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# A Systemic Methodological Framework for IS Research

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**ABSTRACT**

When speaking about Research, it is mandatory to deal with the method to guide the knowledge construction process. Making a systematization and consolidation to facilitate this process is not a simple task. Taking this into account and also considering: the results of any research activity should be applied to its context; information systems (IS) are embed in complex organizational systems; each organization has its own characteristics; and IS must meet those particular needs; the goal of this paper is to propose a systemic methodological framework for IS research, based on the Action Research method and combined with DESMET methodology. This framework is systemic because: it considers the contextual conditions of the research, it is flexible respect to the studied object, and it is able to import or exclude techniques, instruments or relations in every instantiation. More than thirty case studies have been applied and five research areas have been consolidated.

**Keywords**

Framework, Research, Systemic, Action Research

## INTRODUCTION

The Information Systems Research Laboratory (LISI) is a research group of the Simón Bolívar University (USB), whose main area of work is concerned with the study of the technologies produced and the progress made in the field of Information Systems (IS) development. In addition to this, it endeavors to create an infrastructure of material, technological and human resources to facilitate research and interaction with the latest progress made in the field of IS (LISI, 2004), both efficiently and effectively. LISI's mission is translated in a set of objectives which drives all the activities undertaken (LISI, 2004) such as: the study of Information Technologies that support the IS development process, and the guidelines for action that support firms in the Information Technology Sector.

To achieve those goals, beginning in 1995, LISI implemented the Action Research method, given that it is ideal for studying IS, as affirmed by Baskerville (1999): "the Action Research domain is clearer when human organizations interact with IS and when they are more oriented towards the understanding of a complex human process than towards prescribing a universal social law" LISI has led more than thirty (30) Case Studies and consolidated twelve (12) research areas; those are reflected in numerous undergraduate and postgraduate degree theses and national and international publications, as well as in the preparation of human resources of different universities in Venezuela (USB, UC, UCAB, UCV). At the same time, the Venezuelan productive sector has benefited from these studies by participating in them and obtaining information related, among other things, to their processes, strengths, weaknesses and products. After the Introduction, this article briefly describes the Action Research method, the DESMET methodology and the Case Studies. The description of a systemic methodological framework adopted by LISI is presented later on. The research areas being undertaken by LISI, and the results obtained from implementing the framework suggested by each of these, are also described. The paper ends with the Conclusions.

## BACKGROUND

The methodological framework suggested is based on: Action Research (AR) method (Checkland, 1993), the DESMET methodology (Kitchenham, 1996) and the Case Studies (CS).

The framework suggested by LISI is the result of an evolution process in which two maturity or knowledge construction stages can be identified through lessons learned. The first, within the context of the implementation of the AR method with Case Studies; and the second, when DESMET is incorporated to the Evaluation phase of the AR method.

### Action Research Method

The classic research methods such as field studies and, more specifically, exploratory studies, are not easily adaptable for use with the type of research undertaken by LISI. It is thus necessary to use other research methods that enable "soft" problems to be studied. Checkland defines a "soft" problem as: *"a problem related to the manifestations of the real world of human activity systems, characterized by a sense of maladjustment, that eludes the precise definition between what is perceived as reality and what is perceived as what reality could be* (Checkland, 1993). So, clearly research in the field of IS is "soft." According to Baskerville (1999): "the Action Research domain is clearer when human organizations interact with IS and when they are more oriented towards the understanding of a complex human process than towards prescribing a universal social law." On the other hand, the basis of AR is that the process of Human Activity Systems can be studied better if changes are introduced in these processes and the effects produced by these changes are observed. This is because human organizations, in a context where they interact with IT, can only be understood as a total entity (Baskerville, 1993).

So, the ideal domain of the AR method is characterized by a social configuration where (Baskerville, 1999):

- The researcher is actively involved, with benefits expected for both researcher and organization. Since in our case, one of the researchers works in the organization where the research's object is evaluated.
- The knowledge obtained can be applied immediately, not separately from the observer but as an active participant hoping to use any new knowledge based on a clear and explicit conceptual framework. One of the advantages of our investigation is that the results can be immediately fed back into the organization where the study is conducted.
- Research is a process (generally cyclical) that links theory to practice (Baskerville, 1996).

The most frequent description of AR was proposed by Susman and Evered (1978), where the cyclical process is detailed in five phases (see Figure 1):

- *Diagnosing*: Identification of the primary problems that means the underlying reasons for which the organization wants to change.
- *Action Planning:* Stipulates the organizational action through which the principal problems should be eliminated or improved.
- *Taking Action:* Implements the action planned. The participants and researchers cooperate in active intervention in the client organization, channeling certain changes.
- *Evaluating*: The researcher and the participants evaluate the results in order to determine whether the theoretical effects of the action were accomplished and if these effects solved the problems.
- *Specifying the Learning:* the researchers must specify the knowledge acquired based on the results of the evaluation.

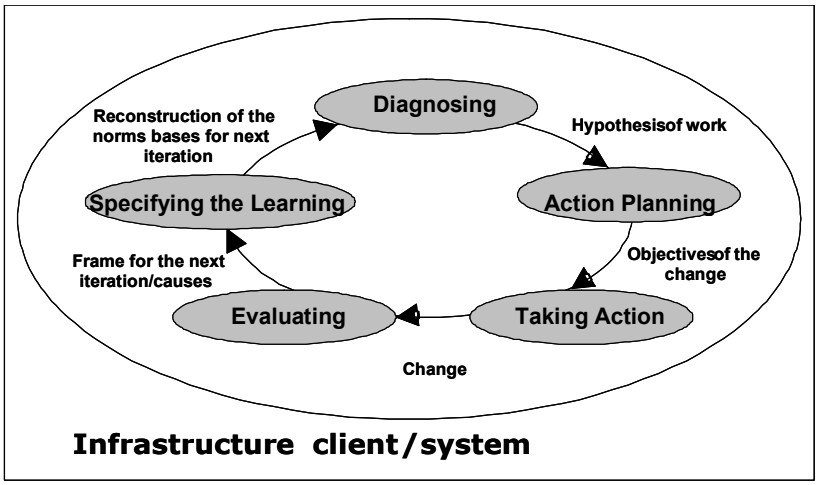


**Figure 1. The Action Research Cycle.**
Source: Adapted from Baskerville (1999).

Thus, AR supports a qualitative research process that inspires soft systems methodologies to enable us to make judgments about the results of research from different points of view or angles (Abu-Samaha, 2003). Natural Science Methods are very difficult to apply to human affairs. Since the field of information provision belongs to the domain of human affairs, AR is a relevant way of investigating it and the issues surrounding it. (Checkland and Holwell, 1998). Therefore AR will be the reference for the framework proposed. This is where the AR application materializes as a coherent framework that gives it consistency.

#### DESMET Methodology

The objective of an evaluation methodology is to reduce the risk of selecting an invalid or incorrect evaluation method (Kitchenham, 1996b). In the methodological framework, the DESMET methodology will be useful in the Evaluation Phase of the AR method. DESMET Methodology arises from the necessity of the software engineers to count on a method to evaluate methods and tools used in this area (Kitchenham, 1996a). The authors try to give support, among other rolls, to academic investigators who develop or investigate a new method.

With the exception of formal experiments, DESMET evaluations are context-dependent, which means that we do not expect a specific method/tool to be the best in all circumstances, what reveals its systemic character. DESMET constitutes an important methodology since it can be used by academia institutions interested in experimental software engineering (Kitchenham, 1996a).

DESMET identify nine (9) different evaluation methods (Kitchenham, 1996a):

- *Quantitative Experiments:* an investigation of the quantitative impact of methods/tools organized as a formal experiment.
- *Quantitative Case Studies:* an investigation of the quantitative impact of methods/tools organized as a case study.
- *Quantitative Surveys:* an investigation of the quantitative impact of methods/tools organized as a survey.
- *Feature Analysis- Screening mode:* a feature-based evaluation done by a single individual who not only determines the feature to be assessed and their rating scale but also does the assessment.
- *Feature Analysis- Experiment:* a feature-based evaluation done by a group of potential user who are expected to try out the methods/tools on typical tasks before marking their evaluations.
- *Feature Analysis- Case Study:* a feature-based evaluation performed by someone who has used the method/tool on a real project.
- *Feature Analysis - Survey:* a feature-based evaluation done by people who have experience of using the method/tool, or have studied the method/tool.
- *Qualitative Effects Analysis:* a subjective assessment of the quantitative effect of methods and tools, based on expert opinion.
- *Benchmarking:* a process of running a number of standard tests using alternative tools/methods (usually tools) and assessing the relative performance of the tools against those tests.

DESMET suggests a set of technical criteria that affect the selection of the evaluation method. These are: the evaluation context, nature of the impact, nature of the object evaluated, the impact's reach, the maturity of the item, the time spent on learning and the maturity of the evaluating organization. It also suggests three (3) restrictions that can influence the final selection of the evaluation method, such are (Kitchenham, 1996b): the time required for different evaluation options, the trust that the user has in the results of an evaluation and the cost of an evaluation. All these criteria stress systemic characteristic of DESMET. In other words, it supports the choice of evaluation method, not only by considering the internal aspects of the object evaluated, but its contextual aspects, focusing even more on the relations between the researchers and the object investigated.

### Case Study

In the field of methods and tools evaluation, the CS is a means for enabling them to be evaluated as part of the normal software development activities undertaken by an organization. The main benefit of the CS is that it enables the effects of new methods or tools to be known when they are applied in real situations. A "real" project that has been used in a CS is referred to as a pilot project or host project. Case study development is a well-established and widely-used research method in social sciences and management fields (Tellis, 1997). IS researchers also recognize it as one of the most important ways in which IS theories are developed or confirmed. (Klein and Myers, 1999) (Pare and Elam, 1997) (Trauth, 2001). There are seven (7) activities for designing and managing a CS (Parikh, 2002): Scanning and preliminary investigation, Selecting the research topic and subject organization, Collecting and analyzing secondary data, Collecting and analyzing primary data, Overall assessment, Structuring and Preparing the write-up.

Kitchenham (1998a), proposes four criteria for designing quality in research and validating the conclusions of a CS. These are:

1. Validations in the Construction: establishing operational measure for the concepts that have been studied.
2. Internal Validations: establishing causal relationships and distinguishing illegitimate relationships.
3. External Validations: establishing the domain for which the findings in the research are generalized.
4. Experimental Reliability: demonstrating that the study can be repeated with the same results.

Note that a CS also fosters cooperation between researchers and the organization in which the case was developed. With the analysis of the data and the preparation of the report, the reflection of what was investigated was reaffirmed. The context in which the case is undertaken will be strongly influenced by the specific experience of the application of the action; this reaffirms its social focus. All of this highlights its systemic nuances.

## SYSTEMIC METHODOLOGICAL FRAMEWORK

According to Abu-Samaha (2003) the literature review on IT evaluation shows a significant bias toward using economical and tangible measures that represent the management's view of what is "good" and "bad". Reith, quoted by Abu-Samaha points out that the purpose of the evaluations is to provide feedback (straightforwardly). Finally, Ezingeard, also quoted by Abu-Samaha, reiterates the importance of evaluating not just the system but its impact on the organization. All this led to the proposal of a framework inspired by AR since the research conducted by LISI is aimed at the study of a Human Activity System; in other words "*on a number of activities connected as a result of some principle of coherence"* (Checkland, 1993); (Checkland and Scholes, 1994); (Checkland and Holwell, 1998). Furthermore, the incorporation of the DESMET methodology gives thoroughness to the choice of the evaluation method. A methodological framework is given below (See Figure 2).

1. **Documentary and bibliographical research to make up the theoretical referential framework**: this activity corresponds to the revision of the bibliographical material related to the topic investigated. It is extracted from different available sources (electronic included) with a view to building a conceptual base that would serve as a reference for the research work. The products obtained include: a set of social, technological and organizational aspects to be considered in the research.
2. **Analysis of the background:** based on the experience of companies around the world on the topic investigated, during this activity critical success factors, possible reasons for failure, best practices and, performance measures that may be useful in the research can be established, in addition to open results and/or problems that guide the objectives of the research.
3. **Formulation of the objectives and scope of the research**: During this activity, the scope of the research is formulated. Its inputs are the results of the two previous activities.
4. **Instantiation of Action Research**: in this activity the framework is specified, considering aspects related to the purpose of the research.

5. **Design of the product to meet the objectives:** this is the first activity in the phase *Taking Action*; in which, based on the previous activities, a product proposal is designed (for example: a method, a system, a model, etc.) in a test version, as well as the considerations of the context in which it must be applied.
6. **Analysis of the context**: this is the second activity of the *Taking Action* phase; the technical criteria proposed by DESMET are analyzed, in order to decide on the right evaluation method to be applied to the product of the previous activity.
7. **Application of the DESMET methodology: is** last stage of the *Taking Action* phase; during this activity the DESMET evaluation that adapts best to the research was selected so as to be able to evaluate the product proposal.
8. **Evaluation of the product proposal**: first activity of the *Evaluating* phase; where the product proposal is evaluated using the method selected according to DESMET in the previous activity.
9. **Analysis of the Results**: second activity in the *Evaluating* phase; consists of studying the results based on the objectives set in the research, in terms of: the application of the evaluation method proposed by DESMET, the tangible products achieved and the changes in the environment. By incorporating the changes needed, a second formal version of the product proposal is obtained for future iterations. In the case where the results were not satisfactory it is necessary to go to activity 10 to review the design.

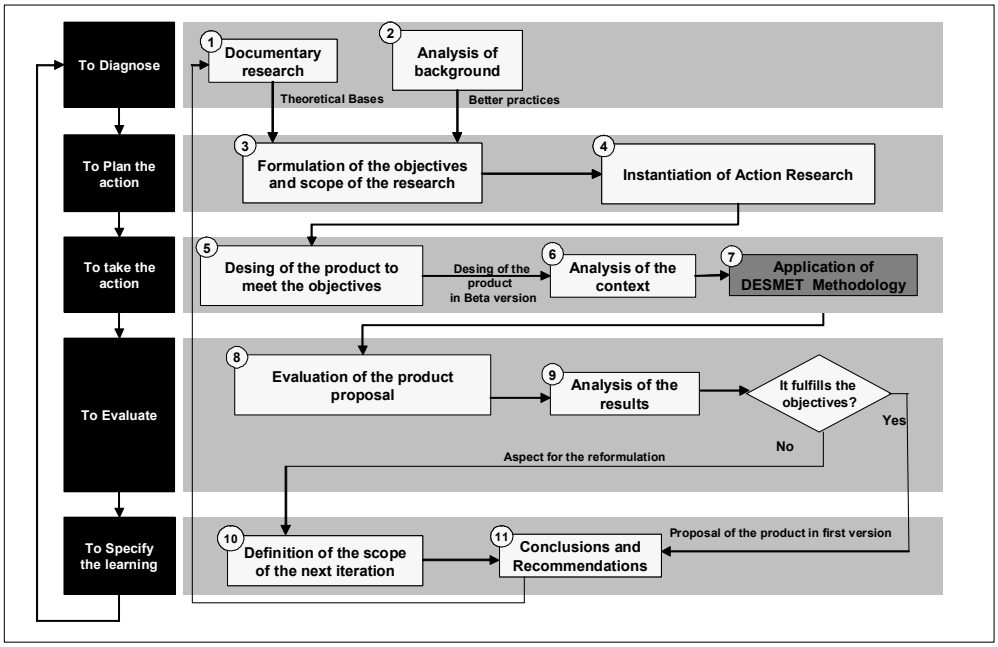


**Figure 2. Methodological Framework Proposed.**

10. **Definition of the Scope of the Next Iteration:** this activity can take place in the *Specifying the Learning* phase, if the results of the evaluation were not satisfactory. By so doing the structure is established for a new iteration of the AR cycle.
11. **Conclusions and Recommendations**: in this activity into the *Specifying the Learning* phase, the conclusions on the product proposal already applied in the event that the results are satisfactory are established; otherwise the scopes of the next interaction of the AR cycle are reinforced.

The framework proposed supports the cooperation process between the researchers and the people from the context investigated; its approach is social, open to the application of the evaluation method that best adapts to the circumstances, and fosters a deliberate reflection of the knowledge built.

The methodological framework proposed also has the following systemic characteristics:

- Being inspired by the AR method, it inherits its systemic characteristics.

- In activity Nº 4; there is an instantiation which depends on the context. This activity enables the research to be feasible (Beer, 1970).
- DESMET methodology stresses that the evaluations are not independent of the context. This is highlighted by activity Nº 6 which makes the conditions of the context become incorporated during the evaluation.
- Within the framework, basic relations between the activities are proposed; however, they can be modified. These changes are introduced in activity Nº 4.
- At least two feedback links are foreseen; this guarantees that it will be iterated as often as necessary in order to attain the goals of the research. This strengthens its feasibility.

All the foregoing makes the framework proposed systemic, because it is open to the conditions of the research context, its flexibility vis-à-vis the object investigated and due to its ability to import or exclude techniques, instruments or relationships every time an instantiation takes place.

## FRAMEWORK APPLICATION IN LISI'S RESEARCH AREAS

As can be seen in Figure 3, LISI has reported and organized its research topics through 12 fundamental areas, oriented toward specific solutions and leading to a quality Information Systems Development Process in keeping with Venezuela's current reality.

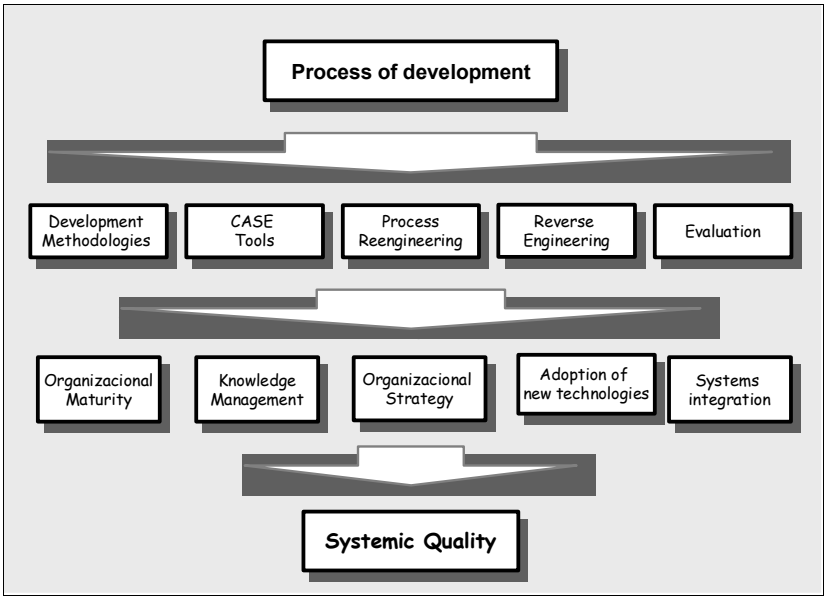


**Figure 3**. **Schematic Diagram of LISI's research areas**.

Source: LISI (2004).

In each research area, LISI seeks to develop Projects that enable effective knowledge to be generated for its practical use. The results obtained are disseminated through publications in specialized magazines and journals, conferences, seminars, workshops, etc., aimed mainly at the information technology sector.

By applying this framework, LISI has managed to generate knowledge and reflect it in:

- The formulation of referential frameworks for different productive sectors in the country, regarding the state of IS and the adoption of IT.
- The generation of more than 70 national and international publications,
- The undertaking of 8 research projects.
- Participation in the design and development of the USB's DID-KMS.
- The design and development of SSD-LISI to select the CASE tools.
- The development of the SIGA-USB system.

Accordingly, through the application of this methodological framework, thirty (30) Case Studies have been conducted in the country in the different sectors of the economy: academic, government, banking, marketing, consulting and development, oil and services, among other sectors. During that time, the level of maturity of the methodological framework was enhanced and the context within which the study was carried out was adapted. The incorporation of the DESMET methodology formalized the selection of the most appropriate evaluation method and the specification of the learning made it possible to disseminate the lessons learned within the context of the study. Table 1 shows the research in which the framework proposed has been applied; in this one it can be seen that most of them were carried out in the Evaluation Phase with case studies.

| **Research Area** | **Quantity** | **Publication** | **Evaluation Type** |
|---|---|---|---|
| Methodology | 02 | *** "Methodological Approach for developing a KMS:a case study" Grimán A., Pérez M. ,Rojas T**. CLEI Electronic Journal .Vol. 5, Mayo 2002<br><br>*** "Feature Analysis for Quality-Based Architectural Design Methods" Losavio F., Chirinos L., Pérez M.** Jornadas Chilenas de Computación 2001. Punta Arena, Chile. Noviembre 2001. | **Feature Analysis** |
| CASE Tools | 04 | *** "Proceso Sistémico para la Selección de Herramientas CASE" Mendoza, L. y Pérez, M.** AsoVAC 2002. Barquisimeto, Venezuela. 17-22 de noviembre de 2002.<br><br>*** "Organizational Indicators for CASE Tools Selection: A Case Study".Mendoza, L.; Rojas, T.; Perez, M.** Revista Colombiana de Computación Vol. 2, N° 2 Diciembre 2001<br><br>*** "Características de las empresas venezolanas que han sido exitosas en la selección de Herramientas Case" Mendoza, L.; Pérez, M. y Rojas, T.** ASOVAC 2001. San Cristóbal, Venezuela. 18-23 Noviembre de 2001.<br><br>*** "Aplicación de un Modelo de Calidad para la Evaluación de Herramientas CASE adaptado al Estándar Internacional ISO/IEC 14102".** Diaz, M.; Perez, M., Mendoza, L; Rojas, T. 1ras Jornadas Iberoamericanas de Ingenierías de Software e Ingeniería del Conocimiento (JIISIC 2001) Buenos Aires, Argentina. 2001 | **Case Study**<br><br>**Case Study** |
| Evaluation | 02 | *** "Evaluación de Arquitecturas de Software para un KMS bajo un Enfoque de Calidad" Angulo, A.; Vargas, X.; Pérez, M. y Grimán, A.** AsoVAC 2002. Barquisimeto, Venezuela. 17-22 de Noviembre de 2002.<br><br>*** Architectural Quality in Development Process: A case study**" Grimán, A. Pérez, M., Universidad Simón Bolívar. | **Case Study** |
| Integration | 04 | *** "Evaluating Critical Success Factors According to Integration Maturity Level" Mendoza, L.; Montoya, H.; Pérez, M. y Grimán, A.** Sixth Annual Conference of the Southern Association of Information Systems SAIS 2003. Savannah, USA. 7-8 de Marzo de 2003.<br><br>*** "Factors for Guaranteeing the CRM Strategy Implementation" Mendoza, L.; Marius, A.; Pérez, M. y Grimán, A.** Sixth Annual Conference of the Southern Association of Information Systems SAIS 2003. Savannah, USA. | **Case Study**<br><br>**Case Study** |

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| | | 7-8 de Marzo de 2003.<br><br>*** Orientaciones para la Selección de Tecnologías de Integración de Sistemas de Software" Perez, M.; Mendoza, L.; Carvajal, Y.** III Workshop de Ingeniería de Software Chillán, Chile - 3 al 8 de noviembre de 2003<br><br>*** "Modelos de integración: El Caso de las Organizaciones Venezolanas". Titaeva, I.; Mndoza, L.; Perez, M.** AsoVAC 2003<br>Maracaibo, Venezuela - 24 al 29 de noviembre de 2003 | **Case Study**<br><br>**Case Study** |
| Knowledge Management | 2 | *** Proposed Knowledge Reuse Model for Application in Venezuela".Rojas, T.; Pérez, M.; Rivas, L.** American Conference of Information Systems AMCIS 2003. Tampa, USA. August, 2003.<br><br>*** "Propuesta Metodológica para Gerenciar el conocimiento al implantar un ERP " Rojas, T.; Pérez, M. y La Rosa, D**. AsoVAC 2003. Maracaibo, Venezuela. 17-22 de noviembre de 2003 | **Case Study**<br><br>**Feature Analysis Case Study** |
| Systemic Quality | 10 | *** "Análisis del Impacto del Proceso de Desarrollo en las Características de Calidad del Software". Mendoza, L., Pérez, M. y Grimán, A**. 6º Workshop Iberoamericano de Ingeniería de Requisitos y Ambientes Software (IDEAS 2003). Asunción, Paraguay - 30 de abril a 2 de mayo de 2003.<br><br>*** "Modelo de Calidad (MOSCA) para Evaluar software de simulación de eventos discretos". Gladys Rincón, Maria Pérez, Sara Hernández y Marinelly Alvarez.** 6º Workshop Iberoamericano de Ingeniería de Requisitos y Ambientes Software (IDEAS 2003). Asunción, Paraguay - 30 de abril a 2 de mayo de 2003.<br><br>*** "Integration of Systemic Quality and the Balanced Scorecard" Juan Solano, María Pérez, Teresita Rojas, Anna Grimán y Luis E. Mendoza.** Revista: Information Systems Management 01/12/2002, Volumen 20, Issue/número 1, pp. 66 – 81.<br><br>*** "Medición de la Calidad de los Sistemas de Software: Caso Aplicación Web Bancaria" Fontcuberta, C.; Belfort, M.; Pérez, M. y Mendoza, L.** AsoVAC 2002. Barquisimeto, Venezuela. 17-22 de noviembre de 2002.<br><br>*** Instrumento de evaluación de software educativo bajo un enfoque sistémico" M.G.Díaz-Antón, M.A. Pérez, A.C. Grimán, L. Mendoza.** En el 6to. Congreso Iberoamericano, 4to. Simposio Internacional, 7mo. Taller Internacional de Software Educativo: Vigo, Nov 2002, Llamas M., Fernández M., Anido L. (Eds.) ISBN 84-8158-228-X, pág. 82, Universidad de Vigo, Servicio de Publicaciones. Colección: Congresos 37.<br><br>*** "Algoritmo para la Evaluación de la Calidad Sistémica del Software" Luis E. Mendoza, María Pérez, Anna Grimán y Teresita Rojas.** 2das. Jornadas Iberoamericanas de Ingeniería del Software e Ingeniería del Conocimiento (JIISIC 2002) Salvador, Brasil. Noviembre de 2002. | **Feature Analysis Case Study**<br><br>**Feature Analysis Case Study**<br><br>**Case Study**<br><br>**Case Study**<br><br>**Case Study**<br><br>**Case Study** |

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| | | *** "Quality Evaluation Framework: the Venezuelan case " T. Rojas, M. Pérez, L. Mendoza; A. Mejías**. AMCIS 2002. Dallas, USA. 3-5 August de 2002. | **Case Study** |
| | | *** "Evaluation of Environments for Portal Development: A Case Study" Luis E. Mendoza, Anna C. Grimán, María Pérez y Teresita Rojas.** Revista: Information Systems Management 28/02/2002, Volumen 19, Issue/número 2, pp. 70 – 84. | **Case Study** |
| | | *** "Indicators for the Selection of Software Quality Management Tools" Luisa A. de Luca, Luis E. Mendoza, María A. Pérez, Teresita Rojas.** CLEI 2001. Mérida, Venezuela. 24-28 septiembre de 2001. | **Case Study** |
| | | *** "Systemic Quality Model for System Development Process: Case Study" M. Pérez, T. Rojas, L. Mendoza, A. Grimán. USB.** AMCIS 2001.Boston, USA. 3-5 Agosto de 2001. | **Case Study** |

**Table 1. Research Areas in which the methodological framework proposed has been applied**

Source: LISI (2003).

Although it can be seen that the evaluation method most frequently applied is the CS, this is not institutionalized in the framework proposed, since DESMET methodology gives the evaluation a systemic character when the technical criteria are analyzed. It may be preferable to use another type of evaluation method, given the analysis of the context.

## CONCLUSIONS

In this article a methodological framework based on the AR method is proposed, incorporating the DESMET methodology in the evaluation phase to select the most appropriate evaluation method.

The methodological framework proposed is systemic because of the treatment given to the contextual aspects of the research and its flexible application vis-à-vis the object evaluated. It also allows the inclusion or exclusion of techniques, instruments and/or relationships each time it is instantiated.

The framework is flexible and suited to LISI's needs. In turn, it enables knowledge to be managed, constructed through the handling of the research conducted at LISI.

Its application has made it possible to take into account the knowledge constructed, obtained through over 30 application experiences.

The systematic application of this framework has made it possible to consolidate twelve (12) research areas that have produced several tangible results and, further, enable LISI to evolve as a research group that operates with the support of its environment.

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