

# Evaluation of Quality in Infrastructure in the Civil Engineering Career

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**Abstract:** The objective of the work was to design a system of instruments that could objectively evaluate the quality of infrastructure in the civil engineering career, given that some evaluation criteria of the University Degree Evaluation and Accreditation Subsystem were found to be incomplete. Theoretical and empirical research methods were employed to establish the foundations for its development. This tool comes with a manual for implementation and was subjected to the criteria of specialists, who deemed its preparation highly necessary and evaluated its structure and content as very appropriate, fulfilling the purpose for which it was created.

**Key words:** quality; infrastructure; system of instruments; civil engineering

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## 1. Introduction

University quality management is a historical and methodological process that raises the need for a new university based on the principles of excellence, quality and relevance, which implies that higher education must be improved in accordance with the external demands of the society to which it corresponds. Raising the quality of education has become a pressing social need in the different regions of the planet. This has a direct impact on university careers and their international recognition, which requires adequate institutional quality as a priority factor in this process.

In Cuba, higher education is no stranger to this process, as it has a range of quality certified university professions and institutions, and those that have not yet done so are due to the recent emergence of university professions based on different factors, such as the current needs or requirements of the country. Therefore, the latter focuses on future scenarios, and technological innovation is the center of its social development. This reality requires the quality of higher education, and accreditation must become increasingly objective and promote it.

Furthermore, Cuban higher education is subject to numerous challenges and the organizations that comprise it are not exempt from them. One of the challenges is to maintain the quality of the infrastructure of university educational institutions, since it is not a novelty that the scope of the infrastructure is a determining factor for the development of the quality of a university career and for the satisfactory achievement of the academic results of the students. In order to achieve a quality education that forms values, instructs and achieves an integrally formed graduate, a minimum set of conditions is required to carry out the educational teaching process.

Some authors state that any place is good for learning and that even the physical space does not matter for the development of knowledge, classifying the physical context as secondary and irrelevant. The author of this research does not deny that the formative seal of the different higher education institutions surpasses any need for physical and/or

technological infrastructure, but the real evidence is conclusive, so it is necessary to have an adequate institution for learning, since these are determinant and intimately correlated with the academic results and the quality of higher education.

This arduous task was formulated by the National Accreditation Board (NAB), one of whose goals is to conduct university accreditation, which is simply the result of a systematic and voluntary evaluation and monitoring process for higher education institutions to fulfill their university functions. This can provide reliable and objective information about the quality of the institutions and university programs it develops.

It is the responsibility of the NAB to outline this new challenge through its objectives: to promote, organize, execute and control the policy of accreditation of higher education, through the coordination of evaluation processes. In the specific case of the present work, the evaluation of university careers, which is legitimized and documented in the Subsystem of Evaluation and Accreditation of University Careers (SEA-CU), which integrates the Regulation, the Quality Standard and the Evaluation Guide, as part of the System of Evaluation and Accreditation of Higher Education (SEA-ES).

The subsystem of evaluation and accreditation of university careers is used to control the quality of each of the university careers in the country, as in the case of the civil engineering career. Among the foundations that support it, five quality variables are identified for the subsystem, including the infrastructure variable. The latter analyzes several aspects, one of which is the availability of teaching facilities in the career (classrooms, workshops, methodological cabinets, libraries, study rooms, etc.), in correspondence with the characteristics of the training process.

From the experience of the author, who participated in the processes of accreditation and self-evaluation, which are other basic elements in the quality management of the civil engineering career of the Faculty of Construction of the Central University "Marta Abreu" of Las Villas, it has been found that there are deficiencies in these two processes, because the SEA-CU proposes tools to evaluate the careers as variables, indicators, etc., but leaves the evaluation criteria very open. In addition, the civil engineering career is not exempt from the need to improve the quality management of infrastructure.

The elements presented so far justify the present research, since there is a need for tools to evaluate the quality of the infrastructure theme for the civil engineering career in an objective way. It is also known that the management of the infrastructure variable is one of the most complex and needs to be improved from this perspective, and that although infrastructure is one of the aspects most faced by civil engineers, it is not very much treated from the point of view of the educational processes of career evaluation. All this limits the objective and precise evaluation of the quality of infrastructure when the processes of self-evaluation or external evaluation of the civil engineering career are carried out. Therefore, a system of instruments is proposed to evaluate the quality of infrastructure in order to improve the self-evaluations and/or accreditations in the civil engineering career.

For the development of the research, the following specific objectives were also outlined:

- To substantiate the theoretical and methodological assumptions that address the infrastructure in the process of quality evaluation in higher education careers in order to improve their self-evaluations and/or accreditations.
- To diagnose the needs that arise in the evaluation of the quality of infrastructure in the civil engineering career.
- To elaborate a system of instruments that objectively evaluates the quality of infrastructure in order to improve the self-evaluations and/or accreditations in the civil engineering career.
- To evaluate the design of the proposed system of instruments through the criteria of specialists.

## **2. Development**

### 2.1 Methodology

In the pedagogical literature, there are numerous works that deal with concepts, typologies and elements related to the quality evaluation process. However, it would not be possible to draw valid conclusions about this term without analyzing its two key and reciprocal words, which are evaluation and quality, both in the educational sphere. Nowadays, the concepts of quality are increasingly intertwined with those of evaluation; however, it is important to distinguish between quality and evaluation, because although both concepts are often equated, each one is unique and has its own function.

One of the criteria for evaluating quality in universities is the satisfaction of the expectations created and of the participants in the educational task. In this way, higher education cannot be content with being effective with respect to the objectives set by educators, but must be relevant to the needs of students and other subjects of the educational institution. In this sense, there is a tendency to evaluate quality based on the degree of satisfaction of students, teachers, employers, and managers.

The author of this research embraces the concept of quality in higher education expressed by Solís and González (2015), "the quality of higher education is a multidimensional concept that should include all its functions and activities: teaching and academic programs, research and scholarships, staff, students, buildings, facilities, equipment and services to the community and the university world" (p. 1). Each of these specific characteristics must be controlled and analyzed periodically, thus carrying out a correct evaluation of quality in higher education.

In Cuba, in accordance with the level of development achieved by the higher education programs and institutions, and as part of the control system of the Ministry of Higher Education, the University System of Accreditation Programs (USAP) was established in 2000. This led to the creation of the SEA-CU in 2003, in a joint effort between the Directorate of Professional Training and the JAN, in its systemic approach with the other USAP systems, and has constituted the fundamental mechanism for evaluating and accrediting the level of quality of the courses developed in the different higher education institutions of the country.

According to Horruitiner (2006), the application of the evaluation and accreditation system in the Cuban university is based on assuming quality not from the point of view of quality inspection or assurance, but rather it is conceived as the integral management of quality. Therefore, the SEA-CU constitutes the main document to evaluate the quality in the courses of the different higher education institutions of the country. Its general objective is the continuous improvement of the quality of the training process. The importance of continuous self-assessment is highlighted as a basic element in quality management, which generates information that can be used to make decisions aimed at the continuous improvement of courses. It cannot be said that a university course is assessed or accredited without this directly affecting the self-assessments or accreditations of the course.

Currently, infrastructure is of great importance, especially because it directly influences the quality of education. "Infrastructure encompasses a set of engineering structures, equipment and facilities with a long useful life" (IDB, 2000, p. 13). However, when applied specifically to higher education, the concept is restructured as "it is the set of educational units dedicated to higher education and research... it must have all the services and be able to provide comfort to students through technology and services that it can provide" (Gatica, 2010, p. 22). Undoubtedly, this is a more encompassing and appropriate concept for the present research, and one that the author embraces.

The process of quality orientation in the management of higher education institutions is not only a matter of procedures, it is above all, the conscious adoption by the organization of the principles of quality and the policy it assumes in this regard (González, 2014, p. 19).

Therefore, the faculties of Cuban universities are the institutions in charge of managing the quality of the infrastructure to improve the educational process of the careers that comprise it. In addition, each faculty allows self-

evaluation of its internal careers, where the infrastructure variable is included based on standards that become a management culture.

To develop this research, the dialectical-materialist method is assumed as the general method of science, based on the proposals of several authors such as Izaguirre Remón (2014), when he expresses that "the rationality of the construction of science implies that all research is designed from the theoretical-methodological starting from a coherent positioning in the reality that serves as a starting point for the inquiry process" (p. 136). This method plays a decisive role in the pedagogical field, especially when there is an evident intention of the researcher to give voice to the participants; in that sense, when not only the obtaining of numerical data is desired, but also the most intimate vision of the participant is sought and qualitative data become very relevant.

In view of the above, it was decided that the research approach to be assumed is the one that combines methods that correspond to the quantitative and qualitative approaches because, from the research perspective, it is a methodology that makes it possible to answer the scientific problem posed, based on the general objective and the specific objectives stated in the theoretical design of this research. In addition, another advantage of research with dialectical-materialistic methodologies is that it allows the researcher to answer explanatory and confirmatory questions simultaneously.

As scientific methods of information gathering (empirical level) are used:

Document analysis: It is used for the review of different guiding documents such as: Cuban Norms, resolutions, established patterns of the SEA (institutions, careers, master's degrees, doctoral degrees and postgraduate degrees) and the SEA-CU implementation manual, with the purpose of determining the objectives and contents to be addressed to improve the process of evaluation and accreditation of quality in the civil engineering career and to facilitate its treatment in the educational practice.

Observation: Observation is used for all the aspects or parameters that define the infrastructure in a career, such as: presence of scientific journals, computer media, basic and complementary bibliography, etc. All this with the purpose of specifying and diagnosing the magnitude of the problem under study.

Interviews: Two interviews were conducted. The first one is applied to professors of the civil engineering career with the objective of confirming the need for a system of instruments that contributes to the evaluation and accreditation of quality in the civil engineering career. The second is applied to specialists in the field from several universities in Cuba, whether external evaluators or career heads, in order to assess the design, quality and convenience of the system of instruments developed.

Survey: It is applied to students of the civil engineering career with the purpose of verifying the needs and key elements of the infrastructure that negatively affect their subjects and, consequently, the career itself.

As scientific methods of information processing (theoretical level) are used:

- Analytical - synthetic: It is used to interpret and process all the information obtained through the application of the research tasks.
- Historical - logical: It is used to determine the historical precedents and theoretical background of the teaching-learning process (object of study of the research), its constant changes and its progress in the Cuban socio-educational context.
- Inductive - deductive: It makes it possible to infer and systematize the particularities presented by the infrastructure within the process of evaluation and accreditation of a career.

## 2.2 Research scenario: population and sample

The research scenario is constituted by the Faculty of Construction of the Central University "Marta Abreu" of Las Villas (UCLV) and the Faculty of Civil Engineering of the Technological University of Havana "José Antonio Echeverría" (CUJAE).

The target population for the needs assessment is the civil engineering, architecture and hydraulic engineering careers of the Construction Faculty of the "Marta Abreu" Central University of Las Villas and the civil engineering career of the Civil Engineering Faculty of the CUJAE. To select the sample a non-probabilistic sampling is used and the selection criterion is intentional, since in order to analyze the infrastructure needs and difficulties in their different academic years, a group of 30 students of the five years of the civil engineering career of the school year 2019-2020 and 5 professors with different years of experience of the Faculty of Construction are selected.

## 2.3 Results and discussion

Once the instruments were applied to the selected sample, the results for the students were as follows:

(1) Of the students surveyed, 93.3% affirm that they are always affected in their preparation and academic performance by a deficient quality of the teaching infrastructure (classrooms, laboratories, student residences, libraries, etc.), while the remaining 6.7% comment that it only affects them sometimes.

(2) 50% of the students analyzed claim that the subjects of their academic year sometimes have printed basic textbooks, while the other 50% state that this only never happens.

(3) Of the students taken into account, 16.7% of them ratify that the subjects of their year always have educational software or virtual laboratories, most of them affirm that this sometimes happens with 73.3% and the remaining 10% of the sample highlighted that this is never the case.

(4) 100% of the sample agrees that they always have access to the center's Intranet and Internet services.

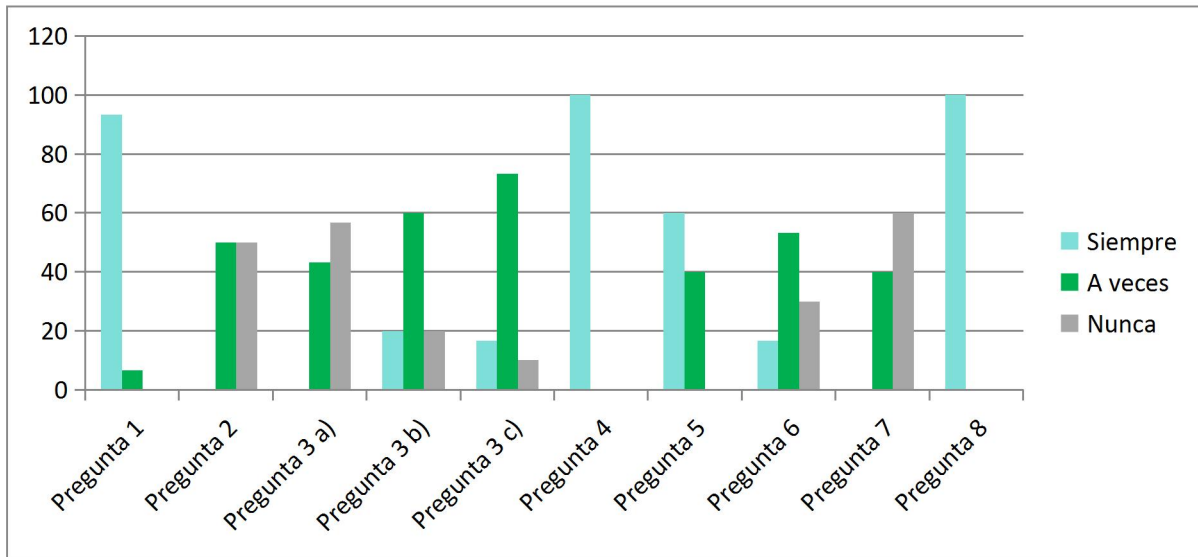
(5) 60% of those surveyed consider that the faculty library always has sufficient bibliography to answer the questions posed in the subjects of their year, and the remaining 40% state that only sometimes.

(6) 16.7% of those surveyed stated that in their opinion the furniture (chairs, tables, blackboards) in the classrooms is always in good condition, another 53.3% stated that sometimes, while 30% said that it is never in good condition.

(7) 40% of the students examined indicate that they are only sometimes satisfied with the work practices of their year, while the other 60% of the sample say that they are never satisfied. It is enough to point out in this question that the students in the fourth year of the career are the main ones who are satisfied because their work experience is developed at the Cayo Santa María headquarters for a long period of time, while the remaining years are developed in a construction company in the territory in only one week.

(8) 100% of the sample agrees that it would always be favorable the existence of an updated "System of instruments" on the quality of their institution, since it would favor the infrastructure of the teacher of their career.

The results of the aforementioned questions applied to the sample of students were tabulated (Figure 1), which shows more solidly the evaluated aspects of always, sometimes or never that responded to each question posed.



Note: siempre: always; a veces: sometimes; nunca: never; pregunta: question

**Figure 1.** Results of the student survey. Source: Own elaboration.

In relation to the interview with the professors, 100% state that a deficient teaching infrastructure does affect the motivation and academic performance of the students, and even determines it, both students and professors will have a better performance if the place where they are located is correct, with the specific conditions for the teaching activity.

80% of those interviewed rate the teaching infrastructure (classrooms, laboratories, student residence, libraries, etc.) in the Faculty of Construction as good due to a series of parameters such as: classrooms with problems of electrical installations and carpentry, defective blackboards and lack of projection screens. The state of the construction materials and geotechnical laboratories is also unfavorable (although they have been repaired and have equipment) but there is a lack of supply of materials, which affects the performance of tests, development of diploma work and research in general. On the other hand, the remaining 20% believe that the teaching infrastructure in the School of Construction is mostly good, since the classrooms are spacious, adequate and comfortable, as well as the laboratories.

60% of the professors consulted rate the teaching infrastructure of the Civil Engineering program at the Cayo Santa María Campus as moderately good, since there is a lack of computer equipment in the laboratories and the student residence has serious construction problems in the lockers, mattresses and air conditioning.

100% of the professors interviewed agree that the existence of a system of instruments that defines each quality parameter in the infrastructure variable would improve the processes of self-evaluation and/or accreditation of the Civil Engineering career. Among their main arguments are:

- The system of instruments would allow the unification of evaluation criteria and would make the accreditations, from their preparation to their realization, more objective.
- It would establish concrete parameters according to the current requirements of the MES in relation to the classes in these times of technologies. The blackboard and the chalk are the basics, and sometimes they are not good, but the new ways of teaching with the use of ICT require to be present in the civil engineering career, so teachers and students must be able to count on them and this must be taken into account in the accreditations and/or self-evaluations.

## 2.4 Developed instrument system

An instrument system is a set of interrelated elements that perform a specific integrated function. It is, therefore, a means or resource to achieve what is desired and that can measure aspects of reality. In relation to the present research, the concept becomes more precise, defining the system of instruments as a set of elements in digital format to measure or evaluate the quality of self-assessments and/or accreditations of the civil engineering degree based on previously defined technical quality parameters of the prevailing reality.

The design of the instrument system has as its fundamental objective to contribute to the evaluation of the quality in infrastructure in the civil engineering career in order to improve the self-assessments and/or accreditations of the same. For the design of the same, the evaluation criteria of the SEA-CU infrastructure variable were first taken as a basis and then these were broken down into technical quality parameters; all of this in a file of sheets and labels in Microsoft Excel format. To evaluate the quality of each established criterion, cumulative scales are defined that are set out in an implementation manual that responds to the instrument system, which will also be prepared by the researcher.

One of the main functions of the implementation manual will be the evaluation of the quality in each of the given evaluation criteria, based on the defined technical quality parameters. For this evaluation, scales will be worked with, mainly, cumulative ones. The implementation manual of the instrument system will work with the scale typology defined according to its purpose, and in particular the attitude scales.

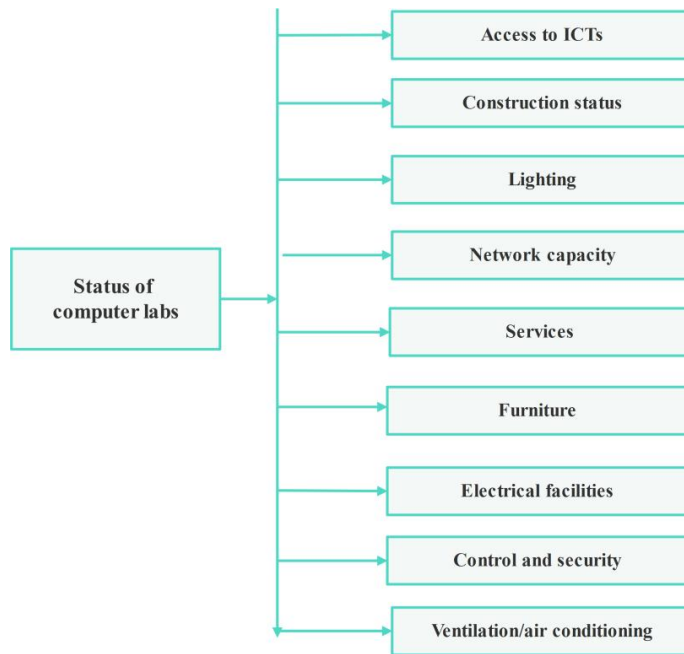
For the objective evaluation of the quality of the infrastructure based on the proposed system of instruments, the previously defined scale is used, which presents a set of statements relevant to the object of measurement, which vary in intensity. The scale was conceived for unidimensional and cumulative scales by Guttman. In the research, according to (González, 2014), "increasing scales of four values between 2 and 5 are used, similar to the traditional evaluation scale in Cuban higher education institutions" (p. 40).

The system of instruments and its implementation manual must be used by the authors to whom they are addressed: the head or coordinator of the civil engineering program of each higher education institution and by the external evaluators who intend to accredit the program. The former will use them in the design of the systematic self-assessment, which will allow to clarify or quantify the defined evaluation criteria. The latter will use them for the comprehensive evaluation of the quality of the program in the infrastructure variable, which will later define the accreditation of the program.

The implementation manual directly corresponds to the designed system of instruments, is based on the SEA-CU, and addresses the theme of quality in university infrastructure. Its educational structure consists of a presentation sheet or cover, the prologue, the index, the introduction, the chapters, the glossary, and the referenced sources. The main chapters are presented below.

In Chapter I, entitled "Integrated and progressive system of teaching aids", the management and assurance of a system of resources and means can be seen from the material support of the course that allows to meet the training requirements and the planned objectives with quality. The management capacity of the course is manifested in the effectiveness of the planning, organization, execution and control of the resources, according to the substantive activities.

On the other hand, Chapter II, entitled "Material assurance in the knowledge area of the course", consists of a topic based on the design of evaluation criteria for the state of the laboratories. In it, technical quality parameters will be evident, such as: constructive state, lighting, ventilation/air conditioning, ambiance, among others, which correspond to the laboratories of the civil engineering course.



**Figure 2.** Technical parameters tree for the quality of the computer labs. Source: Prepared by the authors.

Chapter III is called "Material assurance for the use of computing and ICTs in the course". Figure 2 shows the tree of characteristics or technical quality parameters of the evaluation criterion called: "State of the computer laboratories". Based on the technical parameters defined in the figure and the Guttman scale, the quality of the indicator can be objectively evaluated.

Finally, Chapter IV is the most comprehensive, called "Other teaching facilities used by the course", and represents the most subjective indicator of the infrastructure variable. The evaluation criteria worked on are: state of the classrooms, state of the student residence and state of the library. As with the other indicators, we will work with correctly defined technical quality parameters.

#### 2.5 Evaluation of the instrument system by specialist criteria

A total of 9 specialists were surveyed for the evaluation of the instrument system. The selection criteria taken into account included professional prestige in their respective fields and having accumulated 5 or more years of personal experience in the topics addressed. Seven of them are heads of the program, meaning that all the coordinators of the civil engineering program in Cuba were surveyed. The remaining two specialists have served as external accreditors of the program and possess more than 20 years of experience. According to them, the instrument system exhibits a high degree of correspondence between its tables and the indicators of the "infrastructure" variable of the SEA-CU. Furthermore, it facilitates the simultaneous collection of quantitative and qualitative data and features a very appropriate aesthetic and cover design (with hyperlinks to the program quality pattern and the implementation manual), all aimed at assisting the authors involved in the process.

Regarding the implementation manual, they argued that it contributes to clarifying the evaluation criteria that are open in the variable "infrastructure" of the SEA-CU and its contents respond entirely to the instrument system. The main recommendations were very precise: it was argued that equipment in the student residence, such as fans is computed, which is not always the property of the university, but of the students themselves, and also that if it is intended to generalize to other careers, people without experience in the construction branch will not be able to understand the aspects related to the technical quality parameter "construction status".



Based on the above and to achieve the highest possible quality of this work, all the recommendations offered were taken into account. The specialists argued the important contribution of the instrument system and its implementation manual to the laws of Qualimetry, they stated that they allow for the improvement of self-assessments and/or accreditations of the civil engineering career and finally they commented that the creation of other instruments of the remaining four variables of the SEA-CU should be generalized.

### **3. Conclusions**

The theoretical and methodological foundations of the research highlight the importance of infrastructure in the process of quality assessment in higher education courses, aiming to enhance self-assessments and/or accreditations.

Through the application of various instruments and methods utilized for diagnosing needs in the educational setting, it was possible to verify that the teaching infrastructure of the civil engineering course at the Faculty of Construction is in a poor state, with issues related to furniture, aesthetics, construction quality, etc. These problems, in turn, indicate inaccurate and systematic self-assessments.

The system of instruments and its implementation manual on quality in university infrastructure feature a logical order and an adequate design, incorporating photos, a glossary, statistical elements, and updated information. This enables an objective evaluation of the quality of infrastructure in the civil engineering course.

The assessment of the design, content, and quality of the proposed system of instruments, based on the criteria of specialists, confirms that it is grounded on the indicators of the "infrastructure" variable of the SEA-CU and, along with its implementation manual, contributes to clarifying the evaluation criteria that are outlined in the pattern.

### **Conflicts of Interest**

The author declares no conflicts of interest regarding the publication of this paper.

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