Organizational Indicators for CASE Tools Selection: A Case Study [*]

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Abstract

It is known that the selection, acquisition and implementation process of a CASE (Computer Aided Software Engineering) tool in an organization is a complex process. Fundamentally the impact of a tool is not simply the product of its inherent properties but also depends on the nature of the Information Systems (IS) development process and the organization thereof.

Based on: (a) the foregoing and the support provided by CASE tools for the IS-development, (b) the large quantity and variety of the latter which are present in the market, (c) the characteristics of the organizations which develop their own IS and, (d) the strategic importance of the selection of a CASE tool for the IS-development according to the needs of the specific organization.

This paper **proposes and discusses the application to a significant sample of Venezuelan IS-developing units, a series of organizational indicators, with their corresponding measurement variables, that shall offer a quantitative way of comparing different CASE tools from the organizational standpoint, as per the characteristics inherent to an IS-developing unit in any organizational context and country.**

Keywords*: CASE tools, development process improvement, selection, evaluation, organizational indicators, Information Systems*

1 Introduction

The speed of growth in the use of computers has created a great demand for the IS-development and Information Technologies (IT) management within organizations. Users demand information and their expectations increase in terms of the service and delivery time of the systems provided by the departments in charge of their development [24].

For several years, a broad range of tools has been built to provide support for the IS-development process and the concept of Computer Aided Software Engineering (CASE) has become a common term used in Software Engineering [29]. Given that Software Engineering focuses on the discipline and structure needed for obtaining economic, reliable IS, the objective of the CASE approach is to support the consistent use of the principles of Software Engineering by means of the use of a variety of computer automated aids [17]. The CASE approach is not just a technology, but rather involves a fundamental change in the process of creating and/or IS- developing [8,19]. At the same time, the CASE approach is interesting insofar as it enables IS-developers to apply the principles, methods, techniques and Software Engineering principles [1,30] such as parallel processing, object-orientation and an easily reusable code, with greater ease through the use of computer-

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coordinated aids. These developments are based on a wide variety of automated tools that support the IS-development life cycle processes, such as specification, design, configuration control and testing and, in some cases, code generation and maintenance [8]. However, current experiences have shown that we are still far from enjoying all the expected benefits from CASE environments [1,2,16,23,30].

The use of CASE tools is seen, on the one hand, as a solution to the greater problems related to the traditional way of IS-developing: delays, errors, inconsistencies, difficulty in tests and inadequate documentation [1,10] and, on the other hand, as a means of supporting the development of quality systems by automating the development life cycle [6]. In adopting a CASE tool, organizations have great expectations that this is going to bring about improvements in the quality and speed of the IS-development process [1,23,17,18]. Now then, why have IS-developing companies not adopted them to the degree that had been expected? Or those which have, why haven't they been able to improve the IS-developing process? What factors affect the adoption of CASE tools?

2 A Conceptual Research Model and Organizational Indicators

Research carried out around the world [2,3,4,5,6,10,11,14,20,22,23,24,25,26,27,31,32] regarding the incorporation of CASE tools to the IS-developing process within an organization reveal, among other results, that the process of selection, acquisition and implementation of a CASE tool in an organization is a complex process [20,23,25,26,27,28, 30]. Many factors can affect the adoption of these tools [1]. The most important being the point of view of the IS developer, in the first place, and the point of view of the executive management of the organizations which use them.

The principal objective of this paper is to propose and study the behavior of a series of organizational indicators that would help, in the selection of CASE tools, when having to make a decision as to adopt and use them within an IS-developing unit in any organizational context. Nevertheless, before making a concrete proposal for indicators, the conceptual model -which is the basis thereof- shall be presented. Figure 1 shows a visual format of the adoption of CASE tools which is immersed within the IS-developing unit and which is directly influenced by the interaction existing among the developers and the type of IS developed, as well as the interaction between the project leaders or unit managers and the type of project which is being addressed [20,25,27].

The main task of an IS-developing unit is the execution of IS-development projects under a sociotechnical system approach [7,12]. In this context, it is not difficult to establish two fundamental organizational factors present in the adoption and use of CASE tools, that originate and perform their tasks within the IS-developing unit: one refers to the **managerial aspects** (submerged in the social subsystem) and the other refers to the **operational aspects** (within the framework of a technological subsystem) [7]. In this regard, Premkumar & Potter [24] concluded in their research that the features inherent to a CASE tool are as important as the characteristics that enable the organization to adopt the CASE tool itself. This means that the adoption of a CASE tool also directly depends on the conditions present in the organizational environment where it is to be used [1,23]. According to this, Lai [15] said *"Adopting a CASE tool incompatible with organizational values may cause a conflict of interest and a shift of political balance; whereas implementing a product incompatible with organizational information architecture will create a confusion of work design, a readjustment of work habits, and a decline in work performance. In fact, the importance of compatibility highlights the fact that the various standards, software, and technologies used in the traditional IS development environment are quite different from those*

used in the CASE technology".

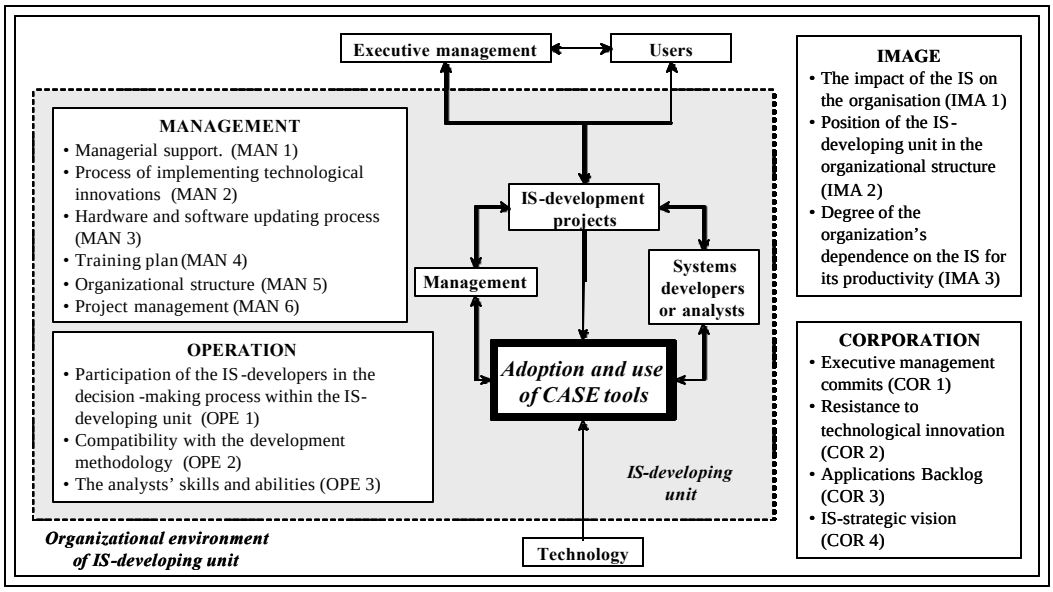

Figure 1. The Interactive process of adoption and use of a CASE tool [20].

The interaction which occurs among the users, the upper management and the IS-developing unit give rise to two other fundamental organizational factors for the adoption and use of CASE tools [3,4], but which are external because the origin and control thereof is not exclusive to the IS-developing unit. In other words, they are in the environment or out of limits: the factors refer to the **image aspects** in the IS-developing unit (directly determined by the perception of the users and upper management with respect to the IS-developing unit and the IS themselves) and that referred to the **corporate aspects** of the organization where the developing unit performs its tasks, with respect to the IS-development. In concordance with this idea, De Freitas already [10] takes these aspects into account, calling them in her paper the *"attributes that arise from the interaction between innovations and their organizational context".*

Tables 1 and 2 summarize the conceptual definition of each indicator and the number of variables that will allow measurement of each at the time of evaluating a CASE tool.

According to Mendoza et al. [20] and Rojas et al. [25,27], in the area of human resources as well as in the organizational area, the technological innovation is in the environment as an aspect which bears a direct influence on the adoption and use of CASE tools; inasmuch as this innovation is what provides for the availability of more and better tools for the IS-development. Although this paper does not broach on all the technological aspects affecting the acquisition and use of CASE tools, it is important to bear in mind the process of acquisition and management of technological innovations within the IS-developing units as well as throughout the entire organization [17,20,25,26,27,28]. Is important to mention that the role of professionals, consultants, vendors, etc., are not represented in this model; these are included in the Technological Indicator model proposed by Díaz et al. [11] and applied by Rojas et al. [26].

These encompass the aspects, which, from the organization standpoint, influence the acquisition and use of

CASE tools by the IS-developing unit. The origin and control of these aspects is not exclusive to the unit.

IMAGE	CORPORATION
This refers to the image reflected in the environment by the IS-developing unit; i.e., its importance according to the rest of the organization. Its indicators are: a) **The Impact of the IS on the organization.** (IMA 1) The degree of impact the IS developed by the IS-developing unit have on the mission, goals and operations of the organization. This indicator will be measured through five (5) variables. b) **Position of the IS-developing unit in the organizational structure.** (IMA 2) Hierarchical position of the IS-developing unit within the organization, with respect to whether it is considered a service unit or a strategic unit for the organization. This indicator will be measured by three (3) variables. c) **Degree of the organization's dependence on the IS for its productivity.** (IMA 3) The degree of dependence of the organization on the IS developed by the IS-developing unit to achieve its goals and objectives and/or survive against its competitors. This indicator will be measured through five (5) variables.	This refers to the vision and stance adopted by the organization to which the IS-developing unit belongs when faced with the IS-development and the acquisition and technological innovations management. Its indicators are: a) **Commitment by the Executive management levels.** (COR 1) The support given by the executive management of the organization to technological improvement plans carried out by the IS-developing unit, internally as well as throughout the entire organization. This indicator will be measured by three (3) variables. b) **Resistance to technological innovation.** (COR 2) The degree of resistance in the organization against the incorporation of innovations, in other words, if it facilitates or not the processes of acquisition of technological capabilities. This indicator will be measured through six (6) variables. c) **Applications Backlog.** (COR 3) The amount of IS applications that the IS-developing unit has delayed. This indicator will be measured through six (6) variables. d) **IS-strategic vision.** (COR 4) The degree of relevance granted by the organization to the IS in order to survive or develop competitive advantages. This indicator will be measured through three (3) variables.

Table 1. Conceptual definition of the External Organizational Factors. Adapted from [20,25,27].

The reference framework provided by Figure 1 lists and classifies the proposed organizational factors (Image, Corporation, Management and Operation) as well as their indicators. As you can see in Figure 1, the *Adoption and use of CASE tools* is highlighted; in this sense, the object of this model is to analyze and compare experiences across companies, with CASE technology, to establish the performance of the organizations that have had success in the adoption and use of CASE tools. Because of this, in the section of the analysis of results, emphasis is made on the behavior of the organizational indicators (independent variables) proposed in order to determine the strengths and weaknesses within the organizations that have had successful experience adopting and using CASE tools (dependent variable). In this way, it will be possible to give to any organization, which wants to improve their IS-development process in a future, some ideas about the conditions that could facilitate the acquisition of CASE tools.

Refer to [27] for a detailed explanation and justification of each factor and a complete definition and formulation of the variables that allow measurement of each indicator shown by Tables 1 and 2.

These encompass the aspects which, from the organization standpoint, influence the acquisition and use of

CASE tools by the IS-developing unit, and which can be controlled by it.	
MANAGEMENT This refers to the development of management processes within the IS-developing unit: from the point of view of how the IS-development projects are conducted with the use of CASE tools and from the point of view of the unit direction to achieve its objectives. Its indicators are: a) **Managerial support.** (MAN 1) The degree of support provided by the project managers of the IS-developing unit to the CASE tools acquisition processes. Measured through three (3) variables. b) **Process of implementing technological innovations.** (MAN 2) The processes stipulated by the IS-developing unit for carrying out the acquisition and use of CASE tools within its development projects. This indicator will be measured through five (5) variables. c) **Hardware and Software updating process.** (MAN 3) Processes stipulated by the IS-developing unit to update the hardware (HW) and software (SW) when the acquisition and use of a CASE tool has been decided within the unit's development projects. This indicator is measured through four (4) variables. d) **Training Plan.** (MAN 4) Processes stipulated in the IS-developing unit to update the knowledge of its IS-developers, at the time of adopting a CASE tool. This indicator will be measured through four (4) variables. e) **Organizational structure.** (MAN 5) Type of organizational structure that characterizes the IS-developing unit, as well as its degree of flexibility to change and/or to be adapted to the effects of adopting the CASE tools. This indicator will be measured through three (3) variables. f) **Project management.** (MAN 6) Processes stipulated in the IS-developing unit for performing the management of the IS-development projects, taking into account the possible adoption of a CASE tool. This indicator will be measured through four (4) variables.	**OPERATION** This refers to the development of operational processes within the IS-developing unit to conduct the IS-developing projects, taking full advantage of the potentialities of the CASE tools and ensuring the success of the acquisition and management of technological innovations. Its indicators are: a) **Participation of the IS-developers in the decision-making process within the IS-developing unit.** (OPE 1) The degree of participation of the IS-developers or analysts in the selection of CASE tools and in the planning of implementation processes for the tools within the IS-developing unit (adoption). This indicator will be measured through three (3) variables. b) **Compatibility with the development methodology.** (OPE 2) The degree of consistency expected from the CASE tool with respect to the processes established and with respect to the needs the developing unit wishes to fulfill with the adoption of the CASE tool. This indicator will be measured through four (4) variables. c) **The Analysts' skills and abilities.** (OPE 3) The degree of experience of the analysts or IS-developers belonging to the IS-developing unit and their capacity to acquire the skills and abilities for the use of CASE tools by means of the corresponding training. This indicator will be measured through three (3) variables.

Table 2. Conceptual definition of the Internal Organizational Factors. Adapted from [20,25,27].

3 Research Method

3.1 Construct operationalization

A set of sixty-four (64) variables was used in the design of the measurement instruments, based on the operational definition of the indicators, as illustrated in Figure 2. These variables are inspired by an extensive review of innovation and diffusion literature on MIS and technology management.

The operational definition of the indicators helped to establish four fundamental aspects for the design of the field study and the elaboration of the measurement instruments: (a) the kind of subject that participated in the field study, (b) the number of variables measured by each indicator,

(c) the measurement scales used for the variables, and (d) the questions used to obtain the information for each variable. In this sense, the field study was aimed at unit heads and/or project leaders, IS-developers or analysts and the users of the IS-developed with CASE tools. A measurement instrument was designed for each type of participant.

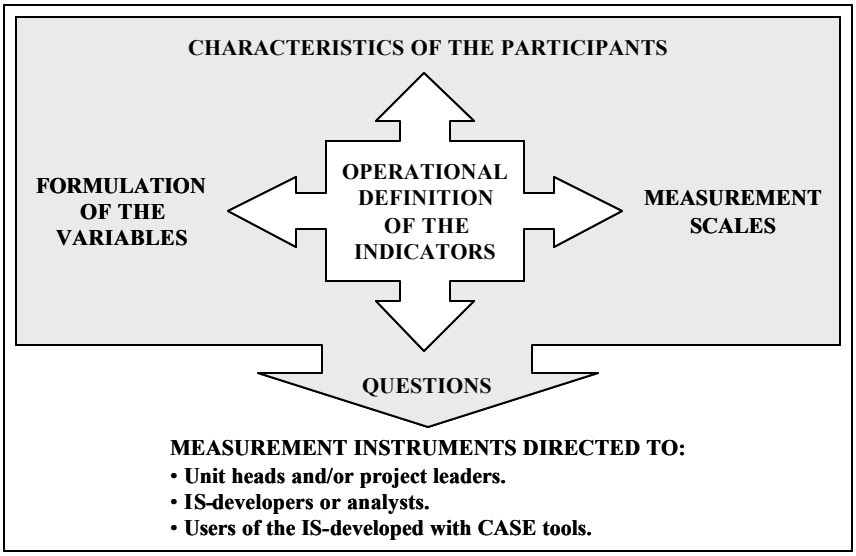

Figure 2. Operational definition of indicators and design of measurement instruments.

Two types of scales were used for measuring the variables: a five-point Likert-type scale (1 to 5) based on the extent of agreement (5) or disagreement (1) with the item, and a continuous scale for these research variables based on percentage ratios (0% to 100%) and absolute ratios (0 to 1).

3.2 Construct validation

Content validity, which assesses the completeness and soundness of the measurement, was established through the careful selection of items that had been previously validated in prior studies [4,5,6,10,14,15,17,20,22,23,24,25,27,28,30,32]. To further reduce the possibility of any non-random error, three academic experts from different universities and two IS senior executives in the software development units were asked to review the questionnaire with respect to its validity, completeness and readability. Their suggestions were carefully reviewed and the questionnaire was adapted accordingly so that it would better reflect industry practices and naming conventions.

Cronbach's alpha coefficient was calculated to assess measurement reliability. The analysis showed that the reliability of variables was significantly higher than the value of 0.86 suggested by Hernández et al. [13] for the early stages of basic research; principal component factor analysis was used to test this validity property. The results of Cronbach's alpha coefficient to the questionnaires are presented in Table 3.

Instrument aimed at	Cronbach's alpha (α) coefficient
Unit heads and/or project leaders	0.9123
IS-developers or analysts	0.9609
Users of the IS-developed with CASE tools	0.9240

Table 3. Reliability analysis.

3.3 Data collection

For the purposes of obtaining detailed feedback on the clarity of the questions and the overall comprehensibility of the instrument, a pilot test was carried out with three unit heads and/or project leaders, three IS-developers or analysts and three users of the IS-developed with CASE tools from two organizations using CASE tools. The result of this pilot study led to some adjustments to the content and format of the questionnaire and terminology used in the survey. The most important adjustments made were: reformulation of some questions, reorganization of some questions within each questionnaire, rechecking of the measurement scales, reassigning questions throughout the questionnaires and planning of the compilation and processing activities of the questionnaires.

The revised questionnaires, along with a presentation letter explaining the nature of the study, were administered to 169 employees of 19 companies that expressed their desire to participate in the field study. To encourage participation, all participants were assured of confidentiality throughout the study. At the end, 162 persons completed and returned the survey. After evaluating the responses, it was found that seven responses were unusable owing to insufficient data. The removal of these unusable responses left a total of 155 usable questionnaires, which represents a response rate of 91.72%. It is worthwhile to emphasize that the high percentage of participation of the poll, was mainly due to the interest and commitment shown by the directors of the participating companies with respect to the objectives of the study; additionally, there were contacts, between the researchers and the IS-developing units, who served as follow-up agents; thereby ensuring a high degree of response. Table 4 shows the distribution of the number of participants in the field study per type.

Type of participant	Total participants per type
Unit heads and/or project leaders	40
IS-developers or analysts	71
Users of the IS-developed with CASE tools	44
Total General	**155**

Table 4. Distribution of participants per type.

3.4 Sample characteristics

The characteristics of the sample are show in Table 5. The largest number of respondents (45) was from the finance and banking industries, representing 29.03% of the responding companies.

Of the 155 respondents, 13 were top-level managers (such as VP of MIS, CEO, CIO and Human Resource directors), 36 were middle-level managers (such as MIS managers, project managers, financial and administrative managers) and 106 were professionals (such as systems analysts, programmers, software engineers, administrators, office workers). Of all respondents, 16 (10.32%) had post-graduate degrees, 45 (29.03%) had graduate degrees and 94 (60.65%) had under-graduate degree. Most of their degrees were in computer science, followed by engineering and business. The age of the participants ranged from 25 to 59, with an average of 35.52 years. Their average length of service in their current job was 4.5 years. The project leaders and IS-analysts, on average, had been working for 12.3 years in software development and using CASE technology for 3.8 years.

Aspect	Characteristic	Number	Frequency (%)
Industry	Computer	41	26.45
	Consulting	5	3.23
	Energy	4	2.57
	Engineering	8	5.16
	Finance/Banking	45	29.03
	Government	19	12.26
	Health	5	3.23
	Telecommunication	5	3.23
	Other	23	14.84
Title	Administrator	16	10.32
	Doctor/Nurse	3	1.93
	Engineer	11	7.10
	Human Resource	4	2.57
	IS-analyst	35	22.58
	Programmer	32	20.65
	Programmer/Analyst	11	7.10
	Project manager	21	13.55
	Technician	9	5.81
	Other	13	8.39
Experience with CASE technology (in years) Note: For this aspect, only respond the Projects leaders and IS Analysts	< 1	5	4.51
	1 – 2	9	8.11
	2 – 3	19	17.11
	3 – 4	41	36.94
	4 – 5	23	20.72
	> 5	14	12.61

Table 5. Profile of respondents.

3.5 Data analysis procedure

The steps followed to carry out the analysis of the information gathered through the questionnaires were the following:

1) **Distribution by sectors of companies participating in the field study.** It became necessary to group and classify the participating companies, as it was observed that certain subsets thereof carry out the same economic activity, in other words, attend to and meet similar needs in the Venezuelan population. In this regard, a research carried out by Dávalos et al. [9] emphasized that *"all companies or entities cannot be treated alike, because they are dedicated to completely different economic activities"*. [9] On the basis of the foregoing; a classification or division by sectors of the participating companies was deemed necessary in order to better interpret the results obtained from the field study; otherwise mixed results would be obtained for dissimilar organizations. The division by sectors undertaken depended mainly on the kind of activity performed by each company. The 19 participating companies were finally grouped as follows:
   - Banking Sector: Companies and institutions undertaking financial activities in the country and, in some cases, in foreign markets.
   - Consultancy Sector: Companies dedicated to providing consultancy and advisory activities to other companies in the fields of engineering and management.
   - IS-Development Sector: Companies carrying out IS-development and maintenance activities.
   - Government Sector: Entities dedicated to activities inherent to the Venezuelan State. The owner of these entities being the State itself.
   - Services Sector: Companies and institutions performing service-related activities, in other words *"Supply of immaterial goods to persons, communities or companies"*. [21]

   The Table 6 shows the detailed distribution of the respondents per type and per sector, after

grouping the 19 participating by sector.

Sector	Unit chiefs and/or project leaders	IS-developers or analysts	Users of the IS-developed	Total respondents per sector
Banking	12	21	15	48
Consultancy	5	7	5	17
IS-Development	10	14	6	30
Government	7	12	4	23
Services	6	17	14	37
Total respondents per type	40	71	44	**155**

Table 6. Detailed distribution of respondents per type and per sector.

2) **Elaboration of the "technical file" to characterize the participating companies in the sector, based on the information supplied by the persons interviewed.** This thus helps to establish the context in which the results obtained are set, so as to provide a solid framework for the comments and conclusions derived from the analysis thereof. The Table 7 shows a summary of the most important aspects of the *"technical file"*.

Characteristic	Sector				
	Banking	Consultancy	IS-Development	Government	Services
Number of employees of the organization	500 - 1500	1200 - 1500	40 - 160	4000 - 5000	3000 - 3500
Organizational structure to which the IS-developing unit belongs	Mixed (functional and project)	Matrix	By project	Functional	Functional
Number of employees of the IS-developing unit	26 - 79	24 - 30	30 - 100	60 - 75	60 - 70
Years of experience of the unit chiefs and/or project leaders	5 - 8	5 - 9	8 - 12	2 - 5	5 - 9
HW and SW platform architecture installed in the organization to which the IS-developing unit belongs	Mixed (Mainframe and C/S platform)	C/S platform and PC networks	C/S platform and PC networks	C/S platform and PC networks	Mixed (Mainframe and C/S platform)
Years of service of the IS-developing unit within the organization	7 - 20	9 or more	9 - 11	3 - 5	5 - 20
Number of divisions or sections of the IS-developing unit	4 or more	3 or less	4 or less	5 or less	3 or less
Unit experience with CASE tools working	5 or less	4 or less	3 or more	3 or less	5 or more
CASE tools most often used in the last 3 years	ERwin, BPwin, Developer2000, Designer2000 (*)				
	Construct, Esperant, Natural CASE, Rational Rose 98	Power Designer	MS Visual Modeler, Visio, Power Designer, Rational Rose (**)		Rational Rose (**)

Notes: (*) All have used these CASE tools.
(**) Both Rational Rose 98 and Rational Rose 2000.

Table 7. The most important characteristics of the sectors.

3) **Preparation of frequency distributions, central trend measurements and variability measurements.** These statistics were prepared from the responses given by each type of respondent to the questions measuring the variables of the indicators for each sector defined in the first step. One of the statistical processes that were accomplished in this stage was to study the degree of confidence of the survey. Table 8 shows the results of the Students t-test of the averages at 95% of confidence of the collected data for each indicator after the standardization described in step 5 of Data analysis procedure.

Indicator acronym (*)	t	GL	Means difference	Confidence interval for difference	
				Lower-bound	Upper-bound
COR 1	39.77	98	3.56	3.38	3.73
COR 2	45.88	95	3.42	3.28	3.57
COR 3	52.27	58	3.81	3.66	3.95
COR 4	35.55	77	3.94	3.72	4.16
MAN 1	20.49	19	3.33	2.99	3.67
MAN 2	30.49	37	3.63	3.39	3.87
MAN 3	29.74	40	3.76	3.51	4.02
MAN 4	20.74	53	2.79	2.52	3.06
MAN 5	37.31	72	2.98	2.82	3.14
MAN 6	31.85	76	3.57	3.35	3.79
IMA 1	38.47	73	3.35	3.18	3.52
IMA 2	31.57	51	3.54	3.31	3.76
IMA 3	21.61	38	3.50	3.18	3.83
OPE 1	24.55	76	2.65	2.43	2.86
OPE 2	27.39	74	3.00	2.79	3.22
OPE 3	26.77	75	2.92	2.71	3.14

Note: (*) Refer to Tables 1 and 2 to see the correspondence between each indicator and their acronym.

Table 8. Results of the survey' Students t-test.

Table 8 shows that the study presents a good measure for significance of the data analysis because all averages have an excellent degree of confidence. All mean difference values are between lower and upper bounds of the confidence interval for difference. The conclusion is to accept the hypothesis of investigation -behavior of the organizational indicators (independent variables) proposed in order to determine the strengths and weaknesses present in the organizations that have had successful experience adopting and using CASE tools (dependent variable)- and to reject the null hypothesis.

4) **First-level analysis of the results obtained.** The measurements obtained from each indicator-measuring variable were analyzed for each type of respondent interviewed and were grouped per sectors. In this manner the behavior of the variables defining each indicator for each type of participant was discussed, for each sector, in order to determine the representative values for the indicators by sector, as a whole. Figure 3 illustrates the procedure that was followed for the first-level analysis.

5) **Standardization of the values obtained for each variable measured by the indicators.** *"Standardizing the values enables the comparison of scores from two different distributions".* [13] Thus, all variables could be treated as if they were on the same scale and all indicators could be treated as if, in measuring them, they could express their values on the same scale of scores. In order to perform this standardization, a 1 to 5 scale was selected, it being the one most frequently used for the formulation of the variables (85% of the variables used were formulated based on the 1 to 5 scale), thus enabling the speeding up and improving the

precision of the standardization process, inasmuch as less calculation steps are needed. Firstly, each variable was standardized to the selected scale so that all variables could express their values in like manner. Then, the amount of all the values obtained was calculated for each variable and all values were once again standardized to the 1 to 5 scale. This permitted the representation of the scores obtained per indicator in one same graph.

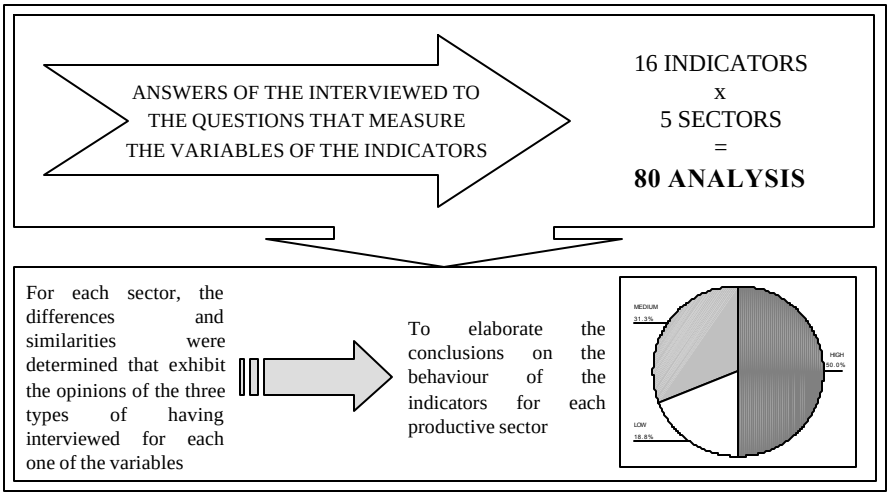

Figure 3. First-level Analysis

6) **Second-level analysis of the results obtained.** The scores obtained by the indicators for each production sector were analyzed and a comparative analysis among the sectors was finally obtained. Figure 4 illustrates the process followed for the second-level analysis.

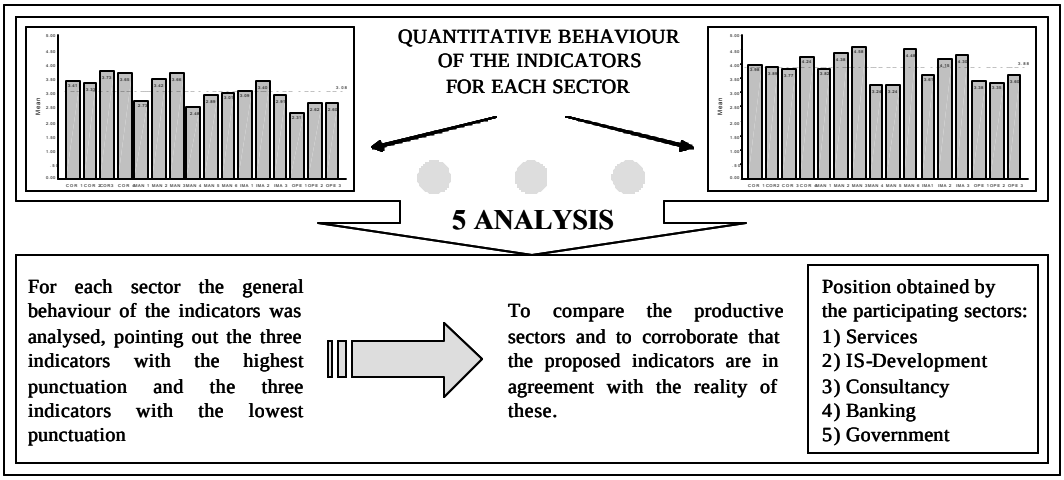

Figure 4. Second-level Analysis.

Given the importance of steps 4, 5 and, 6 in the method, the results obtained from executing these steps shall be dealt with, in more detail, in the following section.

4 Discussion of Results

The field study resulted in the verification that not all the organizations have the same characteristics and cannot be treated equally. It is convenient to group organizations into sectors, based on one (or several) aspect(s) that differentiate one type of organization from another. It would be suitable to take into account one special trait such as the mission, the task fulfilled, the market segment it attends or any other relevant characteristic in order to classify them. This is very convenient because it helps in establishing, more adequately, accurate conclusions. In this sense, the field study corroborated that the behavior of organizational indicators depends on the sector to which they are applied. Through the analysis of the results obtained, it was verified that one same indicator behaves differently for different sectors, whereas some indicators exhibit a similar behavior when compared among sectors having various common traits.

On the other hand, it was important to count on the participation of the three kinds of workers interviewed; these three "actors" offered a systemic vision to the study, the opinions of one group complementing the opinions of the others, thus helping in the drafting of more solid conclusions as to the objective pursued in the field study, which was to take measurements on the organizational indicators proposed in Venezuelan companies.

Next the graphs generated as a result of analyzing the indicators for each production sector are presented. The behaviors of the indicators proposed for each sector are visualized after standardization of the values for the variables on the 1 to 5 scale. Lastly, a brief comment is given, based on the second-level analysis.

4.1 Banking sector

The Figure 5 shows that the average score obtained by the indicators for the Banking Sector is 3.08. The indicators with the lowest scores are *Participation of the IS-developers in the decision-making process within the IS-developing unit (OPE 1), Compatibility with the development methodology (OPE 2), and The analysts' skills and abilities (OPE 3).*

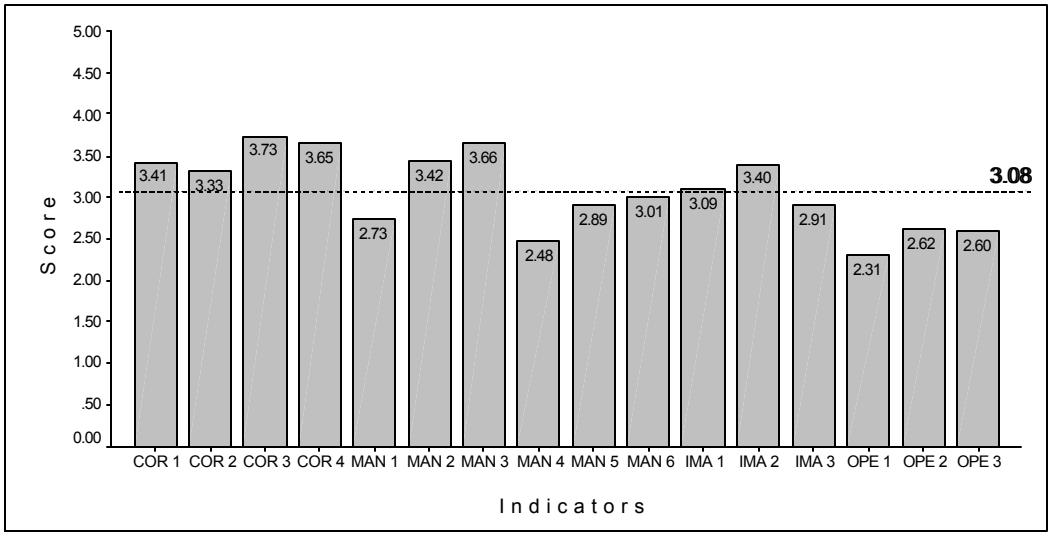

Figure 5. Behavior of the indicators, according to the 1 to 5 scale, in the Banking Sector.

It would seem that the IS-developing units in the sector should improve their operational processes

so as to take full advantage of the potentialities found in the CASE tools and thus assure success in the acquisition and management of technological innovations. The highest-scoring indicators are *Applications Backlog (COR 3), IS-strategic vision (COR 4), and Hardware and Software updating process (MAN 3).* The behavior of these indicators corresponds with the needs of the sector, given the importance granted to IT and IS for the improvement of the operational processes of the sector. The results obtained are in agreement with the real-life situation, insofar as the banking institution, which provides the better service, is the one reflecting a novel IS and IT platform.

4.2 Consultancy Sector

As can be seen in Figure 6, the average score obtained by the indicators for the Consultancy Sector is 3.80. The indicators with the highest scores are *Project management (MAN 6), IS-strategic vision (COR 4), and Commitment by the executive management levels (COR 1),* which corresponds with the characteristics inherent to organizations in the sector, characterized for relating with their clients through the undertaking of projects, forcing them to maintain excellent project management practices. These organizations have a clear vision of IT and IS within the organizations, as they are in charge of providing advisory services to other companies in this respect and must apply their expertise to their own projects. Lastly, they count on the support of the upper management for the adoption and use of new technologies, especially CASE tools, because they have to continuously adapt to market trends in order to best meet the needs of their clients.

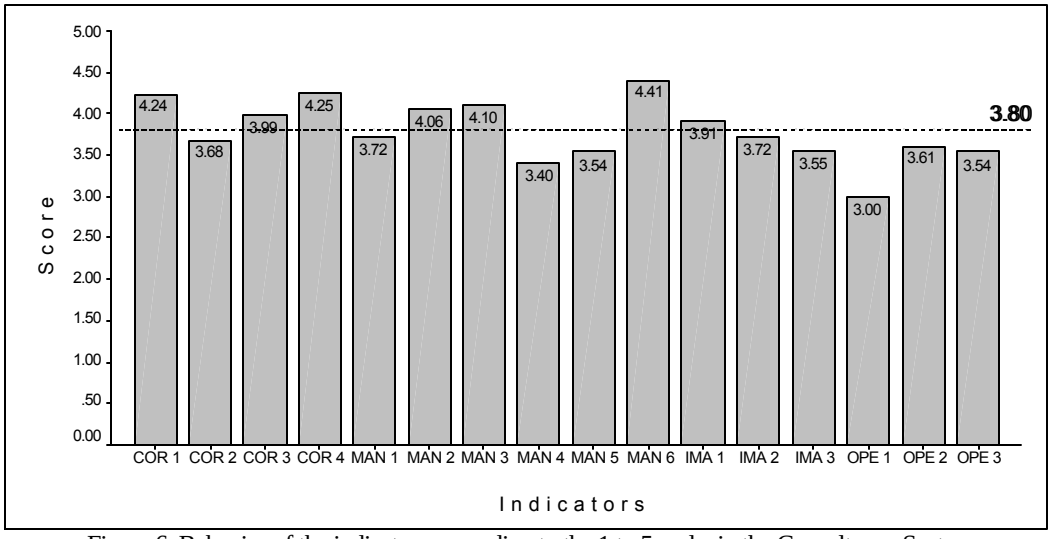

Figure 6. Behavior of the indicators, according to the 1 to 5 scale, in the Consultancy Sector.

As far as the indicators with the lowest scores are *Participation of the IS-developers in the decision-making process within the IS-developing unit (OPE 1), Training plan (MAN 4), Organizational structure (MAN 5), and The analysts' skills and abilities (OPE 3).* As can be observed, these indicators refer to internal factors for the adoption and use of CASE tools, and, even with an excellent project management system in place, have a noticeable effect on taking advantage of the benefits offered by CASE tools. The situation is further aggravated due to deficiencies in the capabilities and skills of the analysts and the lack of a proper training plan. In general, companies in this sector tend to sacrifice their employee training and professional development plans in order to attend to their customer projects. It would be convenient for these organizations to better evaluate this situation and to apply their advisory and consultancy knowledge to themselves; they shall thus be able to improve their internal processes, particularly

those referring to the IS-development with CASE tools.

4.3 IS-Development Sector

The Figure 7 shows that the average score obtained by the indicators for the IS-Development Sector is 3.83. The indicators presenting the lowest scores are *Organizational structure (MAN 5), The analysts' skills and abilities (OPE 3), and Participation of the IS-developers in the decision-making process within the IS-developing unit (OPE 1).* These are centered on analyst-related aspects, such as: skills, capabilities, stability, professional development and identification with the organization, among other factors; in this sense, it appears that, due to the dynamics of the companies in the sector, little time is dedicated to thinking about the key element in IS-development - the human resources in charge of carrying forward their projects; if, on the other hand, analysts are immersed within organizations that are not clear about themselves, they could feel insecure. It would be convenient for organizations in this sector to attend to these deficiencies, thus maximizing the accomplishment of their mission, at the same time as keeping high levels of satisfaction within their clients as well as their employees.

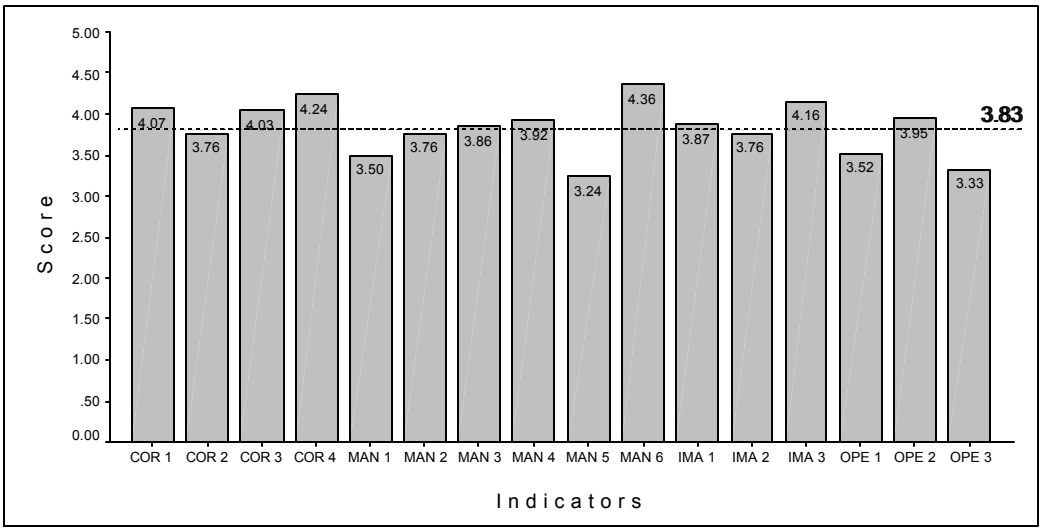

Figure 7. Behavior of indicators, according to the 1 to 5 scale, in the IS-Development Sector.

The indicators exhibiting the highest scores are *Project management (MAN 6), IS-strategic vision (COR 4), and Degree of the organization's dependence on the IS for its productivity (IMA 3).* As it is well known, organizations belonging to this sector (as well as those belonging to the Consultancy Sector), maintain their client relationships through IS development projects; for these organizations, it is important to count on good project management, as confirmed by the indicator referring to this aspect which obtained the highest score.These organizations give great importance to the adoption and use of IS and IT, insofar as the use of technological innovations is extremely important for them, as this allows them to maintain a good competitive edge in the IS-development market; besides, users (in this case the clients) and project leaders have expressed their dependence on IS, which justifies the raison d'être of these organizations.

4.4 Government Sector

As can be seen in Figure 8, the average score obtained by the indicators for the Government Sector is 2.68. This is the sector with the lowest score. Among the indicators exhibiting the highest scores in this sector can be found *IS-strategic vision (COR 4), Applications Backlog (COR 3), and Degree*

of the organization's dependence on the IS for its productivity (IMA 3). In general, although the use of IS and IT to undertake their functions is not a common denominator in entities belonging to this sector, it is worthwhile highlighting that the few entities that are becoming aware of this (some of which participated in the field study), reflect their shift in attitude by means of the three previously mentioned indicators. In this regard, IS-developed with CASE tools and implemented in the entities, have led to increased awareness about the IS-strategic vision and the increased productivity due to the effect of using IS; besides, the IS-developers are conscious of the need to provide the users with quality applications in the shortest time possible. Nevertheless, one must not forget the pressures exerted by the production and economic sectors in the country for these changes to occur in the Government Sector.

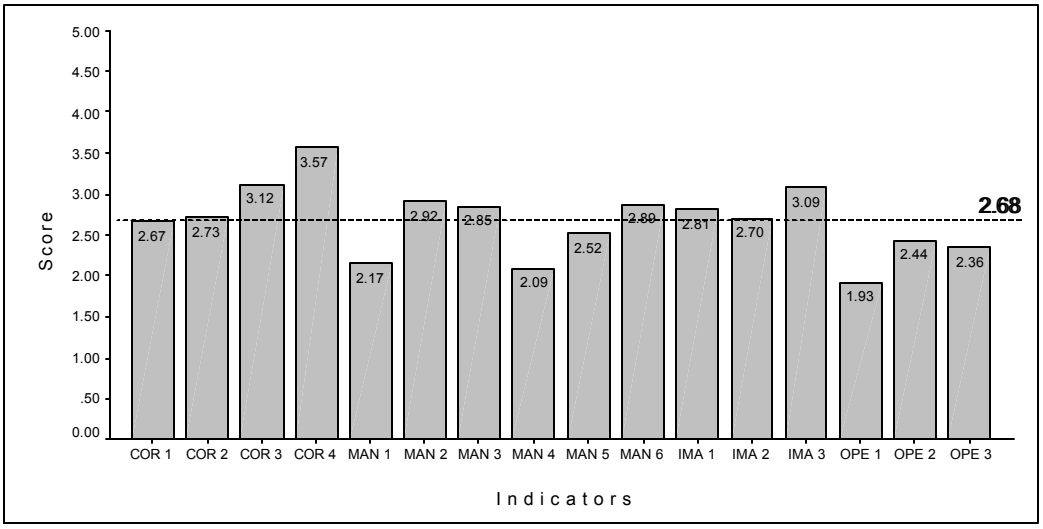

Figure 8. Behavior of the indicators, according to the 1 to 5 scale, in the Government Sector.

The indicators showing the lowest scores are *Participation of the IS-developers in the decision-making process within the IS-developing unit (OPE 1), Training plan (MAN 4), and Managerial support (MAN 1).* In spite of the shifts in awareness manifested in the sector, pending affairs still exist that hinder the adoption, use and application of technological innovations such as CASE tools, as reflected in the low score given to the previously mentioned indicators. Within this sector, there has always been little awareness as to the importance of training plans for the professional development of the employees, as well as the need for improving decision-making processes so that they become more dynamic and less centralized. Finally, it is imperative for resources to be allocated to the maintenance and support of the existing IS and IT in the entities.

4.5 Services Sector

The Figure 9 shows the average score for the Services Sector indicators to be 3.84. This is the sector with the highest score. The indicators exhibiting the highest scores in the sector are *Hardware and Software updating process (MAN 3), Project management (MAN 6), and Process of implementing technological innovations (MAN 2).* These indicators reflect the reality in this sector as far as the development and use of IS and IT; they show that the sector has put forward all its efforts to improve technological innovation implementation processes, that they are aware of the need to continuously update the HW and SW platforms supporting the IS and IT and that they have a consolidated project management. The combination of these elements has enabled organizations in the sector to improve the benefits of their services. This affirmation is supported by the solidity and repercussion of the organizations belonging to this sector and participating in

the field study on Venezuelan society.

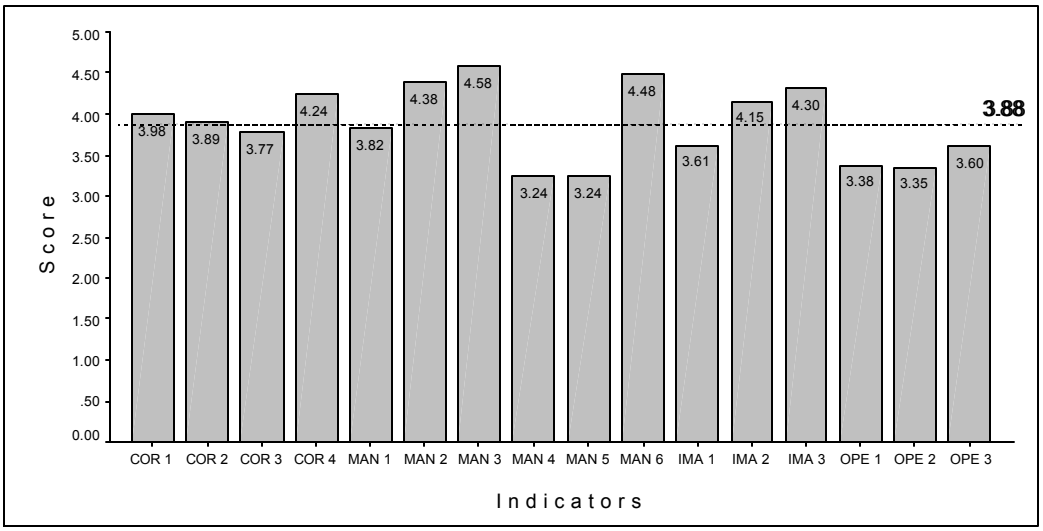

Figure 9. Behavior of the indicators, according to the 1 to 5 scale, in the Services Sector.

The indicators presenting the lowest scores are *Training plan (MAN 4), Organizational structure (MAN 5), and Compatibility with the development methodology (OPE 2).* Although organizations belonging to this sector have demonstrated that they count on strengths such as those previously described, some aspects still have to be improved; their training plan destined to taking advantage of technological innovations such as CASE tools must be clarified; an organizational structure for the IS-developing unit has to be determined, more in accordance with the tasks carried out, that would stimulate unit members and give them more organizational security and that would take into account aspects referring to the compatibility of the CASE tools to be adopted with already-existing tools and with the development methodology implemented within the unit. In spite of these situations that could be improved, and considering these are companies whose objective is not both IS-development and the adoption and use of CASE tools, they have demonstrated their clear awareness as to the role played by IS and IT in competitive world of today.

4.6 Comparison among the participating sectors

A fair comparison among the sectors studied is not an easy task as uneven characteristics are present; however, a hierarchy table can be established showing how organizations in each sector take advantage of CASE tools. In summary, the descending order for the average score obtained by the previously analyzed sectors is shown in Table 9, based on the score received by each in measuring the organizational indicators of the companies participating in the field study.

Position	Sector	Score
1	Services	3.88
2	IS-Development	3.83
3	Consultancy	3.80
4	Banking	3.08
5	Government	2.68

Table 9. Scores obtained by the participating sectors

The sector with the highest average score in the indicators presents a series of conditions enabling the organizations within that sector to better adopt and use the strong points and benefits offered

by CASE tools. These organizations are also in the capacity to experiment with and test new technological innovations. On the contrary, sectors obtaining the lowest average scores for the indicators present a series of deficiencies hindering the organizations from adequately adopting and using the CASE tools. These institutions must work harder to solve their deficiencies in this regard.

5 Conclusions and Implications

In order to select a CASE tool, it is necessary to bear in mind the technical aspects of the tool as well as the organizational aspects of the company that is to adopt it, inasmuch as the selection is not only a product of the properties inherent to the tool itself, but also of the characteristics of the IS-development project and the characteristics of the organization that is going to adopt it. Therefore, the influence of the organizational environment in the acquisition and/or adoption of CASE tools in supporting the IS-developing process must not be set aside.

At this point it is opportune to state that only organizational indicators were used in this research, these understood to mean indicators studying organizational traits in institutions using CASE tools for IS development. Although this can represent a limitation to the study, the fact that it started from a critical position towards the information gathered is in its favor. The partial conclusions were supported by a detailed interpretation of the results obtained, constituting an important contribution to scientific activities in this field in Venezuela. In this sense, the study should center on IS-developing units in Venezuela, because, as stated by Iivari [14],"each country reflects a different reality with respect to the acquisition and use of CASE tools". This is a fundamental contribution insofar as there are no prior studies on these indicators in Venezuela.

The results of the field study led to the conclusion that the proposed indicators reflect the realities faced by Venezuelan production sectors, as far as IS-development with CASE tools is concerned. The indicators pointed to the strengths and weaknesses presented by the organizations in different productive sectors, by taking a "snapshot" of these companies, so that they may count on a reference framework for taking decisions as to the aspects that must be improved upon, reinforced and/or modified.

Organizations using CASE tools for the IS-development exhibit certain conditions that facilitate the adoption and use thereof as a result of changes they have had to undertake and carry out through the incorporation of IS and IT to their organizational environment and particularly due to the experience the organizations have had with CASE tools. A summary of the more important aspects characterizing Venezuelan organizations, which have had success in adopting and using CASE tools, is as follows:

- The IS developed and the IT adopted by organizations have had a positive impact; thereby generating a favorable attitude towards technological innovations.
- Organizations have a clear awareness as to the need for counting on quality IS to improve productivity and to support decision-making processes.
- The upper management levels in the organizations and the management of IS-developing units support all processes related to technological innovations, especially those related to updating HW and SW and those referring to the implementation of technological innovations.
- The organizations are convinced of the importance of IS and IT to develop a competitive edge.
- IS-developing units count on solid project management, where the active participation of IS-developers in making decisions is standard and training plans support the development of the capabilities and skills of the analysts.
- When organizations decide to adopt a technological innovation and particularly a CASE tool,

they take into account the compatibility of this tool with the installed technological infrastructure and with existing work processes (methods and/or methodologies) in order to fulfill organizational objectives.

6 Recommendations and Future Research

This research proposed and validated a series of organizational indicators for the adoption and use of CASE tools in Venezuelan organizations, but can be used in any organizational context and country. The following questions remain nevertheless unanswered: What are the relationships existing among the proposed indicators? What are these relationships like? Further research could propose and take measurements by means of a research model that could explain the relationship among the indicators in a quantitative manner. Other future research could attempt to combine the results of this research with the formulation of technological indicators presented by Díaz et al. [11] and applied by Rojas et al. [26], in order to obtain a global vision of the problem for the productive sectors in the country.

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