RESEARCH

A CONTRIBUTION TO THE MANAGEMENT OF INFORMATION SCIENCE, TECHNOLOGY AND INNOVATION

Una contribución a la gestión de la información de ciencia, tecnología e innovación

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ABSTRACT
Annually at the Cuban Universities the work objectives that guide the substantive processes are identified, research being one of them. The production centers attached to the University of Informatic Sciences, present difficulties for monitoring and control of compliance of the elements of science, technology and innovation that are evaluated in its annual plan and of its workers. The information of the Investigation area is not accessible to workers; the way it´s managed and stored causes delays in the reporting and loss of quality. This paper aims to develop a computer system for managing information associated with the area of Investigation, from plans of annual results, which would help increase the control of information and decision-making. An agile development approach was used, selecting extreme programming as software development methodology. The technologies and tools used facilitated the development and ensured technological sovereignty. Through the Iadov technique the high degree of user satisfaction was verified, aspect that contributed to the successful implementation of the developed solution.
KEYWORDS
Evidence – Information management– Investigation management– Results plan.

RESUMEN
Anualmente en las universidades de Cuba se identifican los objetivos de trabajo que guían los procesos sustantivos, siendo la Investigación uno de ellos. Los centros productivos adscritos a la Universidad de las Ciencias Informáticas, presentan dificultades para realizar el seguimiento y control del cumplimiento de los elementos

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de ciencia, tecnología e innovación que se evalúan en su plan anual y el de sus trabajadores. La información del área de Investigación no se encuentra accesible para los trabajadores, la forma en la que se gestiona y almacena provoca demoras en el proceso de entrega de reportes y pérdida de calidad del mismo. Este trabajo tiene como propósito desarrollar un sistema informático para la gestión de la información asociada al área de Investigación, a partir de los planes de resultados anuales, que contribuya a elevar el control de la información y la toma de decisiones. Se utilizó un enfoque de desarrollo ágil, seleccionándose la programación extrema como metodología de desarrollo de software. Las tecnologías y herramientas utilizadas seleccionadas facilitan el desarrollo y garantizan la soberanía tecnológica. Mediante la técnica de Iadov se comprobó el alto grado de satisfacción de los usuarios, aspecto que contribuyó a la implantación exitosa de la solución desarrollada.

PALABRASCLAVE
Evidencia – Gestión de información – Gestión de la investigación – Plan de resultados.

UMA CONTRIBUIÇÃO A GESTÃO DA INFORMAÇÃO DE CIÊNCIA, TECNOLOGIA E INOVAÇÃO

RESUMO
Anualmente nas universidades de Cuba se identificam os objetivos de trabalho que guiam os processos substantivos, sendo a Investigação um deles. Os centros produtivos que pertencem a Universidade de Ciências Informáticas apresentam dificuldades para realizar o seguimento e controle do cumprimento dos elementos de Ciência, tecnologia e inovação que são avaliados em um plano anual e de seus trabalhadores. A informação da área de investigação não se encontra acessível para os trabalhadores, a forma que é gestionada e armazenada provoca demoras no processo de entrega de reporte e perda da qualidade do mesmo. Esse trabalho tem como propósito desenvolver um sistema informático para a gestão da informação associada à área de investigação, a partir dos planos de resultados anuais, que contribua a elevar o controle da informação e a toma de decisões. Utilizou um enfoque de desenvolvimento ágil selecionando a programação extrema como metodologia de desenvolvimento de sofware. As tecnologias e ferramentas utilizadas facilitam o desenvolvimento e garantem a soberania tecnológica. Mediante a técnica de Iadov comprovou o alto grau de satisfação dos usuários, aspecto que contribuiu à implantação exitosa da solução desenvolvida.

PALAVRAS CHAVE
Evidência – Gestão de Informação – Gestão da Investigação – Plano de Resultados.

56

Vivat Academia. Revista de Comunicación. 15 sept. - 15 dic., 2017, 140, pp. 55-63

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1. INTRODUCTION

Each year, the University of Computer Science (UCI) identifies work objectives that guide substantive processes and are broken down hierarchically for compliance by faculties, departments, production centers and other areas of the University. One of the substantive processes is research and its management is closely linked to the demands of the State Central Administration Organisms, generating impacts on the economic and social. It has among its objectives to increase the visibility of the results of the research, in line with the implementation of the Guidelines of the Economic and Social Policy of the Party and the Revolution.

The objectives of the work are hierarchical, being finally reflected in the plans of results of the workers. The contributions that are obtained from these results plans form the planning of Science, Technology and Innovation (ICT). The ICT results are reviewed and analyzed on a quarterly basis, with a semiannual cut and an annual closure, to finally generate a report called the balance of the ICT and Postgraduate indicators, which specifies the compliance status of the year's work objectives. The productive centers of the UCI have difficulties to follow up and control the compliance with the elements of ITC that are evaluated in their work plan and that of their workers.

In the Electronic Government Center, the information of Investigation is not accessible to be consulted and updated by the workers, to the extent that the results are obtained. 50% of ICT evidence is sent by email, over megabyte in size, and is repeatedly not received when the advisor's mailbox is full or near full. 35% are delivered personally to external storage devices, which must be checked for the existence of computer viruses, the duration of this task varies depending on the capacity and quantity of files of each device. The remaining percent is received in hard format.

Previously used repositories have presented security problems, each person could manipulate the information of any individual, as well as place the evidence in an inadequate space or not properly identify it. In addition, the evidence was not reviewed before being stored. At present a system of folders is used to organize the types of evidence, being able to store some in a space that does not correspond to it, making difficult its location later. In the name of each evidence that is kept, at least the department from which it comes and the name of the first author must be recorded in a standardized way, in order to facilitate their identification.

Statistical reports are not given immediately, data are not standardized and their manual processing causes delays and loss of quality of the same because it is subject

57

Vivat Academia. Revista de Comunicación. 15 sept. - 15 dic., 2017, 140, pp. 55-63

to errors, nor can analysis of trends be performed. These previously mentioned shortcomings make this process cumbersome, slow and unreliable.

2. OBJECTIVES

As a result of the above, it is evident the need to develop a system that allows the management of ITC information, based on annual results plans, to increase the control of information and contribute to decision making in the production centers of The ICU.

3. METHODOLOGY

The following a summary of the study of IT solutions that manage ITC information is presented:

- UCI indicator system, allows the quantitative control of the ITC indicators of the UCI faculties (SIndiCIT), the Vice-Dean of Research and Postgraduate of each faculty and research managers of the university can only record and consult the information. In the system the amounts of ITC results are recorded without checking the existence of the corresponding evidence.
- Computer system for the management of postgraduate training (SICOP), is a system for the management of postgraduate training in professionals of the Mayarí municipality (Otero Méndez, 2010). It does not include control of participation in scientific events, the publication of scientific articles, as well as other STI indicators. It was developed with the proprietary tool FoxPro version 8.0 and only runs on the Windows platform, elements that do not guarantee the technological sovereignty that our country bets on.
- University Management System of the UCI, known as Akademos, is a business planning system for university resources, including the conception of several lines of development grouped in the process areas. Currently, the Research subsystem does not have the functionalities that allow the management of ITC indicators and their evidences.

The following table summarizes the main characteristics of each system according to the indicators used for comparison:

Indicators	SIndiCIT	SICOP	Akademos
Manages ICT Evidence	No	No	Not All
Manage results plan	No	No	No
Keeps evidence by year	No	No	No
Manage ITC indicators	Yes	No	Not all

Taking into account that the existing systems do not meet the indicators considered relevant for the development of research, we opt for the development of a computer system that will solve the existing problematic situation, called GINFOR. An agile

58

development approach was chosen for its development, with Extreme Programming being the applied development methodology.

Technologically GINFOR is a web application that complies with the paradigm of technological independence. As a framework we used Symphony 2.0, designed to optimize the development of web applications and exploit the new features of the PHP programming language. As a database management system was used PostgreSQL 9.3, some of its main features are stability, reliability, extensibility and security. For object-relational mapping, Doctrine 2.0 was used, providing developers with a powerful SQL alternative that maintains flexibility without unnecessary code duplication.

Because of the connection capabilities with most database handlers, especially with PostgreSQL, PHP 5.5.9 was used as a server-side programming language. Take advantage of the benefits of HTML 5, taking into account its compatibility with most web browsers, complementing with the use of Bootstrap to simplify the creation of web designs, it combines CCS 3 and JavaScript to achieve a nice and colorful interface. All of the above is orchestrated using the Netbeans 8.0.1 integrated development environment.

4. RESULTS AND DISCUSSION

GINFOR is a tool for managing the information associated with the Research area, based on the annual results plans. The types of ICT evidence that are managed are related to participation in all kinds of scientific events, the publication of articles in journals, books, event memories, among others. Prizes received individually and / or collectively can also be managed, the results achieved, as well as the master and doctorate defenses.

It contemplates several types of users, according to the administrative structure of the development center, being common in the UCI the following: administrator, director, deputy director, department head and worker. The administrator has access to all the system's functionalities, the director and deputy director can see the information of all the workers of the center, the heads of department can manage the information of their workers and the latter can manage their own evidences of ICT.

Only workers belonging to the development center in question will have access to the system after registering with their user and password. The top bar displays the logo and name of the system, as well as the name of the registered user, their resume and the option to exit the system. Each worker can attach the ICT evidence and record the main data to ensure their identification, as well as review the compliance status of his results plan and the center's, visualize his ICT evidence and download his curriculum vitae.

The department heads, the deputy director and the center director can review the actual status of compliance with the center's ICT plan, as shown in photo 1, and the employee outcome plans, as shown in photo 2.

59

Vivat Academia. Revista de Comunicación. 15 sept. - 15 dic., 2017, 140, pp. 55-63

Photo 1. Initial screen of the system administrator
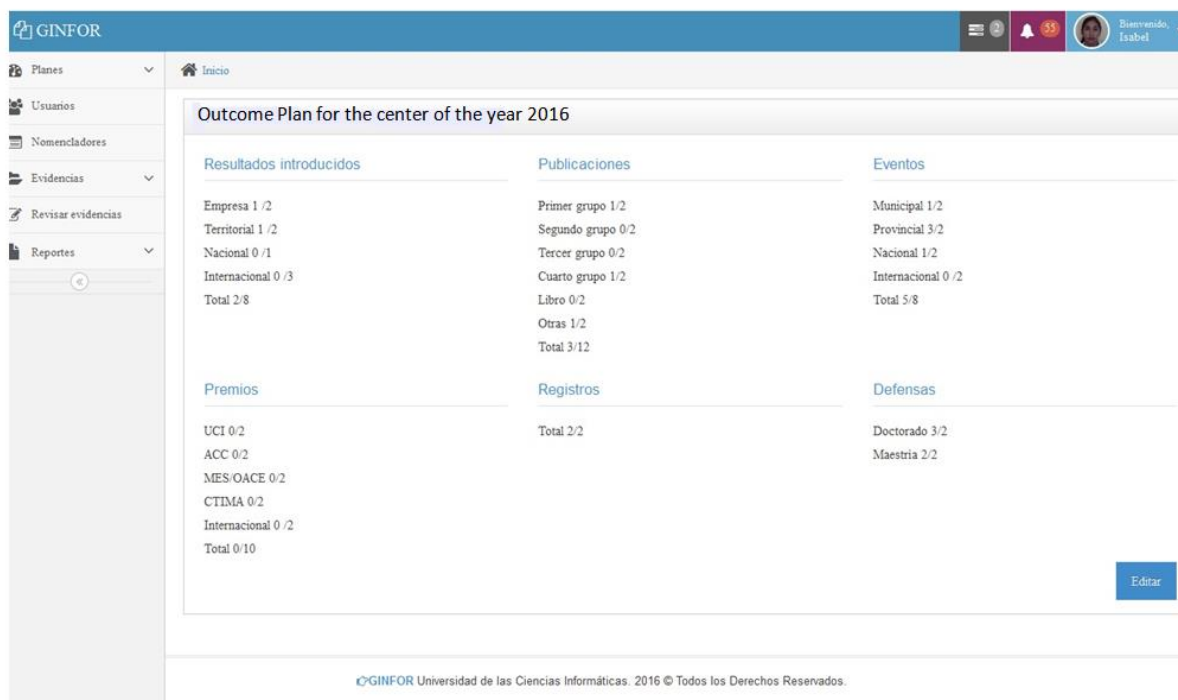
Source: Made by myself

Photo 2. Compliance status of workers' result plans.

Source: Made by myself

The administrator is usually the person in charge of taking control of the research area of the center, has access to the aforementioned functionalities and is responsible for reviewing the evidence of ICT registered by the workers, and finally deciding whether to reject Or approve with or without modifications. In addition, it can carry out the balance of the ICT indicators with speed and reliability in any period of the year, being able to download the corresponding ICT evidences.

The system includes a set of notifications, via e-mail, informing the administrator that a type of ICT evidence was registered by a given worker, the worker is notified, likewise, if it was accepted or not. In the positive case, the quantitative value of the type of evidence approved for the worker and for the center is increased. The reports that are generated allow us to know which are the events with the most participation and those that less number of participations, the magazines in which more is

60

published, as well as the people who participate in the events and who publish in magazines.

The system was reviewed by the team of quality specialists of the Electronic Government Center, the nonconformities detected were corrected, allowing the obtention of the corresponding Liberation Act.

In order to know the degree of satisfaction of the users of GINFOR, the Iadov technique was used, this technique has been applied because of its generic nature. According to (López Rodríguez et al., 2002) the criteria used are based on the relationships established between three closed questions that are intercalated within a questionnaire and whose relationship the subject does not know. These three questions are related through what is called the "Iadov Logical Framework", the survey was applied to 70% of potential users of the Electronic Government Center. The answer questions yes, no or I do not know were:

- Do you consider the system complex and difficult to understand?
- If you could choose between using or not the software developed to perform your work, would you use it?

The third question was: Are you satisfied with the system developed to access the information you need and streamline your work? One of the answer options must be selected: it satisfies me a lot, I do not satisfy myself so much, I do not care, it displeases me more than it satisfies me, it does not satisfy me or I do not know what to say.

The number resulting from the interrelation of the three questions indicates the individual position of each user on the following satisfaction scale: clear satisfaction (A), more satisfied than unsatisfied (B), not defined (C), more dissatisfied than satisfied), Clear dissatisfaction (E) and contradictory (C). The number of responses for each category is used to calculate the group satisfaction index using the following formula (Quevedo & Quevedo, 2016):

GSI = (A (+1) + B (0.5) + C (0) + D (-0.5) + E (-1)) / N

Where N represents the total number of users surveyed. The value of the group satisfaction index allows us to recognize the following group categories:

- Dissatisfaction: from (- 1) to (- 0.5).
- Contradiction: from (-0.49) to (+ 0.49).
- Satisfaction: from (0.5) to (1).

The value obtained from the group satisfaction index was 0.90, which reflects the acceptance of the developed system, a recognition of its usefulness, while users have issued criteria where they show satisfaction.

The Iadov technique contemplates two complementary open-ended questions. These allow to delve into the causes that originate the different levels of satisfaction. The answers given stated useful suggestions for present and future research, one of which is to include in the system the management of Postgraduate activities. In addition, they reflected the satisfaction with the possibility to visualize the compliance status of the workers' plans of results and the ICT plan of the center. The analysis of these opinions yielded satisfactory results due to the preponderance of

61

Vivat Academia. Revista de Comunicación. 15 sept. - 15 dic., 2017, 140, pp. 55-63

positive aspects raised, which serves as a basis for the high value obtained in the group satisfaction index.

4.1 Contribution to decision making

The developed system allows to analyze the behavior of the participations in scientific events, it is possible to know in which period it participates in the greater quantity of events, allowing to make decisions in terms of the management of the traveling expenses destined to this type of activity and the planning of the average expenses for the next years. It is possible to identify the first workers who comply or exceed the fulfillment of the results plans, being able to make a study to identify which are the good practices that they apply, what skills and knowledge they share, with whom they work to achieve the good results that they have.

It also allows knowing the date of sending articles to referenced journals and the date of acceptance, being able to know the average response time of journals, this helps to identify magazines that accept jobs faster. In general, GINFOR contributes to the decision-making process mentioned above, as well as other related to the area of Research in the production centers of the university.

It highlights the impact of the proposal of the guideline 145 of the Economic and Social Policy of the Party and the Revolution, approved at the VI Congress of the Communist Party of Cuba, referred to Education states: "... Achieving better utilization and exploitation of the workforce and of existing capacities". It is currently used in the Electronic Government Center and can be applied in all productive centers of the UCI and other universities in the country.

5. CONCLUSIONS

The research evidenced the need to develop a system that manages the information of Research of the productive centers of the UCI. With the development of the solution, the technological sovereignty for which the country bets is guaranteed, in accordance with the provisions of the guidelines 135, 223 and 226.

A system, called GINFOR, was obtained that allows the management of the information associated to the Research area, based on the annual results plans, which contributes to increase the control of information and decision making in the production centers of the UCI. Promoting better utilization and use of the workforce and existing technological capabilities. Through the technique of Iadov it was possible to verify the high degree of satisfaction of the users.

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63

Vivat Academia. Revista de Comunicación. 15 sept. - 15 dic., 2017, 140, pp. 55-63