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DEVELOPMENT OF A KNOWLEDGE MANAGEMENT MODEL IN A TECHNOLOGICAL INNOVATION CENTER

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ABSTRACT

This article presents a knowledge management model in a *Núcleo de Inovação Tecnológica* (NIT - Technological Innovation Center), considering it as part of an interorganizational network. The object of study is the Coordination of Innovation and Technology Transfer of the Federal University of Sergipe. The methodological procedures characterize the research as applied, exploratory, and qualitative and the design adopted is the action-research method. The literature review points to opportunities for intervention based on the constructive elements of knowledge management: knowledge goals, identification, acquisition, development, dissemination, use, retention and evaluation of knowledge. The application of the proposed model involves the steps of mapping the processes of knowledge creation, diagnosis of knowledge management, definition of methods and tools in knowledge management, elaboration and execution of the action plan and evaluation of the knowledge management system. The results of the research present the mapping of the Coordination processes, the definition of the knowledge profile and the proposition of practices for the management of NIT knowledge variables. It is concluded that the implementation of the management of knowledge networks contributes to the effective fulfillment of the objectives of the Coordination of Innovation and Technology Transfer.

Keywords: Knowledge management; Constructive elements of knowledge management; Knowledge networks; Technological Innovation.

1. INTRODUCTION

The management of technological innovation has been increasingly discussed in Brazilian universities due to the recognition of its importance in the university's final activity, namely, the generation and knowledge dissemination (CINTEC, 2005). According to Quintella *et* Torres (2011), the university should be seen as an institution that has as its raw material knowledge and exists to serve society and contribute to its development, through the training of qualified professionals and the generation of new technologies.

This discussion, regarding the participation of the university in the process of promotion of technological innovation, became more decisive when the art. 16 of the Technological Innovation Law No.10,973, dated December 2, 2004 (Brazil, 2004), regulated on October 11, 2005 by Decree No. 5.563, established that "ICT should have its own *Núcleo de Inovação Tecnológica* (NIT - Technological Innovation Center), or in association with other ICTs, in order to manage its innovation policy."

According to Quintella *et al.* (2013), the NITs were created to be the instances of institutional management of Intellectual Property (IP) and Technology Transfer (TT), and their actions and related needs, in the ICTs. For Silva *et al.* (2014), the concept of innovation in the university environment transcends the orbits of any sector, because there is a change of ambience of the university in its social role. It leaves from a mission that is developer and transmitter of knowledge in its researches of bench to a position of market competitiveness and beneficiary in the generation of human capital and intellectual property, capable of appropriation of the knowledge developed and applied to the industry.

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In this perspective the study object of the present work is inserted: the *Coordenação de Inovação e Transferência de Tecnologia da Universidade Federal de Sergipe* (CINTTEC/UFS - Innovation and Technology Transfer Coordination of the Federal University of Sergipe). CINTTEC/UFS is the main instance for the execution of the institutional policy for the protection and transfer of technology of Intellectual Property in UFS, created from Administrative Rule no. 938, of November 1, 2005, functioning as the institution's own NIT.

The Nucleus of Intellectual Property (NPI) is responsible for the operationalization of the management of intellectual property originated in UFS. The NPI is an integral part of CINTTEC/UFS, inserted in Administrative Rule No. 938, of November 1, 2005, whose duties are: to ensure the maintenance of institutional policy to encourage the protection of creations, licensing, innovation and other forms of technology transfer and opine for the convenience of promoting the protection of developed creations.

These objectives aim to boost the technological prospection in companies and map the results of research developed at the Federal University of Sergipe, in order to spread the word regarding the innovation processes for a triple propeller. The triple propeller of the state of Sergipe, in this context, is understood as a hybrid model of the relations between the UFS, as inducer of relations with companies (productive sector of goods and services) and government (regulating sector and fomenter of economic activity).

In the context of the triple helix, the university becomes a source of technology, as well as of human resources and knowledge, and creates new capacities to transfer these technologies (Etzkowitz, 2013). The actions to consolidate the triple propeller in the state of Sergipe thus integrate the shared use of results of research, innovation and diffusion of technologies, aiming at the production of new knowledge for intellectual property, technological innovation and economic development of the region, including the generation of employment and income, with a view to innovative entrepreneurship.

These objectives are coherent with the formation of an interorganizational network, involving other ICTs, companies, entities of support to the productive sector and other environments of incentive to innovation, such as technological parks and incubators of companies of technological base. The knowledge network in which CINTTEC/NPI-UFS is inserted is, therefore, an environment of creation, sharing, application and dissemination of knowledge in several areas, with emphasis on the development of innovative products and processes, in order to attend to the interests of several components involved in the core actions: students, researchers, inventors, companies, universities, government institutions and society in general.

According to what has been presented, this article is based on the reflection on the following question: what are the steps to implement a knowledge management model in a Technological Innovation Center in a federal university as part of an interorganizational network?

The general objective is to present a model of knowledge management in interorganizational networks, in order to integrate actions to support the generation of knowledge, intellectual property and technology transfer in the sphere of influence of a NIT in a federal university.

From this, the specific objectives are: (i) to identify the knowledge management practices currently adopted by CINTTEC/NPI-UFS and to propose new practices, according to identified needs; (ii) identify the components of the knowledge network in which CINTTEC/NPI-UFS is inserted, as well as the specific technical knowledge required by these elements, and understand the main interactions between the parties; (iii) develop a systematic process for knowledge management, based on the constructive elements of knowledge management proposed by Probst *et al.* (2002) and; (iv) to propose tools to promote the alignment between CINTTEC/NPI-UFS generation, protection and technology transfer activities.

It is justified the relevance of initiatives based on knowledge management, since these can corroborate with the improvement of the process of management of technological innovation through the NITs. According to Strahus (2003), the establishment of a process of knowledge management in research and innovation environments can foster the reuse of information generated, the sharing of best practices identified and the consequent fixation of organizational knowledge.

Knowledge management is still far from the practice of many innovation environments. Even in the academic field, discussions on the subject are recent and most of the research is focused on companies (Augusto, 2012). Moreover, according to Roy *et al.* (2003), there are divergences between the knowledge produced by research and the knowledge demanded by the practice in organizations. Based on these considerations, it is relevant to align the objectives defined by the research groups in the universities and the needs of the companies to the area of interest, referring, in this case, to the transfer of useful knowledge to the users.

For Lima et Amaral (2008), the problems of knowledge management applied to research groups and knowledge management applied to the networks are little known and theoretical models were not found by these authors during the literature review. This affirmation reinforces the need for research of this nature and contributes to the justifications of the present study.

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2. RESEARCH METHODOLOGY

This research is based on the dialectical method, which, according to Marconi *et* Lakatos (2010), is based on the analysis of phenomena through their reciprocal actions, the contradictions inherent in phenomena and the dialectical change that occurs in nature and in society. It is, therefore, a method of dynamic and totalizing interpretation of reality, used in qualitative research.

It is justified to adopt the dialectical method in research aimed at the management of organizational knowledge since, according to Takeuchi *et* Nonaka (2008), the dynamic process in which the organization creates, maintains and exploits knowledge is very similar to the dialectical standard.

As to nature, the present research is an applied research, since it is focused on the acquisition of knowledge with a view to application in a specific situation. Regarding the objectives, the research is classified as exploratory. This type of research, according to Gil (2010), aims to provide greater familiarity with the problem, with a view to making it more explicit or constructing hypotheses.

The approach to the problem is qualitative, appropriate to the need to understand the various situations in terms of the object of study. According to Bryaman (1989 apud Miguel *et al.*, 2010), the characteristics of the qualitative research are: emphasis on the subjective interpretation of individuals; delineation of the context of the research environment; importance in terms of the conception of organizational reality and proximity to the studied phenomenon.

Although the emphasis of the study is on the application, the first stage is characterized by a review of the literature on the proposed theme: bibliographic research. This research is based on Augusto (2012), Brandão *et* Bahry (2005), Davenport *et* Prusak (2003), Etzkowitz (2013), Kaplan *et* Norton (1997), Lima *et* Amaral (2008), Nonaka *et* Takeuchi (1997), Probst *et al.* (2002), Quintella *et al.* (2013), Roy *et al.* (2003), Silva (2006), Silva *et al.* (2014), Strauhs (2003) and Takeuchi *et* Nonaka (2008).

In addition to bibliographic research, documentary research was used as a technique, whose characteristic, according to Marconi *et* Lakatos (2010), is that the source of data collection is restricted to documents, written or not, constituting a source of primary research. In this work, official documents and administrative publications of the institution were used as sources.

Applied research, in order to enable the answer to the research problem, takes the form of an action research. Action research is a type of empirically based social research that is conceived and carried out in close association with action or with the resolution of a collective problem and in which researchers and participants representing the situation or problem are involved in Cooperative and participatory mode (Thiollent, 2008).

Thiollent (2008) places among the knowledge objectives potentially achievable in action research the production of guides or practical rules to solve problems and plan corresponding actions. In this study, the objective is to develop a knowledge management model for CINTTEC/NPI-UFS, defining the knowledge management practices to be used.

In order to meet the research objectives, fieldwork was carried out involving the researchers and the CINTTEC/NPI-UFS team, as well as a survey of NIT 's history. The instruments of data collection defined were observation and interview. In this study, the observation actions are classified as systematic, participant, individual and in real life and the type of interview used was unstructured (Marconi *et* Lakatos, 2010).

The proposed modeling to obtain answers to the research problem is composed by a series of steps to be followed for the implementation of knowledge management in CINTTEC/NPI-UFS. Miguel *et al.* (2010) recommend a line of action for the construction of theoretical models, which was adopted in this research, which includes: choosing an author as a reference; understanding the model of this author in the smallest details; criticizing it to the extent that it does not adequately explain the phenomenon under study; elaborating a variant in order to make it better to explain the phenomenon, answering the research question and, with this, elaborating the model; deriving hypotheses and assumptions from the model and; testing these hypotheses, validating or rejecting the proposed model.

Following this systematic, the knowledge management model of Probst *et al.* (2002) was defined as the main reference. The practical approach, organized in stages that present specific methods, was a point taken into consideration in the selection of this reference model. The studies for the understanding of this model are expressed in the theoretical basis.

From the approaches studied, it was defined that the implementation of a model for the management of knowledge in a NIT contemplates the steps presented in Figure 1: (i) mapping of knowledge creation processes, (ii) knowledge management diagnosis, (iii) definition of methods and tools in knowledge management, (iv) elaboration of the action plan, (v) implementation of the action plan, and (vi) evaluation of the knowledge management system. These described steps are systemic and it is a dynamic and flexible process that must be constantly updated, resembling a PDCA (Plan-Do-Check-Act) cycle.

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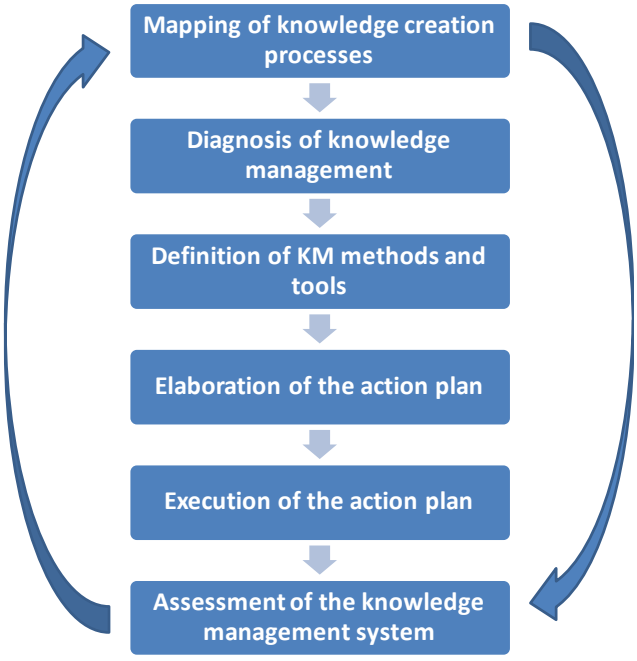

Figure 1. Steps for implementing the knowledge management model for a core of technological innovation
Source: The authors

3. THEORETICAL RATIONALE

3.1. Knowledge management

Davenport *et* Prusak (2003) define knowledge as a fluid mixture of condensed experience, values, contextual information and experienced insight, which provides a framework for the evaluation and incorporation of new experiences and information. Knowledge always begins with the individual, so the organization cannot create knowledge by itself, without the initiative of the individual and the interaction that occurs within the group (Nonaka *et* Takeuchi, 1997). In this way, all investment in production and use of knowledge must focus on human resources, providing them with the technological and managerial support appropriate to the intended objectives.

By virtue of this intimate relationship between knowledge, individual and the context in which it is created, it is understood that there is intrinsic knowledge to the individual: tacit knowledge. Tacit knowledge is that personal, characterized by being created in a specific practical context and difficult to be formulated and communicated. It includes cognitive elements (mental models) and technical (know-how, techniques and skills). On the other hand, explicit knowledge is defined as codified knowledge, transferable in formal and systematic language (Nonaka *et* Takeuchi, 1997).

Probst *et al.* (2002) propose the concept of organizational knowledge base as the individual and collective knowledge assets that the organization can use to perform its tasks, including the data and information on which individual and organizational knowledge is built. In this context, the same authors present knowledge management as an integrated set of interventions that take advantage of opportunities to shape the knowledge base.

In summary, it is perceived that the role of knowledge management is to intervene, in a planned and systematic way, in the organization's work and management methods, in order to favor the creation, diffusion and utilization of knowledge, with the individual as a central element of this process.

For Probst *et al.* (2002), the question of how companies could keep up with the dynamics of their knowledge environment was mainly concerned with organizational learning, whose analyzes are almost always too abstract to serve as a basis for practical interventions. Therefore, these authors present what they call "constructive elements of knowledge management", a set of closely related processes. For them, the constructive elements help to analyze the situation of the organization and structure the activities of knowledge management. The knowledge management model of Probst *et al.* (2002) is shown in Figure 2.

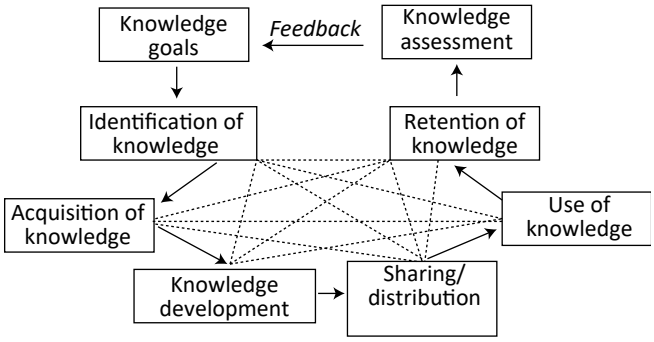

Figure 2. Constructive elements of knowledge management
Source: Probst *et al.* (2002)

For Silva (2006), the method of Probst *et al.* (2002) facilitates the conversion of real organizational problems into knowledge problems, demonstrating their applicability through tools to evaluate the effects of decision-making on intellectual assets. The strength of this method lies in the presentation of several tools that support the architecture of all constructive elements of knowledge.

Based on the model proposed by Probst *et al.* (2002), it is perceived that the processes involved in goal setting

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are the starting point of knowledge management. These knowledge goals, as well as any goals established by the organization, define the guidelines to be followed by all areas. The deployment of goals into specific actions provides the references so that individuals can contribute to the achievement of the organization's objectives. Thus, Probst *et al.* (2002) state that knowledge goals should play the same classical functions as traditional goals: to serve as the basis for decision-making, coordination, motivation and monitoring.

However, for these authors, the tools for defining knowledge goals and targets are still just beginning. An examination of initial attempts shows that there is still a lot of room for creative adaptation of existing tools for developing strategies, so there are no established tools for formulating knowledge goals. Such findings constitute a challenge to be overcome by organizations and an opportunity for the development of studies in order to fill this gap.

Assessing knowledge requires the modeling of a performance measurement system for knowledge management. According to Carpinetti (2010), a performance measurement system is fundamentally characterized by gathering a set of indicators related to processes and performance criteria that most interfere in effectiveness, defined according to the strategic objectives. For the author, these indicators are defined from the identification of cause and effect relationships between the results and the means to achieve them.

The result of this evaluation represents feedback for the revision of the knowledge goals, identifying the need for interventions in the knowledge management established by the organization, in all the constructive elements.

3.2. Knowledge Networks

Knowledge networks are sets of people, resources and relationships between them, which are assembled to accumulate and use knowledge primarily through knowledge creation and transfer processes, for the purpose of creating value (Seufert *et al.*, 1999 *apud* Roy *et al.*, 2003).

Balestrim *et al.* (2005) point out that an organization, or even an interorganizational network, cannot create knowledge, ratifying Nonaka *et* Takeuchi's theory of knowledge creation (1997) that knowledge is created by the individual, from the interaction between tacit and explicit knowledge. However, according to the authors, networks can provide a space for positive and constructive relationships between actors and between actors and their environment. Thus, data exchanges, information, opinion, collaboration and mobilization converge in an effective *ba*[1] to increase knowledge in organizations. Interorganizational knowledge, that is, that created within a network of companies, is one of the broader dimensions of knowledge creation.

Interorganizational relations aimed at the promotion of technological innovation have the participation of the university (through NITs), governmental institutions and the productive sector, leading to the formation of a "triple propeller". According to Etzkowitz (2013), the triple propeller model was generated from the analysis of the government's relationship with the university and the industry, and innovation is increasingly taking shape in the triple helix relationships and in the new actors that are generated by these interactions, such as incubators and technology parks.

The construction of a network of technological innovation, to boost the dynamics of the local triple helix, is efficiently able to integrate the different actors involved in the process of technology transfer, and essential for the economic growth of the country. All these actors must understand their role to act in a harmonic way, generating benefits for themselves and for society (Silva *et al.*, 2014).

3.3. Knowledge management in research and innovation environments

The main problems faced by research groups for knowledge management, as pointed out by Lima *et* Amaral (2008) are: lack of time for group members, lack of a sharing system and dissemination of knowledge, ineffectiveness in transmitting to students the importance of knowledge management, difficulty in terms of working together among research groups, excessive information, lack of historical records, communication difficulties and turnover of members. These same problems can be identified in NITs due to similar characteristics such as dependence on obtaining financial and human resources through short-term projects.

With regard to the retention of knowledge in universities' research, development and innovation environments, one of the main obstacles to the flow of information and knowledge generation, according to Strauhs (2003), is the marked turnover of one of the main actors in the process: Undergraduate and graduate students who work in the nuclei, departments and laboratories.

1 ba can be considered a shared space that serves as the basis for the creation of knowledge.

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These actors, at the end of their period of study, disconnect from the university, representing a substantial loss of knowledge, since there is an evasion of accumulated intellectual capital and, therefore, there is a need to replace it.

As an alternative to minimize this loss of knowledge, the record of lessons learned is important. The lessons learned represent the essence of the experience gained in a project (Probst *et al.*, 2002). At the end of a member's or team's activities, Strahus (2003) states that there should be a period of time reserved for the sharing of knowledge acquired with other members of the group or even the knowledge network.

Another challenge faced by research groups is cooperation with companies. According to Lima *et* Amaral (2008), with few exceptions, Brazilian research groups are little linked to productive systems, preventing the transfer of knowledge in both directions. One of the explanations would be the distinct dynamics of knowledge production. While research groups maintain the character of scientific and advanced research, companies would seek knowledge for the solution of short-term technical problems.

Thus, a knowledge management model for research and innovation environments should point out solutions to the main problems detected, in order to propose methods to systematize knowledge development and appropriation activities.

4. RESULTS AND DISCUSSIONS

The results presented below follow the proposed steps for the implementation of the CINTTEC/NPI-UFS knowledge management model, as presented in the research methodology: mapping the processes of knowledge creation, diagnosis of knowledge management and definition of methods and tools in knowledge management.

Before presenting actions related to these stages, since the model predicts the interaction between the elements of the knowledge network, the main agents of this network were mapped and what their main role is next to CINTTEC/NPI-UFS. Networking interferes in all elements of knowledge management, thus confirming the establishment of a knowledge network management model, because, in the scenario where the study object is inserted, it is not possible to treat the NIT in isolation.

From the perspective of the triple propeller, the creation of a network, representing distinct interest, to build support for technological innovation in a regional focus is the key element in a strategy for economic, scientific and social development (Etzkowitz, 2013).

In addition to identifying the components of the CINTTEC knowledge network, which integrate the local triple propeller, the main knowledge offered and demanded by these components is also defined, in order to develop activities to meet elements to sustain relations based on mutual benefit. Table 1 summarizes this shared technical knowledge.

4.1. Mapping of knowledge creation processes

The mapping of CINTTEC/NPI-UFS processes aims to identify all the processes and activities carried out in the nucleus, in terms of support to the creation of organizational knowledge. In this way, it becomes possible to understand the functioning of the organization, in order to design interventions that can be better adhered to the internal routines.

It is based on the fact that CINTTEC/NPI-UFS has, according to its attributions, two main processes: Intellectual Property Management and Technology Transfer. From these, it was identified, through interviews and observation, the following processes and support activities: development of materials on intellectual property; event promotion; updating of CINTTEC website; search for anteriority; preparation of materials for events and management of the *Programa Institucional de Bolsas de Iniciação em Desenvolvimento Tecnológico e Inovação* (PIBITI - Institutional Program for Initiatives in Technological Development and Innovation).

Taking the Intellectual Property Management process as a reference for detailing the process map, it is considered that it is composed of the main elements presented in Table 2.

4.2. Diagnosis of knowledge management at CINTTEC

The determination of the diagnosis aims to define the situation of the processes related to knowledge management currently implemented in CINTTEC. Considering the processes identified, as presented in item 4.1, the knowledge profile of CINTTEC was determined, based on Probst et al. (2002), who assert that every organization has its own way of dealing with data, information and knowledge and creates its own structures, functions and systems for this purpose, so that there are no standard methods for introducing knowledge management. The best way is to start with the existing structures in your company and apply them effectively to achieve the company's knowledge goals.

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Table 1. Shared knowledge with components of the knowledge network

Elements of the knowledge network	Shared knowledge
Nuclei and Departments of undergraduate and graduate of UFS Instituto Federal de Educação, Ciência e Tecnologia de Sergipe (IFS - Federal Institute of Education, Science and Technology of Sergipe)	Information on technological innovation, intellectual property and technology transfer to promote a culture of innovation between researchers and students and to collaborate with the protection of developed knowledge.
Centro Incubador de Empresas de Sergipe (CISE - Business Incubator Center of Sergipe)	Support in the processes of registration of intellectual property for the new products developed in the incubated companies, promotion of the culture of innovative entrepreneurship and favoring the generation of spin-offs.
Sergipe Parque Tecnológico (SERGIPETEC - Sergipe Technology Park) Sergipe Petroleum and Gas Production Chain Cooperation Network (Petrogas Network / SE) Brazilian Service of Support to Micro and Small Businesses - Sergipe (SEBRAE / SE) Federação das Indústrias do Estado de Sergipe (FIES - Federation of Industries of the State of Sergipe) Euvaldo Lodi Institute - Nucleus regional Sergipe (IEL/SE) Embrapa Tabuleiros Costeiros	Offer of new products or processes that can be implemented in the productive sector and the identification of demands of the productive sector that require solution through innovative products or processes.
NIT-NE NETWORK Instituto de Tecnologia e Pesquisa (ITP - Institute of Technology and Research) Instituto Tecnológico e de Pesquisas do Estado de Sergipe (ITPS - Technological and Research Institute of the State of Sergipe)	Sharing experiences and actions taken to achieve the objectives defined in the network design.
National Forum of Innovation and Technology Transfer Managers (FORTEC)	Sharing of experiences and actions carried out to achieve the objectives defined in the forum.
Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq - National Council for Scientific and Technological Development) Financiadora de Estudos e Projetos (FINEP - Studies and Projects Financier) Fundação de Apoio à Pesquisa e à Inovação Tecnológica do Estado de Sergipe (FAPITEC - Foundation for Research and Technological Innovation Support of the State of Sergipe)	Capturing financial resources through projects focused on the development of research, attraction of human resources and support to the infrastructure supporting the activities.
Instituto Nacional de Propriedade Industrial (INPI)	Information necessary for the deposit and grant of registration of intellectual property and promotion of capacities in intellectual property.
Secretaria de Estado do Desenvolvimento Econômico da Ciência e Tecnologia (SEDETEC - State Secretariat for Economic Development of Science and Technology)	Support to the establishment of public policies to promote local technological innovation.

Source: The authors

Table 2. Detail of the Intellectual Property Management Process

Process element	Description
Suppliers	Inventors, teachers and students, generally involved in research projects of the university (can be in partnership with other icts), which provide information for the process.
Inputs	Requests from inventors, documentation required by the Instituto Nacional de Propriedade Industrial (INPI - National Institute of Industrial Property), procedures to make the registration deposit.
Activities	According to the flow chart of activities developed by the organization, including the receipt of documentation, analysis of documentation, entry of the process with INPI, among others.
Outputs	Intellectual property records deposited and granted.
Customers	Inventors, researchers, university, the process of technology transfer carried out in CINTTEC and, more broadly, society in general.

Source: The authors

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These authors propose, then, to evaluate the strengths and opportunities of improvement of the company due to the constructive elements of knowledge management. This analysis was performed by the author, based on information obtained from the team through interviews, observation and documents, resulting in the diagnosis presented in Table 3.

From this diagnosis, it is identified that, although there is the planning of the annual actions of the nucleus, there is potential for the improvement of the medium and long-term planning as to the actions to be performed. Opportunities exist for improving definitions of the scope and timing of joint actions involving more than two members of the triple propeller. Most of the defined goals refer to the PIBITI projects, which have deadlines and well-established activities, but are short-term, and are the result of public notices that involve development agencies. There are also stipulated goals for scholarships members, which are part of the work plans of the projects to which they belong; however, there could be a study of the correlation with the other areas and processes of the NIT. It also identifies objectives defined externally to the nucleus, such as those defined in the framework of FORTEC, the NIT-NE Network project and national science, technology and innovation policy determinations.

In annual management reports, indicators are identified that allow the perceived performance of the core in terms of some of its main objectives, expressed, for example, in the form of intellectual property registry deposit numbers, number of publications, number of grants awarded, number of projects with results with knowledge appropriation, via INPI, among others. An indicator monitoring system could be nurtured in order to associate them with the defined goals and objectives.

Understanding the current structures, it is possible to establish new practices that are compatible with those already carried out, ratifying the suggestion given by Probst *et al.* (2002) that the best way to implement knowledge management is to use existing structures and methods and apply them in order to achieve knowledge goals.

Table 3. Knowledge Management Diagnostics

Constructive elements of KM	Diagnosis of the situation at CINTTEC
Knowledge goals	The mission and objectives of CINTTEC are defined; There are well-defined assignments within the group; There is a definition of objectives and actions, including from the knowledge network; there is no goal setting.
knowledge identification	IP registration activities carried out on demand; Recent initiatives in terms of development: survey of UFS research projects and portfolio of competencies; Easy access to relevant information.
Knowledge acquisitionf	Training of the team; Participation in events; Project financing; Interaction with members of the knowledge network.
Knowledge development	Mainly through the execution of research projects, which is the responsibility of the executors, and there may be a greater follow-up of CINTTEC, aiming at helping to achieve the project objectives in relation to technological innovation.
Knowledge dissemination	Environment favorable to the exchange of knowledge among the members of the team; Publications and events to disseminate the knowledge produced; Need for greater integration in terms of technological innovation projects with the various members of the knowledge network, especially in the business environment.
knowledge use Obtaining intellectual property, but with low transfer of technology; There is no record of lessons learned; High staff turnover.	
Knowledge retention	Little conversion of knowledge into new products for the consumer market; Information stored in physical and electronic databases (CINTTEC websites and NIT-NE Network); Increase the use of information in reports and documents.
Knowledge assessment	There are annual management reports; There are indicators aimed at evaluating the objectives.

Source: The authors

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4.3. Proposals for knowledge management

Based on the diagnosis presented in the previous item, methods and tools were defined in order to enable the effective application of knowledge management in CINTTEC, considering the interorganizational networks approach, in consonance with the third stage of the proposed model: definition of methods and tools in knowledge management. Table 4 presents a synthesis of the hypothesis of practices to be adopted.

Taking as a starting point for all other actions the definition of knowledge goals, it is proposed that strategic actions be defined based on a strategic planning. These actions will be implemented through the Balanced Scorecard (BSC). It is a consolidated tool, both in theory and in practice, for the management of strategies in private and public organizations. The objectives and goals of the BSC focus on organizational performance from four perspectives: financial, customers, internal processes and learning and growth (Kaplan *et* Norton, 1997)

Although there is no identified experience with the use of the BSC in terms of innovation environments such as NITs, its principles lead to the conversion of intangible assets into results expressed by tangible assets and is therefore suitable for knowledge and innovation intensive environments. In addition, Silva (2006) argues that, for the management of the implementation of a strategy that should value the company's knowledge assets, the BSC system should be adopted, as it aims to complement the traditional financial indicators with the indicators of intangible assets.

In this context, it is proposed to draw up a strategic map in order to identify cause and effect relationships between objectives in each of the perspectives. The strategic map is, however, a static representation of the connections between the strategic objectives. The objectives presented in the strategic map must be deployed in strategic actions. It is proposed to use a tool to record the actions defined from the strategic map and effective construction of the BSC, defining for each BSC perspective the associated indicators, targets and respective strategic actions.

After this stage, we must intensify and seek better ways to promote the systematics of knowledge identification. This identification should be based on the following question: what knowledge is needed to achieve the strategic objectives?

For this purpose, the creation of a database, with information about ongoing research projects in the university, aims to help in the identification of the nature and location of knowledge relevant to the activities of CINTTEC/NPI-UFS, in the context in which research projects are potential generators of innovations and may become the object of obtain-

Table 4. Proposals in Knowledge Management for CINTTEC

KM constructive elements	Diagnosis of the situation at CINTTEC
Knowledge goals	Define / revise mission, vision, values and objectives of CINTTEC; CINTTEC strategic planning.
Knowledge identification	Survey of sources of knowledge; Survey of knowledge network members; Updating information on knowledge offerings and demands.
Knowledge acquisition	Intensive use of the knowledge network; Establishment of forms of intra and interorganizational cooperation.
Knowledge development	Follow-up of research projects; University-company interaction and other collaborative developments; Methods of creativity and problem solving in the development of knowledge.
Knowledge dissemination	Encouraging spontaneous exchanges of knowledge; Holding assemblies, encounters, workshops, meetings, publications and the like to disseminate the knowledge produced.
Knowledge use	Survey of users' need to define internal and project knowledge goals; University-company interaction; Technology transfer.
Knowledge retention	Record of lessons learned; Definition of document templates and reports; Development of a CINTTEC database; Definition of the processes of selection, storage and updating of knowledge.
Knowledge assessment	Definition of performance indicators; Indicator monitoring worksheet.

Source: The authors

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ing intellectual property rights and technology transfer. In addition to the knowledge bases of the projects, there must be a database of the patents deposited by the nucleus and its status.

Another important set of information is the identification of the members of the knowledge network and which knowledge can be acquired or developed by them, using a tool to explain which knowledge can be extracted from the main elements of the network and also where and how it can be done.

The understanding of these components of knowledge identification allows defining the knowledge needed to achieve strategic objectives and which knowledge is available in the core, thus explaining a knowledge gap, which must be eliminated through initiatives of knowledge acquisition or development.

Investments in information technology are also necessary in establishing the process of acquiring knowledge. For example, follow-up of the patent filing process, which is also a knowledge acquisition activity required for decision-making, currently requires labor-intensive activity, since staff members should check INPI to verify the status of the deposit processes performed. CINTTEC has acquired software to track patent deposits, which facilitates this process, with gains in terms of staff productivity and greater control in terms of the management of intellectual property.

As for the dissemination of knowledge, spontaneous exchanges of knowledge should be encouraged, promoting environments and occasions that corroborate this. With reference to current practices, it is proposed to continue the holding of assemblies, encounters, workshops, meetings, publications and the like to disseminate the knowledge produced. These actions, however, should be planned and be consistent with the objectives of knowledge, defining the extent of each action (members of the CINTTEC team, internal to the UFS or interorganizational), citing again the knowledge sharing environments presented by Balestrim *et al.* (2005).

With regard to the knowledge use, a point that contributes to this step is the survey of the users' need to define internal and project knowledge goals, and the tools for mapping innovation offerings and demands.

Another initiative that contributes to the retention of knowledge is to encourage the recording of lessons learned by research groups and internal staff, for example, at the end of each project, event, or team member's disengagement. In this way, it is proposed to monitor the recording of this information in the partial and final reports, comparing them with the final reports of the projects that were accepted as renewal, that is, those with two or more years of execution.

Finally, considering the provisions of the knowledge assessment stage, the indicators defined for each strategic objective listed in the tool for recording knowledge goals should be detailed and arranged as a suitable tool for the monitoring of the indicators over time, presenting: Indicator, method of calculation, data controller, frequency of indicator registration, targets and current performance.

The following indicators are adopted in this model: index of products and technological processes developed; number of patent applications registered in Brazil; number of patent applications registered abroad; number of technology transfer contracts; index of projects supported by the nucleus in relation to the total projects of the institution; number of projects carried out in partnerships with other organizations; number of disciplines in technological innovation supported by the core and number of students in graduate studies in intellectual property and technology transfer; number of publications in technological innovation; index of compliance with project deadlines; number of innovation incentive grants; number of companies and researchers participating in events; raising of financial resources through calls for research and innovation; percentage of studies that generated patent deposits and; resources obtained through royalties.

It is worth mentioning that the evaluation of these indicators, that is, the verification of the achievement of the goals, is the basis of the evaluation of the entire knowledge management system, from which feedback is established, through corrective action proposals, which will be related to the new knowledge targets.

Until then, the CINTTEC process mapping, the diagnosis of the current knowledge management situation and the methods and tools to be adopted were presented, according to the proposed steps for the implementation of a knowledge management model, citing proposed procedures and forms that support this application.

The results of the research then lead to the set of practices in terms of knowledge management to be adopted by CINTTEC/NPI-UFS. For this, as determined by the model, an action plan must be defined, presenting the implementation schedule of actions regarding knowledge management. From this point, the actions should be conveniently carried out by the core team and submitted to the periodic evaluation, with the participation of members of the triple propeller, according to the knowledge measurement tools discussed in the previous item.

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With the development of the research, the dynamic nature of the proposed modeling was perceived. Once actions for knowledge management are implemented, they modify the context in which they intervene, which requires feedback from the system. Thus, new activities are inserted and process mapping must be updated, just as the knowledge profile of the core is changed by the actions performed and new methods and tools are required, confirming the restart of the cycle and emphasizing that there is continuous improvement of practices. Moreover, it is possible to see in the strategic planning that targets the knowledge goals and the evaluation of the system, besides being operationalized through the BSC, the central principle of the knowledge management model. In this way, the model and the constructive elements of knowledge management can be represented as in Figure 3.

In this way, the knowledge management model presents a management system approach, collaborating with the continuous updating of the model and, therefore, ensuring that the interventions in the knowledge assets will be continuously motivated by means of strategic actions directed to the changes in the base of the core knowledge. Thus, the research results point to the development of a set of methods and tools suitable for the implementation of knowledge network management processes, aligned to each constructive element of knowledge management.

5. CONCLUSIONS

This article was developed with the general objective of presenting a model of knowledge management in interorganizational networks, in order to integrate actions to support the generation of knowledge, intellectual property and technology transfer in the sphere of influence of a nucleus of technological innovation in a federal university. This goal was achieved through the definition of a knowledge management model whose implementation steps are: mapping the processes of knowledge creation, diagnosis of knowledge management, definition of methods and tools in knowledge management, elaboration of the action plan, Implementation of the action plan and evaluation of the knowledge management system.

From the provisions, it is noted that the constructive elements of knowledge management have proved to be adequate for the use in network environments of knowledge and innovation. The logical sequence with which the processes are presented, proposing specific practices for each one, considering also the interactions among the processes, is pointed out as an aspect favorable to the application of this model, thus, being an appropriate reference for the implementation of management systems.

The results of this research can be used as guidelines for nuclei of technological innovation, incubators of technological base companies, technological parks and other innovation environments that work in interorganizational networks, to define their knowledge management processes, contributing to leverage the results sought by these organizations in promoting technological development.

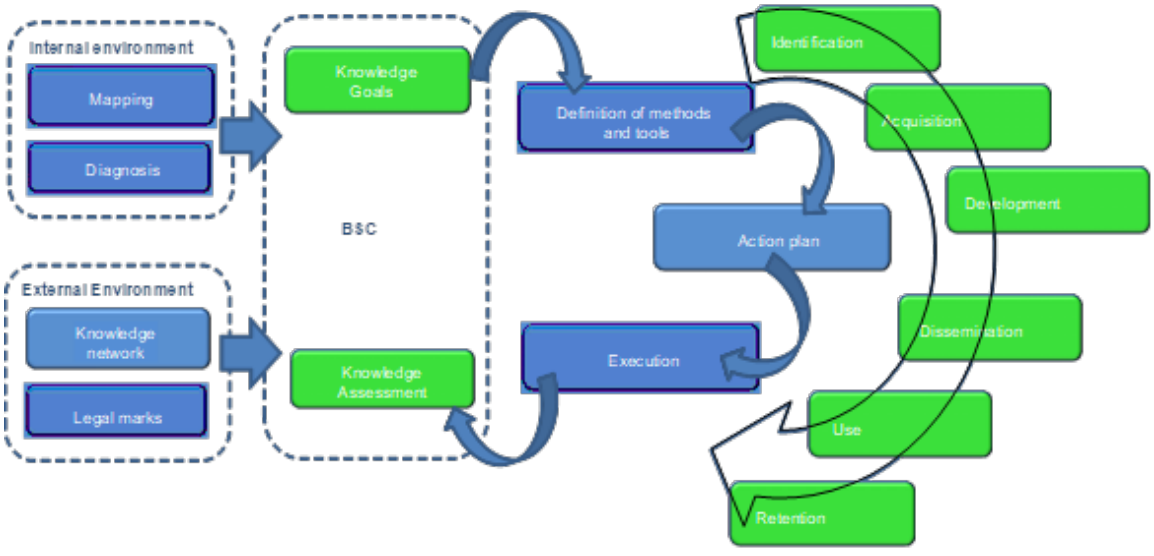

Figure 3. BSC as the central method of the knowledge network management model in a nucleus of technological innovation
Source: The authors

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The model presented by this study aims to meet the principles of knowledge network management. In this case, the application of specific techniques aimed at the implementation of knowledge management in a defined element of this network is taken, taking into account the interventions in the knowledge base of this element due to the interactions with the other elements of the network, identifying the variables external to the system and how these interfere in the system under study. It is a study of knowledge management in an interorganizational network environment. On the other hand, further research can address knowledge management for interorganizational networks, such as networks of technological innovation nuclei. In this way, the proposed model must be adapted in order to model the behavior of the whole knowledge network. Based on the creation of an interorganizational network governance structure, the effort is to identify how the interactions among network elements modify the knowledge base of the network as a whole, directing the management efforts so that the specific interventions in each element positively and cohesively affect the other components of the system in order to obtain the synergy necessary for the development of the entire network.

It was not the scope of this work to present knowledge systems, according to the principles of Knowledge Engineering. However, it is evident in NITs, in particular, at CINTTEC, the need for information systems that can help in the management of the information related to each step of the knowledge management model.

The present study proposes to serve as an incentive proposal for studies and practices aimed at minimizing the differences between the entities involved in the generation and transfer of technologies, corroborating with the improvement of related indices and with the fulfillment of strategies in science, technology and innovation.

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