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# Development of Plan S monitoring and compliance tool in the context of PTCRIS for Portuguese National Science Foundation

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## Abstract

The Portuguese Foundation for Science and Technology (FCT) has endorsed Plan-S since early 2021 and it is working towards implementing its obligations. To ensure an effective fulfillment of its open science policies, FCT is implementing a new monitoring and compliance tool, that will enforce the compliance with Plan-S as well as the new FCT's open access (OA) policy. This paper details FCT's approach to implement this tool and discusses the challenges of integrating information that is spread across multiple systems. The new tool will be built on top of infrastructures and services developed by FCT over the last years under the umbrella of the Portuguese Current Research Information System (PTCRIS) program. This tool comprises an operational component, integrated with the grant management system, and an analytical component, based on a Data Warehouse and Business Intelligence (DW/BI) system. The DW/BI system for the ecosystem of Science and Technology in Portugal will be developed using Kimball's Dimensional DW architecture, which advocates the incremental design and development of dimensional data marts linked by conforming dimensions. In this approach, data marts contain atomic and summarized data, corresponding to the development of elementary and derived dimensional models. Three data marts will be developed for the subject areas of funding, scientific results and for monitoring and compliance. The last data mart will calculate the compliance indicators for Plan-S as well as for FCT's OA policy. The operational component of the new tool then receives, from the analytical component, the list of scientific results per funding registry along with data regarding compliance. A list of non-compliances for each scientific result will be the basis of a notification module that will inform the principal investigator (PI) and the FCT compliance officer.

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## 1. Introduction

Over the last decade, funders around the world have implemented Open Science policies that aim to optimize the application and impact of public funding in scientific research activities, providing the widest possible dissemination of the results of funded research. In September 2018, cOAlition S [1], an international consortium of research funding and performing organizations, launched Plan-S [2] which requires that, from 2021, scientific publications that result from research funded by public grants must be published in compliant Open Access (OA) journals or platforms. The Portuguese Foundation for Science and Technology (FCT) [3] has endorsed Plan-S since early 2021 and is working towards implementing its obligations. To ensure an effective fulfillment of its open science policies, FCT is implementing a new monitoring and compliance tool, that will enforce the compliance with Plan-S.

The new tool will be built on top of infrastructures and services developed by FCT over the last years under the umbrella of the Portuguese Current Research Information System (PTCRIS) program [4]. Launched in 2014, PTCRIS aims at creating and sustaining the development of an integrated and coherent ecosystem at the national level [5]. By promoting a wide and effective integration of several key information systems, PTCRIS contributes to lighten the administrative burden that lies on researchers and streamline management and scientific production processes through access to an authoritative, complete and reliable source of information. Fig. 1 depicts the PTCRIS ecosystem. All regulatory framework and infrastructures highlighted in the figure are already deployed except for the research infrastructures information system. At the services level, the national CV platform (CIENCIAVITAE [6]), the grant management system (MyFCT [7]) are live and several national and local CRIS are interoperable using PTCRIS infrastructures and systems.

FCT also manages the online library of knowledge (b-on) [8] which is the national consortium that ensures the access to scientific international content is available to the Portuguese research community. During 2021, FCT was able to negotiate transformative agreements with publishers which will allow that 60% of the Portuguese scientific outputs will be published without cost to authors. This will enable one route of compliance with Plan-S. Another possible route is the use of open access repositories. FCT is also responsible for managing the national open access initiative, the Open Access Scientific Repositories of Portugal (RCAAP) [9]. The full integration of RCAAP with the PTCRIS infrastructure will be completed during 2022. FCT is also responsible for managing the national scientific journals services, PubIn [10] which contributes to the third Plan-S route of compliance.

Simultaneously, during 2022, FCT aims to implement the monitoring and compliance tool. This paper details FCT's approach to implement this tool and discusses the challenges of integrating information that is spread across multiple systems.

### Nomenclature

APC	Article Processing Charges
BI	Business Intelligence
DW	Data Warehouse
ETL	Extract, Transform, and Load
FCT	Fundação para a Ciência e Tecnologia - Portuguese Foundation for Science and Technology
OA	Open Access
PI	Principal investigator
PTCRIS	Portuguese Current Research Information System
RCAAP	Repositórios Científicos Acesso Aberto de Portugal - Open Access Scientific Repositories of Portugal

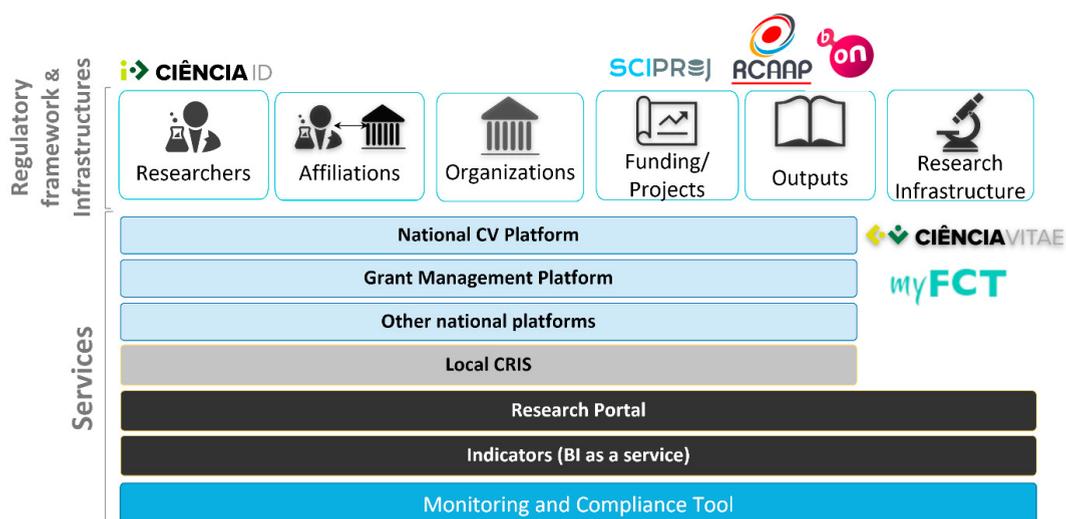


Fig. 1 PTCRIS ecosystem

## 2. FCT Open Access Policy and Plan-S

The benefits of OA publishing are widely acknowledged. These benefits impact directly on research, facilitating interdisciplinarity and increasing its visibility. At the same time, they have a social and economic impact by bringing research to professionals in other fields, to companies and to interested publics. To this end, in May 2014, the FCT published its “Policy on Open Access to scientific publications resulting from research funded by FCT”. This policy determines that scientific publications resulting from research funded by FCT, which are subject to peer review or other form of scientific review, should be deposited in one of RCAAAP's OA repositories as soon as possible, preferably at the time of acceptance for publication. An embargo period is allowed, after which the entire contents of the publications should be freely available. Please consult the FCT's policy for further details [11]

Seven years later, in 2021, FCT signed up for Plan-S. This plan aims to ensure that all publications resulting from publicly funded research are published in OA journals or platforms or made available through OA repositories without embargo. Please consult Plan-S website [2] for further details.

In order to prepare Plan-S implementation, we conducted two sets of studies. The first one was focused on understanding the impact of FCT (2014) policy, as well as its results and implementation critical factors. The second one was focused on understating how to implement Plan-S and the new FCT OA policy. This included, amongst others, the gap analysis between the existing policy and Plan-S, the economic studies (budget impact scenarios), potential legal implications (such as the zero embargo [12] national legislation and/or the funder FCT rights retention strategy [13]), operational systems, as well as the critical success factors for its implementation. This exercise allowed FCT to better define the main processes and the specs needed for the monitoring and compliancy system procurement processes.

The analysis was very detailed and impossible to summarize in this section. However, there are a few points that are worthwhile to mention, namely:

1. The gap analysis between Plan-S and FCT OA Policy with the synthesis of the norms of conformity of scientific outputs with the Plan-S and FCT Policy (Table A1, in appendix A)
2. The conformity check workflows defined for the different types of scientific outputs (an example is presented in section 3.1).
3. The data sources required to implement the conformity check (detailed in section 3.1).
4. The potential use cases of scientific outputs that will be subject to the conformity check (see section 3.3).

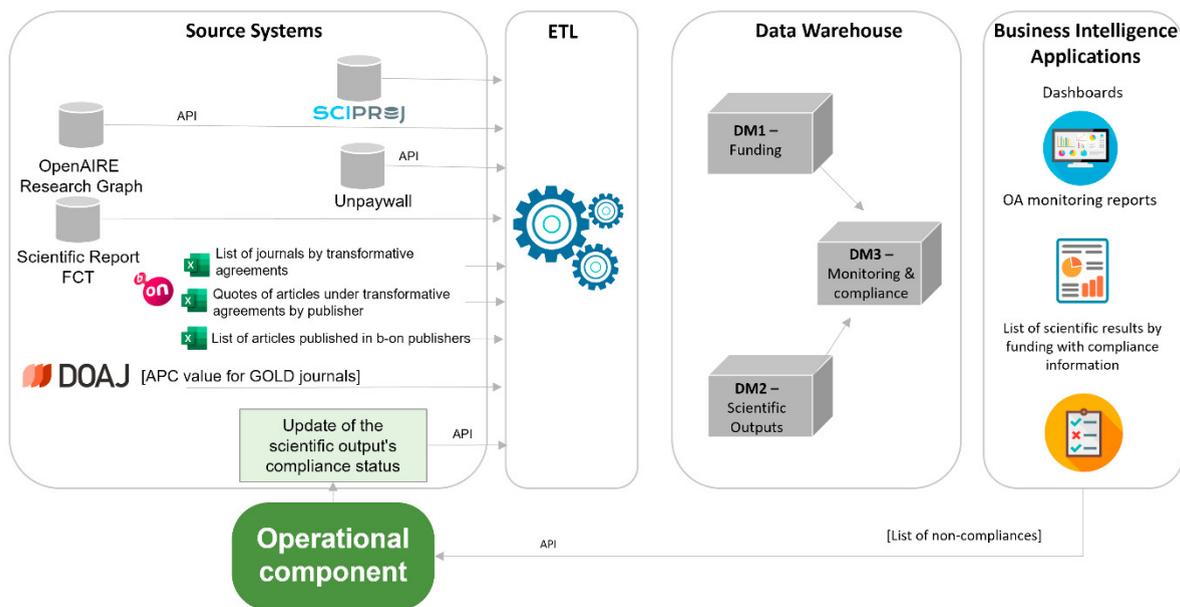


Fig. 2 High-level architecture of the Monitoring and Compliance tool: analytical part (DW/BI system) and operational part

### 3. The Monitoring and Compliance Tool

The monitoring and compliance tool comprises an operational component, integrated with the grant management system, and an analytical component, based on a Data Warehouse and Business Intelligence (DW/BI) system. The goal of the DW/BI system is to analyze the funding that the Science and Technology (S&T) ecosystem in Portugal receives, and consequently the scientific outputs produced by the actors of the ecosystem, namely researchers and S&T institutions, covered by a research and development (R&D) funding program promoted by a funding entity. The DW/BI system will enable the monitoring of scientific outputs in open access, fulfilling three specific objectives: (1) monitoring OA trends and spending on APCs (article processing charges); (2) monitoring and compliance with Plan-S; and (3) Monitoring of the transformative agreements with b-on.

#### 3.1. DW/BI System – Analytical component

The DW/BI system for the ecosystem of S&T in Portugal will be developed using Kimball's Dimensional DW architecture [14], which advocates the incremental design and development of dimensional data marts linked by conforming dimensions. In this approach, data marts contain atomic and summarized data, corresponding to the development of elementary and derived dimensional models. **Error! Reference source not found.** presents the high-level architecture of the DW/BI system, with four main levels: (1) source systems; (2) the ETL (extract, transform, and load) processes; (3) Data Warehouse, or data presentation layer, organized by subject areas or data marts; and (4) BI applications, i.e., the data exploration layer for decision-makers and business users, comprising dashboards and a collection of specific reports. Three data marts will be developed for the subject areas of funding, scientific results and for monitoring and compliance.

The aim of data mart 1 – Funding (DM1) is to analyze the S&T funding granted in Portugal, by FCT and other funding organizations (e.g., European Commission). The primary data source for DM1 is the National Register of S&T Funding (SciPROJ [15]), a database that aggregates information on funding attributed to scientific activity produced in Portugal, developed by FCT. With DM1 it will be possible to answer typical queries about S&T funding

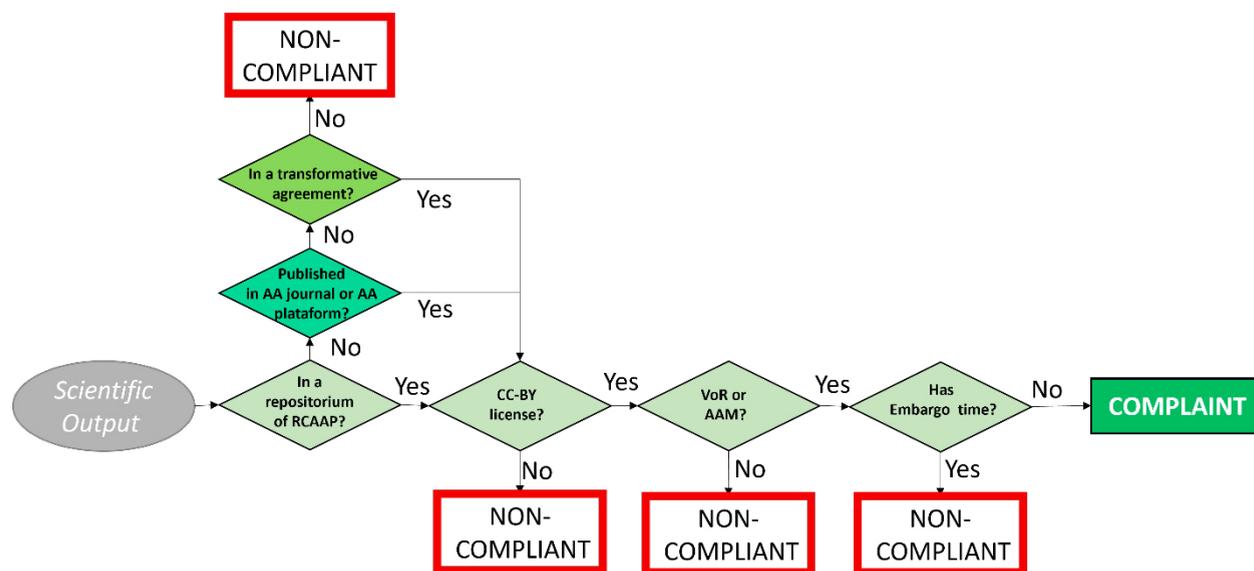


Fig. 3 FCT Open Access policy workflow

trends, such as the distribution of funded R&D projects and funding amounts per institution, per researcher, per scientific field, per funding program, per year, per funder.

The purpose of data mart 2 – Scientific Outputs (DM2) is to allow control of the technical execution at the level of published outputs (Scientific Output Management). The OpenAIRE Research Graph [16] has been selected as the primary data source for DM2. The OpenAIRE data will be enriched with OA information from Unpaywall [17], particularly for licensing information. SciPROJ is also a data source for DM2 for the purpose of enriching, validating and aligning project-related information. Other DM2 data sources include, as displayed in **Error! Reference source not found.**: (1) DOAJ [18], a community directory that references a relevant set of high-quality, peer-reviewed OA journals (with 70% of the journals referenced following the "diamond" model, i.e., publication does not require APC payment, and only 30% are "gold" journals, i.e., they charge publication fees); (2) OpenAPC [19] which aggregates information on APC fees paid on OA journals, as well as book processing charges (BPC's) and amounts associated with transformative agreements; (3) Information contained in the FCT Scientific Reporting, which is a requirement of the FCT funding conditions, in which the principal investigator of each project has to register in the FCT-SIG platform [20] all publications associated with the project, the year, the title and the URI (link to the publication); and (4) a set of Excel files provided by b-on with information regarding the management of the transformative agreements, namely: a list with the journals covered by the transformative agreements; an annual list of the quotas of articles under transformative agreements per publisher; and a list of articles published in b-on publishers (under transformative agreements or with APCs). It is important to mention that DM2 will store multiple instances referring to the same scientific output (e.g., the same publication may be in two different repositories). This information is essential to validate the FCT OA policy. Typical queries for analysis supported by DM2 include for example: the number of scientific outputs per month/year, by project, institution, and publisher, and by access type; and the amounts paid in APCs per year, institution, project, funding instrument, etc.

Finally, the last data mart – Monitoring & Compliance (DM3) will calculate and materialize the compliance indicators for Plan-S as well as for FCT's OA policy. The compliance indicators are defined according to compliance workflows that have been outlined for each type of output (an example is displayed in Fig. 3). Compliance indicators will be generated for all instances of a scientific output. And, consequently, a compliance status will be generated and associated with each record or instance (of a scientific output associated with a funding instrument and within the scope of a policy), as well as a list of non-conformities detected. This information is then sent to the operational component of the M&C tool. The data sources of DM3 are DM1 and DM2, complemented by the information that is

feed-forwarded into the DW as a result of the communication between the PI and the FCT team responsible for compliance.

The previous calculations are the basis for the conformity check process, which encompasses a set of questions to check the conformity of a scientific output. To this end, it is necessary to consult certain fields (from the different data sources) where the compliance rules are reflected. Table 1 shows the equivalence between each parameter (or question) and the fields where this information may be available.

Table 1 - Association between the questions needed for the compliance analysis and the fields where they may be answered.

Question	Source data	Field
Which license?	Unpaywall	Licence
	b-on	OA licence type
Which repository?	Unpaywall	has_repository_copy
		host_type (publisher or repository)
		repository_institution
		oa_locations
		url_for_landing_page
pmh_id (OAI-PMH endpoint where is found this location)		
Eligible repository?	OpenDOAR	
	RCAAP	
Embargo time?	Unpaywall	oa_locations_embargoed
	OpenAIRE Research Graph	publicationdate (entity result)
		embargoenddate (entity result)
Which version?	Unpaywall	version
Embedded in a transformative agreement?	Unpaywall and b-on	journal_issn and check if it exists in excel b-on (fields still to be defined)
OA journal or platform?	Unpaywall	journal_is_oa
		oa_status
		journal_is_in_doaj
	OpenAIRE Research Graph	access
APC's	b-on	paid charges
	Unpaywall and DOAJ	journal_issn (Unpaywall) and verification of APC amount (DOAJ)

In summary, the DW/BI system will be responsible for providing a list of scientific outputs by funding instrument (project), with compliance information, indicating eligible and ineligible outputs according to Plan-S and the current FCT OA Policy. The collected data enables the analysis of trends regarding compliance with the Plan-S and the FCT policy at the access level (e.g., the evolution over time of the percentage of FCT-funded results available in open access).

### 3.2. Operational component

The operational component of the M&C tool receives the result of the compliance analysis, calculated in DM3 (as shown in **Error! Reference source not found.**), and sends notifications with this information to the PI of the project

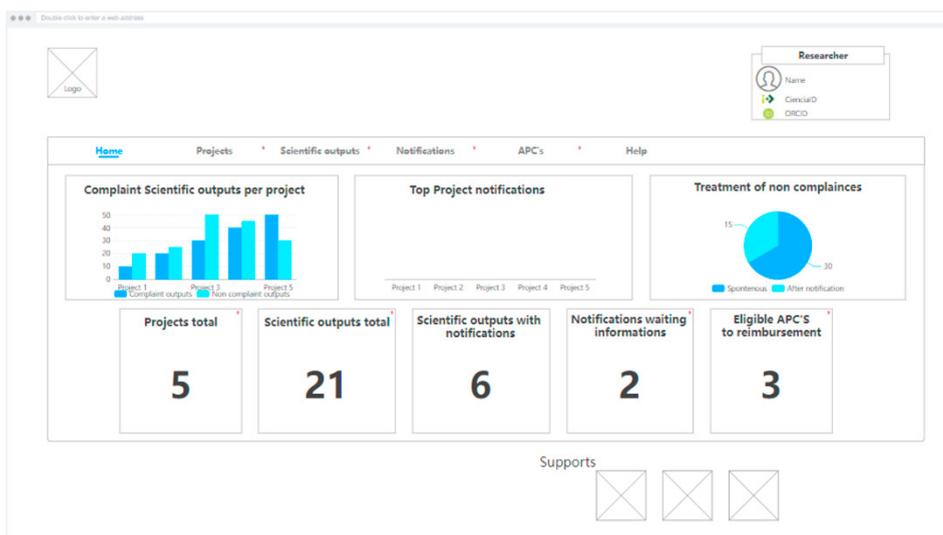


Fig. 4 Mockup of operational component frontend for researcher (namely, principal investigator) type of user.

and the FCT compliance officer. The main objective of this operational component is to manage the non-conformities detected.

The operational component should receive, from the analytical component, a list of scientific outputs, by funding instrument within a given policy, with the status of the record and the compliance information associated with it. This information will then be managed through a system of notifications between the investigator in charge and a team responsible for compliance verification. It will be this team that will determine whether compliance is approved (or not) and flag a record for completion of the compliance calculation. This process may include different steps that will be flagged with a substatus of non-compliance that will be integrated into the analytical component, DW/BI system, in order to assess the entire compliance cycle of a given record. However, it has to be noted that the treatment of non-compliances is performed in another system and is the responsibility of the PI.

The system will allow the FCT compliance officer to update the compliance status of a publication, e.g., "Automatic compliance validation passed", or "Unverifiable", signaling the end of the compliance monitoring cycle for the publication.

This operational component will also have a user interface. This interface will be different and oriented according to the type of user accessing it. The **Error! Reference source not found.** shows a mockup of the home page for a principal investigator as example; this page will show several indicators, from DW/BI, related to the compliance of the principal investigator's projects so that he/she can have an overview of the compliance of all his/her projects when accessing the interface. For each indicator, details of the scientific outputs that originated it will then be provided, such as, in the case of notifications received, identifying them, which scientific outputs they are associated with, and the possibility to respond to them. In the case of the compliance team accessing the interface, it will also provide the notifications sent/received as well as the list of non-compliant scientific outputs with the non-compliance information associated with each one (an example of this information is presented in tabular form in the **Error! Reference source not found.**).

### 3.3. Use cases

Several use cases were defined to test the conformity check process, considering the specific characteristics of the different scientific outputs to be analyzed. Nine non-compliant uses cases were identified:

1. Article published in a restricted access journal and not deposited in a repository
2. Article published in an embargoed magazine

ID	Compliance		License	Repository RCAAP	Embargo	Version	Transformative agreement	OA journals or plataforms	APC's
	Plan S	FCT							
doi1	✓	✗	CC-BY	-	0	AAM	No	Yes	0
doi2	✗	✗	-	handle	0	prePrint	No	No	0
doi3	✓	✗	CC-BY	-	0	VoR	No	Yes	650
doi4	✓	✗	CC-BY	-	6	VoR	Yes	Yes	0
handle1	✓	✓	CC-BY	Handle	0	VoR	No	No	0
doi5	✓	✓	CC-BY	handle	0	AAM	No	Yes	0
doi6	✗	✗	CC-BY	handle	6	AAM	No	Yes	1320
doi7	✗	✗	CC-NC	handle	0	VoR	Yes	No	0
doi8	✓	✓	CC-BY	handle	0	VoR	No	Yes	976
doi9	✓	✓	CC-BY	handle	0	AAM	Yes	No	0

Fig. 5 Result of conformity analysis by scientific output. For each scientific output, identified with an ID, the DW/BI will collect information about each compliance parameter and then calculate the overall compliance for Plan S and FCT OA policy. The highlighted fields in figure are the ones non-compliant with policies requirements

3. PhD thesis deposited in a repository not part of the RCAAP network
4. Article published in hybrid journal without transformative agreement
5. Article published in open access journal without a CC-BY license
6. Article deposited in repository in preprint version
7. Book chapter deposited in repository without license information
8. Article published in hybrid journal with APC
9. Article, within the scope of a rights retention strategy (RRS), published in a restricted access journal and not deposited in a repository

#### 4. Final Remarks

An effective and thrustable monitor and compliancy process relies on the quality of the information and in this case, in the ability to univocally identify persons (Principal Investigator), organizations (affiliations), funding and publications. PTCRIS standards and regulations and its mature infrastructures and services are key to this end as they serve as the foundations on top of which this system will be built, not only ensuring the desirable reliability of the process, but also contributing to speed up its development.

During the analysis processes, it became clear that the “business” can change or new needs can emerge. Therefore, the monitoring and compliance system should be flexible to accommodate future changes and needs.

PTCRIS aims to reduce bureaucracy. In fact, PTCRIS mantra is “introduce once, reuse multiple”. The design of the monitoring and compliancy system has respected this mantra. To this end, FCT will require as few information as possible (minimal records fields) and will use a variety of sources to enrich those records and calculate the compliancy status. Furthermore, all modules of the system for monitoring and compliancy will be interoperable.

FCT believes that the project will also contribute to increase the quality and completeness of the data, not only in the national ecosystem but also in the international one. On example of this statement is the virtuous cycle of information between FCT and OpenAIRE. FCT provides OpenAIRE with FCT’s funding (SciProj [15]) and publication (RCAAP [9]) records. This info is handled by OpenAIRE services that feed OpenAIRE graph which is used by the monitoring and compliancy system. Therefore, enrichments and corrections on these records will allow continuous curation of information.

## 5. Future work

Like in many other cases, once the system is built and explored, many other requirements will emerge. Currently, we have identified three main future requirements.

1 – Scope. The first system use case is publications. However, we would like to extend its use to the remaining research output types (e.g., research data, software, protocols, etc.).

2 – Reporting automation. Grantees have the obligation to deliver to FCT a report that contains the list of all outputs. This production of this report should be automated. Therefore, we would like to develop a module for this purpose.

3 – Monitoring and compliancy system interoperability. Given that some institutions have local CRIS systems, we believe that each monitoring and compliancy system modules should have API’s allowing therefore institutions to integrate with them.

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## Appendix A. Standards of compliance with Plan S and FCT OA policy

Table A1 Table A1 presents the detailed information about the gap analysis between Plan S and FCT OA policy requirements.

Table A1 - FCT Open Access Policy vs Plan S.

	FCT Open Access Policy (since May 2014)	Plan S	Additional information to be included in the new FCT Open Access Policy
Scope	Scientific publications resulting from research funded by FCT.	Scientific publications resulting from publicly funded research.	-
Scientific Outputs	<ul style="list-style-type: none"> <li>- Scientific publications/articles subject to a validation process such as peer review;</li> <li>- Conference proceedings;</li> <li>- Posters;</li> <li>- Books;</li> <li>- Book chapters</li> <li>- Monographs;</li> <li>- Theses.</li> </ul>	<ul style="list-style-type: none"> <li>Publications subject to peer review and arbitration.</li> <li>Open Access is recommended for all scientific outputs.</li> </ul>	A distinction should be made between publications/articles subject to the validation process and other publications.
Publication versions	<ul style="list-style-type: none"> <li>- Version of Record (VoR);</li> <li>- Author’s Accepted Manuscript (AAM)</li> <li>- Or both versions.</li> </ul>	<ul style="list-style-type: none"> <li>- Version of Record (VoR);</li> <li>- Author’s Accepted Manuscript (AAM)</li> <li>- Or both versions.</li> </ul>	The policy should include clear information about the versions.
Routes	<ul style="list-style-type: none"> <li>2 routes:</li> <li>1. Publication in Open Access journals or platforms;</li> <li>2. Immediate availability in Open Access repositories (VoR/AAM);</li> </ul>	<ul style="list-style-type: none"> <li>3 ways:</li> <li>1. Publication in Open Access journals or platforms;</li> <li>2. Immediate availability in Open Access repositories (VoR/AAM);</li> </ul>	The route of publication in Open Access subscription journals under transformative agreements should be considered. This route acts as indirect funding.

		3. Publication in Open Access subscription journals under transformative agreements.	It should also be noted that deposit is required in all routes.
Open Access Repositories	All publications subject to arbitration or other review and validation processes must be deposited in at least one repository within the RCAAP network, without prejudice to their possible deposit in other repositories.	The repository must be registered in a directory as referred to in the policies - OpenDOAR	It should be stated that the selected repository must be registered with OpenDOAR.
Open Access journals and platforms		Open Access journals or platforms must be registered with DOAJ, or in the process of being registered.	Add clear information about Open Access journals and platforms and information about the requirement that they be registered or in the process of being registered with DOAJ.
Transformative Agreements		Transformative agreements support the transition to Open Access and should be temporary and transitional. Under the agreements it is accepted that the funder supports APCs (no later than December 31, 2024).	Emphasis on using transformative agreements to ensure transition to Open Access. (date limit in accordance with Plan S)
Eligibility of APCs	In the context of funding projects, R&D units or grants to which the results in the publication refer, the APCs required by some publishers will be eligible for reimbursement. For this purpose, some conditions must be met: - Immediate access to the full content of the final version of the publication; - Authorization for immediate deposit of the version in repositories other than that of the journal or publisher itself; - CC BY license, or equivalent; - Reasonability of costs.	Given the 3 possible routes: 1. The funder may support the PCAs 2. The funder will not bear the costs in the case of "hybrid" models 3. The funder will be able to support the APCs until December 31, 2024 at the latest.	Given the 3 possible routes, it should be clear that: 1. FCT will be able to support the PCAs 2. FCT will not bear the costs in case of "hybrid" models 3. FCT may support APCs indirectly through transformative agreements.
Licenses & copyrights	Application of a policy-compliant access and reuse license, namely the CC-BY license or equivalent.	Authors must retain copyright of their publications. License application CC BY or, exceptionally, CC BY-ND.	Rights Retention Strategy. Be clear that other licenses equivalent to CC BY may be accepted upon request and justification.
Monitoring	There is no mention of monitoring.	Monitoring must be assured.	State that there will be monitoring and follow-up of the requirements of the new policy.
Penalties	There is no mention of any kind of penalty.	Each funder should determine how best to monitor compliance with Plan S and what penalties to introduce.	Some possible examples of penalties might include: - Withholding funds; - The exclusion of non-compliant project holders in future funding applications; - Etc.

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