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# KNOWLEDGE MANAGEMENT AND SOFTWARE DEVELOPMENT PROCESS

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## **Abstract**

In the software development organizations a process of new knowledge generation is being carried out. This process produces, manages and transfers knowledge and experience acquired from the software development process. Knowledge management has evolved rapidly in recent years, and if it is managed efficiently, it will ensure a product with quality and social usefulness. Taking that in account, the main goal of this paper is to share a strategy supported by technologies for the knowledge management inside an industrial software development project. This strategy will contribute to the development and continuous learning of individuals and to the creation of a favourable environment for the exchange, storage and management of information and knowledge in the software development process. Methodologically, some indicators were assumed in order to evaluate the contribution made by the strategy, and the experts' evaluation method was also used, as well as to assess the theoretical-methodological conception and verify the practical use of the proposal. The practical contribution of the proposal is based in the identification of activities to strengthen the exchanges of knowledge to enable its socialization, the identification of the trained personnel, the maximizing of resources and available means, as well as the minimizing of time loss and the effectively use of information for decision making.

Keywords: Knowledge management process, software development process.

## **1 INTRODUCTION**

(Carr, et al 2011), argues that many scholars and a lot of scientists do not write to use the words written in order to communicate knowledge. On the other hand, (Pérez-Montoro, 2009) is more explicit and said that knowledge carries information, but do not confuse these terms, nor interpret them as synonyms. Experts say that the society evolves from an age in which was predominant the information-based economy, to a different one in which the economy is knowledge-based. Therefore, knowledge management is now an essential procedure for any organization looking to be competitive, due to the relationship of that process to productivity, innovation and quality. The knowledge management process in general terms, looks to design strategies for creating and comprehensive utilization of knowledge in organizational contexts.

Since the 90s decade of century XX, the computerization of Cuban society is promoted by the government. Some of the actions that encompass this computerization process was the creation in 2002 of the University of Informatics Sciences (UCI). The UCI has a network of Software Development Organizations (Centers). The function of this network is to achieve integration around a scientific field of the processes of training, research and software development. To accomplish that is needed a high quality, reliability, accuracy and cost efficiency process of software development. Although is needed to possess the competent and qualified staff, enabling to adapt to the customers' needs and to achieve orientation in the direction of the recent advances in technology.

As a result of the reality observation, document analysis, interviews y surveys, it was identified some contradictions that stop the adequate knowledge and information management. As an example of that, is inefficient the access to research, development and generated innovation, as well as the introduction of scientific result to achieve scientific excellence and technological innovation. There are commitments and administrative obstacles that impede information management and knowledge innovation. It is perceived a lack of an entrepreneurial culture for the scientific and technological innovation. Moreover, few actions are taken to promote scientific culture and research competence. Is inefficient the integration of the processes of training, research and software development, which conduct to the insufficient on the interrelationship between actions, tasks and resources of the organization, to increase the levels of management, integration and storage of the knowledge and information generated. There is a need to learn how social, political and cultural values affect the scientific research and the technological innovation and how those affect society, politics and culture.

Is to incipient what is known as knowledge management; because the information management and technology are easily confused, as the practical and administrative way of knowledge management, as well as to consider that only the managing of large volumes of data and information, involves the generation of new knowledge. The previous outlined difficulties let us to declare the following goal: to design a strategy for knowledge management supported in technologies for the industrial software development process, to contribute to the development and continuous learning and creation of a favourable environment to exchange, manage and storage of information and knowledge.

## 1.1 Materials and methods

- Historical – logical method: to discover the logic and to analyse the evolution, historical conceptualization and development trends through the review of original information sources.
- Analytical – Synthetic method: to study, analyse and synthesize the foundations of the knowledge management process.
- Systemic method: to analyse, reproduce and integrate the properties of investigated object.
- Observation method: to directly obtain, the information of the objective reality of the knowledge management process.
- Interviews: to identify the degree of knowledge of the involved people in the knowledge management process.
- Document analysis: to analyse, categorize, verify, and select the contents in the literature and research reports, concerning to the knowledge management process.
- Surveys: it was a source for the initial characterization of the object under investigation; and for the determination of contradictions.
- Experts' Evaluation: to evaluate the proposal presented in this paper, taking into account the valuation of present significance of the results, internal validity, applicability and feasibility.

## 2 THEORETICAL AND PROPOSED SOLUTION

On the basis of the matrix model of conversion or transfer of knowledge (SECI) of (Nonaka et al. 1999), the knowledge go through a process that transforms them from tacit (contained in the information systems, databases and people) to explicit (captured and stored in a reusable format useful for searching) and again to tacit, which allow others people in the organization to learn and use that knowledge.

Vygotsky in his postulates (Vygotsky, L, 1985) identifies that knowledge is a process of interaction between the subject and the context, understanding the environment as social as much as cultural context where there are determinant features such as consciousness and language. Furthermore, there are mental functions (what to do and what is acquired and developed through social interaction between people first and by themselves later), psychological skills (what intrapsychological-itself- must be first interpsychological-social, the result of an analysis and a group practice), the zone of proximal development (current level of development and the level of potential development that is needed to solve problems, understood as the ability to learn with the support of others), psychological tools (the most important is language and is related to knowledge and thinking) and mediation (raises the relationship between language, thinking and culture, as a process of cultural development).

The systematization of methodological-theoretical foundations let to identify the following:

- Knowledge is a resource that each person can have, which can be transferred and is based on the use of certain information to solve problems and stimulate to obtain certain outcomes. Furthermore, knowledge has social nature, because it's acquired as a result of the implementation of a practical task and in relationship with others. Also, knowledge is a result of an activity that generates the need to obtain the most possible output. Itself does not exist, is inherent to the people. It's not valuable until it is revealed as a result. It is not static in thinking, but dynamic; that increasingly develops and transform every time the subject has a new contact with the object and the people with learn from. Furthermore, it can be represented as a key resource for achieving competitive advantage, because scientific activity generates necessity, transforms society and encourages innovation. And finally, has different ways of being in the organization, as part of human capital, and relational capital and structural capital.

- Knowledge management is a systematic, organized, dynamic and continuous process, aimed to increase the learning process of the people that socially learn and develop. It is based in that is only possible to learn by questioning what is known and using the known knowledge, supported by the integration of concepts, theories, methods, and unknown novel aspects that arouse interest. Furthermore, it is centralized in three elements. The first led to the development and continuous learning of individuals, which takes into account the measurement of intellectual capital. The second element arise to the management and storage of information and knowledge. As the last element, the interaction with technology. Knowledge management has an activity-based process character, which is related to the generation of new knowledge.

The organizations that pretend to achieve information and knowledge technology-based management, require an organizational change management of large scale. So, it is necessary to apply knowledge management models and to project the strategies with specific actions to achieve the exchange, collaboration and conversion of knowledge into information sources; and to manage, administer and preserve the value derived from the knowledge and the ability to innovate.

After analyzing the definitions, principles and components of management strategies also substantiated by the authors (de Armas, et al 2011; Chirino, et al 2011), is possible to identify that a knowledge management strategy is based on several steps such as organization, implementation, monitoring, counseling, monitoring and evaluation process, through a system of dimensions, components and relationships. It is defined by stages, phases or moments centered business to know what the organization has, what can do and what have value. Such strategy has a guiding principle with clear and precise objectives, where is evident the desired state to achieve. It has a scope that allows people to guide the decisions to determine the resources and the main actions to achieve the proposed objective and therefore the effective functioning of the organization. It defines lines of action taking into account the environment where it going to be applied and also includes a set of actions and procedures that are well founded and be running through tasks. This system of actions should be done on a scheduled time. In addition, it must have an implementation approach and responsible partners to fulfill these tasks.

The knowledge management strategy must has a feedback and a relationship between components as well as functioning principles and a plan for implementation and evaluation of results. The assessment is seen throughout the all strategy implementation. However, has three key moments considering the structure and characteristics of the environment where it is applied. The first moment is when there is systematically evaluated the impact of each proposed action in comparison with the targeted objectives. The second moment is the partial evaluation on the defined lines of action, based on the assessments of the accomplishment of the objectives for each one. Lastly, the final evaluation is collected in an outputs report where is confirmed the effectiveness of the proposal, based on the comparison between the diagnosed initial state and the final state.

## 2.1 Proposed strategy for knowledge management supported by technologies in software development process

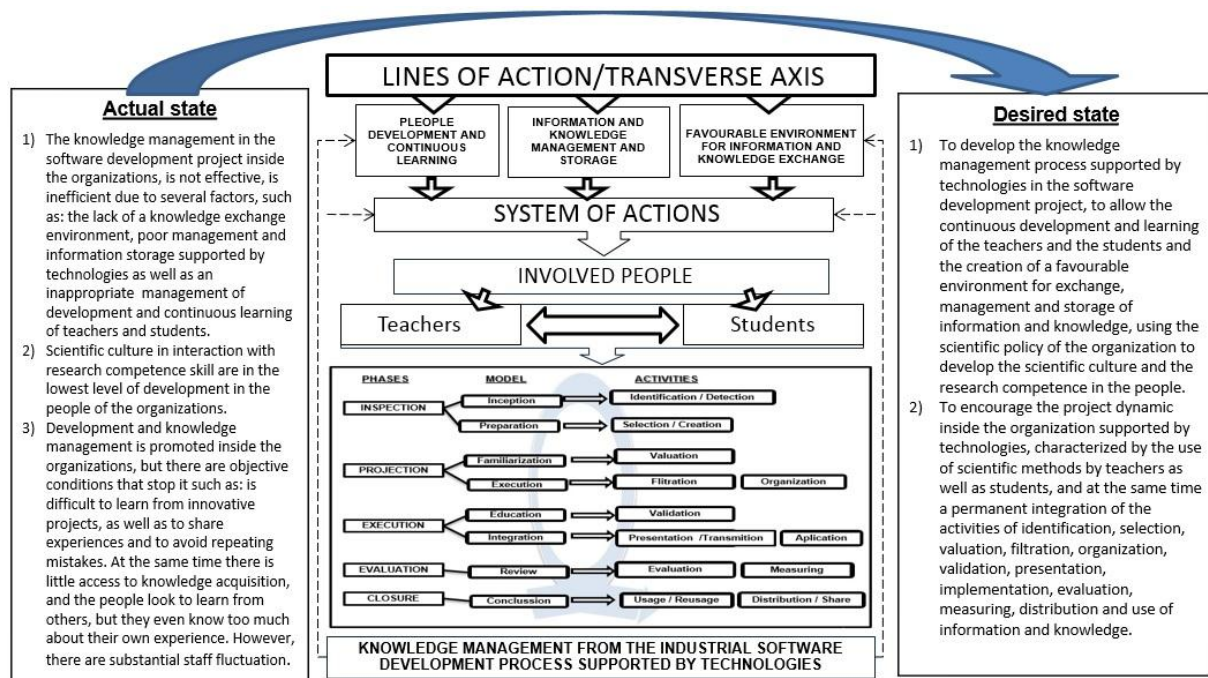


Figure 1. Graphical representation of the proposal.

The proposed actions system to implement knowledge management in the software development organizations consist in:

### LINES OF ACTION: PEOPLE CONTINUOUS DEVELOPMENT AND LEARNING

- To diagnose the current state in the organization for the knowledge management.
- To formalize and document the activities of the knowledge management process.
- To implement a guide for self-study of literature and bibliography.
- To develop a set of scientific-methodological activities in relation to knowledge management process.
- To implement guides for individual and group tutoring.
- To develop training courses around the knowledge management field.

### LINES OF ACTION: MANAGEMENT AND STORAGE OF INFORMATION AND KNOWLEDGE THAT IS GENERATED FROM THE SOFTWARE DEVELOPMENT PROCESS

- To storage the information coming from the systematization.
- To publish in a magazine and in a webpage for scientific socialization the outputs obtained as a result of the activities execution.
- To formalize the actions to ensure the introduction and generalization of the results.
- To implement the self-assessment of the knowledge management process in the organization.
- To verify the effectiveness of the actions proposed in the strategy.
- To implement the phases of the selected knowledge management model.

## **LINES OF ACTION: CREATION OF A FAVOURABLE ENVIRONMENT FOR THE INFORMATION AND KNOWLEDGE EXCHANGE**

- To create workshops, debates and spaces for methodological questions related to the knowledge management process.
- To create a knowledge management board that integrates the Software Development Organizations.
- To organize the Scientific Day for the Software Development Organization.
- To design a digital magazine or newsletter as a way to socialize the knowledge and the know-how.
- To design a knowledge management software to facilitate the use of the approach of the proposed model.
- To use a Virtual Learning Environment for projects and research lines.
- To use applications for knowledge creation that are used in courses and workshops such as COMPENDIUM to visualize knowledge.
- To create the Knowledge and Experiences Catalog acquired from projects.
- To keep the use of GESPRO computer software to control and to track the projects and Alfresco or eXcrista computer softwares for project document management.

## **3 RESULTS AND DISCUSSION OF THE KNOWLEDGE MANAGEMENT STRATEGY IMPLEMENTATION**

The actions that have been implemented have positively influenced in some essential aspects, such as: improving the work environment as well as the selection, training and the mood of teachers and students of the software development project, as in the creation of a team spirit. Those actions also stimulated the growth and development of people within the organization, which encourage that teachers and students spend time, intelligence, creativity and skills in useful activities that add value to the organization. The actions also meant that staffs have high levels of commitment, performance and efficiency, always promoting satisfaction. All of this leads to use the talent to benefit the organization for adding value to the services and products of the organization.

### **3.1 Characterization results on two software development organizations**

In the selected sample is not enough what is understood in terms of knowledge management as a:

- Process to transfer good practices, documentation and learned lessons; where is essential the measurement of teachers and students performances; as well as a major link in the systematization of knowledge from projects.
- Process capable of develop and refine activities to plan, guide, monitor and evaluate projects; where the training of students and teachers is used as a crucial and specific to obtain better products, as well as to achieve motivation, commitment, responsibility and always incorporate technologies as an active component that simplifies and supports this process.

The two organizations of the sample have more than ten (10) projects, with low experience and training needs related with computing, business knowledge, Pedagogical and Education Sciences, with an emphasis on the study of university-software industry relationship and Educational Technology. This scenario determines the need of courses, workshops and conferences that allow the people of the organization to update the acquired knowledge and to add competent personnel to software development teams as to software product and services. That allow, if it's properly managed, to accept contracts for projects encompassing, to face major competitors, to socialize knowledge and to decentralize the specialists workload in the knowledge area where they work.

In the selected sample the 86.6% manifest that the main obstacles for creativity and continuous improvement have come from the lack of knowledge, technological and social skills, ability for communicating with others, as well as teamwork motivations and to find a favourable climate to training.

At the same time, the 76% manifest that there is a growing demand for information management inside the project to measure quality and efficiency of products and services developed in the projects.

This requires to have properly distributed the work, the resources, the means, and the collection and management of information and knowledge using tools and methods for a quick and timely analysis for decision-making and issuing assessments. The proposed strategy will require to raise the organizational culture about services and intellectual property, technology transfer, as well as the new role and requirements of human capital.

All cases of the sample agreed the creation of the Knowledge Management Group inside the Software Development Organization which involved the organization administration, to ensure the implementation of the proposal and this way ensure alignment with the organization strategic objectives. The same quantity of the sample stated that the organization must be able to identify what they know and make efficient use of knowledge. Therefore it's important and meaningful to achieve in the organization the acquisition, representation, retention and manage of the gained knowledge in the projects.

### 3.2 Experts' evaluation of the knowledge management strategy proposal

After the evaluation by the experts of the proposal of the knowledge management strategy, they agreed that there are some elements in which it is necessary to emphasize, such as:

- The research has the necessary elements from the theoretical foundations about knowledge management and its application in social practices; but to research is a complicated process in the practice, because people do not like it, as lack of motivation, experience and perhaps for lack of time to publish the results they achieve in academic or scientific journals with national or international scope.
- The results of the investigations are hardly known among the members of the project teams. Rarely training among team members are develop; as well as the identification of the most knowledgeable in a topic to teach others or share experimental use of alternative technologies or project development.
- At the same time, not too much times the team members use a role rotation system to let everybody to develop in all the phases of the software development process. Therefore, is a need for the software development center administration to compromise with the execution of every strategy action through all outputs the enterprise can make to favor the change.

In general, to now the practical use of the proposal look at the following figure.

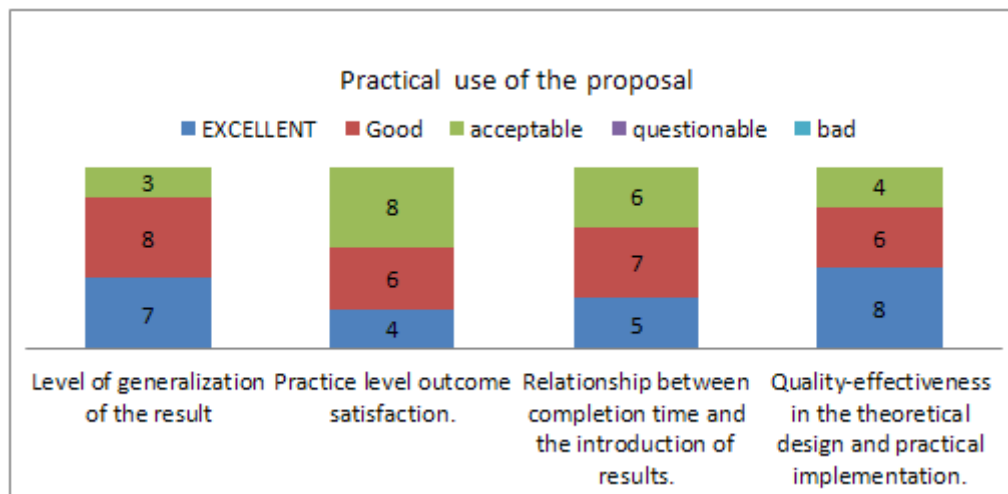


Figure 2. Practical use of the proposal from expert judgment.

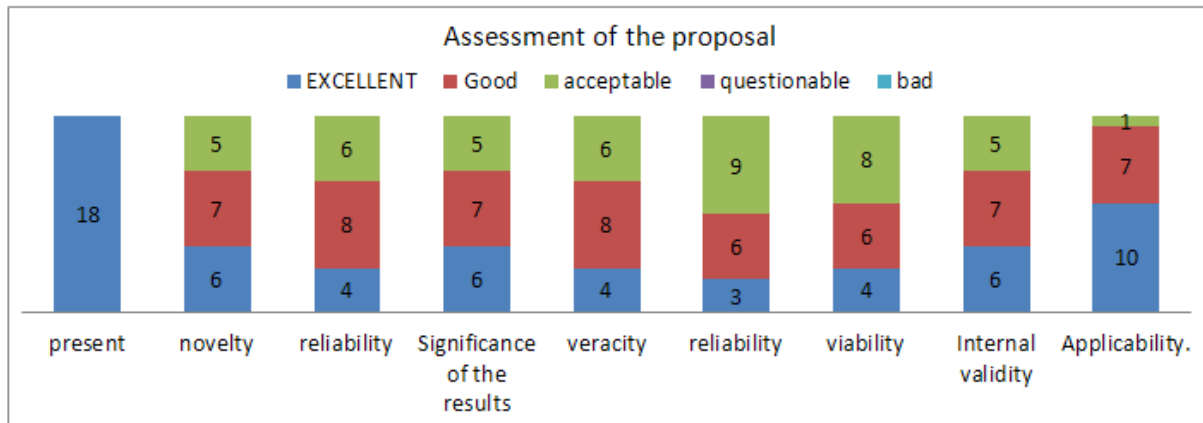


Figure 3. Experts' criteria evaluation.

## 4 CONCLUSIONS

- Due to the analysis of the historical evolution of the theoretical and methodological foundations is evident that the knowledge management is a systemic, organized, dynamic and continuous process, aimed to increase the learning process of the learners that socially develop.
- The application of the instruments provided the initial characterization, where was evidence the poor and disjointed knowledge management in software development projects of the studied organizations.
- Related to what is proposed in the reviewed scientific literature based on the knowledge management context from industrial software development process, is evident the necessity of an strategy that interrelates organizational culture, intellectual capital and technology, aimed to promote the development and continuous learning of people, as to create a favourable environment for managing, exchange and storage of information and knowledge-based technology.
- The proposed knowledge management strategy, constitutes an implementation guide that interrelates organizational culture, intellectual capital and technology, oriented to the development and continuous learning of people, creating a favourable environment for the exchange, management and storage of information and knowledge, based on the technologies.
- The evaluation criteria of the actions system included in the proposed strategy, show levels of applicability, reliability and validity from the context of industrial software development process. The scientific nature of the proposal and its effectiveness were recognized by experts. In addition, the instruments applied in the assessment process of the proposal, corroborated its feasibility to continue the execution.

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