe the selection criteria for architect, a factor analysis was carried out using the Statistical Package for Social Scientists (SPSS). The principal component method of analysis was used, and the factors were rotated by varimax method. The factor analysis of the selection criteria variables shows that six (6) factors accounted for 72.5% of the variance in the result. The component loadings in Table 2 reveal the variables that the factors represented. The first factor which accounted for 14.0% of the variance in the data represented the responsiveness of the architect. This is because the variables, which loaded highly on this factor, indicate how much interest the architect takes in the clients. The variables were special attention the architect gives to the client, looking for the clients' best interest and friendliness of the architect. The variables, which loaded highly on the second factor and accounted for 13.8% of the variance in the data were the variety of services offered by the architect, the understanding of the architect and previous relationship. The variables appear to represent how much knowledge of the architect the clients had and represented the acquaintance with the architect.

The high loading variables on the third factor were the experience, competence and capacity of the architect for innovation as well as the quality of previous projects. These factors accounted for 12.9% of the variance in the data. They were termed as the perceived professional competence of the architect. Accounting for 11.3% of the variance in the data and loading most highly on personal relationship and pleasantness of the architect, the fourth factor represent the personality of the architect. The fifth factor accounting for 10.9% of the variance in the data was the budget of the client. The variables that loaded highly on the factor were the ability of the architect for timely delivery and the cost of the service. The last factor

Table 1: Project profiles

Measures	Items	Percentage (%)
Type of service received	design	48
	construction	2.4
	design and construction	40
	project management	2.4
	renovation	7.2

Source: Field Survey (2011)

Table 2: Dimensions of client selection criteria

Factor (Percentage of variance)	Variables	Component Loadings
Responsiveness of architect (14.0%)	looks for my best interest	0.871
	special attention to my needs	0.787
	friendliness	0.592
Acquaintance with the architect (13.8%)	variety of services offered	0.797
	understanding	0.751
	previous relationship	0.674
Perceived professional competence of architect (12.9%)	competence in particular project areas	0.795
	capacity for innovation	0.770
	quality of previous projects	0.630
	experience in the industry	0.563
Personality of architect (11.3%)	personal relationship	0.823
	pleasantness of my service provider	0.802
Budget (10.9%)	ability for timely delivery	0.875
	cost of service	0.848
Prominence of architect (9.7%)	availability to attend to me	0.750
	reputation in my area of need	0.687
	popularity in the field	0.522

Source: Field Survey (2011)

as shown in Table 2 loaded highly on the availability, reputation and popularity of the architect. It appears that this factor has to do with the renown of the architect. It accounted for 9.7% of the variance in the data and was labeled the prominence of the architect. Cronbach's alphas were computed for the variables of each factor. The value ranged from 0.607 to 0.71, which is acceptable according to George and Mallery (2003). This suggested that the items were internally consistent in measuring the factors. These factors may however be confirmed in further studies as this is an exploratory study. This result suggests that the factor that best describe the criteria used by clients in selecting architects was the responsiveness of the architect. This was followed by the acquaintance with the architect.

To answer the second question of the study on the relative importance attached to the factors based on the

nature of service, the overall ranking based on the mean weight of the selection factors was computed by service type. The mean scores of each factor across the sample will be zero because factor scores are standardized during factor analysis. The building types were plotted against the mean weight attached to the selection factors (Figure 1). While personality and responsiveness of architect ranked highest as architect selection factor for design services, budget and prominence of architect were the highest ranked for construction services. Where the client however required design along with construction services, prominence and acquaintance with the architect were the highest ranked. Acquaintance with architect, followed by budget, were the highest ranked for project management services, while clients that sought renovation services ranked budget and personality of the architect highest.

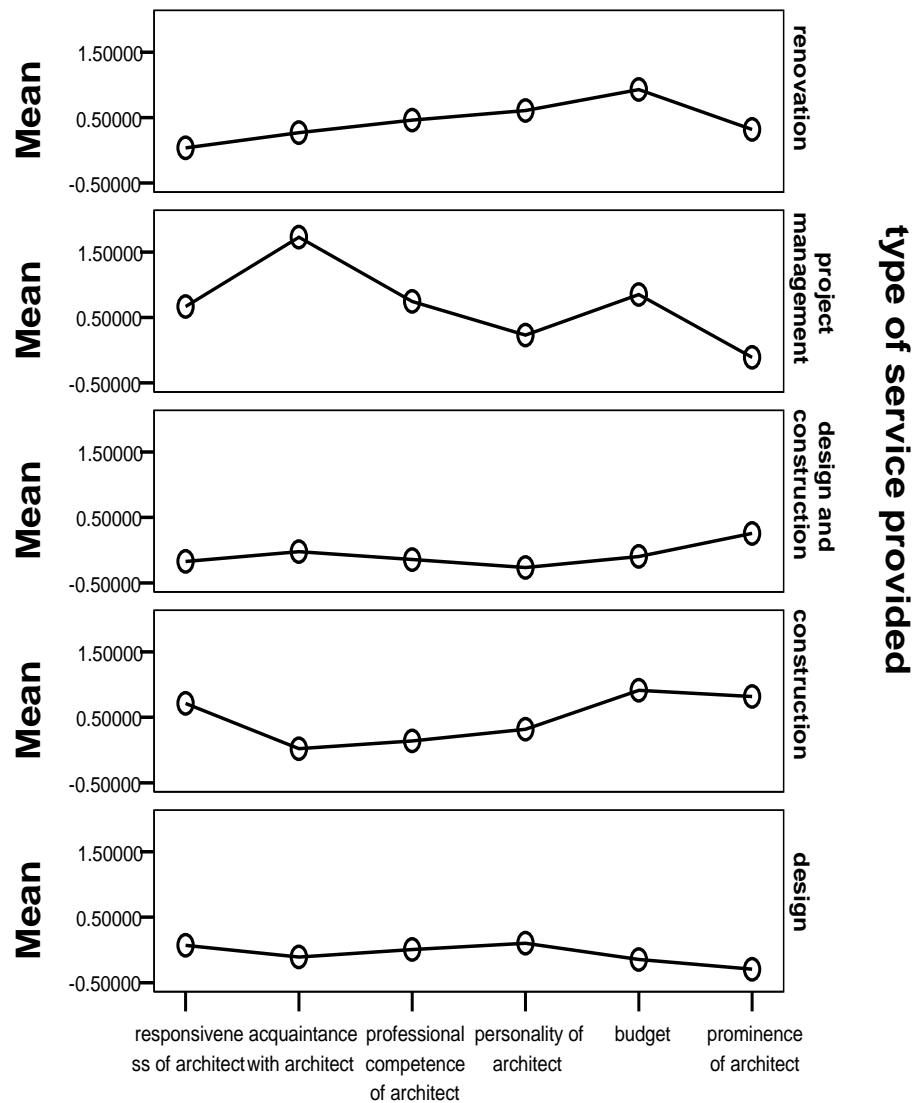


Figure 1: Mean scores of clients on selection factors by the type of service required
Source: Field Survey (2011).

DISCUSSION

These results are similar to the findings of Day and Barksdale (2003) that buyers of architectural services select architects based on the chemistry between clients and the architects as well as perceived competence. This is because chemistry, which was defined as the provider's relationship and communication skill, is similar to the personality factor found in this study. Similarly, perceived competence appears to be the same as the perceived professional competence factor. A major finding of this study is that the responsiveness of and acquaintance with the architect best described the criteria used by private sector clients in selecting their architects. The fact that the responsiveness of the architect best described

the criteria for the selection of architects may be because of the fact that first-time clients are often highly dependent on the architect to work in their interest. This is because a first-time residential client may be carrying out construction work for the first time and may have little experience in the process. Such a client may therefore desire an architect who can be trusted to render services that place the interest of the client first. Next to the responsiveness of the architect, the acquaintance with the architect best defined the criteria used by clients in the selection of architects. This is probably because a first-time residential client may have few options to choose from, as their knowledge of architects may be limited. They may therefore base their selection of the architects they know by virtue of their contact with such

architects. The first-time clients in the study also based their selection of architects seeming ability of the architect to carry out the work. This may often be based on the contact of the client with the works of the architect. Personality of the architect was probably a factor considered in the selection of architects by first-time clients because such clients may have few options and since they have to be in personal contact with the architect, an agreeable person may be better to work with.

Although not a strong definer, budget in terms of cost and time was also found to be one of the factors considered by first-time clients in selecting architects. An explanation for this may be that building projects are often investments and the client needs to be sure that the architect can provide required service on time and at acceptable costs. Least defining the factors used in selecting architect by the first-time clients in the study was the prominence of the architect which represent the reputation of the architect. This appears to be a recurring factor in the selection of professional service providers. Reputation has been found to be an important factor used by clients in the selection of doctors (Razzouk et al., 2004); accountants (Scott and Walt, 1995); and banks (Almossawi, 2001). In addition, the three dimensions of selection criteria suggested by Kugyte and Sliburyte (2005) were found in the study. The responsiveness, acquaintance, professional competence and budget factor could be summarized as pre-purchase knowledge criteria. The prominence factor is similar to the credence dimension, while personality factor is similar to the relational dimension.

The survey shows that generally, responsiveness of the architect and the acquaintance with the architect were the best definers of the criteria used by first-time clients in the selection of architect. The results of the relative importance of these factors based on the nature of service rendered by the architect however show that acquaintance with the architect was scored highest as a selection criterion for only project management services. This probably suggests that although clients will generally identify these factors as best defining their selection of architects, the importance attached to them varied with the services. For design services, personality of the architect was scored highest. It is possible that personality will suffice as these clients may not be able to judge based on other attributes that may border on the capability of the architect. In addition, when a client receives just design services for residential building from an architect, such client may still seek second opinions before proceeding to construct the building. Being able to work with the architect on the basis personality may therefore be sufficient. Next to being able to work with the architect, this category of clients ranked the responsiveness of the architect, which represents how the architect is able to look out for the interest of the client. This is probably because these clients may not have

enough experience in the process to look out for themselves.

When an architect carries out a construction project, another architect may have carried out the design. The essence of construction is to enable the client to see the physical product of an architectural design. As such, during construction, clients may want to be sure that they are not incurring too much cost outside that which is necessary to put up the building. This is probably the reason why the budget was the most highly scored factor. Next highly scored was the prominence of the architect, which more or less gives the client confidence that since the architect is reputed to be good, the construction work will be probably well finished. This is likely to be because with construction works, more of the resources of the client are involved and the client may find it more convenient working with a reputable architect.

The prominence of the architect was also scored highest as a factor used in the selection of architects for design and construction services by the first-time clients in the study. This is probably because more of the resources of the client are involved. In addition, since the same person designs and constructs the building, the process may preclude the contributions of others. To ensure that the project is of the highest quality, the client may probably be more comfortable working with a reputable firm. The choice by this category of clients is also highly based on their acquaintance with the client. This suggests that familiarity with the architect is important to these clients. It is noteworthy that first-time clients who required project management services for residential projects also scored acquaintance highest. One would have expected that this category of clients would also score prominence of the architect highest. This expectation is because project management services imply that the architect is in charge of the project from the conceptual stage to the handing over stage. In other words, the client may completely hands off the project once the needs have been communicated to the architect. It was therefore expected that this category of clients would want to work with a reputable architect. Contrary to expectation however, prominence was scored lowest and acquaintance scored highest. This probably suggest that first-time clients that sought project management services clients based their selection of architects most on the familiarity with the architect. An explanation for this may be that the project management clients are more involved in the process than expected and as such would rather work with architects they are familiar with. It is also possible that this category of clients are trying to save money they would have paid to reputable architects by working with those they are familiar with who may engage other considerations in charging their professional fees. This can be inferred from the fact that the next factor that scored high in the selection of architects for project management services in the study was budget. Although project management

services are often procured for large and/ or complex projects, the residential clients are concerned about their budget. This is also probably because residential buildings are often investments on the part of the clients and though the project may be large and/ or complex, this category of clients still wants to watch their budget.

It is interesting that budget is also the most highly scored factor used in the selection of architects for renovation projects. It may be that since renovation services are often offered for projects, which exist and are probably inhabited. The service is not expected to increase the assets of the client, although, it may enhance the value of the property. The client may therefore be more interested in carrying out the work as fast as possible at the least possible cost. The next factor scored high in the selection of architects for renovation services is the personality of the architect. An explanation for this may be because the client needs to work closely with the architect to carry out necessary amendments even as the work progresses and may thus prefer to work with an agreeable architect.

The findings of this study suggest that the importance attached to architect selection criteria vary with the services that the clients sought. An interesting observation however is that budget was scored high as architect selection criteria for all service types except design services. It thus appears that the first- time clients in the study who procured design services rated other factors higher than cost when selecting their architects. In fact, the quality of relationship that they had with the architect was the most important. The fact that cost was scored high by first- time clients who desired other services probably suggest that cost is a popular criteria used by first- time clients in selecting architects except when design services are required. It is possible that the level of innovation often required during service has to be paid for. As such, design clients are willing to pay to get such innovation. AIA (2008) suggested that inexperienced clients will not use qualification- based- selection criteria which is based on the competence, experience, reputation and reputation displayed by the architect. This study however found that first- time clients who engage architects for residential projects considered the competence of the clients, although the level of importance to the selection process varied. In addition, AIA suggested that qualification- based- selection criterion is used with cost- based selection. The results of this study show that budget is considered before professional competence in the selection of architects for design and construction and project management services. However, although budget came first as a factor used by the first- time clients in the selection of architects for construction and renovation services, other factors were considered before professional competence. This probably suggests that although professional competence is important to the clients when selecting their architects, some other factors take precedence. It is also possible that with construction and renovation services, professional competence is assumed

and as such, is not highly rated as architect- selection criteria

CONCLUSION

The results of the study extends understanding on client decision- making by providing better understanding of the factors used in selecting architects by first- time clients who engaged architects for residential projects and the relative importance attached to investigated factors based on the type of service required. The results generally show that the criteria used by the first- time clients in the study encompassed the pre-purchase knowledge (in terms of professional competence, pricing/ budget, as well as access to the architect); the relational and credibility aspects as suggested by previous authors. The variance in the importance attached to the factors based on the procurement methods also suggests that scholars should approach the decision- making process with consideration for the type of service rendered instead of a generic approach to professional service provider selection. Scholars have suggested that higher importance should be accorded to qualification and reputation rather than cost in the selection of professional service providers in order to reduce perceived risks of potential clients. The results of this study reveal that for first- time clients, budget is accorded higher importance than professional competence in the architect selection process except when design services are sought. There may therefore be a need for more indepth study on the ways this category of clients ensure quality service and reduce their risks in the process of procuring architectural services.

The fact that the importance attached to the factors used in the selection of architects by the first- time clients varied with the nature of service has implications for the practice of the profession. Architects could use the results of this study to improve on factors which will enhance their chances of being selected by potential clients. The training of architects should also include human relations as personality has been found to be an important factor that clients in this study based their selection on.

The results of this study may not be generalized as only first- time clients were considered. Further studies may therefore consider first-time clients with other building types. In addition, it may be worthwhile to compare the relative importance of the factors used by first- time clients with that used by repeat clients within the same context. The complexity of the project had not also been considered in this study. Further studies may take into consideration the complexities of projects. It should also be noted that only factors within the control of the architect were investigated in this study. Other characteristics of the clients may also determine the choice of clients. The architect may however not have any control on those factors.

Conflict of Interests

The author have not declared any conflict of interests.

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Full Length Research Paper

Modeling to assess the influence of knowledge on the technological innovation performance capacity in high complexity environments: Towards Brazilian multinationals companies

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The present paper aims to contribute to the knowledge and innovation planning guidelines in the high complexity environments. Thus, a modeling proposal is presented to assess the influence of knowledge on the technological innovation performance capacity of multinationals companies. This procedure was prepared according to the following phases: Phase 1: Determination of the conceptual model; and Phase 2: Verification of the conceptual model, systematized in the following steps: Step 1: Modeling the overall influence of knowledge on the technology innovation performance capacity of multinationals companies; Step 2: Determination of the correlation of the knowledge and multinationals companies' technological innovation capacity; and Step 3: Modeling of the optimal efficiency rate of knowledge influence on the company's technology innovation performance capacity. The research was conducted based on the specialized literature and a survey of Brazilian multinationals companies. The research involved the intervention of experts knowledgeable on the object studied, selected by technical-scientific criteria. The data were extracted using an assessment matrix. To reduce subjectivity in the results achieved, the following methods were used complementarily and in combination: multicriteria analysis, multivariate analysis and neurofuzzy technology. The results were satisfactory, validating the modeling approach.

Key words: Modeling; Assessment; Influence of Knowledge; Technological Innovation Performance Capacity; High Complexity Environments; Brazilian multinationals companies.

Introduction

Recently, relevant changes have made organizational boundaries more fluid and dynamic in response to the rapid pace of knowledge diffusion (Abrahamson, 1991; Griliches, 1990; Teece, 1986), innovation and international competition (Chesbrough and Rosenbloom,

2002; Christensen, 2003; Damanpour, 1996). This helps to reconsider how to succeed with innovation (Teece et al., 1997; Tidd, Bessant, and Pavitt, 1997; Teece, 1986; Wheelwright and Clark, 1992). Thus, innovative companies make use of their capabilities to appropriate

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the economic value generated from their knowledge and innovations (Griliches, 1990; Teece, 1986). Therefore, the supply of innovative products is presented as a quality standard in the race for pressing demands. It is believed that companies that can offer their products to customers more efficiently and faster will probably be in a better position to create a sustainable competitive advantage (Prahalad and Hamel, 1990; Amit and Schoemaker, 1993; Nonaka and Takeuchi, 1995) due to knowledge and innovation (Tidd, Bessant, and Pavitt, 1997; Nonaka and Takeuchi, 1995; Johannessen, Olsen and Olaisen, 1999). In this dichotomy, technical efficiency is a parameter of the developing capacity of innovative products, which translates into one of the most remarkable logical arguments to potentialize and encourage competitive advantage (Wheelwright and Clark, 1992). One of the main challenges is to develop products in high complexity environments. Solutions to these challenges have been offered by the companies' equally innovative technical capabilities, greater efficiency, productivity and high quality (Wheelwright and Clark, 1992).

It is true that a new product or process can represent the end series of knowledge initiatives and the beginning of a process value creation, which, under conditions imposed by various parties, can produce efficient results in the global performance of the value chain, reaching not only businesses that innovate, but also correlated companies (Klette et. al., 2000; Beugeldjck and Cornet, 2001). Knowledge can lead to performance improvements of other co-related or co-located companies (Klette et. al, 2000). The knowledge may represent a strategic tool, increasing the institutional capacity of the Entrepreneurs in their assignments of formulation, evaluation and execution of such projects (Fletcher, Yiannis, and Polychronakis, 2007). The knowledge would work as a facilitator instrument of improvement, contributing for the quality of services and the enhancement of the agility to decide. Thus, the knowledge should be a mechanism to have incremental gains and competitive advantage. And the innovation is a dynamic process and perhaps the most dynamic of all industrial activities (Schumpeter, 1943). This requires the combined effort of various innovative activities, a condition of limited resources.

Traditionally, the literature references two main types of innovation activities: internal and external (Veugelers and Cassiman, 1999; Cassiman and Veugelers, 2006). External activities are related to licensing knowledge access through external sources, research and development (R&D) outsourcing and hiring highly qualified researchers, with relevant knowledge (Arora and Gambardella, 1990) and others. Internal innovation activities use the firm's internal capacities (Vega-Jurado et al., 2008), where knowledge production is internalized. Recently, the state of the art introduced a third innovation activity route, cooperation with other partners to develop innovations (Chen and Yuan, 2007), which can be considered a combination of internal and external

innovation (Pisano, 1997). Deciding on an ideal balance regarding innovation activities is a complicated issue (Chen and Yuan, 2007), there are barriers to be challenged and substantially reconfigured (Assink, 2006) in order to obtain an optimal and combined convergence of the various activities in confluence with the firms' desired and acceptable performance. Innovation activities are admittedly complex and risky. Thus, it is difficult to accurately assess (Afuah, 1998; García-Muin and Pez Navas-lo, 2007) the innovation capacity and also discern the firms' range of acceptable performance. All these elements are difficult to accurately define and interpret. As it is a procedure in which attributes have subjective characteristics, reference methods and compliant and robust assessment techniques have to be reformulated, considering not only the objective attributes, but also the subjective dynamics produced within the decision context. Recently, studies have referenced knowledge and innovation as a key factor affecting the performance of firms. Companies make use of its innovative capacities to achieve sustainable competitive advantage. The present paper aims to contribute to the knowledge and innovation planning guidelines in the high complexity environments. Thus, a modeling proposal is presented to assess the influence of knowledge on the technological innovation performance capacity of Brazilian multi-nationals companies. Within this context, this paper is structured according to the following sections: methodology, which presents the conceptual model and the methodological procedures; verification of the conceptual model and analysis of the results; implications for management practice, the paper concludes with the final considerations.

METHODOLOGY

Conceptual Model: Constructs and hypotheses

This section examines the conceptual model (Figure 1) and presents the hypotheses to be tested throughout this work.

Acknowledged as one of the most significant forms of globalization, technological innovation stands out as a potential to ensure the firms' long-term survival and growth (Schumpeter, 1939; Ancona and Caldwell, 1992; Baumol, 2002). Therefore, technological capacity is understood as an organization's complete set of characteristics that facilitates and supports its technological innovation strategies (Burgelman et al., 2004). Within this outlook, it is possible that R and D is the central component of firms' technological innovation activities. It is believed that the organizational efficiency in these activities that lead to innovation enables the firms to achieve the satisfactory and desired performance, traditionally measured by sales growth, net income growth and return on investment (Tallon et al., 2000).

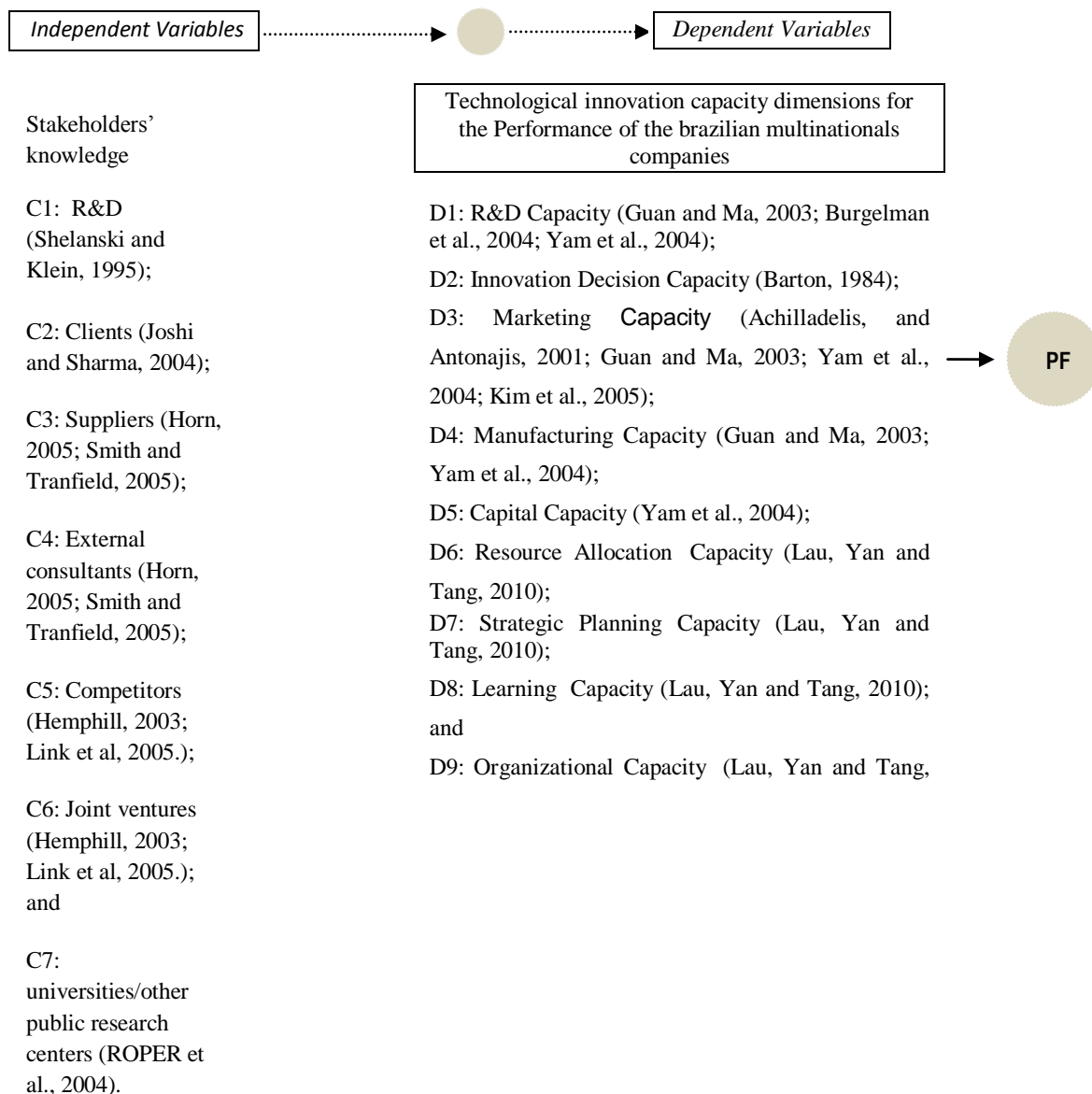


Figure 1. Conceptual Model of the Study

Guan et al. (2006) have defined technological innovation capacity as consisting of seven capability dimensions, namely learning capability, R and D capability, manufacturing capability, marketing capability, resource exploiting capability, organization capability and strategic capability. Adler and Shenbar (1990) defined four innovation capabilities: (1) ability to satisfy market requirements by developing new products; (2) ability to manufacture new products using appropriate technological processes; (3) ability to satisfy future market needs by developing and marketing new products and technological processes; and (4) ability to effectively respond to unanticipated technological activities by competitors and unforeseen market forces (Wang, Lu, and Chen, 2008).

Recent studies have advocated the impact of technological innovation capabilities on firms' competitive performances. Specifically, R and D, resource allocation, learning and strategy planning capabilities can significantly improve the innovation sales. R and D and resource allocation capabilities can also significantly improve new product introduction (Lau, Yan, and Tang, 2010).

The building-up and managing of the companies require highly complex analytical approaches, which include subjective elements. Hence, the technical mastery of various technological, legal, financial and political aspects and the procedures required. In this context, the knowledge can represent a strategic tool,

increasing the institutional capacity of the companies to assign the formulation, evaluation and execution of such projects. The knowledge factor could work as an instrument that facilitates improvement, contributing to the quality of services and enhancing the agility to decide. Knowledge should be considered as the most important information factor, as it includes precise context, concrete meaning, respective interpretation and reflection, in addition to personal wisdom. It also considers far ranging implications (Davenport And Prusak, 1998). Thus, is fundamental to assess the influence of knowledge on the technological innovation performance capacity in brazilian multinationals companies, to both researchers and practitioners. From the theoretical excerpts, the following variables and hypotheses of this study were raised.

Independent Variables: The independent variables were extracted from the specialized literature and assessed by experts for confirmation. The following independent variables were identified: Stakeholders' knowledge: C1: R and D (Shelanski and Klein, 1995); C2: Clients (Joshi and Sharma, 2004); C3: Suppliers (Horn, 2005; Smith and Tranfield., 2005); C4: External consultants (Horn, 2005; Smith and Tranfield, 2005); C5: Competitors (Hemphill, 2003; Link et al, 2005); C6: Joint ventures (Hemphill, 2003; Link et al., 2005.); and C7: Universities/other public research centers (Ropper et al., 2004). For the Clients dimension, the construction used is based on Joshi and Silva (2004); Sansão and Terziovski (1999). For the suppliers variable (Horn, 2005; Smith and Tranfield, 2005), the content was derived from the construction used by Dow et al. (1999) and Forza and Filippini (1998). For the R and D variable, the construct was mainly derived from Shelanski and Klein (1995); Gupta et al. (2000) and Chiesa et al. (1996), which capture two important R&D aspects: capabilities and connections. As for the variable External Consultants, the construct is based on Horn (2005); Smith and Ranfield (2005). The variable Competitors is based on Hemphill (2003); Link et al (2005). Finally, the variable Joint Ventures is based on Hemphill (2003) and Link et al (2005).

Dependent variables: The dependent variables were extracted from the specialized literature and assessed by experts for confirmation. The following independent variables were identified: Technological innovation capacity dimensions for the Performance of the brazilian multinationals companies: D1: R and D Capacity (Guan and Ma, 2003; Burgelman et al., 2004; Yam et al., 2004); D2: Innovation Decision Capacity (Barton, 1984); D3: Marketing Capacity (Achilladelis, and Antonajis, 2001; Guan and Ma, 2003; Yam et al., 2004; Kim et al., 2005); D4: Manufacturing Capacity (Guan and Ma, 2003; Yam et al., 2004); D5: Capital Capacity (Yam et al., 2004); D6: Resource Allocation Capacity (Lau, Yan and Tang, 2010); D7: Strategic Planning Capacity (Lau, Yan and Tang, 2010); D8: Learning Capacity (Lau, Yan and Tang,

2010); and D9: Organizational Capacity (Lau, Yan and Tang, 2010). The following hypotheses were formulated using the conceptual model: *Hypotheses:* The knowledge has positive influence on the multinationals companies' technological innovation capacities.

Research Design

Scope of the Study

The brazilian multinationals companies are very sensitive to technology advancement and demonstrate high innovation growth. These are industries characterized by high intensive capital, highly technical level and complex production process, short life cycle and high R and D investments. These companies require robust and efficient tools to support their decisions.

Sample and Data Collection

The present paper aims to contribute to the innovation planning guidelines in the high complexity environments. Thus, a modeling proposal is presented to assess the effects of knowledge on the technological innovation performance capacity of brazilian multinationals companies. The researcher selected the well-known firms. The data collection was performed using a scale/ matrix assessment questionnaire. The technique used was the stated preference. In this classification framework, the research interviews and consultations with the experts are highlighted. Before applying the final collection instrument, a pretest was conducted with five experts to clarify whether the instructions were clear and objective; to verify that the questions were objective and without interpretation ambiguity and to investigate possible comprehension problems by the experts on the expected responses. There were few adjustment suggestions. Next, a survey was conducted with 38 experts, selected according to their technical-scientific criteria. The researcher regarded the new product project managers, experienced product planning personnel, innovation managers, organizational managers, R and D managers, knowledge management, technology managers, planning, technological innovation and modeling managers. The data collection instrument was sent to thirty-five experts. Of this total, twenty returned answered. The phases and steps of the model were based on the following methods: Multivariate Analysis; multicriteria: Compromise Programming, Promethee II, Electre III and neurofuzzy technology. Next, these procedures were detailed.

Conceptual Model Verification and Underlying Analyses

This section is structured in three phases:

Phase 1: Modeling the overall influence of knowledge on the technology innovation performance capacity of multi-nationals companies;

Phase 2: Determining the correlation of the knowledge and multinationals companies' technological innovation capacity; and

Phase 3: Modeling of the Optimal Efficiency Rate of Knowledge Influence on the Company's Technology Innovation Performance Capacity (OERP). These different phases are detailed here.

Phase 1; Modeling the overall influence of knowledge on the technology innovation performance capacity of multinationals companies.

This section evaluates the dimensions of knowledge on the technological innovation performance capacities of companies. Thus, we first identified the following stakeholders (knowledge sources): cluster (i) research and development – R and D (Shelanski and Klein, 1995); cluster (ii) Customers (Joshi and Silva, 2004); cluster (iii) Suppliers (Horn, 2005; Smith and Tranfield, 2005); cluster (iv) External consultants (Horn, 2005; Smith and Tranfield, 2005); cluster (v) Competitors (Hemphill, 2003; Link et al., 2005.); cluster (vi) Joint ventures (Hemphill, 2003; Link et al., 2005.); and cluster (vii) universities/ other public research centers (Roper et al., 2004). After the knowledge sources survey, the stakeholders' main spectrum of knowledge considered in the personal development planning/ photodynamic therapy (PDP/PDT) were identified. The knowledge identified were: I – Project Scope; II – Concept Development; III – Prototype Development; IV – Integration of Subsystems; V – Prototype Production; VI – Market introduction; VII – Post Product Launch. It should be noted that the activities presented for the case in question are for the technology development process (PDT). The results obtained are as follows: I – Invention; II – Project Scope; III – Concept Development; IV – Concept Development; V – Technology Optimization; VI – Technology Transfer. After identifying the technology development stages, the next step was to identify the knowledge needed to converge each of the stages in the PDT stages. The results showed the following knowledge according to the PDT steps (Clark and Wheelwright, 1992): (i) Strategic Planning of the company; (ii) Technology Strategy determination; (iii) technology; (iv) consumer; (v) Generation of ideas; (vi) project scope development; (vii) mapping future plans; (viii) patent survey; (vix) identifying opportunities; (x) identifying potential ideas under certain conditions through preliminary experiments; (xi) identifying necessary resources and solutions for the shortcomings identified; (xii) projection of product platforms; (xiii) creation of QFD for technology (technology needs); (xiv) conducting available benchmarking technology; (xv)

development of partner networks; (xvi) defining new technology functionalities; (xvii) identifying technology impact on the Company; (xviii) documents analysis and generation of technology concepts; (xix) selection and development of the superior technology concept; (xx) definition of commercial products and processes and possible processes; (xxi) decomposition of system functions into subfunctions; (xxii) definition of system architecture; (xxiii) definition of system architecture; (xxiv) use of mathematical models that express the ideal function of technology; (xxv) prototype development and testing; (xxvi) identification of market impact and manufacture of these possibilities; (xxvii) preparation to implement the business case; (xxviii) identification and evaluation of critical parameters; (xxix) technology optimization from its critical parameters; (xxx) analysis of factors that can result in platforms; (xxxi) development of the platform subsystems; (xxxii) carrying out optimizing experiments; (xxxiii) design of integrated subsystems platform; (xxxiv) system performance tests and (xxxv) defining the technology selection criteria. After this procedure, then evaluates the dimensions of knowledge (clusters) on the technological innovation performance capacities of companies.

This procedure was developed using the multi-criteria analysis. The methods used were Compromise Programming, Electre III and Promethee II. The results achieved confirm Hypothesis 1: The knowledge have positive effect on the technological innovation performance capacities of multinationals companies and assigning values to each criterion, we arrive at a matrix of Criteria x Alternatives that together with the vector weights provides the necessary support to apply the multicriteria methods. In other words, one applies the selection and classification methodology of alternatives, using the Compromise Programming, Promethee II and Electre III methods. The Compromise Programming due to its wide diffusion and application simplicity and understanding renders, it is an alternative to evaluate problems as referenced in this application. The problem solution compromise is the one that comes closest to the alternative. This method was designed to identify the closest solution to an ideal one, therefore it is not feasible, using a predetermined pattern of distances. In Promethee II there is a function of preferences for each criterion among the alternatives which must be maximized, indicating the intensity of an alternative to the other one, with the value ranging from 0 to 1. Of the Electre family (I,II,III,IV and V), Electre III is the one considered for the cases of uncertainty and inaccuracy to evaluate the alternatives in the decision problem.

All these methods enable to analyze the discrete solution alternatives and taking into consideration subjective evaluations represented by numerical scores and weights. As these are problems involving subjective aspects, the methods that best fit the situation of this research are the methods of the family Electre and

Table 1. Assessment of preferences – Knowledge x Innovation Capacity Performance of multinationals companies

Knowledge	Classification		
	Promethee II	Compromise Programming	Electre III
R&D (Shelanski and Klein, 1995)	1 ^a	1 ^a	1 ^a
Clients (Joshi and Sharma, 2004)	2 ^a	2 ^a	3 ^a
Suppliers (Horn, 2005; Smith and Tranfield, 2005); Universities/other public research centers (ROPER et al., 2004)/ C6: Joint ventures (Hemphill, 2003; Link et al, 2005)	3 ^a	3 ^a	2 ^a
Competitors (Hemphill, 2003; Link et al, 2005.)/ C4: External consultants (Horn, 2005; Smith and Tranfield, 2005)	4 ^a	4 ^a	2 ^a
	4 ^a	4 ^a	3 ^a

Promethee. It should be mentioned that although the Compromise Programming method is not part of this classification, it has similar characteristics, showing much simplicity in order to understand its operation, which makes it feasible for this application. Within this perspective, the multicriteria methods are viable instruments to measure the performance of the innovation capacity dimensions for the performance of high-tech companies. The results produced by this prioritization enable managers to better focus their efforts and resources on managing the capacities that perform best, which results in achieving the goals sought by the companies. The structure of this prioritization (classification by hierarchical analysis) is proposed at three planning levels in a judgment matrix, in which at the first hierarchical structure level it defines the goal, which is to achieve the overall performance of the companies that will feed the system; the criteria are in the second level, which are the knowledge. The dimensions of Technology innovation capacities are in the third level. The prioritization process obeys the judgment of the evaluators (experts). With the results of the judgment matrix, the methods were applied: Promethee II, Electre III and Compromise Programming to evaluate the knowledge on the innovation performance capacities. Table 1 shows the results produced.

The results produced by the methods demonstrate the knowledge of R and D as the most significant ones to ensure the innovation performance capacity of multinational companies. When comparing the results in terms of performance, the Compromise Programming and Promethee II methods did not differ in their classifications. For Electre III, the results were incompatible. And this is because the p, q and v veto thresholds, respectively, of indifference, strong preference and veto or incomparability have a discrepancy in the structure of their results (classification). Electre III presents a set of solutions with a more flexible hierarchical structure. This is due to the conception of the method, as well as the quite explicit consideration of the

indifference and incomparability aspect between the alternatives. The results referenced by the Promethee II and Compromise Programming methods reflect the preference, according to the experts, for R and D in the technological innovation capacities. The essence of the technological innovation process is the accumulation of knowledge over time. The increase of the knowledge volume is produced by different mechanisms associated with different learning modes, such as: learning derived from R and D or Learning before doing (Pisano, 1997). Traditionally the greatest importance goes to R and D than to the other learning modes (Nieto, 2004). Based on the specialized literature R and D has a strong impact on a company's performance. R and D is a core component of the technological innovation activities of firms. In fact, many studies on innovation use R and D as technology innovation indicators. R and D is considered a key aspect of innovative activities. Next, the degree of correlation between the dimensions of knowledge and innovation capacities was determined. For this Spearman's multivariate statistical technique was used. The technique adapts to the case in question.

Phase 2: Determining the correlation of the knowledge and multinationals companies' technological innovation capacity

In this section the correlations between knowledge and technological innovation capacities of the companies are determined. Spearman's correlation is often used to describe the relationship between two ordinal characteristics. The data were extracted by the experts from a judgment matrix. Table 2 shows the results.

Grouping the knowledge and capacity dimensions, there is a strong correlation between the knowledge of R and D / Universities/other Public Research Centers and Strategic Planning Capacity and R and D Capacity / Innovation Decision Capacity / Learning Capacity. R and

Table 2: Correlation of the knowledge and technological innovation capacity dimensions of the multinationals companies

Variables: Knowledge dimensions	Knowledge On The Technological Innovation Capacity Performance Of The Multinationals Companies								
	1	2	3	4	5	6	7	8	9
R and D / Universities/other public research centers	1								
Suppliers / Clients	0,81	1,00							
Joint ventures / Competitors / External consultants	0,72	0,92	1,00						
R&D Capacity / Innovation Decision Capacity / Learning Capacity	0,85	0,50	0,52	1,00					
Strategic Planning Capacity	0,74	0,55	0,46	0,59	1,00				
Resource Allocation Capacity / Organizational Capacity	0,25	0,27	0,14	0,15	0,70	1,00			
Manufacturing Capacity	0,13	(0,02)	(0,06)	0,32	(0,17)	(0,24)	1,00		
Capital Capacity	0,47	0,30	0,33	0,50	0,53	0,08	0,40	1,00	
Marketing Capacity	0,45	0,35	0,06	0,16	0,62	0,35	(0,10)	0,32	1,00

D efficiency reflects the product development process dynamics, reduces time-to-market, improves product profitability, increases productivity, as well as other benefits. Studies on R and D efficiency have many applications as a management tool. R and D is strong performance measure, similar to return on investment (ROI). It can also be used as a means of comparison (benchmark). R and D efficiency is also an aggregate measure of the overall success of a company's product in the development effort. R and D brings the percentage of researchers employed; success rate of R and D products; patent number and R and D intensity; the decision for innovation capacity informs the degree of innovative R and D ideas; the collaboration intensity with other companies or R and D centers; R and D sharing capacity; forecast and evaluation of innovative technology initiatives for business innovation. Technological innovation is multi-dimensional in nature and no single model is sufficient to explain the performance of technological innovation and innovative behavior of multinationals companies, especially when it comes to evaluating the organization's technological innovation activities. However, learning is often used to describe the innovation process. It is true that companies innovate through constant learning processes that generate new technological knowledge (Nonaka and Takeuchi, 1995). Here the main features of the technological innovation process are (Teece, 1986) continuous in nature; irreversible and affected by uncertainty. The essence of the technological

innovation process is the accumulation of knowledge over time. The increase of the knowledge volume is produced through different creative mechanisms associated with different learning modes, such as: learning from R and D or "Learn before doing" (Pisano, 1997); "Learning by doing", which arises spontaneously in the production process (Arrow, 1962); "Learning by using" (Rosenberg, 1982); and "Learning by failing", from the analysis of bad decisions by top managers (Maidique and Zirger, 1985). Such learning modes, particularly the last three, have a clearly progressive nature in that it generates a continuous flow of technological innovations or new knowledge. Traditionally, more importance has been given to R and D than to other learning modes. And technological innovation in companies is a learning process through a stream of new knowledge. And the capacities are generated for the companies to mobilize and expand their technology, human and financial resources in the innovation process. Resources are always a critical factor for all kinds of activities and processes. Evangelista et al. (1997) propose that technology resources will increase its importance as a strategic factor for the company's performance in the near future. Some studies have also found that resource allocation capacity enables to sustain competitiveness (Yam et.al., 2004; Guan and Ma, 2003). Then, an overall performance evaluation of technological innovation capacity was developed for the dimensions considered in the performance of multinationals

companies.

Phase 3: Modeling of the optimal efficiency rate of knowledge influence on the company's technology innovation performance capacity (OERK)

This phase focuses on determining the optimal efficiency rate (OERK) of knowledge influence on the multinationals companies' technology innovation performance capacity using neurofuzzy modeling. It is a process whose attributes usually possess high subjectivity characteristics, in which the experience of the decision maker is very significant. Thus within this spectrum there is the need for a tool that allows adding quantitative and qualitative variables that converge towards a single evaluation parameter (Cury and Oliveira; 1999; von Altrock, 1997). This model combines the Neural Networks and Logic Fuzzy technology. Here this model supports the planning of technological innovation capacities of high-tech companies, as it allows evaluating the desirable rate toward the acceptable performance of high-tech companies. The model shown here uses the model of Cury and Oliveira (1999). Based on the neurofuzzy technology, the qualitative input data are grouped to determine the comparison parameters between the alternatives. The technique is structured by combining all attributes (qualitative and quantitative variables) in inference blocks (IB) that use fuzzy-based rules and linguistic expressions, so that the preference for each alternative priority decision of the optimal rate of technological innovation performance determinants, in terms of benefits to the company, can be expressed by a range varying from 0 to 10. The model consists of qualitative and quantitative variables, based on information from the experts. The neurofuzzy model is described below.

Determination of Input Variables (IV): This section focuses on determining the qualitative and quantitative input variables (IV). These variables were extracted (15 variables/ranking) from the independent variables (knowledge of multinationals companies). The linguistic terms assigned to each IV are: High, Medium and Low. Accordingly, Phase 1 shows the IVs in the model, which are transformed into linguistic variables with their respective Degrees of Conviction or Certainty (DoC), with the assistance of twenty judges opining in the process. The degrees attributed by the judges are converted into linguistic expressions with their respective documents, based on *fuzzy* sets and IT rules (aggregation rules), next (composition rules).

Determination of Intermediate Variables and Linguistic Terms: The qualitative input variables go through the inference fuzzy process, resulting in linguistic terms of intermediate variables (IVar). Thus, the linguistic terms assigned to IVar are: Low, Medium and High.

The intermediate variables were obtained from: K1: R and D performance; K2: Clients / Suppliers / Competitors Performance; K3: External consultants Performance; K4: Joint ventures Performance; and K5: universities/other public research centers Performance. The architecture proposed is composed of eight expert fuzzy system configurations, four qualitative input variables that go through the *fuzzy* process and through the inference block, thus producing an output variable (OV), called intermediate variable (IVar). Then, the IVar₁, which join the other IVar variables form a set of new IVars, thereby configuring a sequence until the last layer in the network. In the last layer of the network the output variable (OV) of the *neurofuzzy* Network is defined. This OV is then subjected to a defuzzification process to achieve the final result: optimal efficiency rate of knowledge influence on the technological innovation capacity performance of multinationals companies. In summary, the fuzzy inference occurs from the base-rules, generating the linguistic vector of the OV, obtained through the aggregation and composition steps. For example, when the experts' opinion was requested on the optimal efficiency rate for the knowledge on the technological innovation capacity performance of the company A, the response was 8.0. Then the fuzzification (simulation) process was carried out, assigning LOW, MEDIUM and HIGH linguistic terms to the assessment degrees at a 1 to 10 scale. Degree 8, considered LOW by 0% of the experts, MEDIUM by 55% and HIGH by 45% of the experts. In summary, the expert's response enabled to determine the degree of certainty of the linguistic terms of each of the input variables using the fuzzy sets. The generic fuzzy sets were defined for all qualitative IVars, which always exhibit three levels of linguistic terms: a lower, a medium and a higher one. After converting all IVars into its corresponding linguistic variables with their respective DoC, the *fuzzy* inference blocks (IB), composed of IF-THEN rules, are operated based on the MAX-MIN operators, obtaining a linguistic value for each intermediate variable and output variable of the model, with the linguistic terms previously defined by the judges. With the input variables (features extracted from product development projects), the rules are generated. Every rule has an individual weighting factor, called Certainty Factor (CF), between 0 and 1, which indicates the degree of importance of each rule in the *fuzzy* rule-base. And the *fuzzy* inference occurs from the rule-base, generating the linguistic vector of OV, obtained through the aggregation and composition steps.

Determination of Output Variable – Optimal Efficiency Rate of Knowledge Influence on the Technological Innovation Performance Capacity

The output variable (OV) of the neurofuzzy model proposed was called Optimal Efficiency Rate of Knowledge

on the Technological Innovation Performance Capacity in multinationals companies.

The fuzzification process determines the pertinence functions for each input variable. If the input data values are accurate, results from measurements or observations, it is necessary to structure the fuzzy sets for the input variables, which is the fuzzification process. If the input variables are obtained in linguistic values, the fuzzification process is not necessary. A fuzzy set A in a universe X, is a set of ordered pairs represented by Equation 1.

$$A = \{(\mu_A(x), x) | x \in X\} \tag{1}$$

Where $\mu(x)$ is the pertinence function (or degree of pertinence) of x in A and is defined as the mapping of X in the closed interval [0,1], according to Equation 2 (PEDRYCZ and GOMIDE, 1998).

$$\mu_A(x): X \rightarrow [0, 1] \tag{2}$$

Fuzzy Inference: The fuzzy inference rule-base consists of IF-THEN rules, which are responsible for aggregating the input variables and generating the output variables in linguistic terms, with their respective pertinence functions. According to Von Altrock (1997), a weighting factor is assigned to each rule that reflects their importance in the rule-base. This coefficient is called Certainty Factor (CF) and can vary in range [0,1] and is multiplied by the result of the aggregation (IT part of inference). The fuzzy inference is structured by two components: (i) aggregation, that is, computing the IF rules part and (ii) composition, the THEN part of the rules. The Degree of Certainty (DoC) that determines the vectors resulting from the linguistic processes of aggregation and composition are defined with Equation 3.

$$DoC_i = \max\{FC_1, \dots, \min\{GdC_{A11}, GdC_{A12}, \dots, GdC_{1n}\}, \dots, FC_n\} \cdot \min\{GdC_{An1}, GdC_{An2}, \dots, GdC_{Ann}\} \tag{3}$$

Defuzzification: For the applications involving qualitative variables, as is the case in question, a numerical value is required as a result of the system, called defuzzification. Thus, after the fuzzy inference, fuzzification is necessary, that is, transform linguistic values into numerical values, from their pertinence functions (Von Altrock, 1997). The IT Maximum Center method was popularized to determine an accurate value for the linguistic vector of OV. Based on this method, the degree of certainty of linguistic terms is defined as “weights” associated with each of these values. The exact value of commitment (VC) is determined by considering the weights with respect to the typical values (maximum values of the pertinence functions), according to Equation 4 presented below (Von Altrock, 1997; Cury and Oliveira, 1999).

$$OV = \frac{\sum_{i=1}^n DoC_i \cdot X_i}{\sum_{i=1}^n DoC_i} \tag{4}$$

$$\sum_{i=1}^n DoC_i \cdot X_i$$

Where i DoC represents the degrees of certainty of the linguistic terms of the final output variable and i X indicates the end of the typical values for the linguistic terms, which correspond to the maxima of fuzzy sets that define the final output variable. By way of demonstration, using assigned IT (average) hypothetical (Company A) enters-IT into the calculation expression of Rate TPKTj with GdCi of the following linguistic vector of the output variable, also hypothetical: LOW=0.30, MIDDLE=0.49, HIGH=0.14. The numerical value of optimal efficiency rate (OERK) of knowledge influence on the multinationals companies’ technology innovation performance capacity at a 0 to 1 scale corresponds to 0.7352, resulting from the defuzzification mean of the values resulting from the defuzzification of each of the simulated twenty judges. This value corresponds to an average value for OERK. With this result (optimal efficiency rate: 0.7352) produced for a better combination and interaction of knowledge strategic that converged toward a single parameter, it is feasible to assert that this combination of knowledge of the firm at this time, can at least ensure the performance desired by the firm at that time. It is plausible that the company maintains at least this value (0.7352), which ensures the desired performance. It is also plausible to state that, to some degree, there is efficiency in the management of those planning innovation in this category of companies. To illustrate this, assuming that the study-object companies demonstrate the following optimal efficiency rates. The expected reference performance for companies is hypothetical (Figure 2). It is concluded that, Companies A and E show efficiency in the combination of their knowledge strategies, based on the performance expectations (C1: R and D (Shelanski and Klein, 1995); C2: Clients (Joshi and Sharma, 2004); C3: Suppliers (Horn, 2005; Smith and Tranfield, 2005); C4: External consultants (Horn, 2005; Smith and Tranfield, 2005); C5: Competitors (Hemphill, 2003; Link et al., 2005.); C6: Joint ventures (Hemphill, 2003; Link et al., 2005.) and C7: universities/other public research centers (ROPER et al., 2004). The priorities of knowledge are dynamic and dependent on constraints and uncertainties that come from the environment at any given time. Companies B, C and D are not efficient in combining their strategies of knowledge, since they do not meet the desired performance expectations. The environmental contingencies are crucial and essential to adapt the strategies. The modeling approach presented here enables this sophistication refinement for every contingency presented.

Implications for management practice

The last few decades have seen a growing number of

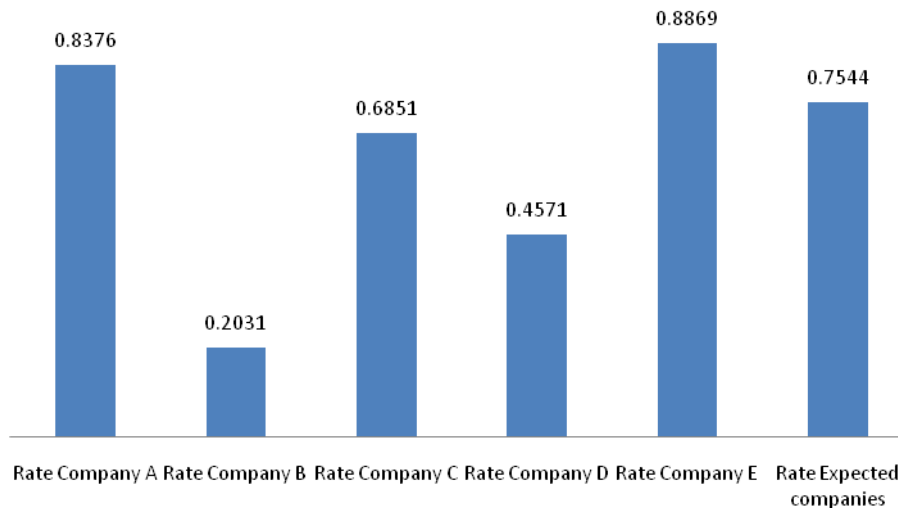


Figure 2. Optimal efficiency rate of knowledge influence on the technological innovation performance capacity

studies on knowledge and innovation. Knowledge and innovation are essential to the competitiveness of firms. With the development of the knowledge-based economy, research has shifted its focus from technological change to innovation, that is, to the creation and diffusion of new knowledge through novel products and processes. Knowledge is one of the most important strategic resources (Tappeiner et al., 2008), but in a competitive environment, knowledge developed by one firm may be appropriated by other firms at hardly any cost, or at least at a much lower cost than would be required to develop that knowledge from scratch (Montoro-Sa'nchez, Ortiz-de-Urbina-Criado and Mora-Valenti'n, 2011). An assessment of the influence of knowledge for innovation capacity performance is relevant, because it informs both firms in their strategic decisions. In firms, varieties of specialized knowledge are distributed among individuals, teams and units. In fulfilling its purpose of producing goods and services, a firm has to bring together specialized knowledge from different sources (Kumar and Ganesh, 2009). In this study, knowledge management is a widely accepted factor of success for multinational companies brasilian [...] (Wilkesmann, Fischer and Wilkesmann, 2009). As such, investments in knowledge management continue to increase dramatically from year to year (Mills and Smith, 2010). Knowledge management supports the process of decision of firms. Specifically, the capacity for innovation.

CONCLUSIONS AND LIMITATIONS

The present paper aims to contribute to the knowledge and innovation planning guidelines in the high complexity environments. Thus, a modeling proposal is presented to assess the influence of knowledge on the technological

innovation performance capacity of brazilian multinational companies. The study strived to fill a gap in the existing literature of the influence of knowledge on the technological innovation capacity in brasilian multinational companies. Technology innovation capability is a complex, elusive and uncertainty concept that is difficult to determine. Technological innovation capabilities engender multi-dimensional difficulties that involve numerous organizational functions and resource integration among various departments (Wang, Lu, and Chen, 2008).

There are of course several issues to be further explored in other such studies and is hoped that it contributed to a plausible methodological discussion, with much still to be explored. Innovation admittedly poses significant challenges to both research and practice, requiring the need for active learning in high-tech companies. This learning capacity involves not only the development of new capabilities within a company, but also crosses borders. Interactions with other companies, other knowledge sources and experts are becoming an important and emerging focal point for technological innovation.

The presence of R and D creates an organizational setting that is favorable to questioning, promoting corporate/company flexibility, with an ability to integrate new concepts and adaptability to market changes (Freel, 2000). In addition, the knowledge and past experience gained with R and D, as well as their lasting and not sporadic existence, renders it instrumental to innovation (Brouwer and Kleinknecht, 1996). R and D and innovation are susceptible to sectorial influences [...] (Becheikh et.al., 2006). Product innovation is considered stronger in multinational companies. Moreover, the central element is the internal role of R and D to maximize the benefits of innovation from other forms of

knowledge (Love and Roper, 1999, 2001). It should be noted that companies with a strong customer focus are able to anticipate the needs of current and latent customers (Paladino, 2007). Bastic and Leskovar-Spacapan (2006) state that customer-focused companies focus on Product innovation versus process innovation and continuously collect information on the needs of competitors and target customers and check their ability to use this information to create superior customer value. A company's strong customer-focus can lead to an emphasis on innovation that is derived from the desire to continually adapt to customer needs (Santos-Vijande and Alvarez-Gonzalez, 2007). Rowley (2002) calls attention to the fact that client knowledge enables the companies' regrouping and creation of incremental value. And within this perspective, Garcia-Murillo and Annabi (2002) show that companies should take every opportunity to interact with customers in order to enrich their customer knowledge base. Consequently, a company can gain a thorough understanding of its customers, thus better able to meet their demands.

Thus, of the different dimensions, the results show a predominance of R and D efforts. However such innovation capabilities have to keep up with up-to-date changes and should be viewed as a priority of the present moment, with regards to systemic efforts guided by defining and redefining the performance of high-tech companies over time. It is plausible that building capacities occur over a continuous process and converge to the desired performance, which is in constant transformation through the new demands. Therefore, the innovation policy for companies in this category should be anchored by efficient planning. Hopefully the R and D capacities can open way, hence allowing multinationals companies to expand their existing technologies and to establish new technologies or improve the R and D functions. It is also evident that the knowledge and technological innovation capacities are a dynamic list of priorities, depending on the essential and desired existing capacities that emerge over practice time, always bringing new concepts and demanding new behaviors, new content and technical implementations, thus fundamentally requiring to permanently reconfigure the new capacities for the new innovation performances. Innovation admittedly poses significant challenges to both research and practice, requiring the need for active learning in high-tech companies. This learning capacity involves not only the development of new capabilities within a company, but also crosses borders. Interactions with other companies, other knowledge sources and experts are becoming an important and emerging focal point for technological innovation.

In this perspective, the modeling approach presented gains emphasis, such diversity of methods when combined are valuable tools with great potential and significant added value, contributing to the robustness of the modeling. This proposal is an additional tool available

to managers, which helps to greatly reduce the uncertainty of technological innovation decisions. There are of course several issues to be further explored in other such studies and is hoped that it contributed to a plausible methodological discussion, with much still to be explored.

In this study, the innovation decision capacities refer to the capacity to enforce innovative technology decisions in the companies. These capacities include the degree of R and D innovation, the collaboration intensity with other companies or R and D centers (Lefebvre et al., 1998; Achilladelis and Antonajis, 2001), the R and D capacity to share knowledge (Guan and Ma, 2003), forecasting and evaluating technological innovation (Yam et al., 2004; Burgelman et al., 2004), and business innovation initiatives (Guan and Ma, 2003). These capacities are evaluated subjectively. Marketing resources indicate a solid capacity to promote and sell products based on demand, which is primarily influenced by the market (Manu and Sriram, 1996), degree of competitiveness of new products, monitoring of market forces (Guan and Ma, 2003), marketing specialized unit (Achilladelis and Antonajis, 2001) and the percentage of exports (Sterlacchini, 1999; Guan and Ma, 2003). All these variables are subjective in nature. Secondly, the efforts are for production capacity, in which companies must transform R and D into results of product and technical improvement and product quality. Manufacturing capacities, such as advanced manufacturing technology (Guan and Ma, 2003), the level of product quality, success rate of commercialization (Yam et al., 2004), quality level of production personnel (Yam et al., 2004) and product cycle time (Guan and Ma, 2003) are evaluated subjectively. Finally, capital capabilities that are necessary to ensure that the advance of the companies' technological capacities are mainly from fundraising capabilities, optimal allocation of capital inflow (Burgelman et al., 2004), capital intensity (Sterlacchini, 1999; Guan and Ma, 2003) and return on investment (Manu and Sriram, 1996). It is also evident that the technological innovation capacities are a dynamic list of priorities, depending on the essential and desired existing capacities that emerge over practice time, always bringing new concepts and demanding new behaviors, new content and technical implementations, thus fundamentally requiring to permanently reconfigure the new capacities for the new innovation performances. In addition, the knowledge may represent a strategic tool, increasing the institutional capacity of the companies in their assignments of formulation, evaluation and execution of such projects (Fletcher, Yiannis and Polychronakis, 2007). In this context, the knowledge is a facilitator instrument of improvement, contributing to decide. Regarding this effort, the research on such priorities should be applied permanently and periodically.

relationships between variables. Furthermore, a survey In the research, cross-sectional data used in this study

may not be appropriate to establish fundamental was developed for Brazilian companies in a static context, which may represent a limiting factor. Therefore, it is recommended to reproduce and replicate the model in companies from other countries in order to confirm the results. It is also recommended that the innovation capacity dimensions should be extracted from the state of the art, but strongly confirmed by the state of practice, by the judgment of other experts (from other countries), taking into account that values, beliefs, cultures and experiences are determinants in the assessment, which can overturn the effects on the results. It is also underscored that the methodologies and technical basis of this modeling should undergo evaluation by a multidisciplinary team of specialists permanently and periodically, hence proposing possible additions or adjustments to these methodologies. And also replace some of the technical implementations used herein by others, in order to provide a similar role to verify the robustness of the model. It is clear that innovation and knowledge are vital to organizational success. We hope the current paper provides an impetus for future research in this area.

Conflict of Interests

The author have not declared any conflict of interests.

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