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Development of a research information management system based on knowledge repositories: Case of the Directorate of Research and Extension at the National University of Colombia – Manizales Campus

Desarrollo de un sistema de gestión de la información de la investigación basado en repositorios de conocimiento caso: Dirección de Investigación y Extensión de la Universidad Nacional de Colombia - Sede Manizales

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Abstract: Knowledge has become one of the most valued intangibles by organizations due to its value for decision making and competitive advantage. In universities it is necessary to have technologies that allow storing, recovering and using knowledge from research projects. This study presents the development of a research information management system implemented as a knowledge repository. The Unified Process was used as a software development methodology. The developed system was applied to a case study at the National University of Colombia in Manizales. The results show that the system made it possible to manage and monitor the products derived from research groups' projects. In addition, the system was tested for a MinCiencias call aimed at measuring and recognizing research groups.

Keywords: knowledge management, research information management system, web application, university, knowledge repository.

Resumen: El conocimiento se ha convertido en uno de los intangibles más apreciados por las organizaciones debido a su valor para la toma de decisiones y el logro de ventaja competitiva. En las universidades es necesario contar con tecnologías que permitan almacenar, recuperar y utilizar el conocimiento proveniente de proyectos de investigación. Este estudio presenta el desarrollo de un sistema de gestión de información de procesos de investigación implementado como un repositorio de conocimiento. Se utilizó el proceso unificado como metodología de desarrollo de software. El sistema desarrollado se aplicó en un caso de estudio en la Universidad Nacional de Colombia – Sede Manizales. Los resultados muestran que el sistema permitió gestionar y hacer seguimiento a los productos derivados de la ejecución de proyectos realizados por grupos de investigación. Además, el

sistema fue probado para una convocatoria de MinCiencias dirigida a la medición y reconocimiento de grupos de investigación.

Palabras clave: gestión del conocimiento, sistema de información de gestión de la investigación, aplicación web, universidad, repositorio de conocimiento.

1. INTRODUCTION

Organizations possess a series of tangible and intangible resources that allow them to be in constant development. Among the intangible resources is knowledge, which contributes to generate competitive advantages, and depending on its proper management, seeks to innovate methodologically, technologically and strategically the processes in companies [1].

The organizational sector includes higher education institutions, which are characterized by generating knowledge with high levels of creativity and innovation. However, the management of this knowledge in many cases is complex because there is no repository to store and manage it properly [2].

Therefore, the adoption of models and methods to manage and exploit the knowledge of higher education institutions is required. Learning as an essential process to turn current societies into innovative and knowledge societies, has its basis in the processes related to the creation, application, generation and transfer of knowledge at personal, group, organizational and territorial levels [3].

In addition, it is important to monitor and evaluate the processes that are carried out in higher education institutions and that result in research products [4]. However, the monitoring and evaluation of these products is a complex process [5].

The purpose of this study is to present a research process management system that facilitates the recording, updating and processing of the products generated by each research group of a higher education institution incorporating concepts of organizational knowledge repositories. For the testing and validation of the study, a case study was developed at the Universidad Nacional de Colombia Sede Manizales.

The study is organized as follows. The first section presents the introduction. The second section presents the related work. The third section describes the background of the study. The fourth section presents the methodology used in the study. The fifth section describes the system developed. The sixth section presents a case study where the developed system was applied. Finally, the conclusions of the study and future work are presented.

2. RELATED WORK

Literature related to the study focuses primarily on the implementation of Research Information Management Systems (RIM).

[6] provides an overview of RIMs and their evolution over time. It focuses on their role in research information management at the institutional and national level. In addition, it focuses on their role in research evaluation and Open Science implementation.

[7] discusses the impact of a RIM in the Indian higher education system and a use case with different stakeholders such as students, academics, faculty members, scientists, research administrators, funding agencies and policy makers.

[8] explores how public universities can improve research management by using the principles of Axiomatic Design (decomposition of functional requirements of a research project into independent design parameters) and RIM to promote high quality research outcomes.

In [9], Oklahoma State University's experience in selecting and implementing a RIM for its campus is described, focusing on privacy-related conversations and decisions.

In [10] the research information management practices of Chinese researchers are explored, focusing on how they use RIMs and the implications of these practices for academic libraries.

To implement various functionalities of RIMs, the developed study incorporates the concept of knowledge repository to capture and store the academic products of research groups.

3. BACKGROUND

The backcground is based on knowledge management, knowledge repositories and research information management systems.

3.1. Knowledge management

Knowledge management consists of a series of practices and processes designed to capture, develop, share and use knowledge effectively [11]. Its main objective is to transform tacit knowledge (personal and difficult to formalize) into explicit knowledge (formal and easy to communicate) and vice versa, to facilitate innovation and decision making [12][13].

Knowledge management includes several activities such as creation, capture, storage, distribution and application of knowledge [14].

Technology plays a relevant role in knowledge management with tools such as document management systems, databases, online collaboration platforms, and AI software. These tools help capture, store, and distribute knowledge efficiently. According to [15], advanced technologies are revolutionizing the way knowledge is managed in organizations.

Another factor to consider is organizational culture as a mechanism to foster open information sharing, create a continuous learning environment, and encourage collaboration. This will improve the effectiveness of knowledge management initiatives and overcome cultural barriers [16].

3.2 Knowledge repositories

Knowledge repositories are systems designed to store, organize, and facilitate access to knowledge and information within an organization [17]. Their objective is to centralize knowledge, making it accessible and reusable by organization members to improve efficiency, collaboration, and decision making. These systems can be digital, physical or a combination of both.

Knowledge repositories contain various types of information, including documents, manuals, procedures, reports, case studies, etc. [18].

3.3. Research Information Management Systems

These systems are technological platforms designed to collect, store, manage, and disseminate research-related information in academic and research institutions [19]. In addition, they serve as centralized databases that allow universities, research centers, and other organizations to manage aspects of their research activities [20].

4. METHODOLOGY

To develop the research information management system, the Unified Process (RUP) was used as a formal process for software development. RUP is part of traditional software engineering methodologies and is driven use-case and architecture-centric. In addition, it uses UML as a tool for graphical notation of different system models [21]. RUP is composed of the phases of conception, elaboration, construction and transition.

RUP was chosen because it allows the software to be tailored to the user's preferences. It provides a series of intuitive steps that detail each phase and provides detailed documentation of them.

5. SYSTEM DEVELOPMENT

For the description of the system, the UML use case diagram, the entity-relationship model, a UML activity diagram, an UML deployment diagram and implementation aspects will be presented.

5.1. Use case diagram

The research information management system developed has the following actors:

- System administrator: Person in charge of user profile administration. He/she can register, delete and update groups, members, co-authors and associated production information. He/she also generates reports.
- Verifier: Person in charge of creating research groups in the system, registering members and associated directors. In addition, he/she is in charge of reviewing the groups by registering and validating the associated production, together with the uploading of supports and registration of observations.

Fig. 1 shows the system's use case diagram and Table 1 details each use case.

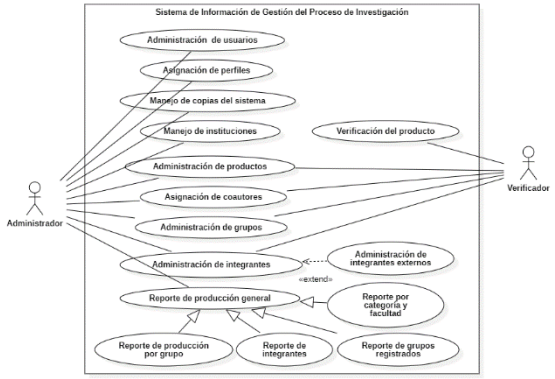

Fig. 1. *Use case diagram.*

Table 1: *Description of the web application use cases.*

Use case	Description
User administration	Creates, queries and updates user data.
Assigning profiles	Assign a user profile with permissions for roles in the system.
Backups management	It generates backups of the system in a .db file. In case of data loss, the administrator restores this backup.
Product administration	Develops products according to a research group's category and type. The products can be edited or deleted.
Assigning co-authors	Record the group members who participated as co-authors of the products.
Product verification	Verify the validity of the product data to be recorded.
Institution management	Creates an institution. Institutions can be updated or deleted.
Group management	Creates, eliminates or updates a research group. In its registration, the group's director is assigned and linked to a faculty and category.
Managing group members	It links a member, internal or external.
Managing external members	Creates an external author, which can be updated or deleted by the administrator.
Group members report	Generates a report of the members associated with a group, categorized by member type.
Production report by group	Generates a report of group production, classified by category and type.
Production report by category and faculty	Generate a production report showing if the product was verified along with observations.
General production report	Generates a report of products by group and categories.
Registered groups report	Generates a report showing the registered groups.

Source: *own elaboration*

5.2. Entity-Relationship Diagram

Fig. 2 shows the entity-relationship diagram of the system and Table 2 shows the description of each entity in the model.

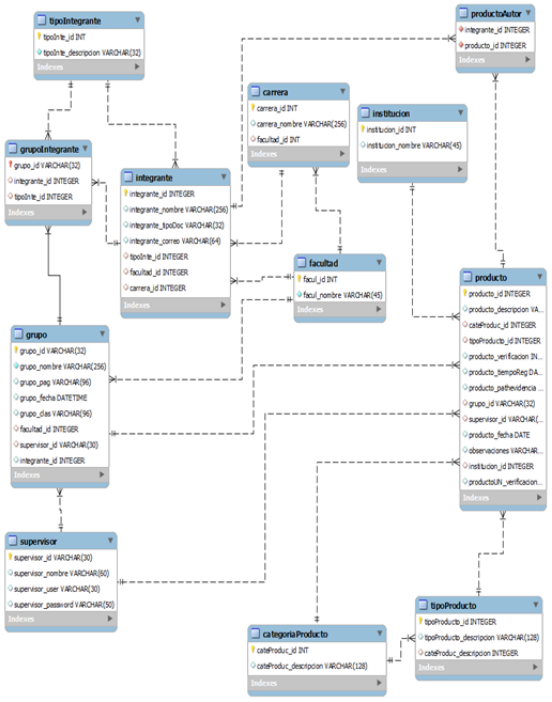

Fig. 2. *Entity-Relationship Diagram.*

Table 2: *Description of the entities of the E/R model.*

Entity	Description
Group	A group of researchers that make up a research group attached to a faculty, with an associated production resulting from research work.
Integrant	A person who is part of a research group, who may be a faculty member, graduate student, undergraduate student or a person external to the university.
IntegrantType	Classification for members of a group. It can be an undergraduate student, graduate student, teacher, external or director of the group.
IntegrantGroup	Represents a member who is associated with a research group, which has an associated member type.
Supervisor	Person in charge of the follow-up in the system and registers the groups and associated production.
Degree	Represents an undergraduate or graduate program attached to one of its faculties.
Institution	It represents the higher education center where research products are developed.
Product	It represents the result of a research work by members of a group. It has a defined type and category.
ProductType	Represents the type associated with a product, defined by MinCiencias, is associated with a category of a product.
ProductCategory	Represents the classification of the products resulting from the research process, as defined by MinCiencias.
ProductAuthor	Represents a member of a group, who is the author of a product resulting from research.

Source: *own elaboration*

5.3. Activity diagram

Fig. 3 shows a UML activity diagram that starts with the creation of a research group and ends with the

registration of its production. This is carried out by a verifier.

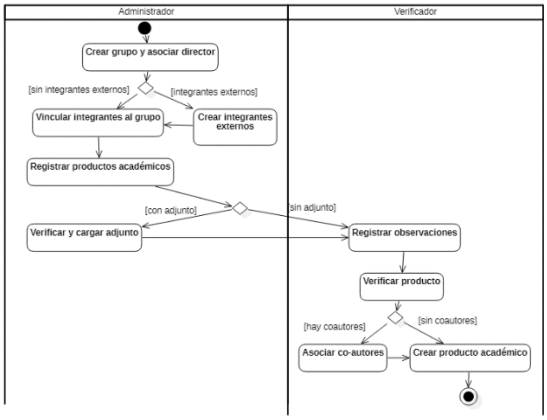

Fig. 3. *UML activity diagram.*

5.4. Deployment diagram

Fig. 4 shows a UML deployment diagram of the developed system. The diagram shows a clear and modular system structure, where functionalities are well distributed among different role-based menus (verifier and administrator). The architecture was designed to facilitate user management, group administration, product upload and review, and report generation. It also has a user interface that ensures intuitive and secure navigation.

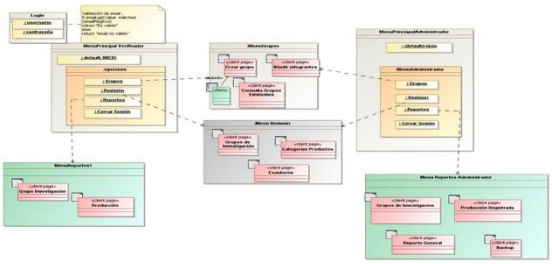

Fig. 4. *UML deployment diagram.*

5.5. Implementation aspects

Implementation aspects include the definition of the programming language, database engines and security aspects.

For backend development, SqLite (database engine) and Bottle, a lightweight Web framework written in Python, were chosen. For the frontend design, Bootstrap was selected as the development framework, based on HTML, CSS and JavaScript, responsive and compatible with mobile devices. For its deployment, an analysis of alternatives was performed, which led to the choice of Heroku as a service platform (PaaS) that allows building, running and operating applications in the cloud. Heroku is known for its ease of use and simplicity in deploying and managing web applications.

5.5. Graphical user interface

The graphical user interface of the research management system starts with the web page shown in Fig. 5, after validation with username and password.

Fig. 5. *Web application home page.*

To manage groups, select the “Groups” link to display the tabs for creating groups, adding members and consulting existing groups. As shown in Fig. 6, there is a form that can be used to establish a research group.

Fig. 6. *Research group management - Create a group.*

Fig. 7 shows the "Add members" tab of a research group, which can be teachers, students or external members.

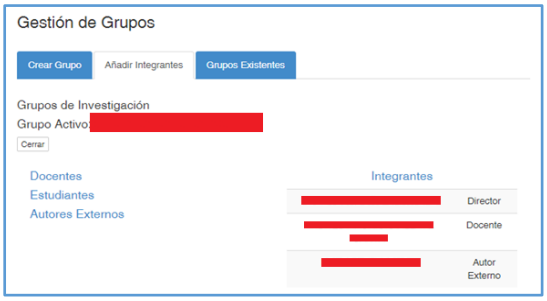

Fig. 7. *Research group management - Add members.*

Fig. 8 shows the different options that the verifier role can perform with respect to recording bibliographic information, social appropriation of knowledge, training activities, evaluation activities, other work and co-authors.

Fig. 8. *Verifier options.*

Fig. 9 shows the production of a research group, in this case, an article, which has already been verified, it was found to be a product of the university and some observations were noted.

Fig. 9. *Production recorded by a group.*

6. CASE STUDY

The Universidad Nacional de Colombia - Manizales has considered as a challenge the demand for knowledge needed for its mission and objectives, including research. The University has different research groups recognized by the University itself and MinCiencias, revealing special interest in knowledge with added value generated from the activities they perform. This is, i.e., applying knowledge management processes.

Despite the fact that the Universidad Nacional de Colombia has multiple information systems, the lack of interoperability among them, the difficult access to information and the lack of continuous monitoring of the research groups are clear reasons that prevent adequate management of the groups and their products.

Four (4) main factors have been identified that have a negative impact on research management at the Universidad Nacional de Colombia – Sede Manizales:

- Lack of registration and updating of research groups.
- Lack of support in the formulation, formalization and registration of research groups.
- There is no updated information showing the amount and type of products each research group generates.
- Lack of use and implementation of ICT tools that accompany strategic processes for successful projects.

The case study was applied to the Dirección de Investigación y Extensión (DIMA) de la Universidad Nacional de Colombia Sede Manizales, which is responsible for managing the resources allocated to research processes at the university. For this reason, this unit conducts strategic activities that support the execution and continuous improvement of its groups and researchers. DIMA has registered 54 research groups in 3 faculties and monitors the research projects carried out by the different groups.

At the end of the system development, it was used to participate in a call for recognition of research groups by MinCiencias. Table 3 shows the number of groups registered and participating in the call.

Table 3: *Research groups registered and participated in MinCiencias's call for proposals.*

Faculty	Registered groups	Participating groups
Management	14	10
Engineering and Architecture	31	21
Natural Sciences	9	8
	54	**39**

Source: *own elaboration*

DIMA used the system developed as a pilot test where each faculty was assigned to two professionals, with an average of 6.5 groups per person. The final verification resulted in an estimated total of 2,496 academic products, which were then registered in the MinCiencias database. Table 4 shows the MinCiencias classification results.

Table 4: *Research groups classified in the call for proposals.*

Ranking	Amount
A1	8
A	4
B	6
C	11
D	1
Not recognized	9
Total	**39**

7. CONCLUSIONS

The research information management system developed and applied at the Universidad Nacional de Colombia Sede Manizales, beyond the collection or updating of data of research groups and the registration of their academic products, allows the establishment of new and better practices for support and strengthening of research groups at the university.

The developed system implements concepts of knowledge repositories that allow storing, organizing, and facilitating access to the knowledge of academic products that are the results of research projects. The case study applied to the Universidad Nacional de Colombia Sede Manizales helped classify MinCiencias groups.

Future work will consist of a more exhaustive validation of the proposed information system based on its functionality and usefulness perceived by different users of university research process management.

REFERENCES

[1] A.A.M. Macas, S.M.B. Carchi, H.J.O. Valencia, y C.D.U. Urgiles, “Knowledge management in organizations: A conceptual systemic vision”, RISTI - Revista Ibérica de Sistemas e Tecnologías de Información, 2019(E21), 2019, 327-340.

[2] Y. Acevedo-Correa, A. Valencia-Arias, L. Bran-Piedrahita, S. Gómez-Molina, y C. Arias-Arciniegas, “Alternatives for knowledge management models in higher education institutions”, Ingeniare, 27(3), 2019, 410-420. https://doi.org/10.4067/S0718-33052019000300410

[3] A. Serenko, N. Bontis, y E. Hull, “An application of the knowledge management maturity model: The case of credit unions”, Journal of Knowledge Management, 24(7), 2020, 1591-1616. https://doi.org/10.1108/JKM-01-2020-0022

[4] D. Hernández-Gutiérrez, B. M. Pichs-Herrera, y F. Benítez-Cárdenas, “La evaluación institucional frente a los retos actuales de la universalización de la universidad”, Revista Pedagogía Universitaria, XI(2), 2006, 18-30.

[5] T.J. Ríos-Delgado, “La gestión del conocimiento y la educación superior universitaria”, Gestión en el tercer milenio, 2012, 15(30), 43-48. https://doi.org/10.15381/gtm.v15i30.8797

[6] P. DeCastro, y H. Puuska, “Research Information Management Systems: covering the whole research lifecycle”, University of Strathclyde, UK & CSC - IT Center for Science Ltd., 2023.

[7] K. Palavesm, y J.P.S. Joorel, “IRINS: Implementing a research information management system in Indian higher education institutions”, Procedia Computer Science, 211, 238-245. https://doi.org/10.1016/j.procs.2022.10.197

[8] A. Ech-Cherif, K. M. Albarrak, y A. K. Alnaim, “Leveraging axiomatic design and research information systems to promote research outcomes at public universities”, Department of Management Information Systems, King Faisal University, 2022. https://doi.org/10.1109/ACCESS.2022.3175995

[9] M. Macken, y C. Iakovakis, “Privacy and research information management systems”, Serials Librarian, 2021, 81(1), 88-98. https://doi.org/10.1080/0361526X.2021.1875959

[10] S. Wu, “Exploring Chinese researchers' research information management practices: Implications for academic libraries”, The Journal of Academic Librarianship, 2021, 47(3), 102348. https://doi.org/10.1016/j.acalib.2021.102348

[11] M. Alavi, y D. E. Leidner, “Knowledge management and knowledge management systems: Conceptual foundations and research issues”, MIS Quarterly, 45(3), 2020, 1077-1101. https://doi.org/10.25300/MISQ/2020/45.3.02

[12] L.M. Villasana-Arreguín, P. Hernández-García, y É. Ramírez-Flores, “La gestión del conocimiento, pasado, presente y futuro. Una revisión de la literatura”, Trascender, contabilidad y gestión, 2021, 6(18), 53-78. https://doi.org/10.36791/tcg.v0i18.128

[13] I. Nonaka, y H. Takeuchi, “The wise company: How companies create continuous innovation”, 2021, Oxford University Press.

[14] L. Prusak, y J. Cranefield, “Managing your own knowledge: a personal perspective”, Personal knowledge management, 2016, 99-114. Routledge.

[15] J. Chen, y I. Nonaka, (Eds.), “The Routledge companion to knowledge management”, 2022, Taylor & Francis.

[16] D. Hislop, R. Bosua, y R. Helms, “Knowledge management in organizations: A critical introduction”, 4th ed., Oxford University Press, 2021.

[17] P.P. Chhim, T.M. Somers, y R.B. Chinnam, “Knowledge reuse through electronic

knowledge repositories: a multi theoretical study", Journal of Knowledge Management, 2017, 21(4), 741-764. https://doi.org/10.1108/JKM-03-2016-0126

[18] L. Taskin, y G. Van Bunnen, "Knowledge management through the development of knowledge repositories: Towards work degradation", New Technology, Work and Employment, 2015, 30(2), 158-172. https://doi.org/10.1111/ntwe.12049

[19] S. Hagen, y T.M. Deserno, "Research information management systems - A requirement analysis framework and a case study", Journal of Information Science, 45(1), 2019, 71-85. https://doi.org/10.1177/0165551518781955

[20] R. Bryant, y S. Junnarkar, "Implementing a research information management system: A multi-institutional experience", New Review of Academic Librarianship, 2017, 23(1), 38-54. https://doi.org/10.1080/13614533.2017.1296013

[21] L. Rodríguez, y P. Gómez, "Implementación del Proceso Unificado en entornos ágiles", Revista de Ingeniería de Software, 15(2), 2021, 123-135. https://doi.org/10.12345/riso.2021.002