

KNOWLEDGE NETWORK AS AN INSTRUMENT OF ENVIRONMENTAL MANAGEMENT

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ABSTRACT

Nowadays, a society generally develops in a scenario of high complexity, due to the diversity of economic, social, political and environmental phenomena, which take a generation of an expressive amount of information every day. Due to failures or inefficiencies in the mechanisms of communication, this information does not always turn into effective knowledge, becoming available for numerous social demands. In this way, forms of organization and information sharing assume increasing importance, and within this context, the present work presents the initial experiences of the Sistema Estadual do Meio Ambiente e Recursos Hídricos (SISEMA), the State Foundation of the Environment and Water Resources in Minas Gerais, with the creation of a Knowledge Network that aims the creation, organization and sharing of scientific technical knowledge as a way to enhance the work carried out by this agency and, therefore, to meet social demands related to the environment. This work is based on a brief description of the organizational structure of SISEMA, drawing attention to relevant points related to its social role and functionality. It can be pointed out that the improvement of the efficiency in the processes related to knowledge generation and management can play a relevant role in improving the attendance to the environmental demands.

KEYWORDS: Knowledge Network, Information, Environment

1 – INTRODUCTION

Currently, society generally develops in a scenario of high complexity, due to the diversity of economic, social, political and environmental phenomena. The multiplicity of actors involved in this context, the processes of globalization and technological dissemination produce an intense flow of information, which is often not used in its potentiality, due to failures in communication mechanisms. The inefficiencies in the flow of information lead to their underutilization, which causes, especially in organizations, the generation of rework and delays in certain activities. In this way, the information generated does not effectively become knowledge.

In public entities responsible for regularization and environmental inspection, this type of delay can lead to numerous inconveniences. The slowness in environmental control processes may hinder the economic and social development of the regions, when private initiative needs to respond to requirements that are somehow unclear or even pertinent, and on the other hand,

it can put at risk natural assets, when one does not have in detail the importance of the same and the realities in which they are inserted. Therefore, the answers must be fast and scientific embased and the science aiming to address the obstacles to environmental sustainability in a comprehensive and holistic manner must be multiscalar, integrated, interdisciplinary, and neither global nor entirely local, but a combination of the two [1 – 3].

In this sense, the processes of knowledge management emerges as a potential modifier of this framework, which provide subsidies to environmental protection since they articulate and enhance the work and knowledge of the various agents involved in the processes of interest. Knowledge management is based on the assumption that knowledge generated in institutions, developed by people and contained in processes, belongs to organizations and, especially in the case of the public sector, to society. Therefore, it is extremely important that this knowledge should be articulated with the needs of the social sectors and also disseminated in order to promote collective and organizational knowledge, which is a great vector of synergy for the institutions. In this way, knowledge management becomes a strategic resource for the entities and, inserted in the context of environmental institutions, an instrument for environmental management.

Within this approach, this paper aims to present the scope and main objectives of the project of development and implementation of a Knowledge Network for the State Foundation of the Environment and Water Resources in Minas Gerais – SISEMA. This Knowledge Network is characterized by a virtual environment that aims to manage, integrate and make available the works developed by SISEMA, besides stimulating the accomplishment of environmental research projects and articulating the knowledge developed with social needs, through the formation of partnerships with national and international universities.

Knowledge networks can be defined as spaces where information and experiences exchange among professionals occur from different areas. In this sense, it is worth remembering that these are not only related to the advancement of technology, but can be facilitated by this. What makes establishing a Knowledge Network seems to be the common goal between its links and the horizontal nature of its organization. Many networks of knowledge arise from the need to structure an idea, solve a situation, a collective problem, or to carry out knowledge transfer [4]. In this regard, meeting the deep challenge of environmental sustainability highlights the imperative to overcome collaborative barriers in science and governance [5-

7]. Aware of this, and to mobilize financial resources from multiple countries, scientists have formed networks to advance scientific understanding of complex nonlinear, cross-scale environmental dynamics.

The SISEMA Knowledge Network aims to promote environmental public policies, transfer of knowledge and technologies that include the encouragement of sustainable innovations, good industrial production practices and diversification of the energy matrix through renewable sources, in order to deal with the issues of technological innovations, energy management, environmental regulation and the rational use of environmental resources within a context of sustainability. Also, it is presented the thematic structure of the Network and the institutional structure of SISEMA, which the thematic structure aims to reflect, the implementation tools and the management and maintenance strategies. The roles that the main collaborates, in this case, universities and academic centers, are intended to play in the context of the Network, which are linked to the generation of knowledge aligned with social needs and high quality due to the incorporation of several professional profiles to the projects of interest. Therefore, knowledge management can be considered as an environmental management tool, since it provides the efficiency of the processes of the institutions and a more effective environmental protection, through the generation of relevant information and knowledge that accelerates and improves the quality of the environmental protection carried out by the representative entities.

2 – DEVELOPMENT

This paper aimed to describe the initial experiences of SISEMA with the implementation of a Network of Cooperation and Knowledge that aims to promote the synergy between the professionals that integrate SISEMA and entities that generate knowledge, promoting a more effective service to the needs of society concerning environmental demands. The Knowledge Network is characterized by an online physical environment of sharing of technical and didactic materials produced by the SISEMA member bodies and for the technical support to this same body. Also part of the Network are the partner universities that, by forming this cooperation network, may incorporate specific environmental demands for research projects into their undergraduate and postgraduate courses. A Knowledge Network plays an important role in the management of organizations, as it is responsible for the retention, organization and enhancement of knowledge. The Knowledge Network of the State Environmental System for Environmental Management and Planning aims to transfer knowledge and technologies, as

well as to elaborate strategies for sustainable development in the state of Minas Gerais and for the various “stakeholders” (organizations, policy-makers and society in general) through the preparation of technical-scientific didactic material and its dissemination through awareness-raising campaigns, seminars, workshops and courses. It is, therefore, a mechanism of communication and knowledge management that, when integrated to the reality of a state environmental agency, and aiming to improve the processes of regularization and environmental control, becomes an environmental management tool.

2.1 Knowledge management

According to the Sociedade Americana para Treinamento e Desenvolvimento (ASTD) cited by Siemens [8], the American Society for Training & Development, the amount of knowledge in the world is doubling every 18 months. In order to avoid halving knowledge, organizations have been forced to develop methods to disseminate instruction. Siemens [8] elucidates some important trends in learning:

- Many learners will move through a variety of different areas, possibly unrelated to one another, during the course of their lives.
- Informal learning is a significant aspect of the learning experience, which occurs in a variety of ways - through communities of practice, personal networks, and through completion of work-related tasks.
- Learning is an ongoing process, lasting for life. Learning and work-related activities are no longer separate. In many situations, they are the same.
- The organization and the individual are both learning organisms. Increased attention to knowledge management underscores the need for a theory that attempts to explain the link between individual and organizational learning.
- Many of the processes previously addressed by learning theories (especially in cognitive processing of information) now can be downloaded to technology or supported by it.
- Knowing how and knowing what is being supplemented by knowing where (knowledge to find where is the knowledge that is needed).

Learning requires the ability to form connections between information sources and then create useful information patterns. The theory of connectivism manifests that knowledge is constructed through networks and interactions. This process, in a dynamic, continuous and

complex way, can benefit from the new technological alternatives. Connectivism presents a model of learning that recognizes changes in society, where learning is no longer an internal, individualistic activity. In order to compose and organize learning processes from this dynamic and integrated perspective, corporations have developed and adopted knowledge management activities [8]. In a particular way, in the Public Administration the Knowledge Management has a very broad purpose. It has been that [9]:

"In addition to increasing the effectiveness of public action in addressing relevant issues to society in a competent manner, with minimum resources and timeliness, public organizations should manage knowledge to: address unexpectedly and unexpected challenges and disasters; Prepare citizens, nongovernmental organizations and other social actors to act as partners of the State in the elaboration and implementation of public policies; Promoting social inclusion, reducing social inequalities and an acceptable level of quality of life for the population through the construction, maintenance and expansion of social capital and intellectual capital of companies; and create a competitive society in the regional and global economy by educating citizens to become competent knowledge workers, and by developing organizations to become competitive in all areas of knowledge. "

The role of knowledge management in public administration, therefore, serves the purpose of improving organizational performance, so as to enhance the role of public agencies in their social functions, inserting the country into the worldwide economy.

2.2 Environmental management

Environmental Management is an administration system that emphasizes the concept of sustainability in its practices, aiming the use of administrative methods that seek to reduce to the maximum the environmental impact of economic activities on natural resources and biodiversity. According to Dias [10], the concept of "Sustainable Development" became popular after the Stockholm Conference of 1972 and establishes the idea that this type of development will only be achieved if three fundamental criteria are obeyed simultaneously:

social equity, ecological prudence and economic efficiency. In the private initiative, the adoption of environmental management methods seeks to, among other things, comply with the current environmental legislation, and implement productive processes in an efficient way, aiming to save resources and reducing waste generation and economic expenditure. In the public-private field, environmental management takes on a broader character, ranging from the mapping of social realities to the elaboration and proposition of pertinent regulations, until the establishment of mechanisms for compliance and enforcement of such legislation. The responsibilities and competencies of an environmental body are generally comprehensive, involving diverse areas of knowledge and, therefore, the work of professionals with differentiated profiles. Communication and information sharing therefore assume a strategic role for the institution. Environmental management in public agencies aims to meet social needs, both in terms of providing protection measures and conservation of resources, as well as monitoring compliance with current legislation.

In this sense, social demands must be met and the pressure exerted by society, demanding transparency and agility in solving such demands, directly conflicts with the way in which the Brazilian State has been managed, given its peculiar formation of a bureaucracy that is devoted to the elites - is spent a lot, but poorly, given the chronic inefficiency of such a management model [11].

2.3 Structure of the Sisema

According to the State Law 21.972 from January 2016 [12], the SISEMA is the set of agencies and entities responsible for the environmental and water resources policies, with the goal of conserving, preserve and recover the environmental resources and to promote the sustainable environment and the improving of the State environmental quality. It is formed by the Secretaria de Estado de Meio Ambiente e Desenvolvimento Sustentável – SEMAD (Secretary of State for Environment and Sustainable Development), the State Environmental Policy Councils – COPAM, and also the Water Resources councils – CERH and by the linked organs: Fundação Estadual do Meio Ambiente – FEAM (State Foundation for the Environment), responsible for the State environmental quality, Instituto Estadual de Florestas – IEF (State Forestry Institute) and Instituto Mineiro de Gestão das Águas – IGAM (Institute for Water Management in Minas Gerais). Figure 1 shows the organizational structure of

SISEMA, and it presents an overview of the role of their constitutional organs. Among the main competences of SEMAD, SISEMA highest organ, there are:

- Plan, propose and coordinate integrated environmental management in the State, aiming the maintenance of ecosystems and the sustainable development;
- Consolidate, together with agencies and entities that operate in the environmental area, technical standards to be observed by them, coordinating the pertinent actions;
- Promote the application of legislation and specific standards of environment and natural resources;
- Coordinate and supervise actions that aim environmental protection;
- Ensure implementation of the State's environmental policy and water resources management;
- Develop informative and educational activities related to environmental problems;
- Establish technical, financial and institutional cooperation with international and foreign organizations, aiming at environmental protection and the sustainable development of the State.

It can be seen, therefore, that SISEMA has a heterogeneous structure and a great diversity of roles, ranging from issues related to environmental conservation in a preventive way, to the creation and supervision of environmental legislation, technical support and applied research. The entity brings together a significant number of professional profiles, working in complementary areas, which reinforces the importance of the information management mechanisms to guarantee the quality of the environmental processes involved.

2.4 SISEMA existing obstacles

The SISEMA is characterized by a very robust structure, which includes several organs and, in the case of SUPRAMs, these bodies are located in different parts of the territory of Minas Gerais, in order to meet state demands in the best possible way. The great territorial extension of the State of Minas Gerais and the diversity of demands related to the environment requires that the professionals related to the area have an interdisciplinary formation and a systemic vision of the society. However, this same scenario often leads to the emergence of new demands to be addressed in localities whose professionals do not have the necessary training for these specific cases. Often the most suitable professional for that particular situation is in

another segment of SISEMA, and often he or she cannot be identified and indicated for the care of that particular case.

This type of situation generates rework within the organizational structure, and it often leads to delays, especially in cases of environmental licensing. Delays in this type of process often end up creating difficulties for private initiative, which may end up migrating their investments from place to place, thus causing damage to the state. Under this type of context, the Knowledge Network assumes a fundamental role of centralizing, organizing and making available all the technical and theoretical framework generated by SISEMA, and, by making this content and its information related to authorship available, it allows greater integration among professionals, who have easy access to training and individual specialties.

In this way, the SISEMA Knowledge Network aims to promote environmental public policies, transfer of knowledge and technologies that include the incentive to sustainable innovations, good practices of industrial production and diversification of the energy matrix through renewable sources, in order to deal with the issues of technological innovation, energy management, environmental regulation and the rational use of environmental resources within a context of sustainability.

3 SYSTEM KNOWLEDGE NETWORK

Knowledge Networks play a role in creating, organizing, making available and integrating relevant knowledge among communities that have common interests. The use of effective mechanisms for sharing information and knowledge allows them not to be lost, and in this way, to be used more efficiently. The Figure 1 presents some schemes in which the entities, in general, can use and make available their generated knowledge.

Centralized Systems are those that do not share their information with other entities, and any form of consultation is therefore conditional upon participation in this particular entity and access to its central information system. The Decentralized System has a differentiated system of sharing where there are subsystems responsible for the distribution of information. Both the centralized and the distributed system are subject to losses or inefficiencies in the flow of their information, since some point of the system may have difficulties in identifying where the information of their interest for a certain purpose is. The Distributed System is one that

shares its knowledge throughout all its component subsystems, without any type of centralization. In this way, the flow of information becomes known and less subject to failures or inefficiencies in its use. Knowledge Networks are, therefore, distributed systems of information.

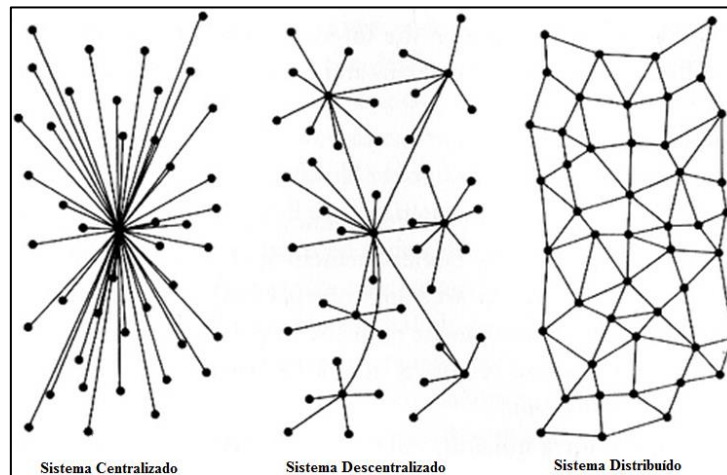


Figure 1: Schemes of information systems.

Knowledge Networks facilitate access to information, providing content of interest along a network of constituent entities that, in addition, communicate with each other in order to generate only knowledge relevant to the interests of all parties involved.

3.1 Repositories

Knowledge Networks generally have virtual environments as tools for sharing knowledge and dialogue between the entities involved. In this sense, it is very common to use repositories. Repositories are systems available on the web that mainly provide deposit facilities and access to digital objects. Digital objects, in turn, can be considered as all digital material that stores intellectual content to be made available to scientific society. In this sense, the repositories add a great variety of facilities, in great part related to the management of the digital objects deposited in them.

In addition, repositories manage the digital documents, have facilities related to the preservation of them and are flexible systems that can suit several purposes. The repositories are of academic origin, with the main purpose of disseminating scientific productions, however, they have also been used for other purposes, such as legal libraries or collections.

The repositories are used to gather materials or documents with the same characteristics or to gather works from the same institution.

There are also thematic repositories, where the origin of the deposited documents can be diverse, as long as they have a main theme as a form of aggregation. These classifications help to understand the general principles of a repository and its characteristics, but they are not rules, since the dissemination of the use of the repositories has diversified its forms of application and purposes. There are several software for this purpose today. However, DSpace is noteworthy, mainly due to its presence in several institutions, such as the most widely used software for the implementation of open access repositories [13].

3.2 Deployment Steps

The Knowledge Network has the main purpose of generating, organizing and making available relevant knowledge that can support the main work works carried out by SISEMA, promoting the synergy between professionals. It is made up of the SISEMA member bodies - SEMAD, COPAM, CERH, FEAM, IEF, IGAM and SUPRAMs – and by the partners, in this case, national and international universities. Each member has their roles defined in terms of entries and exits to the Network.

The entries are the relevant works and contents generated by the work of their respective bodies, which must be shared through the Network's web environment. The outputs are the needs of the body in terms of knowledge to be generated. Such needs may lead to the proposal of research projects to be developed within the SISEMA itself, or sent to the partner universities that can adopt such projects as objects of study to be carried out by their undergraduate and graduate students. The stages of knowledge network deployment are illustrated in Figure 2.

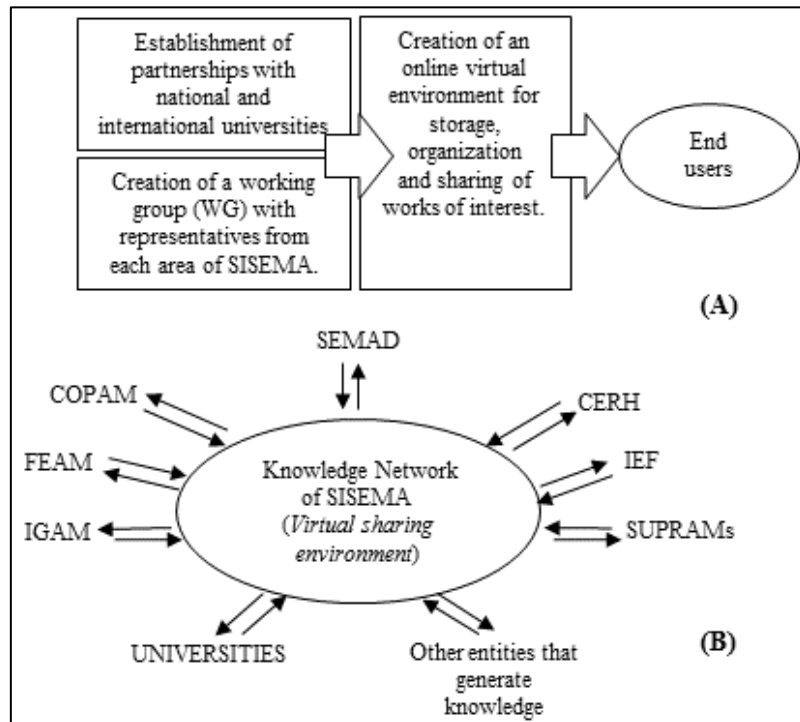


Figure 2: Stages of the deployment of the SISEMA Knowledge Network.

The SISEMA Knowledge Network is an environmental management tool that, although designed for the specific needs of SISEMA, can be easily expanded by integrating federal environmental entities and international institutions. The elaboration of the conceptual project concerns the definition of the objectives of the Knowledge Network, its members, main strategies of implementation, management and supervision . It is also necessary to define the virtual environment of sharing of the Network and the main partner universities. The next step is to make contact with universities, where the terms of commitment and cooperation, which establish the roles of each of the parties, must be established. The terms of cooperation must be signed by all those involved, attesting to their agreement.

Next, the determination of the Thematic Axes of the Network must be implemented, which relate to the large areas of interest in the generation and availability of knowledge. These axes should reflect the entire structure of SISEMA, covering its main areas of activity. It is then necessary to determine which type of web environment is most suitable for receiving the Network. The following steps concern the determination of procedures to ensure the availability of materials of interest in the Network. For this purpose, the flow policies of the digital documents or objects must be defined, gathered and made available. These policies determine which people can /should include their work in the system, which people should review and approve or not the submitted materials.

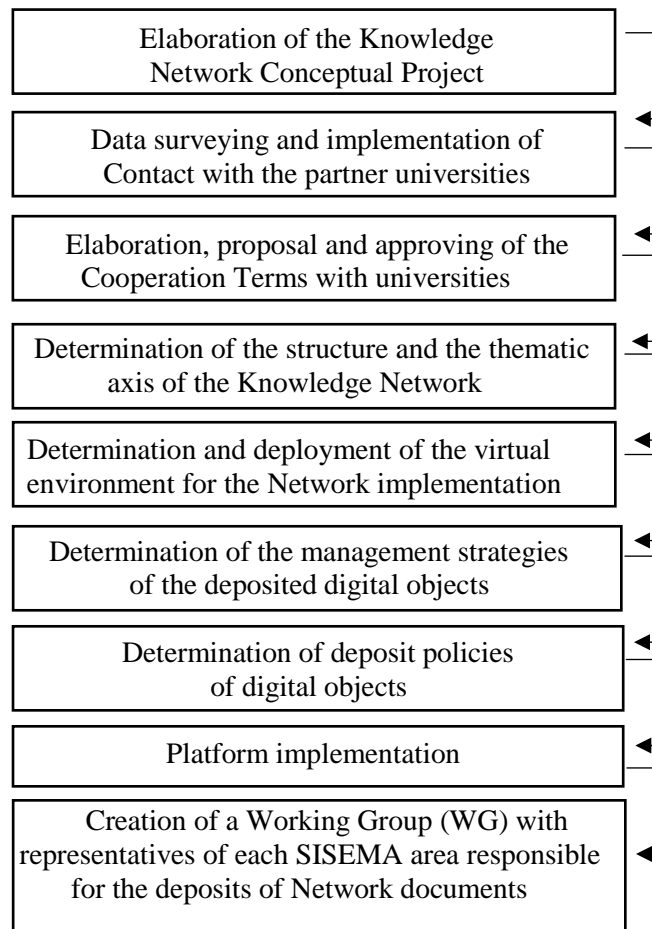


Figure 3: Deployment steps.

3.3 Thematic axes

The knowledge gathered and made available has as basic assumption its adequacy to the main thematic axes dealt within SISEMA. The thematic axes relate to the large areas that make up the environmental theme. Each major axis is subdivided into lines of action, which, in turn, are the targets of studies, projects or the development of public policies. The table 1 brings together the thematic axes and lines of action of the SISEMA Knowledge Network. The maintenance of this Network is the responsibility of an administrator, who evaluates the work, the information provided during the submission, its correlation with the thematic axes and approves or not its integration to the content of the Network. This process occurs in a continuous stream, whenever any author wishes to make their work available. Thematic coverage, submission flow steps and process managers are characteristics that should be periodically discussed to ensure a dynamic operation of the Knowledge Network.

Table 1: Thematic coverage of the Knowledge Network

KNOWLEDGE NETWORK	THEMATIC AXIS	LINES OF ACTION
	Water	Effluent management.
		Water quality.
		Water monitoring.
		Management of water resources.
	Air	Air quality.
		Degraded areas.
	Energy	Renewable energy.
		Energy transition.
		Energy efficiency.
Waste	Urban solid waste.	
	Solid, industrial and mining wastes.	
	Special wastes.	
Ground	Contaminated area.	
	Degraded area.	
Sustainable Technology Innovations	Sustainable production and consumption.	
	Sustainable buildings.	
	Environmentally friendly technologies.	
Sustainable Environmental Planning	Support for environmental licensing.	
	Environmental management tools.	
	Natural and technological risks.	
	Climate changes.	
Biodiversity	Monitoring of plant cover and biodiversity.	
	Conservation and restoration of ecosystems.	
	Conservation units.	

This process occurs in a continuous stream, whenever any author wishes to make their work available. Thematic coverage, submission flow steps and process managers are characteristics that should be periodically discussed to ensure a dynamic operation of the Knowledge Network.

3.4 Virtual environment

The virtual sharing environment determined for the reception of the SISEMA Knowledge Network was DSpace. The Brazilian Institute of Information in Science and Technology presents the DSpace [13]:

DSpace was developed to allow the creation of digital repositories with functions of storage, management, preservation and visibility of intellectual production, allowing its adoption by other institutions in federated consortium form. The system has been designed to be easily

adapted. DSpace repositories allow the management of scientific production on any type of digital material, giving it greater visibility and ensuring its accessibility over time. Examples of digital material are: documents (articles, reports, projects, presentations at events, etc.), books, theses, computer programs; Multimedia publications, news stories, bibliographic databases, images, audio and video files, collections of digital libraries, Web pages, among others.

This software offers numerous facilities for sharing scientific materials. The deposited content can be stored in Communities, Subcommunities and Collections. The Communities and Subcommunities usually gather materials related to a certain large area of knowledge or even to a particular institutional segment. The collections, in turn, are usually intended to receive different types of documents.

The availability of materials in this system is done by the deposit of files or digital objects by an author or depositor, after providing login information in the virtual environment of DSpace. During the deposit process or flow, various information related to the deposited document as presented in Table 2 should be provided.

Table 2: Information related to the deposited document [13]

Content Related Information	Information related to intellectual property of content	Information related to the format of the content
Title	Creator	Date
Subject matter	Contributors	Format
Relations	Editor	Identifier
Source	Rights	Language
Coverage		
Kind		

When you deposit a document, it is not automatically made available in the virtual sharing environment, unless previously set by the administrator. You can adjust the warehouse settings so that the material is necessarily analyzed by the administrator, who receives a warehouse notification, and then analyzes the document and the information provided, whether or not it is approved, in the virtual environment. This step is very relevant to the quality of knowledge sharing by the Knowledge Network, since it is linked to the availability

of only interesting contents and also the quality of the description of the digital objects provided, which is directly linked to the quality in the retrieval of these objects The search environment of the Network.

The Knowledge Network Layout was designed to gather, in addition to the relevant knowledge organized in the thematic axes, shortcuts to the other institutional portals of SISEMA, such as the Digital Library, InfoHidro, etc., in order to integrate even more the content provided by the State System for the Environment. For the deployment and configuration of the DSpace Layout it is necessary the performance of a professional in the area of information technology, preferably in contact with the software administrator.

CONCLUSIONS

Today's society is characterized by an intense flow of information generation related to various areas. However, organization, delivery and communication processes generally do not always occur in a way that ensures the transformation of this information into knowledge. This fragility was observed in some segments of the SISEMA, and was pointed out as the cause of some disorders in environmental processes. Thus, the present work presented the initial proposal to create a Knowledge Network, conceived in light of the main characteristics of SISEMA, which aims to create, organize and make available the knowledge generated by this institution and its partners, in order to enhance the work developed by this institution and the fulfillment of society's demands. The Knowledge Network allows a mechanism to generate synergy between SISEMA professionals and the knowledge generating agents of society.

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