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QUALITY EVALUATION FRAMEWORK: THE VENEZUELAN CASE

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Abstract

Quality must be an issue when software systems are mentioned. Quality applies both to the development processes and the resulting product. Whenever a customer is asked what is expected, one of the answers will always be "a quality product." Now this is only possible if quality is borne in mind right from the outset, and guaranteed throughout the development process.

The Information Systems Research Laboratory (Spanish acronym: LISI) which is a Venezuelan research center, has been proposed two separate quality models: one for the development process and another for the product (the system). Both of them offer advantages but they are not integrated. The purpose of this paper is to propose a formal integration of Process and Product Quality Models. The integration method Through Shared Concepts was applied and an Integrated Process and Product Framework Model with a systemic approach was obtained. Since the inputs for this integration were two models that have been proposed and instantiated in Venezuelan organizations, integration serves as a framework of reference for assessing quality in Venezuela.

Keywords: Information systems, development process, quality model, process quality, systemic quality

Introduction

Some software quality models focus on process quality and others on product quality (Ortega 2000; Ortega et al. 2000); nonetheless, both are closely inter-related, as can be seen in the Systemic Global Quality model, through the quality matrix, which suggests a balance between process and product qualities (Callaos and Callaos 1996; Voas, 1999).

Currently there are a Process Quality Model (Álvarez 2000; Pérez et al. 2001) and a Product Quality Model (Ortega 2000; Ortega et al. 2000) based on Callaos' Global Quality, which were developed by the Information Systems Research Laboratory (LISI) – a Venezuelan research center –; however, in order for the balance to be right, they must be formally integrated. The **objective of this article is to describe the first version of a formal proposal to integrate the process and product quality models using a systemic approach.** This integration enables a systemic vision to be obtained by formalizing the synergy between the models, complemented by the integrative vision of the project in which these models are present.

This research is currently at the Research in progress stage, so its scope only goes as far as the formulation of the proposal of the integration model. This is the reason, to complete this research, we are proposing the application of the DESMET Method (Kitchenham et al. 1997) (especially designed for selecting methods that enable software engineering tools and methods to be evaluated), in order to determine the best evaluation method for validating the integrated model. With this activity, and once the research has been conducted, a more refined model will be available to help Venezuela's private and public sector measure the quality of the systems they use or buy for their activities.

Background

Software Quality

Quality is a commonly used term in all areas of industry and there is consensus that it is a determining factor in the success of any organization and/or product (David 1997). It is important then to endeavor to establish clear quality concepts and delimit them to the scope of system quality, taking into account the various relationships between process quality and product quality. A systemic quality approach (Callaos and Callaos 1996) enables the different dimensions of system quality (Process and Product) to be balanced, taking into account the users and the clients, as shown in the Systemic Quality Matrix.

Quality Models

With a view to determining more specifically the attributes that guarantee process and product quality based on the systemic quality approach, LISI proposed two quality models with a systemic approach: one of them **Product-oriented** (Ortega 2000; Ortega et al. 2000), the other **Process-oriented** (Álvarez 2000; Pérez et al. 2001). The first model links the ideas of the ISO/IEC 9126 standard of the product and Dromey's Model. The result is a set of attributes required by any quality system, with the factors that influence them. They are broken down into four different groups represented by the four dimensions of Callaos' quality approach (Ortega 2000; Ortega et al. 2000). This model is shown in Figure 1.

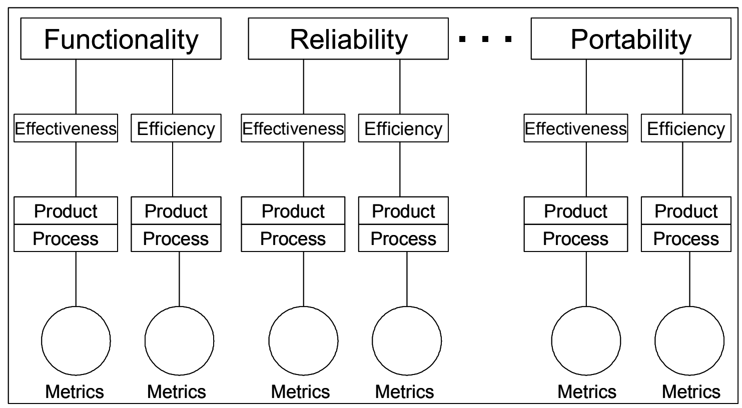

Figure 1. Software Product Quality Model
(Ortega 2000; Ortega et al. 2000)

A case study was carried out to validate this model in which two software products used by the Management of Risks organization belonging to a bank in Venezuela (Ortega 2000):

- Special Monitor System: this system makes pursuit to the clients of risk in those that circumstances are given or alert signs that can affect to the behavior normal and/or punctual payment of their operations appear. Once detected the situation, the function of the system should be completed with actions that they allow to correct or to avoid the loss of the risk with anyone of the clients. For that, pursuit is not only made but rather also takes action.

- Valuation System: internal administration system measures in an approximate way the quality of the company and of the risk that they have with it, with the perspective of establishing their current and future capacity of execution of their payment commitments.

Two Project Leaders, two Product Analysts/Developers and two Strategic Users participated in the application of this model. This sample was determined based on the two referred, being this way evidenced the relevance that has the element project in the integration of the models (Ortega 2000). The case of study where the Product Quality Model was applied indicates that the improvement in the audit process get a better product. The relevance of this research resides in evaluating a software product considering aspects of the process that impact direct or indirectly on the characteristics of quality of the product.

The second model developed at LISI integrates the systemic quality approach with the characteristics present in the SPICE process model. It consists of a 5 level hierarchy: **Life Cycles, Categories, Principles** and **Base Practices**, which are a set of organizational guidelines must implement to achieve a principle. This model guarantees the right equilibrium between efficiency and effectiveness through a balanced proposal of base practices (Álvarez 2000; Pérez et al. 2001). The model can be seen in Figure 2.

This model was also validated through a case study in two Venezuelan organizations that develop systems (Álvarez 2000; Pérez et al. 2001):

- Organization A: characterized by being a small company, specializing in the development of automation solutions for the telecommunications industry. Its field of action is centered on the development of products and services for small and medium enterprises, through open, ready-to-run software packages.

- Organization B: is a large company that has become consolidated over the years and specializes in the financial area. The field of action of systems development is limited to one departmental unit.

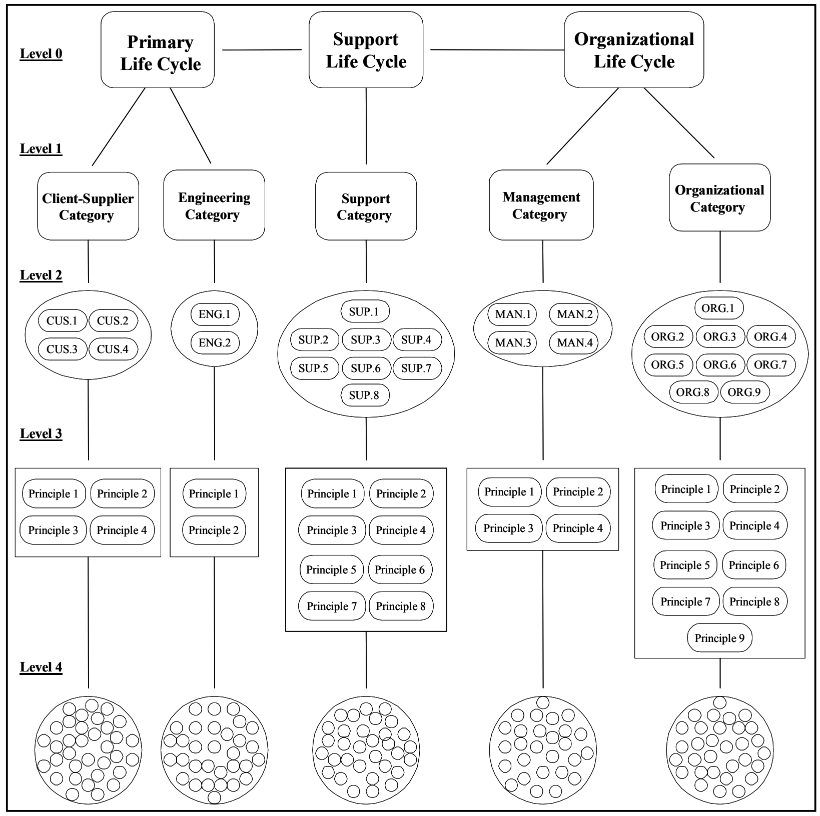

Figure 2. Process Quality Model
(Álvarez 2000; Pérez et al. 2001)

Three categories of people participated in the application of this model: Analysts, Project Leaders and Managers. A total of three people were interviewees per organization units (Álvarez 2000). The case of study where the Process Quality Model was applied had the following results:

- Organization A has implemented the Customer-Supplier (CUS), Engineering (ENG) and Management (MAN) categories, though not effectively. The Support (SUP) and Organizational (ORG) categories have still not been implemented. Organization A lacks quality in the development process since none of its categories is fully satisfied. This implies that there is anarchy in the way the projects are implemented; leading to unpredictable results as far as implementation time and the results obtained are concerned.

- Organization B has implemented the Customer-Supplier (CUS) and Engineering (ENG) categories, since the level of satisfaction of both are above 75%. Even though they were implemented, the Support (SUP) and Management (MAN) categories have some effectiveness problems, and the Organizational (ORG) category has not been implemented. Organization B has a basic type of quality, since the Customer-Supplier and Engineering categories are met; meaning that the primary life cycle is fully met.

Information Systems Development Projects

In all quality approaches, software quality included, the organization needs to be seen as an organic rather than a mechanical organization. It has the resources, the ideas and the efforts required to transform inputs into quality goods and services. So, the characteristics and technologies needed to attain this type of approach must be determined. This is why the **project** is considered the organizational element through which software development is managed (Jacobson et al. 1999). According to authors Yourdon (Yourdon 1999), Jacobson (Jacobson et al. 1999), Clements (Clements 2000) and Pressman (Pressman 1998), the **project** consists of the following elements: *Inputs:* requirements (needs, quality), resources (time, cost, people), objectives, business rules; *Process:* workflow, software engineering paradigm, cultural determination process, organizational learning process; *Outputs:* Product, goals met; this includes the process and the product which have an impact on the organizational as well as the business environment (Yourdon 1999). So, the project can be considered **as the system that defines the context of the process and product quality models respectively.** It's a concept that is not taken into account in the process and product quality models developed by LISI. Kitchenham considers the project as a domain in which a coherent set of data with real project values is associated with real project values, instantiating a development model (Kitchenham et al. 2001). Thus the project can be considered an instance of systemic quality in a quality-oriented development model.

The projects developed in our country have dimensions that have already been evaluated by the models proposed in the previous sections, hence the need for their formal integration to provide Venezuelan organizations that develop software systems with an evaluation tool that takes into account both the software product and its development process. On the one hand, the Product and Process Quality models meet the demands of the systemic approach proposed by Callaos, although they still need to be integrated, because if they remain separate it will be impossible to have a global vision of the synergy between them. In order to achieve integration, a strategy needs to be established. According to Whitten, integration strategies can be (Whitten et al. 2001): “Top-Down,” which goes from the general to the specific; “Bottom-Up,” going from the specific to the general; “Big-Bang,” where components are tested as a final system; and “Sandwich,” which combines a Top-Down strategy with a Bottom-Up strategy to make a Sandwich approach. The next section presents the methodology that was followed in order to integrate the quality models.

Integration Methodology

Initially the Top-Down integration strategy was applied as it has the advantage of being simpler to apply and less time taking, as well as providing results with a global vision of the integrated model. Nevertheless, the level of abstraction handled is too high to be able to evaluate the integration between the models proposed by LISI, since although it gives a general vision of the systemic quality, it is hard to set determine specific courses of action that enable it to be implemented in a real case. It must therefore be complemented by Bottom-Up integration. This strategy enables the integration sequence to be controlled and planned in order to obtain an integrated model with a higher level of detail. In each of the previous strategies, the integration of models Through Shared Concepts was applied as follows (Pohl 1999): (1) establish the integration context: this consists of determining which are the basic conditions for integration, identifying the theoretical bases that make up the context of each model and choosing the integration strategy to be applied; (2) establish the key concepts for each model and their relationships; (3) identify the concepts shared by each model; in the event of a naming conflict, apply synonyms or homonyms, as appropriate (Elmasri and Navathe 2000); and (4) integration of models Through Shared Concepts. Figure 3 shows the flow chart for the integration method (A and B represent the models to be integrated).

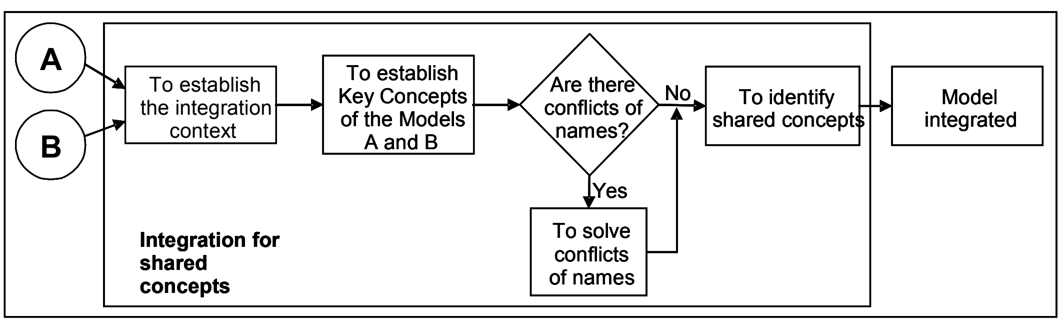

Figure 3. Flow Chart of the Method of Integration through Shared Concepts

In summary, the integration Methodology following and applied in the next section was:

1) To apply the Top-Down strategy, integrating the models Through Shared Concepts:
   1.1) To establish the integration context.
   1.2) To establish the key concepts of each model and their relationships.
   1.3) To identify the concepts shared by each model.
   1.4) To integrate the models Through Shared Concepts.

2) To apply the Bottom-Up strategy, integrating the models Through Shared Concepts:
   2.1) To establish the integration context.
   2.2) To establish the key concepts of each model and their relationships.
   2.3) To identify the concepts shared by both models.
   2.4) To integrate the models Through Shared Concepts.

Proposal for the Integrated Process/Product Quality Model

Top-Down Strategy

The purpose of applying this strategy is to determine the relationships and shared concepts of the dimensions of systemic quality at a theoretical level.

(1) Establish the integration context: The theoretical basis for the integration context consists of *Systemic Quality,* reflecting eight classes of quality, represented by Callaos' Systemic Quality Matrix (Callaos and Callaos 1996). These can be summarized as Process Quality (Process Effectiveness and Efficiency) and Product Quality (Product Effectiveness and Efficiency) from the customer's and the user's points of view. There is also the *Software Development Project,* which includes both efficiency and effectiveness (Callaos and Callaos 1996) and in turn has: **inputs** (requirements, quality, time, cost, people, objective, business rules); **processes** (workflow, software engineering paradigm, cultural determination process, organizational learning process) and **outputs** (product, meeting goals) (Yourdon 1999; Jacobson et al. 1999; Clements 2000; Pressman 1998)

(2) Establish the key concepts of each model and their relationships: Figure 4 shows the model of the concepts that integrate Process Quality and Product Quality models, and their relationships, through the OMT notation (Rumbaugh 1991), according to the definitions of Process Effectiveness and Efficiency, based on Efficiency = Output/Input and Effectiveness = Outputs/Objectives (Rojas and Pérez 1995). These are shown in Figure 4 as aggregations, which are a special association case used in the OMT notation (Rumbaugh 1991). Similarly, the relationship between the Process / Product and the other elements in the Figure 4 is one of aggregation. Figure 4 also shows the inheritance relationships between the Customer and User sub-class and the People super-class. Figures 4 represent the models under a common notation that prepares them for integration.

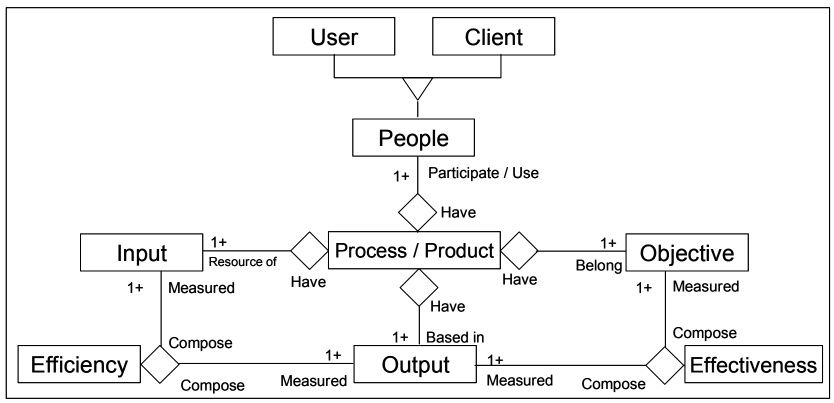

Figure 4. Process and Product Quality Models Concepts

(3) Identify the concepts shared by each model: the concepts shared by the two models are: Input, Efficiency, Output, Effectiveness and Objective.

(4) Integration of the models Through Shared Concepts: Figure 5 shows an integrated model of the concepts that make up systemic quality. **This integration indicates which are the basic concepts that an integrated process and product quality model should have at a conceptual level;** systemic quality is instantiated there through the project which contains the elements of the faces of the systemic quality matrix, including the human dimension, taking customer and user intervention into account.

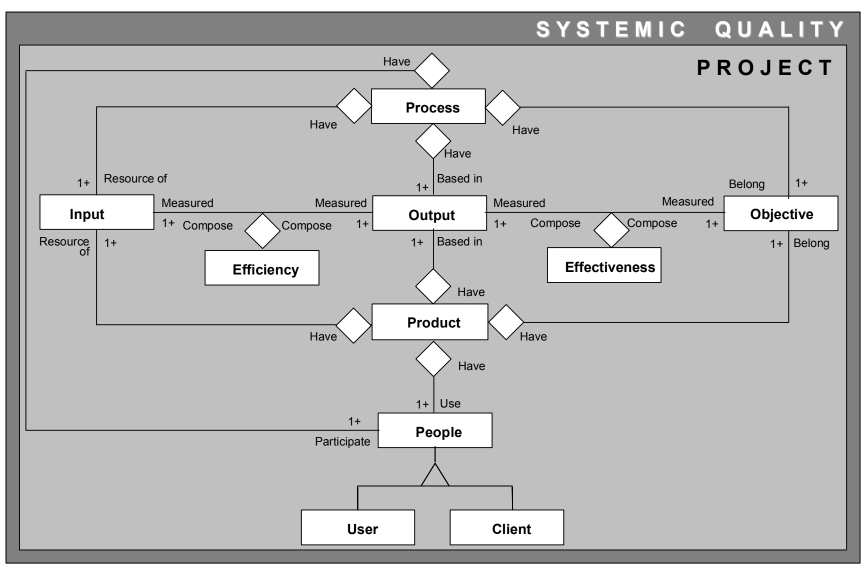

Figure 5. Integrated Model of Systemic Quality Concepts

Bottom-Up Strategy

The purpose of applying this strategy is to achieve the integration of the process and product quality models proposed by LISI. This strategy enables the integration sequence to be controlled and planned in order to obtain an integrated model with a higher level of detail.

(1) Establish the integration context: The context for achieving the integrated model is the union between the contexts of the process and product quality models. On the one hand there is a process-oriented approach in which process effectiveness and efficiency are distinguished; this is also present in the software development project. Thus the basic conditions of the integration context are systemic quality and the software development project (See Figure 6).

(2) Establish the key concepts of each model and their relationships: Five levels are distinguished in the Process Quality evaluation model (Álvarez 2000; Pérez et al. 2001); these will be taken into account as key concepts. They are: **Life cycles**, **Categories, Processes, Principles** and **Base Practices** (See Figure 2). In the Software Product Quality Model (Ortega 2000; Ortega et al. 2000), which focuses only on estimating software product quality, and disregards the quality side of the process (Mendoza et al. 2001), product quality is seen as a set of internal properties and characteristics which determine its external quality attributes (Ortega 2000; Ortega et al. 2000). The following are distinguished as key concepts of the model: **External Attributes,** which focus on **Effectiveness**, such as Usability, Functionality, Reliability, Maintainability, Efficiency, Portability and they determine the quality of the product based on the **internal attributes,** which focus on **Efficiency**, such as requirements, design and implementation. For each external attribute, the relationships between product effectiveness and efficiency are established and the best metric for enabling the results to be evaluated is determined (See Figure 1).

(3) Identify the concepts shared by both models: When graphically reviewing the models in order to identify the shared concepts, these did not appear to be as obvious as in the Top-Down integration; however, in all cases there are naming conflicts that can be resolved by using synonyms to describe similar concepts (Elmasri and Navathe 2000). To do so, the shared concepts of the Top-Down integration were used (Objective, Effectiveness, Efficiency, Input, Output). They can be seen as synonyms that cover the key concepts of the process and product quality models at a higher level and are grouped into three Integration Areas, these being: **Objective**, in this area everything meaning object, end, attempt, purpose, goal, aim, intention and/or result in the two models is included in this area (Cabanella 1989), such as: levels 0 (Life cycle) and 1 (Category) in the Process Model and the general and specific objective of the Product, which are given by the ISO/IEC 9126 standard and Dromey's model; **Effectiveness/Efficiency,** this area includes everything connected with obtaining effectiveness and efficiency, such as: levels 2 (Processes) and 3 (Principles) in the Processes Model and the characteristics affecting effectiveness and efficiency in the Product Model; **Input/Output,** in this area level 4 (Base Practices) of the Process Model with the metrics of the product quality model.

(4) Integration of models Through Shared Concepts: Based on the integration areas that group together the shared concepts, we have:

- Objectives Area: On the Process Model side, the Categories (Customer/Provider, Engineering, Support, Management and Organizational); each of them comes from a life cycle, determining its intention; the categories in turn define each of the goals and objectives of the processes of the following level. On the one hand in the Product Model there are the External and Internal Attributes that determine the goals and objectives of the characteristics present in the Effectiveness/Efficiency area, as shown in Figure 6.

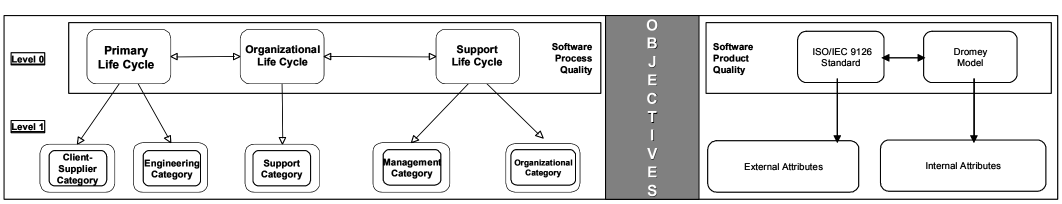

Figure 6. Objectives Area

- Effectiveness / Efficiency Area: On the Process Model side are those processes that are related to the Customer and Supplier, the Engineering processes, the Support processes, the Management Processes and the Organizational processes, which affect process effectiveness and efficiency. On the Product Model side are the product quality characteristics: Functionality, Reliability, Usability, Efficiency, Maintainability and Portability. Each of these attributes in turn is influenced by different internal attributes such as: computable, complete, and assigned, among others. Thus this area is made of the relationships between the processes of the Process Model and the set of characteristics of the Product Model (see Figure 7).

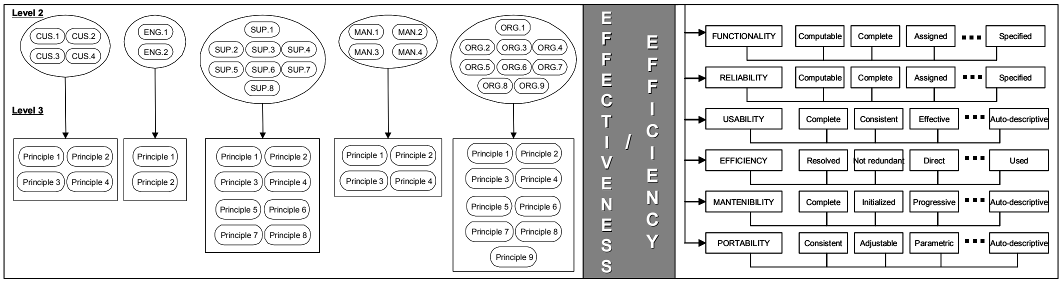

Figure 7. Effectiveness/Efficiency Area

Each process in level 2 affects the efficiency and effectiveness of the process and is related to a particular set of Product Model characteristics. This is based on the Product Quality Model research (Ortega 2000; Ortega et al. 2000), which provides a set of matrixes that show which processes influence process effectiveness and efficiency, and in turn which of those processes is related to the characteristics of the Process Model.

- Input / Output Areas: This area must show the relationship between the base practices of the process quality model and the questions that enable them to be evaluated, with the metrics of the product quality model (see Figure 8).

These relationships must reflect the systemic vision of the model by enabling positive and negative feedback links to be created between the inputs/outputs of one model and the inputs/outputs of the other. To do so means analyzing which Base Practices (Process) and which Metrics (Product) belong to the set of inputs and outputs of the integrated model, which will be the next step in this research.

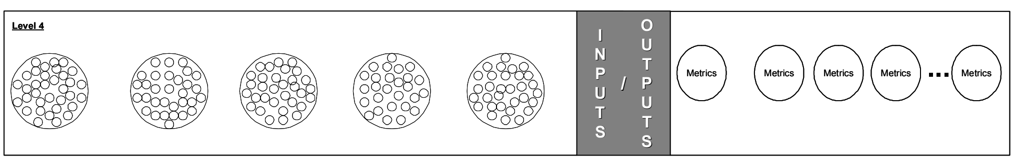

Figure 8. Input/Output Area

Figure 9 shows the model resulting from the integration of the Process Models and the Product Model Through Shared Concepts, which shows, in the first place, the **systemic quality** instantiated through the **project**, where both of them fit the context of the integrated model. The Process model (left), the Product model (right) and the integration areas: **Objective Areas**, **Efficiency / Effectiveness Areas** and **Input/Output Area** are all part of the project. The Figure 9 integrates the parts shown in the Figures 6, 7, and8, highlighting the common elements among the Process and Product models.

Conclusions

Integration of the product quality and process quality models proposed by LISI was undertaken using the method of integration Through Shared Concepts. In focusing a Top-Down strategy, the Shared Concepts that were later used in the Bottom-Up strategy could be identified. This paper is a preliminary report of research in progress and the next step will involve analyzing Base Practices and deciding which Metrics belong to the set of inputs and outputs of the integrated model based on Venezuelan reality. Later the Model proposed will be refined by applying the method suggested by the DESMET Method (Kitchenham et al. 1997). This step is extremely important to enable Venezuelan firms (public and private) to have a process through which they can measure the quality of their systems according to the country's reality.

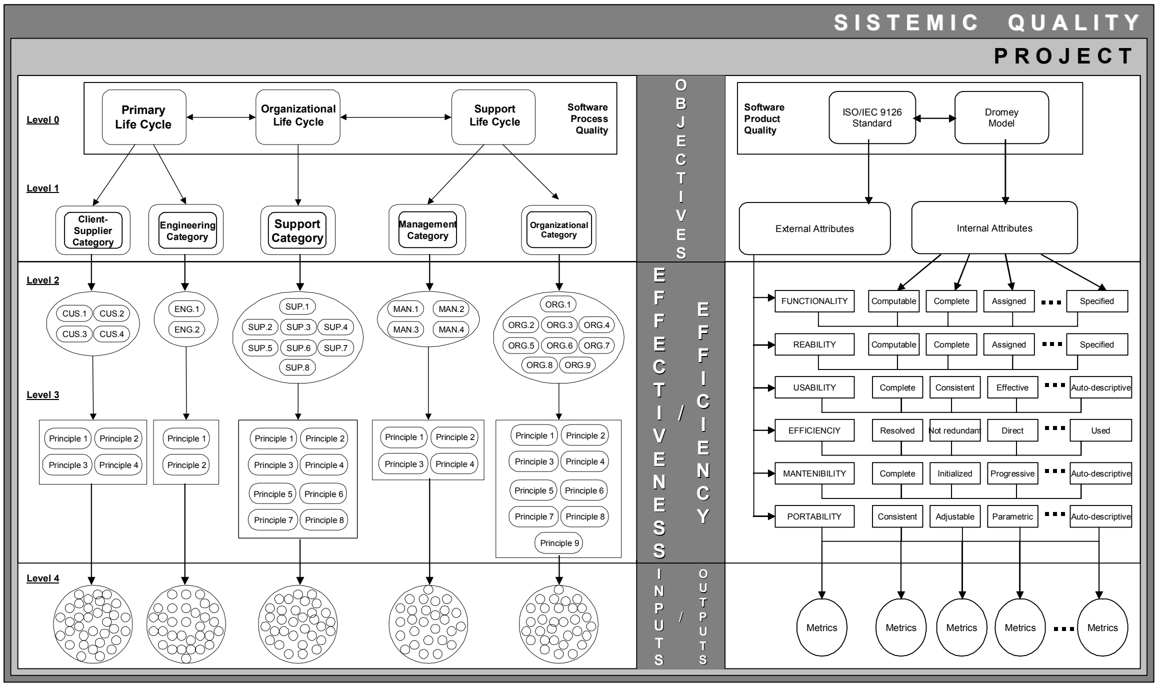

Figure 9. Integrated Model Through Shared Concepts

References

The references are available upon request from Teresita Rojas (trojas@usb.ve).