Impact of the Implementation of a New Information System in the Management of Higher Education Institutions

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Abstract

Those responsible for management in Higher Education Institutions require real-time Information Systems, which provide reliable and well-presented information, while helping them in this management and in decision-making. The financial information, emanated from these Systems, becomes a basic input, since the financial results of a company now become the most used and relevant reference of the actions of its leaders. In this article, we present the different Modules that are used for university management, Modules that have an Information System in their administrative and financial component —Budgets, Financial Accounting, Treasury, Payroll, Purchases, Inventory, Payments— and, also it describes the most outstanding functionalities of each Module. In order to determine the impact of the implementation of the System in the Corporacion Universitaria del Caribe—CECAR, the metrics of the ISO/IEC 25010 quality model are used, in terms of the achievement of each User, to determine the effectiveness, efficiency, satisfaction, utility and flexibility. The results show the impact of the System on the administrative and financial dynamics of the Institution.

Keywords: university management, Information Systems, decision making, financial execution control, change management

INTRODUCTION

The internationalization of education has resulted in different institutions and universities providing their services throughout the world, revolutionizing access to knowledge and new contexts and challenges of education. This has led the Higher Education Institutions (HEIs) to rethink and change their management and administration forms, in order to survive and compete in the current capitalist world, with new mechanisms of integration of Society-Knowledge.

To address these new challenges, HEIs must improve their decision-making processes, integrating and analyzing all available information to optimize resources, provide a quality service and increase the relevance and permanence of their programs. Therefore, Information Systems should be implemented that provide a wide range of data, with information aimed at students, teachers, researchers, graduates, the community and the administration and management of the institution. The Information System must, above all, allow to evaluate, analyze and solve different problems, as well as the effects of internal educational actions and on society[1].

Currently, the conception of Information Systems in different organizations has changed, given that today it is used more as a support tool in decision making than as a simple record of historical data. This is indicated by the different hardware and software marketing documents: *"the information Systems are gradually leaving the 'back room' to which they have been relegated and passing to the direct interaction rooms of the executive levels. The information and technology used to support their acquisition, processing, storage, recovery and dissemination have acquired strategic importance in all types of organizations and also in education at all levels of the System, whether public or private, and whether they plan, coordinate and evaluate as if they execute educational actions directly, ceasing to be elements that only had to do with operational and administrative support or that served to comply with the stipulations of a regulation, norm or program"* [1].

Traditional Information Systems

The Information Systems that are normally used in companies in the education sector, have focused on obtaining basic information for contact and monitoring of students and teachers. The information stored has not been analyzed and is, in most cases, backward, disorderly, repeated and not reliable or complete. This is the main shortcoming of current Systems: not providing information for the decision making of an institution.

Information Systems, at the analytical level, have maintained an evolution over time, which has consisted in responding to changes in business dynamics [2]. This is how, initially, for decision-making there were summary reports and ERPs, then answering questions such as "what happened?, why did it happen?, what can happen?, what is happening?, what we want it to happen?" And, in this way, evolving to new analytical tools, datamarts, KPIs, predictions with predictive modeling, dashboard, data governance, real-time analysis, scorecards, decision automation, corporate KPIs, business governance, collaborative process es, globalized services, Global KPIs [3]. Figure 1 shows in detail the evolution, at the analytical level, of the Information Systems.
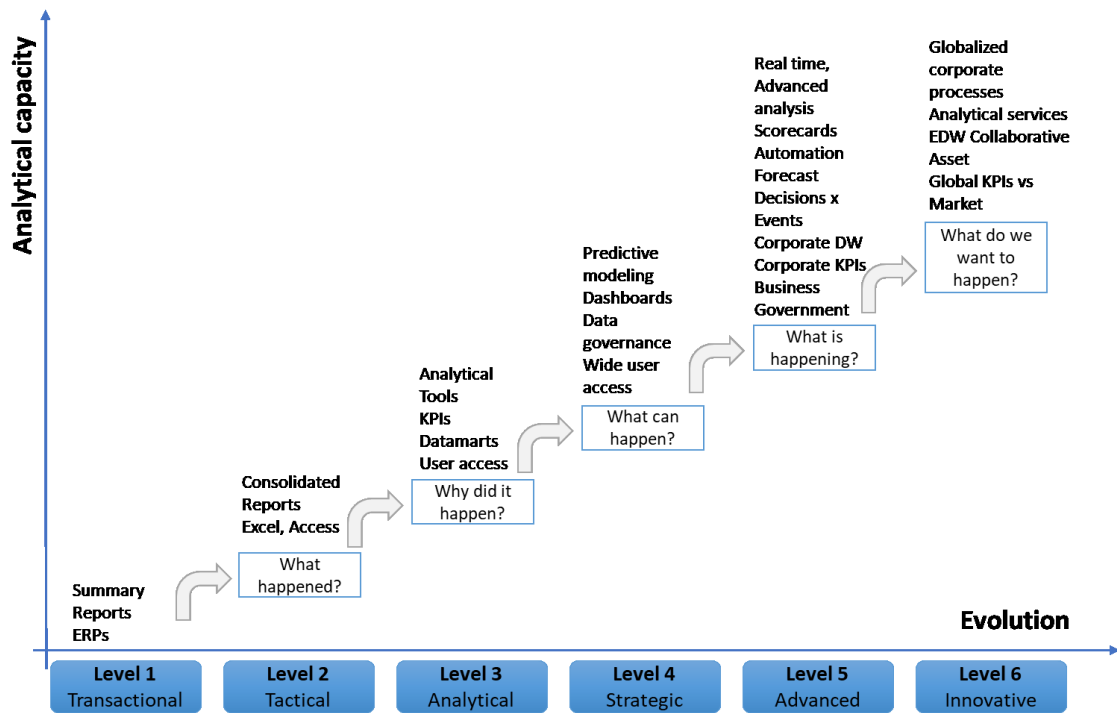
Figure 1: Evolution of Information Systems at the Analytical Level

The traditional Systems in Colombia have been mainly focused on Levels 1 and 2, that is, Transactional and Tactical Level, mostly accompanied by poor management of IT processes, where the strategic leadership levels do not appropriate the importance of the Information System. This leads to the institution lacking adequate indicators to evaluate the quality and productivity of substantive processes. It is normal to find dependencies of institutions that have more consolidated information than others, but this does not allow making inferences or interrelation of indicators between one and the other that helps to see the institution as a whole where one decision can affect another dependency.

Other characteristics of traditional Information Systems are [4]:

- The training of personnel who use the System does not correspond to the needs of their position and their relationship with other institutional processes.
- Generalized absence of a Systematic analysis of the Management Processes and Central Services, as well as little attention to the opinions of the Users that require information for the daily work and for their decisions.
- Scarce vertical and horizontal coordination in the Services and in the Information Systems for management.

As it has been demonstrated, innovative models of educational management must be developed and implemented with adequate Information Systems that help strengthen Higher Education Institutions, which include the participation of not only students and teachers, but also the dependencies and the community. The System must allow the adoption of decisions

in a fast way, that allows to help the evaluation as a permanent and continuous process, evolving progressively to the Analytical, Strategic, Advanced and Innovative Levels, as shown in Figure 1.

For all the above —in the same way that the managers of any entity, for profit or non-profit, need information necessary for management— the managers of HEIs can not be alien to this trend. It is necessary, then, to investigate about what type of computer tools universities use for the management and control of their operations, so this article aims to analyze the impact of the implementation of a new information System in the Corporacion Universitaria del Caribe–CECAR, explaining the characteristics and functionalities that most support the financial management of the entity, based on the ISO/IEC 25010 quality model that, through a survey, obtains information on the experiences that have been given when using the new Information System, in this case called Aldea.

INFORMATION SYSTEMS

Characteristics of an Information System for Higher Education Institutions

An Information System that complies with the current dynamics of Higher Education Institutions must include, among others [5]:

- Integration of Databases: Which allows the interconnection of variables and indicators.
- Characterization of the Student Population: With information not only of basic data, but also demographic data, social and family situation, vulnerability, financial data, and others.

- Traditional Elements of the Organizational System: Human, financial, technological, material resources, data or archives supports, processing means and resulting information.
- Production of Dynamic Report: For decision of different levels that make up the Institution.
- Organizational Objectives and Strategy: Including the action plans for each academic and administrative unit.
- Possibility of Evolution of the System: To increase the analytical capacity.

An Information System is made up of components that carry out functions, such as collection, collection or collection of data, classification, compression, storage or archiving, administration, processing or transformation, transmission and recovery, exposure or presentation of data or information. The purpose of the System is to provide information in order to make decisions and to facilitate coordination between the various activities. The Information Systems, in a restricted sense, include all programmed information processing, but in a broad sense it includes all the human and mechanical components involved in the coordination and decision-making [6].

For the Information to be efficient, it must meet a series of requirements, so that the utility it provides justifies the use of the resources that had been applied to produce it. In particular, the requirement of the temporary reference of the information must be met, so the Information of a certain period of time must be prioritized so that said information is really operative.

A characteristic of the Systems for the Institutions of Higher Education are the Management Indicators: *"An indicator is defined as an observable manifestation of a feature or characteristic of one or more variables of interest, susceptible of evaluation, which provides quantitative information and/or qualitative about that characteristic"* [7]. A System of indicators can be defined as the structured and coherent set of indicators combined or not, according to a System of variables and categories that represent the management or functioning of an analysis unit with respect to a specific function. For example, Financial Management, Teaching, Extension, Research or Institutional Service [4].

The development and use of Indicators as criteria for policy formulation, planning and decision making in Higher Education Institutions are associated with a very important change in the methodology traditionally used to manage, monitor and control Information. And they are intended to present the situation of an entity in a given period of time.

Objectives of the Information System

The concept of university autonomy has meant that in Colombia Higher Education Institutions are considered autonomous entities, in terms of planning, management and control. Therefore, the managers of these entities have had the autonomy to take the decisions they have considered appropriate, taking into account the decisions of their collegiate bodies and the current regulations that frame the university action, both the state provisions (many of them contingent to European regulations) such as the regulations of the Autonomous Community where the university itself is located and the regulations issued by the university itself in its different areas of work: the University, the University Centers, the Departments, the University Institutes, others [8].

Due to the aforementioned, it is important that the information that the IES managers have to count on for the performance of their duties and to inform their stakeholders, should be as complete and appropriate as possible. Therefore, it is mandatory that the Information System with which all the departments and instances of said HEIs must work must be comprehensive and diversified, so that the information flows do not overlap and complement each other, and, in this way, can be taken advantage of by a high number of Users within the entities.

In the case of the Aldea Information System, implemented in the Corporacion Universitaria del Caribe—CECAR, it can be established that the main objective is to maintain consolidated and integrated all the Institutional Information, supported in the different processes that allow the fulfillment of the Mission and Vision of the institution. Likewise, that all this Information is articulated with the plans and strategies to improve the quality, and that in turn serves to feed back at a strategic level the decision making.

The Aldea Information System allows the institution to move from a reporting System at a tactical and transactional level, to a System that allows the analysis of information in real time with the use of analytical tools, predictive modeling, creation of datamarts, KPIs, with a planned data government, which ensures that the Institution, at all its hierarchical levels, plans, controls and manages at a strategic level.

The new Information System generated internally, in the dependencies of the Institution, different reactions, among them the rejection of the change. Numerous research studies show that a large number of Information Systems development and implementation projects tend to end in failure due to resistance to change [9], mainly due to fears and fears of the unknown, to failure, to lose power, to learn new skills, to incorporate new human talent, to fear of being replaced or to question the increase or decrease in the workload.

Any change brings with it uncertainty, therefore, it is very important that managers —from their leadership position— contribute to reducing it generating trust, providing information on the project and the impact it will have on the way of working, involving staff so that can know all the advantages that will provide both their work performance and their professional development in conjunction with the organization [10]. Change management is a vital component of the development of Information Systems and implementation projects and, in addition, risk management and appropriate methodologies increase the chances of success of a project. That is why, in this article, we analyze how the User's perception of the System is in such a way that improvement actions can be taken, as part of the change management process.

ISO/IEC 25010 Quality Model

When a company chooses to acquire software instead of continuing to use the software it has at the time, it is because it knows that it will improve both the functionality and the generally accepted practices that are operating in its sector. Therefore, in an implementation of a new software, there must be an adaptation of both parties. That is, the new software must adapt to certain processes of the company, and the latter also has to adopt certain know how that is already incorporated in the software.

There are several aspects to take into account when acquiring new software for a company, but in this article —and in the case of the experience of that purchase in CECAR— we will focus on the functional aspect, that is, on the capacity of each of the Modules or components of the new software that was acquired to meet the minimum requirements of the operation, as well as the capacity of said Modules to withstand sudden changes produced by internal and external factors, regardless of the supplier.

Due to the above, an analysis of all the components of the new software will be carried out measuring the productivity and effectiveness of the end User when using it, through the methodology of software evaluation consigned in the ISO/IEC 25000 standard, which consists of the elements shown in Figure 2. One of the measures included in this regulation is the model to measure the quality of use of a software, which is used to certify the "usability" of a software, measuring its capacity to meet the needs of Users. To do this, the degree to which the usability of the software covers the tasks and helps to meet the Users' objectives must first be measured; second, the software's ability to generate correct and accurate results; and, third, the software's ability to provide an appropriate set of functions for specific User tasks and objectives.
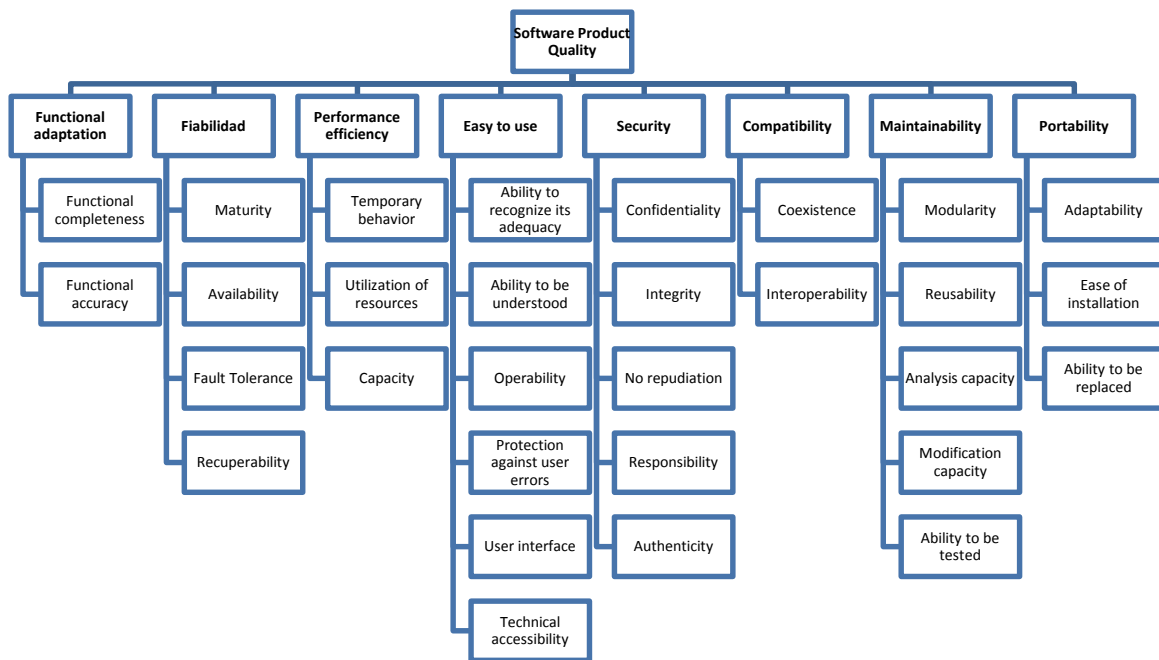
Figure 2: Model ISO/IEC 25010 for the Quality of a Software

In the case of measuring the quality in use, the quality model of ISO/IEC 25022 defines five characteristics to be evaluated: Effectiveness, Efficiency, Satisfaction, Risk Freedom and Context Coverage, each with its respective sub-characteristics.
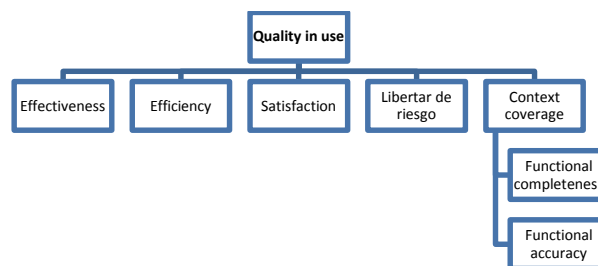
Figure 3: ISO/IEC 25010 model to determine the quality in use

Definitions of Quality of Use Characteristics

- Effectiveness: It is the software's ability to achieve the User's objectives, using the minimum resources.
- Efficiency: It is the software's ability to achieve the Users' objectives, using the minimum of resources.
- Satisfaction: Is the ability of the software to meet the minimum needs of Users when using it.
- Risk Freedom: The ability of software to reduce the potential risk related to the economy, human life, health or the environment.
- Context Coverage: It is the software's capacity to be used with effectiveness, efficiency, freedom of risk and satisfaction in the field of use for which it was defined to acquire the software.

The standard provides metrics to measure the quality of use of software. Users can use the standardized metrics of the standard and also modify or add new ones, specifying how the metric relates to the ISO/IEC 25010 quality model. It is necessary, then, to select the characteristics and sub-characteristics of quality to be evaluated and identify the metrics more appropriate for this, then interpreting the results objectively, making the measurement in a real environment where the System is running. That is why this research is ideal, since all the work is done after 6 months of having implemented and starting the new academic and administrative management software of CECAR. The gathering of information to apply the standard is done through a survey where the question is asked for what is indicated in each metric.

The metrics that allow evaluating the characteristics of the quality of use of a software are the following, according to ISO/IEC 25022:

Table 1. Characteristics of the quality of use of a software

Characteristics	Sub-Characteristics	Metrics
Effectiveness	Effectiveness	Completeness of the Task Effectiveness of the Task Error Frequency
Efficiency	Efficiency	Time of the Task Relative Time of the Task Task Efficiency Relative Efficiency of the Task Productive Percentage Relative Number of User's Actions
Satisfaction	Utility	Level of Satisfaction Discretional Use of Functions Customer Complaints Percentage
Freedom of Risk	Flexibility	Flexible Design Function

IMPLEMENTED ADMINISTRATIVE AND FINANCIAL INFORMATION SYSTEM

The Aldea System implemented has an Administrative and Financial Module, which allows both Administrative and Financial Management. Next, the different components are detailed.

Administrative Management

The Administrative Management Module has the following components:

a. Procurement Module

It allows to register in a centralized or distributed way the requirements of elements and/or services for each of the dependencies and cost centers, directly controlling the budget allocation for each item and consolidating the requirements to obtain an excellent negotiation with the supplier.

b. Fixed Assets Module

It receives from the Warehouse Module the necessary information to make an effective control of the elements assigned to each responsible, allowing to make additions, improvements and replenishment of references, recording the history of each fixed or devolutive asset. The Module of Fixed Assets, additionally, will register monthly in the Accounting and Budget Module all the information of the depreciations and transfers that are presented.

c. Warehouse and Supplies Module

It is enabled to control the deliveries made by the supplier, automatically registering the prices and quantities agreed in the Purchase Order, in order to avoid possible errors in the process of typing. Enables the dynamic definition of transactions, both input and output, storage sites and address schemes or locations of items within the warehouses.

Financial Management

The financial management Module has the following components:

a. Module of Accounts Receivable, Credits and Billing

It is responsible for generating the income of the organization, managing the capture of inscriptions, orders or suggested orders, allowing the student the possibility of choosing the best form of payment or financing required.

The Billing Module allows the sale of products and services, has a close link with the Budget, Accounting and Treasury Modules, and keeps information on immediate and deferred income updated, reporting to the Financial Modules the start date of the deferred and the periods to differ. Based on this information, the System will generate the future vouchers and facilitate the obtaining of the financial statements at the end of each period, since it avoids the imputation of these income manually.

b.   Budget Module

Due to the conception of the Iceberg System, the Budget Module has become the heart and gateway of the entire Financial System. From this point, the information coming from the Administrative System is received, the control of the documents to be canceled or expenditures is carried out, the movements of the Accounts Receivable and Billing Modules, and those of the income from the sale of services or tangible goods.

c.   Accounts Payable and Payment Requests

The Accounts Payable Module is, together with the Accounts Receivable Module, the tool for more control of the Iceberg System, since, from that point, the official can receive automatically the filing of the expenditure commitments made in the Module. Budget. Once you have selected the account you wish to pay, the System will generate the registration number, which will be the only search pattern that the provider will need when you want to know the status of your account.

d.   Treasury

Among the multiple functions that the Treasury Module has, we highlight mainly the strict control it carries out over the management of the income and expenses of the organization. Starting from the elaboration of the Cash Receipts, on documents that come from the Accounts Receivable and Billing Module, until the tracking of the resources for their subsequent consignment. Expenditures are executed based on the commitments made from the Budget Module and authorized by Accounts Payable, for the preparation of various forms of payment such as: bank draft, bank transfer and payment relation.

e.   Accounting Module

Operates as repository of all the financial information of the Iceberg System, there the operating parameters of the other Modules are defined, such as Funds, Sources, Functions, Accounts Plan and the controls that must be exercised on these elements. From Accounting you can obtain any type of global or detailed information, since the control of the auxiliary movements is supported by each of the Modules that generated the movement.

f.   Payroll Module

The Payroll Module performs the integral process of liquidation and payment of salaries, benefits and employer contributions of each employee of their organization, as well as the management of the social, fiscal and parafiscal security regime, social benefits, provisions, etc. Allows the management of independent payroll by type of payroll and its consolidation, recursive settlement of multiple contracts at the Social Security and Withholding Tax.

RESULTS

As indicated in Section 2.3, based on the application of a survey, the necessary information was collected to evaluate the characteristics of quality of use according to ISO/IEC 25022. The survey was applied to all administrative and financial personnel (151 employees), who freely filled it. The survey responds, according to each of the characteristics of use, as indicated in the following Table:

Characteristic	Sub-Characteristics	Question to the User
Effectiveness	Effectiveness	• How long have you been using the Information System? • Do you consider yourself a User? • Indicate approximately the number of tasks you must complete in the Information System on a normal work day. • Indicate the number of tasks that you complete correctly in the Information System of those reported in the previous question • What is the frequency of errors made by you in the System? • In your opinion, is an Information System in the Corporation necessary?
Efficiency	Efficiency	• How long does it take to complete a task compared to the Previous System? • How much time do you think a normal User needs to complete a task compared to an expert? • How efficient are you as a User of the System? • Do you add value to the institution by efficiently using the Information System at one level? • Do you know all the functions of the Information System regarding the Modules you use? • What is the frequency of your errors in the Information System?
Satisfaction	Utility	• Do you consider that the Information System helps you fulfill your duties? • Do you consider that you still require training to use the ALDEA Information System? • Do you consider that the Information System helps you fulfill your duties?
Freedom of Risk	Flexibility	• To what extent do you consider that the System can be adapted to meet the different needs of new Users?

Effectiveness

Once the survey has been applied and the effectiveness of the Information System has been determined, it is shown in Figure 4 (A) that 35% of the System Users have between 6 and 8 months using the software, 30% have been using it more than 8 months and 24% more between 4 and 6 months. Figure 4 (B), indicates that 85% of Users of the software is considered a User with normal skills in its use.

In Figure 5 (A), it is shown that throughout the day 54% of Users of Aldea software perform between 1 and 10 tasks in the application, 15% perform between 11 and 20 tasks, 10% perform between 21 and 30 tasks and 9% perform more than 50 tasks. Figure 5 (B) shows the result obtained from the amount of tasks that the Software Users complete correctly throughout the day, where 46% correctly complete between 76% and 100% of said tasks, 36% complete correctly between 51% and 75% and 10% correctly complete between 26% and 50%.

In Figure 6 (A), it is observed that 63% of Aldea software Users make errors with a frequency between 1% and 25%, while 22% of Users do not make any errors in the software. Regarding the opinion of the Users, when asked if the institution requires an Information System, these - in 97% - state that it is required, as shown in Figure 6 (B).
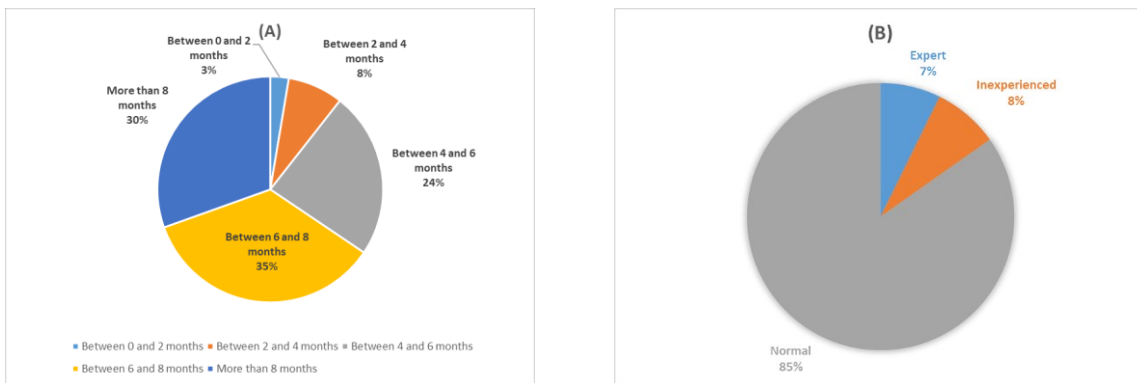

Figure 4: (A) How long have you been using the Information System? (B) Do you consider yourself a User?

Figure 5: (A) Indicate approximately the number of tasks that you must perform in the Information System on a normal work day, (B) Indicate the number of tasks that you complete correctly in the Information System of those reported in the previous question
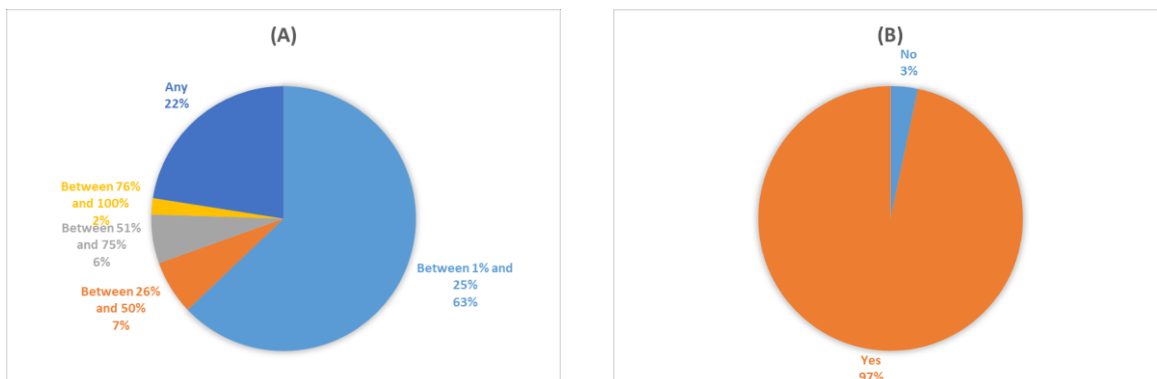

Figure 6: (A) What is the frequency of errors made by you in the system? (B) In your opinion, is an Information System in the Corporation necessary?

Efficiency

The effectiveness was initially evaluated by asking about the time it takes for the User to complete a task, compared to the previous System. It was found, as seen in Figure 7 (A), that 58% indicate that less time, 20% that takes the same time and 22% that more time. Normal Users require more time to execute a task, by 69%, when compared with the time of an expert User (Figure 7 (B)).

The values obtained in Figure 8 (A) indicate that 44% of Users of the System are highly efficient in its use, while 54% of Users have an average efficiency in the use of the software.

In Figure 8 (B), it is observed that 72% of the Users of the software contribute a high value to the Institution, efficiently using the Information System.

43% of the Users of the Administrative and Financial Modules state that they know all the functions of the Information System with respect to the Modules they use, as shown in Figure 9 (A). These same Users, indicate that the frequency of the error rate is low by 54%, average by 30% and high by 4%, as shown in Figure 9 (B).
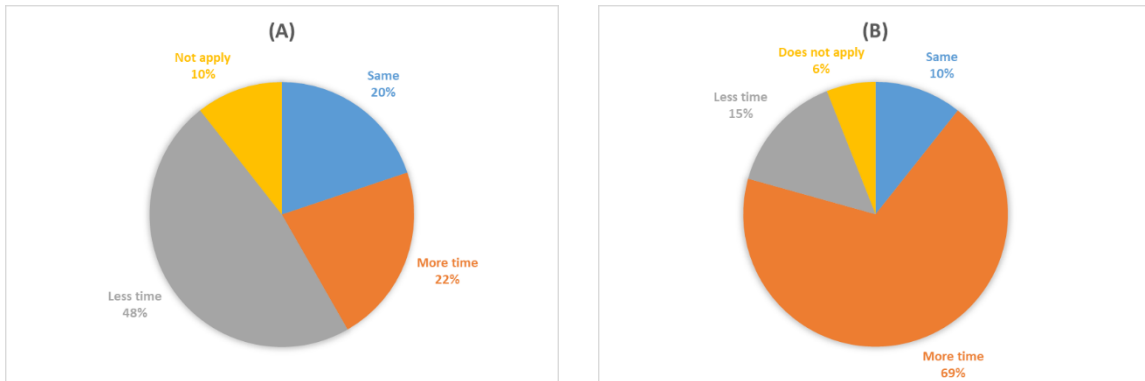

Figure 7: (A) How long does it take to complete a task compared to the previous system? (B) How much time do you think a normal User needs to complete a task compared to an expert?
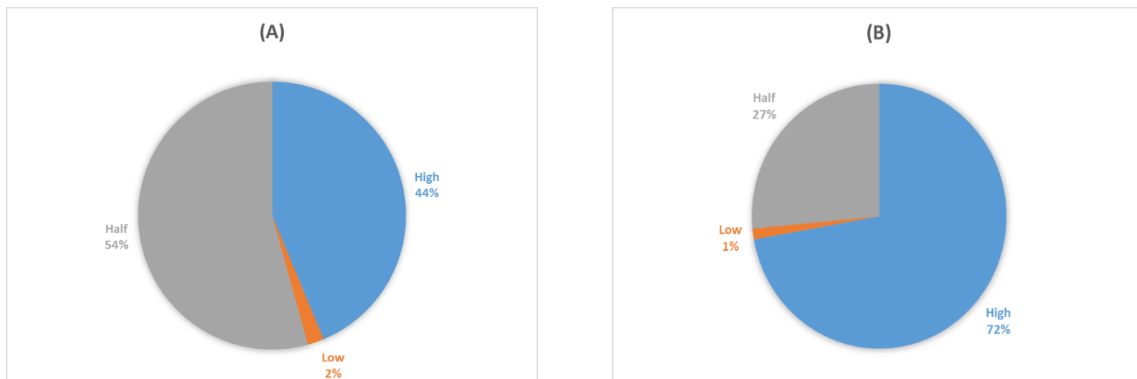

Figure 8: (A) How efficient are you as a User of the System? (B) Do you add value to the institution by efficiently using the Information System at one level?
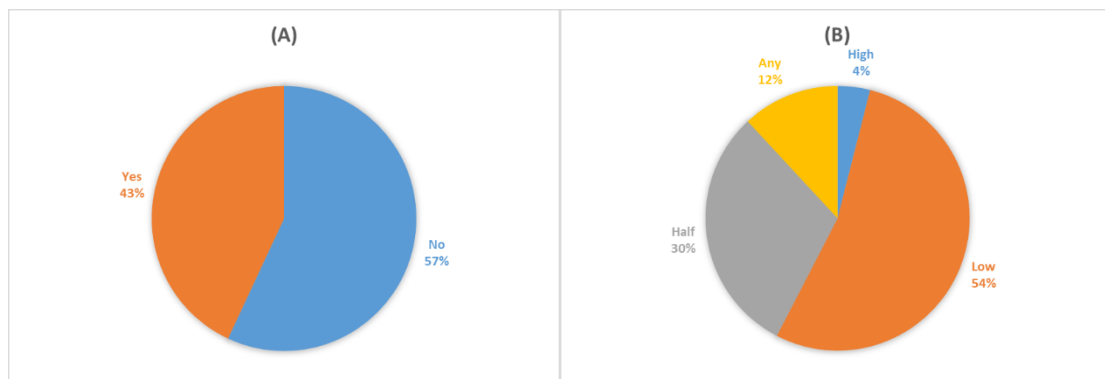

Figure 9: (A) Do you know all the functions of the Information System regarding the Modules you use? (B) What is the frequency of your errors in the Information System?).
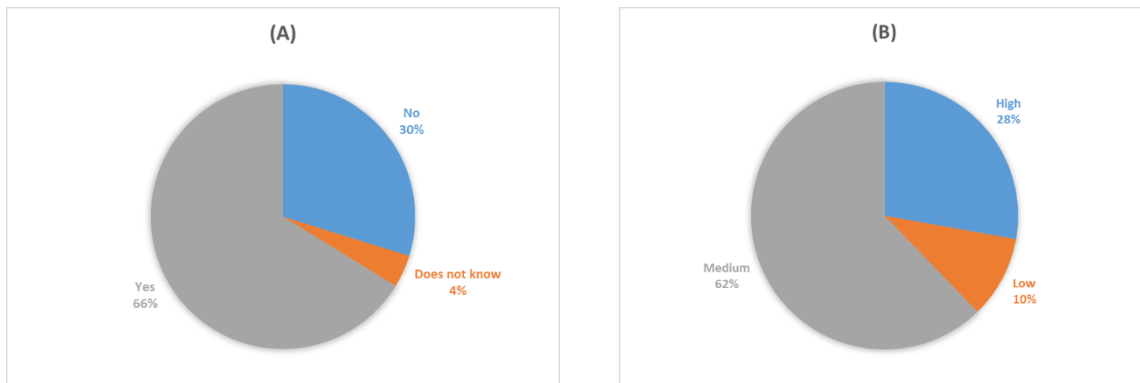
Figure 10: (A) Do you consider that you still require training to use the ALDEA Information System? (B) What is your level of satisfaction with the System?

Satisfaction

According to the results of the survey, Figure 10 (A) shows that 66% of Users of Aldea software require more training to use the Information System, while 30% do not require further training. In Figure 10 (B), it is indicated that 62% of the Users of the software are moderately satisfied as a User of the same, while 28% are highly satisfied as a User of it.

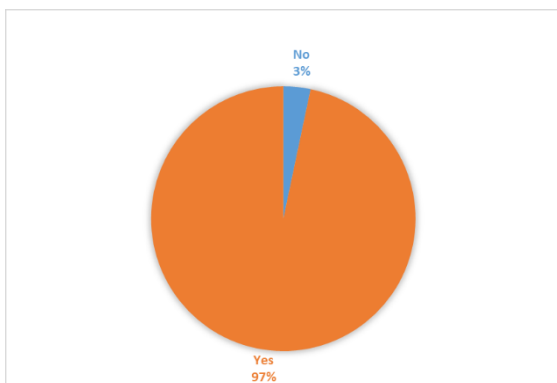Figure 11 indicates that 97% of Users consider Aldea software to be helpful in fulfilling its functions.

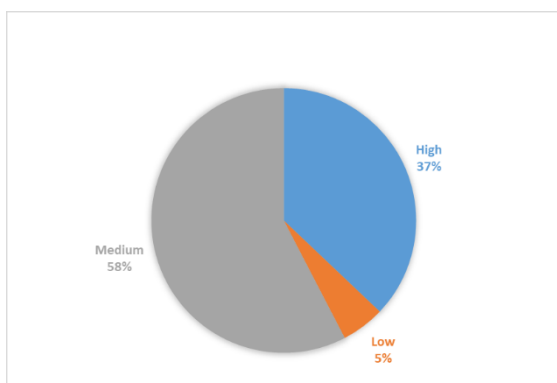**Figure 11:** Do you consider that the Information System helps to fulfill its functions?

Figure 12: To what degree do you consider that the System can be adapted to meet the different needs of the Users?

Freedom of Risk

In Figure 12, it is observed that 37% of the Users consider that the software can be adapted to meet the different new needs of the Users in a high degree, while 58% consider that the System can adapt moderately to satisfy the different needs new of the Users.

CONCLUSIONS

The Institutions of Higher Education require Information Systems in real time, which provide reliable information to increase the strategic performance in management and decision making. It is necessary for institutions to evaluate the performance of their systems in order to identify the risk variables of their implementation. The ISO/IEC 25010 quality model, regarding the use of each user, allows to determine the effectiveness, efficiency, satisfaction, usefulness and flexibility. And, based on the results, establish risk mitigation plans, especially in relation to the rejection of the change. In the case of the implantation in the Corporacion Universitaria del Caribe—CECAR, it can be determined that the System complies with the established objectives. However, it is necessary to expand the training in its use. Also, make an analysis of the individual characteristics of each Module to determine the exact point where the functional improvement of the software should be done.

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