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Open Science Project Management. A Sociotechnical Approach

Gestión de proyectos de ciencia abierta. Un enfoque sociotécnico

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Abstract

Open science is a category that has been gradually assimilated by academia to encompass research experiences characterized by the distributed location of cognitive resources and infrastructures, collaborative work practices and interaction patterns based on open licences. In this article we propose to explore the management of open science projects from a sociotechnical approach. To this end, in the first instance, the characteristics of this approach are explained as an expression of an integral understanding of knowledge, science and technology; subsequently, the adequacy of some notions of project management to the perspective of development of knowledge assets in open science is exposed, and later an analysis of an experience of open science project management carried out in a Research and Development center is offered. As a result, a set of approaches is presented to support the relevance of the sociotechnical approach as part of a theoretical-methodological platform for project management linked to open science.

Keywords: cognitive commons; open knowledge; knowledge-based projects; project processes; product development.

Resumen

La ciencia abierta es una categoría que ha sido paulatinamente asimilada por la academia para englobar experiencias de investigación caracterizadas por la ubicación distribuida de recursos cognitivos e infraestructuras, las prácticas de trabajo colaborativo y los patrones de interacción basados en licencias abiertas. En este artículo se plantea explorar la gestión de proyectos de ciencia

Palabras clave: *bienes comunes cognitivos; conocimiento abierto; proyectos basados en conocimiento; procesos de proyecto; desarrollo de proyectos.*

abierta desde un enfoque sociotécnico. Para ello, en primera instancia, se explican las características de este enfoque como expresión de una comprensión integral del conocimiento, la ciencia y la tecnología; posteriormente, se expone la adecuación de algunas nociones de gestión de proyectos a la perspectiva de desarrollo de bienes de conocimiento en ciencia abierta, y más adelante se ofrece el análisis de una experiencia de gestión de proyectos de ciencia abierta realizada en un centro de investigación y desarrollo. Como resultado, se presenta un conjunto de planteamientos para fundamentar la relevancia del enfoque sociotécnico como parte de una plataforma teórico-metodológica de gestión de proyectos vinculada a la ciencia abierta.

Introduction

Knowledge and technology can be described, conventionally, as the results of human effort in design and development activities in order to build functional systems. In this way, technology is the effect of the application of instrumental rationality, governed by optimization criteria in a world constituted by functional criteria. This approach considers that technology is autonomous and efficient in solving social problems (determinism) and that its effects are universal because they are rational (instrumentalism) (Martínez and Suárez, 2008). However, adopting these alternatives excludes others; for example, social problems require a political response that precedes the technical response.

Since knowledge and technology emerge from the practical and interpretative strategies of social actors, it is necessary to recognize the agents, norms, resources and dynamics that allow knowledge to participate in production relations and mediate social relations in a historical and sociocultural context. This should not result in a sort of social determinism, but precisely in the possibility offinding ways of dialogue between the technical and public spheres.

These ideas have gained greater importance, since the adoption ofapproaches based on free access to information assets has recently been favored,through a set of practices covered under the category of "open science" (Fecher& Friesike, 2014; FOSTER, 2018). In this sense, a way of thinking about academia that is based on the distributed nature of resources and collaborative research-management has gained ground, so it is necessary to explore new alternatives inthe field of project and knowledge management to make such initiatives viable.

The concept of open science encompasses various currents related to the principle of unrestricted access to knowledge, such as free software and hardware, open access to publications and open data. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO):

> [...] open science is defined as an inclusive construct that combines various movements and practices in order to make multilingual scientific knowledge openly available and accessible to all, as well as reusable by all, to increase scientific collaborations and information sharing for the benefit of science and society, and to open the processes of creation, evaluation and communication of scientific knowledge to social actors beyond the traditional scientific community (UNESCO, 2021, pp. 4-5).

In this sense, open science includes different types of practices that emerged even before the popularization of the concept. As UNESCO states:

> Open scientific knowledge refers to open access to scientific publications, research data, metadata, open educational resources, software and source codes and hardware that are available in the public domain or protected by copyright and are the subject of an open license that allows access to them, as well as their reuse, repurposing, adaptation and distribution under specific conditions [...] and free of

> charge. Open scientific knowledge also refers to the possibility of opening research methodologies and evaluation processes (UNESCO, 2021, p. 5).

In summary, the concept of open science refers to the elimination of restrictions of different kinds (technical, legal and economic) for access and reuse of knowledge assets, such as research articles and data, educational resources, computer code, hardware designs, etc., through initiatives such as open access declarations, free licenses and citizen laboratories (FOSTER, 2018). Thus, open science and technology are akin to movements for free access to academic knowledge, a model that undoubtedly carries important implications for the design and unfolding of knowledge development processes.

This article argues that knowledge products (data, content, documents, software, devices and systems, among others) can be described as part of the socio-political and cultural relations in a given context. In a broad sense, the category of "technology" includes knowledge and devices, but also methodologies and organizational models, and even part of the relationships established in a social context. This is why it is pointed out that every technology has a physical- functional dimension and an interpretative-organizational dimension, a premise of the sociotechnical approach.

With this in consideration, the present paper brings together edges already present in various works on open science research processes (e.g., in García- Peñalvo et al., 2010) and, in particular, of their applications in the development of management systems (García-Holgado and García-Peñalvo, 2018). Since this article proposes to explore the management of open science projects from a sociotechnical approach, it also relates to works based on this approach (Mumford, 2006), with special orientation to the design of sociotechnical systems (Baxter & Sommerville, 2011).

In the first instance, the characteristics of the sociotechnical approach are explained as an expression of an integral understanding of knowledge, science and technology. Then, some notions of project management adapted to the perspective of knowledge asset development in a context of collaborative networks are presented, followed by a synthesis of an experience of open science project management carried out in a Research and Development Center. Finally, a set of approaches is presented to support the relevance of the socio-technical approach as part of a project management proposal linked to open science conditions.

Knowledge and technology as socio-technical problems

The production of knowledge and technologies can be understood as the result of forms of interaction that combine the functional and social dimensions of technical systems. In this respect, this section delves into two interrelated concepts: socio-technical systems and networks. In doing so, it is hoped that the characterization of the object of interest of project management as a discipline will be substantiated.

Socio-technical systems

Hess and Ostrom (2016) define knowledge as "all intelligible ideas, information and data in whatever form they are expressed". In this sense, they consider data as "raw fragments of information" and information as "data organized in a certain context". Thus, knowledge is "the assimilation of information and the understanding of how to use it". The authors also point out that the category of "knowledge" is complex, because it represents a social and personal process, and is translated into cultural goods (such as academic works), which is both a human quality and an economic good. Briefly, the concepts can be defined as follows:

- Data: abstract units representing qualities of phenomena.
- Information: set of related data subject to interpretation.
- Knowledge: patterns of handling and executing information.

Other important terms are "technique" and "technology". Technique is commonly considered as a systematic set of knowledge susceptible of being applied empirically with predictable results. Technology is understood as a set of systems and artifacts designed for the automatic execution of technical processes and tasks (Toribio, 1995). Technique is observable through the implementation of systematic knowledge, while technology is in the functional systems and devices that automate and optimize the execution of technical tasks.

Although these definitions are precise, it is necessary to explain other implications of the concepts. For example, García et al. (2001) note that technology consists of organizational systems, functional systems and devices that accomplish some kind of task.

> More precisely, we can tentatively define technology as a collection of systems designed to perform some function. We speak then of technology as systems and not only of artifacts, to include both material instruments and technologies of an organizational nature (García et al., 2001, p. 42).

Taking into account the above, the following definitions are adopted:

- Technique: set of systematic principles integrated in contexts of action.
- Technology: organizational and functional systems operating in technical contexts.

From these bases, it can be suggested that there are two attitudes to observe technology: one focuses on the functional characteristics of the technological devices/systems, or the other on the interpretative contexts and practical strategies that condition the technical variables. In the first case, one would be adopting an instrumentalist attitude (Martínez and Suárez, 2008), and in the second, a critical attitude (Feenberg, 1999, 2002). Recognizing the explanatory advantages of each, this paper attempts to bring together both approaches in a framework that makes visible the instrumental properties (not only "instrumentalist") and the social properties (not only "constructivist") of technology. An example of this perspective is found in the sociotechnical approach (Thomas and Fressoli, 2009; Roca and Ochoa, 2014).

There are physical technologies (devices and functional systems) and social technologies (methodologies and organizational models), whether on the small scale of the user or on the large scale of societal models (Varsavsky, 2006). In this sense, four dimensions can be observed in the phenomenon of technology (Thomas and Fressoli, 2009):

1) Cognitive dimension: encompasses the individual and collective frameworks of knowledge, as well as the strategies for generating it.
2) Technical dimension: concerns the tacit and explicit knowledge put into practice, as well as the existing devices and networks of devices.
3) Productive dimension: describes the cognitive and technological conditions of production and the nature of production relations in a network.

4) Political dimension: deals with the dynamic arrangement of power relations and their structured expression in the determining legal and political conditions.

The cognitive and technical dimensions encompass what is commonly understood as technology, including its technical and organizational correlate, while the productive and political dimensions enter as part of the social realization of the former. In this way, technological systems have a physical- functional and interpretative-organizational character that is manifested in the context of the social relations where they fulfill their purpose. Knowledge and technology, as socio-technical phenomena, group together systems and social networks that consign the aforementioned dimensions in concrete scenarios of social activity.

Regarding open science, the distributed nature of resources and the collaborative work modality encourage not only the collaborative management of resources, processes and research results, but also the co-creation of contexts of meaning that contribute to maintaining cognitive resources as shared goods; this is the case of the interpretation of cognitive goods as "commons" (Hess and Ostrom, 2016). To better understand this point, it is necessary to delve into the concept of sociotechnical networks.

Socio-technical networks

The sociotechnical approach allows framing technology as a set of interpretative and functional relationships between people and technical systems. Therefore, once it is clear what the technical systems are, it is necessary to characterize the agents that participate in the socio-technical dynamics. We then speak of "socio-technical systems" and "socio-technical networks" (Feenberg, 1999, 2002). Socio-technical networks are made up of agents and relationships that have an impact on the formation of socio-technical systems. Thus, it is necessary to know how the subjects that influence the development and adoption of technologies relate to each other, which will lead to ask about the characteristics of the organizational relationships institutionalized in a socio-technical context.

Evidently, the selection of a strategy according to a prioritized conception of value implies the preference of one set of decisions over others, which influences the trajectory of technological development. Although the discursive contents of economic rationality and functional rationality offer conceptual elements to such strategies, it would be difficult to admit that only instrumental rationality drives technological change. Therefore, the definition of public policies must take into account the interaction between technological agents, recognizing their particular characteristics, such as interpretative contexts, interests, strategies and resources.

Feenberg's (1999, 2002) critical perspective affirms that if the paths of social construction of knowledge are not strictly oriented by instrumentalism, then the evolution of technical systems has a political character. In this sense, the incorporation of civic strategies in development dynamics can contribute to translate the interests of social movements into codes of technical development, which, seen from the political arena, could constitute a sort of "democratic" rationalization that contributes to closing the gap between the technical and public spheres. Of course, such an approach holds the possibility that civic agendas may take on more of what today seems to be the terrain of academia, governments and businessmen.

From the perspective of open science, the commons are managed through collaborative schemes by virtue of the presence of governance rules that order the management of cognitive goods and the participation of co-creators in the production flow (Hess and Ostrom, 2016). This arrangement is preceded by the conformation of producer-user groupings whose objectives are channeled through more or less consensual patterns of interaction and agreements. Therefore, socio- technical networks can become pillars of participatory governance schemes that enable the integration of resources, management rules and communities in open science networks; and, consequently, also agents with the capacity to influence the direction of public knowledge, science and technology policies.

Knowledge projects management

In the previous section, open science projects were described as initiatives that are distinguished by aspects such as the distribution of research resources and the dynamics of collaborative work, in a context that considers the participatory management of the commons to be legitimate. In such a framework, it seems necessary to explore the management conditions of open and collaborative projects, so this section examines a conception of "project management" specifically oriented to open knowledge projects, and its adaptation to the creation of knowledge goods from a socio-technical approach.

Project management elements

Project management is a discipline made up of strategies, methods and tools aimed at controlling the achievement of project goals in organizations (Project Management Institute, 2013). However, this type of definitions tends to place on the same plane projects whose processes and results are qualitatively different; for example, projects that generate information and knowledge assets (such as software, hardware, publications and training) must be supported not only by general project management procedures, but also by specific knowledge asset management methods, by virtue of the particular nature of their goals and indicators. In this sense, this article attempts to problematize the concept of "project management" in order to adapt it to the implementation of open science projects.

Project management has a set of steps that define, from the early stages, aspects such as objectives, scopes, human and material resources, costs and risks, and so on. A predictive or plan-oriented approach is generally used, which certainly contributes to the management of a research and development project; For example, project monitoring, as a project management activity, provides a useful set of tools for estimating the physical and financial progress of project goals. However, the recommendations of this approach tend to be normative and are not specifically aimed at fostering the development of research products, nor development and training, and less so in the field of open science.

Iterative projects seem better aimed at product generation in general. Among these are adaptive perspectives such as "agile" methods (Project Management Institute, 2017), which place more emphasis on user experience than on predictive planning. However, both plan-driven and user-driven approaches lack concrete techniques to handle the specific processes of cognitive asset development. Research product development, as both a production of tangible-intangible goods and an indicator of organizational performance, deserves a focus on both the processes and outcomes of knowledge-based initiatives.

In considering these ideas, a project management approach tailored to the needs of open, distributed and collaborative projects is required. A project can be defined as "a temporary effort undertaken to create a product, service, or outcome" (Project Management Institute, 2013, p. 2); thus, it is the rational and structured investment of tangible and intangible resources in order to generate an outcome that benefits an entity. Projects attempt to solve specific needs or problems, but they are temporary because they are exhausted once they fulfill their raison d'être. In addition, project execution is distinct from the day-to-day management of the organization, although they are obviously related.

Projects are aimed at generating products and services, or finding ways to improve existing products and services. Despite their conjunctural framework, they offer the possibility of concentrating resources on the achievement of goals, such as human talent and information assets. Conventionally, the stages of a project include initiation, planning, execution, monitoring, control and closure; in addition to these, aspects such as scope, quality, schedule, budget, resources and risks must be managed (Project Management Institute, 2013, pp. 5-6). Therefore, the project constitutes the framework in which the action of developing a good or a process is developed.

In this sense, project management is defined as "the application of knowledge, skills, tools and techniques to project activities to meet project requirements" (Project Management Institute, 2013, p. 47). Currently, different forms of management are considered defined according to the way in which the project phases are organized, determined by the control needs themselves, this is known as the "project life cycle" and can be (Project Management Institute, 2013, pp. 45-46):

1) Predictive (plan-oriented) life cycle: these are determined at the beginning of the project and consider aspects such as scope, time and cost. This is the most representative form of what is meant by "project".
2) Iterative life cycle: related to the stages of the project (iterations), activities are repeated repeatedly as the development of product features continues.
3) Adaptive life cycle (agile): similar to the iterative ones, they focus on the design or planning of the product with very limited iterations that include customer participation.

However, there are two types of operations oriented to the achievement of project objectives. On the one hand, project processes seek to move the project efficiently through its life cycle (e.g., the goal of creating an online course platform). On the other hand, product processes are determined by the product's development characteristics (e.g., the techniques for developing online courses). Project management deals strictly with the first type of process, so, despite its implementation, it would still be necessary to apply different methodologies to develop different types of knowledge assets.

In project processes, the project life cycle can be understood in predictive (plan-oriented), iterative or agile (user-oriented) order. However, in product processes, projects take actions oriented to the generation of information and knowledge products and by-products. The proposal of this paper is that such a process includes two sub-processes:

1) Work schemes: these are the methods used to organize the development of a product; in these, each stage contains, in turn, a set of steps to fulfill its objectives and generates its own assets, which can be observed through different indicators. For example, the ADDIE method consists of the contiguous stages of Analysis, Design, Development, Implementation and Evaluation.
2) Resource development: these are the methods used to execute the development of a product. During this process, by-products are developed, which are part of the overall product and add to the results of the project, in addition to generating indicators. To exemplify the idea, each input requires a production method: the videos before and for their elaboration require elements such as scripts, graphic material, audiovisual material, et cetera.

The development of a project depends on the conjunction of project and product processes, as well as the articulation between work schemes and resource development methods. This has a direct impact on project requirements, e.g., the human talent required and the distribution of tasks, as well as consequences for the definition and achievement of project products and by-products. The relationship between these concepts can be seen in Table 1.

Table 1. Project and product processes

Process	Process content
Project processes (project management)	Projects: predictive (plan), iterative and agile (user)
Product processes (product management)	Work schemes: agile software development method, free hardware development method, ADDIE course development method, editorial management method.
	Resource development: software (code), hardware (prototype), multimedia courses (educational resources), publications (editorial products)

Source: By the author

The difference between project processes and product processes determines that the management of training, research and development projects requires different lines of work to achieve their goals. Within the framework of a socio- technical approach, this differentiation makes it possible to observe the tangible and intangible resources, as well as the organizational schemes that take part in the creation of specific knowledge assets.

From the perspective of the management of open science experiences, the expected information resources and the creators responsible for their development can also be registered, so that it is possible to establish goals and interaction patterns that support both the project implementation and the institutional character of the commons. Therefore, the visibility of the socio-technical character of a cognitive asset is correlated with the determination of the socio-technical network of the project, which will nurture planning and management activities. This approach is illustrated in the following section.

Socio-technical management of knowledge projects

In this work, socio-technical management is understood as a component of project management that recognizes the physical-functional and interpretative-organizational spheres of knowledge assets. Consequently, the project processes are organized around such a conception, in the context of the dynamics of knowledge goods production.

The contribution of the socio-technical approach to project management is that it makes it possible to represent the resources, subjects and relationships found in a knowledge creation context. It would thus be possible to specify the factors that may intervene in the formulation of policies and programs, to define their objectives and actions, and even to represent the dynamics of project work (Roca, 2021). Socio-technical management recognizes the participation of information resources and active communities in knowledge projects. From a public policy perspective, the interaction between resources, rules and actors defines the socio-technical content of concrete policies.

Therefore, the socio-technical approach favors the management of projects focused both on products and on the promotion of participatory communities, in particular because it implies the definition of information assets as part of processes. In this sense, knowing better project and product management techniques can strengthen knowledge creation through networks that co-construct the interaction patterns of socio-technical systems and networks for the creation of knowledge commons.

However, according to the socio-technical approach, cognitive goods have a material dimension and an organizational dimension, so that, within the framework of project management, the production of knowledge goods can generate products such as software and methodologies in areas as diverse as planning, education and data analysis. For example, an editorial management proposal can be supported by editorial software and underpin the generation of other knowledge products, such as consultancies, courses and publications.

In this sense, the overall project can become a framework for the development of various knowledge products from a socio-technical perspective, as long as it makes visible the possibility of working on goods oriented to the material or organizational dimension, in different formats and with the support of various creators articulated among themselves.

Project management can benefit from the socio-technical approach in the formulation of the different stages of project development, in that it is possible to recognize the factors involved in a socio-technical dynamic as a process of producing a good. In other words, it is possible to identify the actors and relationships that can be integrated into project processes, product processes and resource development.

In the same sense, the design and development of goods can adopt the socio-technical approach to underpin the understanding of different aspects of the production process and the possibility of concentrating efforts on tangible and intangible results. To go deeper into these approaches, it becomes necessary to have a closer look at how knowledge projects are managed in an open science space.

Case study in knowledge project management

This section explores a concrete experience of project management in an entity linked to open science, in order to systematize its key aspects, contrast the practice with the concepts explained in these pages and justify a set of theoretical- methodological proposals oriented to the design of knowledge projects. The aim is to approach the foundations of a socio-technical management approach applied to the production of open knowledge goods in training, research and development experiences.

Since this research was carried out after the execution of the projects presented as case studies, the socio-technical approach was used to propose a set of categories that allowed the organization of the observations and data collected in each project. In this sense, an ex post facto analysis of a project management experience is offered, in which a set of open science and technology initiatives were examined through the socio-technical management approach.

This case in project management is presented in five categories that synthesize the information according to the objectives of this work: project conceptualization, information production, work teams, tools used and evaluation of activities. It also presents a synthesis of work experience in four areas: free software, free hardware, online courses and publications, as representative examples of management of knowledge-based initiatives. The projects examined as a reference for this work were the following:

1) Free software: web-based system to support strategic and operational planning (Álvarez et al., 2016).
2) Free hardware: programmable automaton prototype for process control (Díaz et al., 2013).
3) Online courses: platform for the management of online courses (Montilla et al., 2018). Publications: publishing management space (Ochoa et al., 2016).

Table 2 summarizes the information collected in each project, according to the category scheme derived from the management scheme.

Comments on the case study

The categories presented summarize the main characteristics of the projects examined. In the case of project management, project conceptualization, life cycle, team building, work tools and modes of evaluation provide a quick view of the structure and dynamics of the projects as coordinated forms of action linked to the organizational context. In terms of project management, the following aspects were observed:

1) Projects were conceptualized following the objectives and vocation of the organization. Design and development parameters oriented to knowledge as a public good and implementation of open source technologies were included.

2) In general, a predictive approach was adopted, although work schemes and development methods based on task analysis and user characterization were assumed, according to the objectives of each project.

3) The integration of multidisciplinary teams was achieved by creating the figures of management team and technical team. The management team was responsible for the direction of the project and work plan, as well as for design activities (requirements, instructional design, etc.), control (follow-up, testing) and support (external communications). The technical team concentrated on the development of information artifacts (programming, layout, etc.).

4) The tools used responded to the needs of the project processes (Trac information system) and product processes (programming systems, audiovisual editing, etc.). Priority was given to open source software platforms and programs.

5) Monitoring techniques were based on the delivery of products associated with the project plan. Each stage of the plan generated products and evaluation inputs (design documents, programming packages, etc.); in turn, the delivery of the final product was evaluated. Activities not contemplated in the plans were also carried out (participation in events, academic publications, etc.), which contributed to broadening the scope of the project.

Table 2. Knowledge projects and free technologies

	Concept	Production	Teams	Tools	Evaluation
Free Software	It was conceptualized by the team and the roadmap was defined by an open source software development method (Alvarez and Bravo, 2015). The process began with the gathering of information from the analysts to develop the process model, the definition of requirements and the use cases. Subsequently, the development of the software was carried out, following the coding, testing and documentation steps. The result was a system to support planning processes.	It included several design, development and documentation activities. The main activities of this process were: conceptualization, requirements gathering, process modeling, use case writing, coding and correction, testing and documentation.	The team was divided into two sub-teams: information analysts and software programmers. The analysts focused on modeling, functional and non-functional requirements, use cases and documentation, while the programmers were in charge of software coding, installation and support. Some tasks, such as testing, were performed collaboratively between the two profiles.	The Trac platform was adopted with modules such as Wiki, code repository and software version control system, which allowed recording all aspects of the project. Development frameworks such as Drupal were also used.	Indicators such as the number of documents delivered and the number of code packages were adopted in relation to the planned goals. Similarly, the fulfillment of support activities, such as feeding the public blog with project information and writing experience articles, was also taken into account.
Free Hardware	It was conceptualized by the team and built on a free hardware development method (Medrano et al., 2008), which included technical requirements gathering, design, development and testing of the prototype (Medrano et al., 2008).	It included design, development and documentation activities included in the open hardware methodology. The main activities were: conceptualization, device design, hardware fabrication, assembly and mounting, laboratory testing, manual development and field testing.	The team consisted of a group of developers from various areas (electricity, electronics, programming) who were responsible for different tasks at each stage of design, development and testing of the prototype. In addition, there were support and management personnel for tasks such as field testing and dissemination of the experience.	The Trac platform was used to document tasks and progress, as well as the repository of programming code, schematics and project documentation. Specialized programs were also used for the design, modeling and simulation of the prototype (KiCAD), programming and manufacturing software.	Indicators such as the number of designs delivered, code packages developed and devices manufactured were adopted, based on the planned goals. Also, support activities, such as publication in the team's blog, participation in events and writing of research papers, were tracked.
Online courses	It was designed to promote the adoption of the Center's content. Each course underwent a conceptualization stage.	The activities carried out for online courses were: conceptualization, instructional design,	The team was made up of educational design personnel, researchers in the thematic areas and	The Trac platform was used as a repository for documents, software files and educational resources	Indicators such as the number of educational resources and the number of courses

	Concept	Production	Teams	Tools	Evaluation
	As a result, a package of courses was consolidated that allowed interaction with other organizations and users.	development of learning objects, installation of the course on the platform, testing, validation, implementation of the course, certificate management, evaluation of the implementation and dissemination.	educational resource developers. Course conceptualization and design, platform management, enrollment management and certificate generation were in the hands of the management team, while the subject specialists were co-developers of content and facilitators of the courses.	for the courses. Other tools were used for the production of educational content, such as text and presentation editors (LibreOffice), and audiovisual editing programs (Inkscape, Audacity and OpenShot). The courses were implemented using the ExeLearning content manager and the Chamilo content management platform.	delivered according to planned goals were adopted. Specific indicators were also used, such as the number of people enrolled and approved per course, and the opinion of users through surveys. Support activities, such as participation in events and the publication of articles, were also counted.
Publications	It emerged as an initiative to integrate different editorial products in a single space. An attempt was made to give the project its own identity and the publications were nourished by ideas that began to guide a set of standards and editorial practices based on the philosophy of open access (repositories, licenses, etc.).	Publishing production includes activities that require various content creation techniques and tools. The main publishing activities were: conceptualization, research, content development, revision and improvement, layout, publication and dissemination.	The management team was made up of personnel responsible for editorial policies, supported by a technical team in charge of tasks such as layout and repository management. The editorial management activities focused on the compilation, preparation, refereeing and publication of the contents.	Free software office tools were used to record basic information, such as the route of publications. In addition, Open Journal System (OJS) was used as a repository for content management and publication. On the other hand, free software tools such as Writer, Scribus and LaTex were used for the layout of publications.	Indicators such as the number of journals delivered and planned goals were adopted. There was also interest in achieving the inclusion of publications in public directories. Participation in academic events was also taken into account.

Source: by the author.

The idea of presenting this synthesis is to obtain an enriched image of different open knowledge projects, which will make it easier to recognize the information resources and methodologies involved in the co-creation of knowledge assets; to visualize the relationship between knowledge resources, agreements and teams in a collaborative work framework; and to detail the project processes, product processes and components at the operational management level.

Open project management, as any knowledge-based project, can benefit from the schematic recording of such organizational layers for the conformation of collaborative networks, as well as the monitoring of the path and its results.

One aspect of interest is the possibility that the development of a specific product allows the generation of additional products, which is where the difference lies between, for example, making software available for download and making available an offer of consulting, research, development, training and support services around the software.

Although great efforts were made in the projects to multiply results in the form of publications, courses, public presentations, among others, there is a need to optimally plan such initiatives to make them more efficient, incorporate the teams to a greater extent, improve the design of research assets and increase organizational learning.

Based on the theoretical contributions presented and the reflection on the case study, the following recommendations are made in order to continue exploring the relevance of the socio-technical approach in the management of open projects:

1) Formulate iterative and adaptive projects. Implement approaches based on techniques such as task analysis, user characterization, iterative development and iterative testing. Encourage schemes of work that incorporate task and user feedback into the design of research assets.
2) Record project processes and product processes in terms of requirements, procedures and results. Use this record to formulate project-product design, planning, implementation, documentation, and evaluation activities.
3) Encourage research and learning schemes of work and resource development oriented to each type of asset, integrating a task and user analysis approach.
4) Incorporate sub-processes and activities based on this information to improve the overall planning, product design, work process and impact of the processes in the organization. Promote the generation of results as input to feed back to the organization's goals.
5) Recognize collaborative team management as a technical knowledge. Investigate and learn techniques for planning, management and evaluation of open science networks. Link network management with collaborative governance project management.

Conclusions

Open science offers a set of options to encourage the participation of researchers and developers in problem-solving activities in terms of training, research and development activities. Open science can even be part of new research experiences that contribute to overcome the fragmentation imposed by self- employment and dependence on centralized entities. In this sense, it is of interest to explore how to promote participatory forms of knowledge creation that allow for autonomous experiences in the field of open science.

This paper presented a socio-technical approach that considers knowledge and technology as both processes and products: processes of constructive adaptation between technical systems and social systems, encompassed by the constitution of social networks where meanings are cultivated and then transformed into technical codes; and products in their dual physical-functional and interpretative-organizational dimensions, which encompass concrete devices (software, courses, etc.), forms of subject-object interaction (methodologies) and organizational designs where they make sense (institutions). Such an approach is compatible with the institutional framework of co-creation of commons and can support the planning of better forms of integration between resources, norms and communities.

The development of products based on knowledge and open technologies can become the core of the effort of several agents coordinated among themselves for the formulation of collaborative projects. This would allow the foundation of working networks linked in the creation of knowledge with a socio-technical approach, within the framework of participatory governance schemes. The open science "product" is the core of a collaborative effort, while the "project" is the organizational framework that makes it possible. However, both depend on the processes and sub-processes that characterize knowledge production as a concrete experience. In this sense, knowledge in management models and techniques is necessary to reinforce the design of collaborative work experiences. For this reason, we chose to approach project management tools from the perspective of the complex nature of cognitive assets, the social relations linked to their creation and the institutionalist conception of common goods.

Likewise, elements were offered to consider the development of knowledge assets as the basis for initiatives that integrate distributed agents and resources in the deployment of collaborative experiences. The socio- technical approach opened the perspective of knowledge development as a product and participatory process, oriented to the generation of knowledge goods in different formats and supports, susceptible of being organized in the form of distributed networks or other organizational initiatives. The formulation of projects and the design of products made sense as theoretical-methodological platforms for mutual recognition and collaborative integration of creators, in experiences where complementarity and reciprocity prevail as values of open science.

At the project management level, the aspects reviewed provide the basis for further exploration of a set of management principles and methods for the formation of training, research and development networks. The development of research assets as the focus of the efforts of networks and organizations can become the basis for different training, research and development activities, taking into account that each "project" is a driver of different interrelated research assets (software programs, documents, content in different formats, courses, training programs, etc.). From the perspective of open science, distributed work and collaborative research can integrate producers in initiatives for the creation of knowledge goods with reciprocity and complementarity.

These approaches can contribute to the conformation of an ecosystem of socio-technical management of knowledge goods as common goods. The projects that emerge within this framework would help lay the foundations for an exchange system that integrates creators from universities, research centers and small companies in open science experiences that serve as an example to other researchers and developers. In this sense, open science initiatives have the potential to improve the performance of these organizations as promoters of training, research and development activities, which is an advantage in bridging the boundaries of knowledge.

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