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Project Evaluation Methodology and Software Tool for Innovation Contests

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Abstract- In this research, job results are oriented to help organizational entities that need to select easily from a group, those projects developed with the highest quality. In addition, this system provides support and in project competitions authors establishes impartiality and the possible greater numerical accuracy. This paper proposes a methodology to evaluate innovation, creativity, and quality in a project competition, to determine the best ones. Authors implement them through a software application including a qualimetric model. This assists evaluators in determining, with the greatest numerical accuracy possible, the outcome of the competition.

Finally, authors give some practical guidelines to concrete a correct instrumentation of the evaluation procedures, such as ranking, presentation and documentation.

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I. INTRODUCTION

Within the academic environment for an evaluator, it is not easy to render a judgment on projects that are outside his field of expertise. In many cases, the juries must determine a project quality in-use values, based upon subjective criteria, not allowing an objective evaluation of important characteristics as functionality or usability. [6], [7], [8], [9], [21], [24].

Several standard models are at hand to provide guidance while measuring selected characteristics, giving organizations products and projects access to reach a higher quality level. In theory and in practice, it is necessary to adjust the models to obtain a qualimetric model allowing a quality characteristics evaluation and measurement. Frequently, these models fulfill different purposes, such as buying, renting, using, and adapting projects and products. [23], [24].

Distinctive characteristics of a project must distinguish them. One of the most important one is to be unique because the goal of a project is to create a very new product or service. Therefore, in these cases, a comparative analysis of various products and projects carried out on the base of the quality in-use level will help to decide which the best is.

The model introduced is based on international standards IEEE610 [1], IEEE1061 [2], ISO / IEC 9126 [3], ISO / IEC 14598 [4], Project SQUARE (ISO 25000) [5], SUMI [6] and others, as well as in other Mexican models (MECHDAV-MECRAD [14], [17], [18], [20]), [21]), PROYEVA-PROJEVA [15], [19], [22], [24] ORMEX [25], [26], [27]).

II. BACKGROUND

¨Experiments and Devices" projects have been organized year after year, for several decades, by various academic bodies. In addition to inducing participants to research and learn, the presentation of such projects helped in also reaching practical objectives. It could be said that they are relevant for today's society, which needs motivating and stimulating professionals and student's creative potential and capacity at all levels [9],[10].

III. CONTESTS

Any person having an innovative idea, converted to a project developer may participate. Technology must support such an idea born of the ingenuity of an individual or a group. An existing Technical Committee then evaluates and analyzes the presented project, and, accept those projects that followthe specific objectives, spirits and initiatives of the contest in question.[9], [10], [16]

A. Current National Prototype Competitions

Since the nineties, technological and scientific expositions have been booming. Creativity contests are very important both for the institutions that pursue an award, as well as major companies and for entrepreneurs who are looking for fresh ideas and services, thus providing more benefits to their production management. [15], [16], [19].

B. State of the Art

An exhaustive investigation was made on the existence of software systems that evaluate projects in terms of quality and, therefore, focus on issues such as creativity, innovation, and invention, or when evaluating a technological, scientific, or technological achievement, cultural or environmental

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recognized by society itself. A finding of this investigation is that most quality results are not technological related but mostly dealing with cost-benefit and cost-effective analysis evaluations. [10], [13],[22], [24].

Examples of this sort of project evaluating software are the following:

- EvalAS 1.3 [12] (Software for Investment Project Production Evaluation). This software determines the best financial feasibility cases by pointing out the profitability of industrial, agriculture and forestry production projects.

- Intecplan [11] evaluates only investment projects, scoring the best according to possible financial or production revenues.

- SEPI [22] is similarly an evaluation system for investment projects.

IV. METHODOLOGY

When evaluating projects or products participating in creativity, innovation and invention contests, the application of a metric plan within the framework of a methodology or model is required [13]. That is why we select MECHDAV-MECRAD [14]. Further, we select the PROYEVA [21], [22], [24] model to apply a metrics program. Let us now present, and then discuss, the proposed methodology (Figure 1).

Product measurement must be done easily and economically, and theirs results must be interpreted in the same way by all stakeholders. The manner, in which we define the quality characteristics, does not permit their direct measurement, so it is necessary to establish metrics that correlate these features to a product (project). Each internal or external quantifiable attribute interacts with its environment and correlates with a feature that we establish as a metric. The basis on which we select the metrics depends on the product itself, upon project priorities and upon evaluator´s needs. [7], [8], [9], [23].

A. Proposed Integral System Methodology

Therefore, we examine a set of product metrics. This set we applied to the quantitative assessment of the quality of projects. In all cases, the metrics represent indirect measures, and never really measure quality, but a manifestation of it. Quality in-use is the user's view of the quality of a system (project or product) and we measure it in terms of the result of using it, instead of the properties of the product itself. It is the combined product quality effect of the characteristics as perceived by the user. [21], [22], [23], [24].

B. Requirements analysis

According to data collected from the potential product stakeholders (mainly competitors), authors define requirement components and parameters of the desired system to permit their evaluation by designated jurors.

C. Design of the proposed evaluation model

To determine a product quality level, resulting of the evaluation of the different features, we summarize them. The evaluator must follow a procedure, establishing criteria for different quality characteristics.[13]. This procedure includes other aspects such as the specification's evaluation. In this part, we determine the measurement scope, providing the starting point for the selection of evaluation attributes and metrics

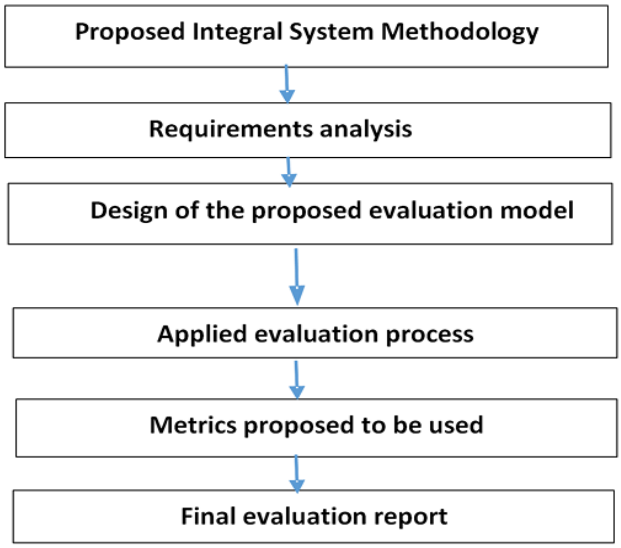

Figure 1. Proposed methodology. Source: Own.

D. Applied evaluation process

Evaluation Metrics. They are grouped according to the corresponding sub-characteristics and attributes and serve to carry out the assessment.

Measurement types. They are used to compare the quality in-use of the various products, and/or projects to be evaluated. They come represented by discrete evaluation variables of two types: binary discrete elemental evaluation variables and multilevel discrete evaluation variables. Table 1 present the numerical ranking scale for each of the metrics [18], [19], [20] and [22].

TABLE 1. Metric levels range. Source: Own.

Value	Compliance (%)	Meaning/Interpretation	Range
1.0	90-100	Excellent(Always	A
0.8	70-89	Satisfactory/Often	B
0.6	50-69	Acceptable/Regularly	C
0.4	30-49	Poor/Sometimes	D
0.0	0-29	Unacceptable/Never or rarely	E

E. Proposed metrics to be used

The PROYEVA model displays each of the measurements and calculations of each metric with four quality levels, compacted in its forty-four Characteristic-Factor / Sub-Characteristic-Subfactor / Attribute / Metric combinations (Table 2). [22], [24]

TABLE 2. Proposed Full Model. Source: Own.

Characteristic Factor	Sub-features Sub-factor	Attribute	Metric
1.1.1.1.F1	Project 1	Science & Technology	Metric 1
1.2.1.1.F1	Project 2	Health & Environment	Metric 2
1.3.1.1.F1	Project 3	Social Economic-Education	Metric 3
1.4.1.1.F1	Project 4	Artisan-Cultural	Metric 4
2.1.1.1.F2	Identification	Delimitation	Metric 5
2.1.2.1.F2	Identification	Hypothesis	Metric 6
2.2.1.1.F2	Objectives	General	Metric 7
2.2.2.1.F2	Objectives	Specific	Metric 8
2.3.1.1.F2	Scope	Technique	Metric 9
2.3.2.1.F2	Scope	Socioeconomic	Metric 10
2.4.1.1.F2	Limitations	Technic	Metric 11
2.4.2.1.F2	Limitations	Socioeconomic	Metric 12
3.1.1.1.F3	Originality	Invention	Metric 13
3.1.2.1.F3	Originality	Innovation	Metric 14
3.1.3.1.F3	Originality	Creativity	Metric 15
4.1.1.1.F4	Feasibility	Financial	Metric 16
4.1.2.1.F4	Feasibility	Technique	Metric 17
4.1.3.1.F4	Feasibility	Sustainable	Metric 18
5.1.1.1.F5	Substantiation	Operational technique	Metric 19
5.1.2.1.F5	Substantiation	Socioeconomic	Metric 20
5.1.3.1.F5	Substantiation	Technique	Metric 21
6.1.1.1.F6	Formality	Level	Metric 22
6.1.2.1.F6	Formality	Level of Complexity	Metric 23
6.1.3.1.F6	Formality	Mathematical model	Metric 24
6.1.4.1.F6	Formality	Graphic model	Metric 25
7.1.1.1.F7	Intellect property	Patent	Metric 26
7.1.2.1.F7	Intellect property	INDAUTOR	Metric 27
7.1.3.1.F7	Intellect property	Utility model	Metric 28
7.1.4.1.F7	Intellect property	Industrial Design	Metric 29
7.1.5.1.F7	Intellect property	Integrated Circuit Layout	Metric 30
7.1.6.1.F7	Intellect property	Trade mark	Metric 31
8.1.1.1.F8	Level	Coverage	Metric 32
8.1.2.1.F8	Level	Exhibition	Metric 33
8.1.3.1.F8	Level	Contest	Metric 34
8.1.4.1.F8	Level	Forum	Metric 35
9.1.1.1.F9	Product	Finished	Metric 36
9.2.1.1.F9	Report	Full	Metric 37
9.2.2.1.F9	Report	Final Product	Metric 38
9.2.3.1.F9	Report	Manuals	Metric 39
9.2.4.1.F9	Report	Models	Metric 40
10.1.1.1.F10	Presentation	Idem domain	Metric 41
10.1.2.1.F10	Presentation	Slides	Metric 42
10.1.3.1.F10	Presentation	Video	Metric 43
10.1.4.1.F10	Presentation	Animation	Metric 44

The complete Model proposed for Quality in-Use Technical Evaluation of Projects-Products-Services in Innovation Events, so-called PROYEVA, we describe below [22], [24]:

1. Identify the area locating the project to evaluate among the following four possibilities:

   I. Science – Technology,
   II. Health and Environment,
   III. Socio-economic, Administrative, and Educational.
   IV. Craft and Cultural.

2. Once the location of the project is chosen, you select metrics using the general decomposing procedure proposed for the ten Characteristics (Factors), seventeen Sub-features (Sub-factors), forty-four Attributes and metrics presented in the model.

3. Then you assign a score to each project depending on its type.
The scores assigned for each type are the following:

I = 1.0, II = 0.9, III = 0.8 and IV = 0.7.

4. To calculate each component and subcomponent mentioned in the metric, the system applies its corresponding formula. Figure 2 shows a documentation format sample of one of the forty-four metrics listed. In Tables 3, 4 and 5 the metrical composition for each level: upper middle, basic middle and basic are given.

5. Finally, you apply an equation synthetizing all the evaluation factors, enabling judges to submit their opinion of the project. The final score of a project is the mean combination of the recommendations given by all judges involved.

Factor 2. F2 PROBLEM APPROACH

Subfactor 2.4 Limitations
Attribute: 2.4.2 Socio-economic
Metric 12: B4
Objective: To determine the values that the project can take, in that corresponding item, according to the assessment of the jurors, within the parameters defined by the system.
Method: Analyze the project approach to define at what level, of the five possible ones, the Socieconomic Limitations can be located
Formula: X4 = B4.
Measures: B4 = Level of the socio-economic scope of the corresponding project
Evaluation: E (x) = {(0.2), (0.4), (0.6), (0.8), (1.0)}
Interpretation: Level of completeness of each project
0.2 = X <= 1.0; The closest to 1 is the best.
Reference source: MECHDAV, PROYEVA, ISO / IEC 9126.

General formula to calculate Subfactor 2.4: $X_i = (A_i + B_i)/2A_i \quad A \neq 0$ $\qquad X = \sum_{i=1}^{n} X_i / n$

General formula to calculate the Factor F2 2. $(a,b) = \{1.0, 0.8, 0.6, 0.4, 0.2\} \qquad 1.0 \geq X \geq 0.0$

$X_i = (A_i + B_i)/2A_i \qquad A \neq 0$

$$x = \left\{ \left[\frac{(a1+b1)}{2a1} + \frac{(a2+b2)}{2a2} + \frac{(a3+b3)}{2a3} + \frac{(a4+b4)}{2a4} \right] / 4 \right\}$$

Figure 2. Documentation format proposal. Source: Own.

F. Final Evaluation Report

After obtaining the respective values of the selected project evaluation as well as the rate of quality compliance, the system generates a final evaluation report in which gives the results and the compliance percentages [22], [24].

TABLE 3. Submodule and metrics of the Basic average level. Source: Own.

Characteristic Factor	Sub-features Sub-factors	Attribute	Metric
1.2.1.1.F1	Project 2	Health & Environment	Metric 2
1.4.1.1.F1	Project 4	Artisan-Cultural	Metric 4
2.1.1.1.F2	Identification	Delimitation	Metric 5
2.2.1.1.F2	Objectives	General	Metric 7
2.3.1.1.F2	Scope	Technique	Metric 9
2.4.2.1.F2	Limitations	Socioeconomic	Metric 12
3.1.1.1.F3	Originality	Invention	Metric 13
3.1.2.1.F3	Originality	Innovation	Metric 14
3.1.3.1.F3	Originality	Creativity	Metric 15
5.1.1.1.F5	Substantiation	Operational technic	Metric 19
7.1.2.1.F7	Intellectual property	INDAUTOR	Metric 27
7.1.3.1.F7	Intellectual property	Utility model	Metric 28
7.1.6.1.F7	Intellectual property	Trade mark	Metric 31
8.1.1.1.F8	Level	Coverage	Metric 32
8.1.2.1.F8	Level	Exhibition	Metric 33
8.1.3.1.F8	Level	Contests	Metric 34
9.1.1.1.F9	Product	Finished	Metric 36
9.2.1.1.F9	Report	Full	Metric 37
9.2.4.1.F9	Report	Models	Metric 40
10.1.1.1.F10	Presentation	Idem domain	Metric 41
10.1.3.1.F10	Presentation	Video	Metric 43

The final equation calculates the average of the averages of each one of the categories, to obtain the final qualification reached by the competing project:

Project Final Grade: Variable (X)

$$X = \frac{\sum_{i=1}^{n} x(i)}{n}$$

where $\sum_{i=1}^{n} x(i)$ is represented by the sum of the variables (x) calculated in each combination of parameters and *n* is the total number of accounted factors in the evaluation, for example, type of project, problem statement, etc.

An alternative to calculate the weights of each factor comes from the application of the following formula:

$$X = \sum_{i=1}^{i=10} Wi * Fi$$

Where each of the W_i weights is obtained by the consensus of judge's opinions. They can also be established according to organization guidelines or policies of each innovation event in their respective calls, which may change, year after year, as it suits them.

TABLE 4. Sub-model and metrics of the basic middle level (secondary). Source: Own.

Characteristic Factor	Sub-features Sub-factor	Attribute	Metric
1.1.1.1.F1	Project 1	Science & Technology	Metric 1
1.2.1.1.F1	Project 2	Health & Environment	Metric 2
1.3.1.1.F1	Project 3	Social Economic-Education	Metric 3
1.4.1.1.F1	Project 4	Artisan-Cultural	Metric 4
2.1.1.1.F2	Identification	Delimitation	Metric 5
2.2.1.1.F2	Objectives	General	Metric 7
2.2.2.1.F2	Objectives	Specific	Metric 8
2.3.1.1.F2	Scope	Technique	Metric 9
2.4.2.1.F2	Limitations	Socioeconomic	Metric 12
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6.1.1.1.F6	Formality	Level	Metric 22
6.1.2.1.F6	Formality	Level of Complexity	Metric 23
6.1.3.1.F6	Formality	Mathematical model	Metric 24
7.1.2.1.F7	Intellect property	INDAUTOR	Metric 27
7.1.3.1.F7	Intellect property	Utility model	Metric 28
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10.1.3.1.F10	Presentation	Video	Metric 43

V. RESULTS, CONCLUSION AND FUTURE WORKS

The PROJEVA software allows a very generic technical assessment, based on quality in-use, creativity, and project implementation characteristic levels. Some prototypes of this type of software were developed, which is the proposed tool for a panel of judges who efficiently evaluate the quality in-use of the project participants in a particular creativity contest. The assessment is very general, so it may issue an opinion on any project in any discipline and any level of competition: local, regional, state, or national. [22], [24].

PROJEVA system is a service that can be useful for different government agencies, industries that require an easy, fast, and objective evaluation process to select a winning project in different contests categories. It has enough mobility to interact virtually in any mobile device having WI-FI within the range of broadband network provided by the host institute of the competition.

TABLE 5. Sub-model and metrics of the upper-middle level (High School: preparatory). Source: Own

Characteristic Factor	Sub-features Sub-factor	Attribute	Metric
1.1.1.1.F1	Project 1	Science & Technology	Metric 1
1.2.1.1.F1	Project 2	Health & Environment	Metric 2
1.3.1.1.F1	Project 3	Social Economic-Education	Metric 3
1.4.1.1.F1	Project 4	Artisan-Cultural	Metric 4
2.1.1.1.F2	Identification	Delimitation	Metric 5
2.2.1.1.F2	Objectives	General	Metric 7
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10.1.2.1.F10	Presentation	Slides	Metric 42
10.1.3.1.F10	Presentation	Video	Metric 43

Figures 3, 4, 5, 6, 7, 8, 9 show some representative screens of some of the proposed prototypes, to evaluate the projects in the innovation contests selected for testing in different academic levels of participation.

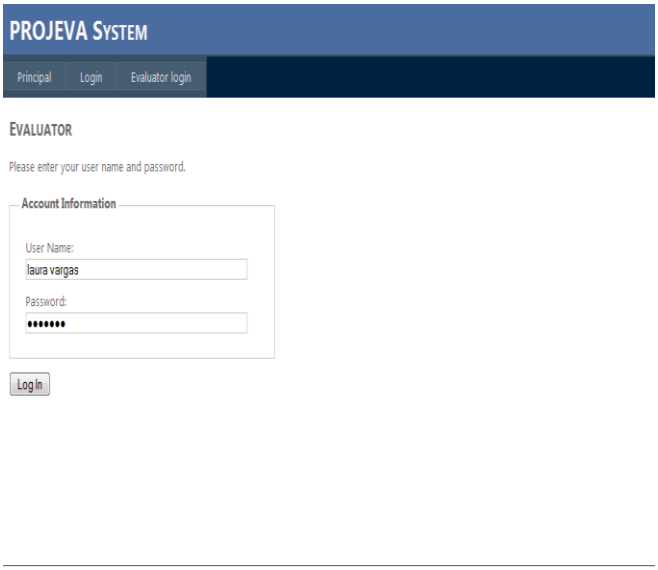

Figure 3. Evaluator data entry in the jury´s login option within PROJEVA. Source: Own.

This prototype has been tested in Mexico at the Creative National System of Higher Education Technology State Competitions organized by different universities, and at national contests organized by the National Institute for Women, at the National Thesis Competitions and at the National Contests and Exhibition Projects linking different government sectors [16], [21], [22], [24].

Figure 4. Selection screen of the different academic level of the project in evaluation within PROJEVA. Source: Own.

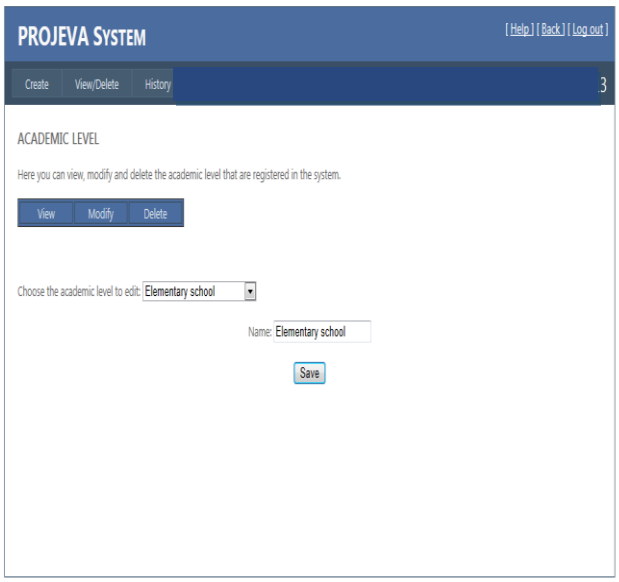

Figure 5. Selection screen of the academic level of the project in evaluation within PROJEVA. Source: Own.

Figure 6. Start screen for project evaluation items within PROJEVA. Source: Own.

Figure 7. Start screen for project items evaluation within PROJEVA. Source: Own.

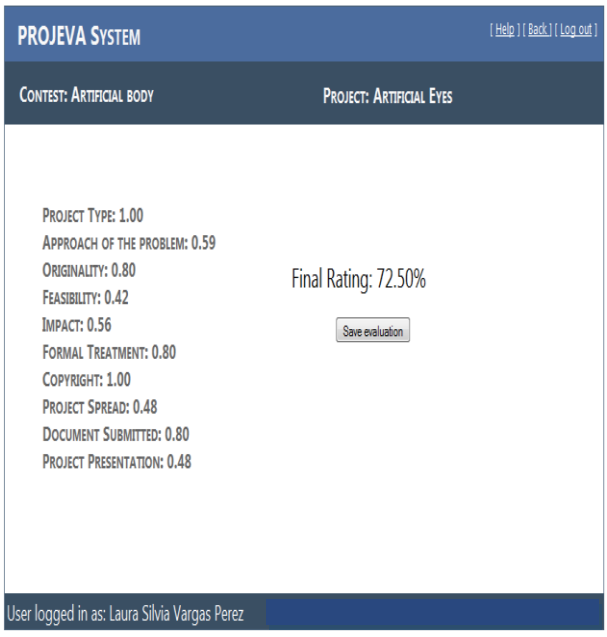

Figure 8. View of a project partial evaluation results within PROJEVA. Source: Own.

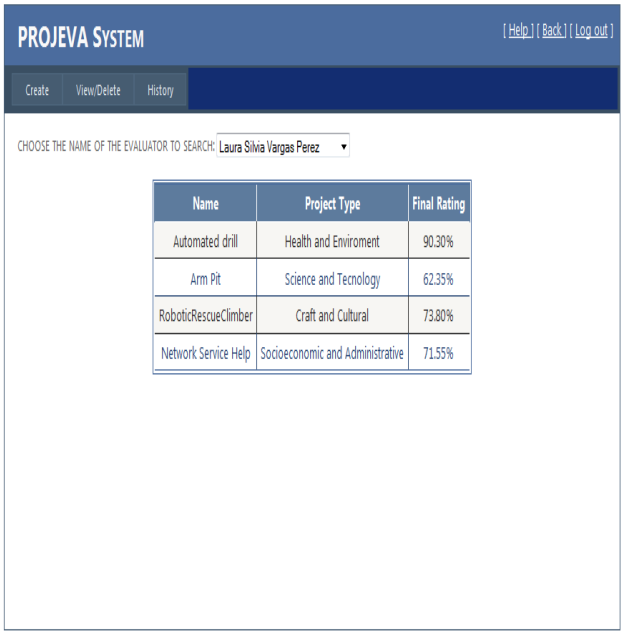

Figure 9. View of the projects evaluation results assigned to an evaluator within PROJEVA. Source: Own.

VI. ACKNOWLEDGEMENTS

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