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Summary

The OpenAIRE web site will offer functionalities for administrators, anonymous and registered users to manage an Information Space of FP7-funded open access publications. The aim of this document is to describe the conceived structure and semantics of this Information Space, i.e., the *Open AIRE data model*, by providing an abstract definition of its main entities and the relationships between them.

In this definitional process, the intended interaction (Task 7.2) between the OpenAIRE Information Space and the EC Participant Portal software systems (e.g., CORDIS web site and CORDA database) plays an important role in the specification of project data, i.e., how project data should be described, stored and exported in OpenAIRE. At this stage of interaction, we shall consider as authoritative sources for project data the CORDIS web site and the relative CORDA database, which contain information on projects and participants in FP7. As such, we shall store project information adopting a schema inspired by CORDIS. Furthermore, with regard to data export, the results of projects such as CERIF and KE-CRIS-OAR are taken into account as inspiring guidelines.

Finally, the document will analyze the impact of the OpenAIRE data model on the repository managers willing to expose, through OAI-PMH interfaces, metadata conforming to the OpenAIRE Information Space, so as to avoid double ingestion work to their researchers.

1 Scenario

The OpenAIRE web site will offer functionalities for administrators, anonymous and registered users to manage an Information Space of FP7-funded open access publications. In particular:

- *anonymous users* will be able to search and consult the Space;
- *registered users* will be able to insert and update content in the Space;
- *administrators* will have full access and rights to such Space and in particular are in charge of validating/invalidating insertions/deletions/updates from registered users.

In our reasoning we generalize the concept of publication to that of *project result*, so as to be able of including further kinds of research outputs whose production is "economically supported" by a EC project. Examples of project results may range from traditional publications to experimental data, software products, patents, books, ORE aggregation (i.e., compound object web representations). Similarly, we extend the notion of author to that of *person*. Other typologies of person may be required in the future, so as to describe future scenarios of interest.

Currently, OpenAIRE registered users can ingest information relative to *project results of type publication*, *persons*, *organizations* (companies, research centers or institutions) in order to link them together with so-called *authorships.* An authorship represents the fact that a given *person* has (co-)authored a given *publication project result* while being affiliated with a given *organization*. Besides, project results are always associated to one or more *instances* of the results, in the sense that different "physical representations" of the same result may exist. For example, the same publication may be kept in two different repositories, both exposing the payload file (e.g., PDF) at different internet locations (URLs). Accordingly, an instance of a project result is represented as a combination of zero or more *web resources* relative to the project result and of the internet *data source* (e.g., OAI-PMH accessible repositories, FTP sites, web sites) from which such resources are accessible/available. **Note**: the purpose of the project result-instance-web resource model is to capture a list of internet pointers relevant to the project result and not that of capturing the compound object structure that some results may have. If a project result is a compound object (e.g. ORE aggregation), its instances will likely be associated to web resources embodying its compound object nature (e.g., ORE resource maps).

Of crucial interest to the OpenAIRE Information Space is also the identification of the European *projects* which co-funded the research that has led to a given publication. In particular, data describing European *projects* will be fetched from the authoritative EC CORDA database, together with the *organizations* or *persons* which are *participants* of projects. While project data will authoritatively originate in EC databases, information about organizations may be also ingested by users, for example to complete authorships information in the database.Similarly, information relative to Data Sources, mainly repositories, will be inspired by the OpenDOAR system, which will act as main authoritative entity for repositories in Europe.

Project data models Focus studies on the results of CERIF project and the KE-CRIS-OAR initiative are being carried out in WP7. In particular, with regard to project, organization and publication data, it will be considered to adopt the description schemes proposed by such projects as models of the correspondent entities in the OpenAIRE data model. In this document, however, we shall proceed taking inspiration from the choices made by the EC

databases on that respect, in particular by CORDIS web site and the underlying CORDA IT Lab.

Outline In the following, Section 2 provides a detailed description of the entities that come into play by providing an Entity Relationship model and a relational database representation, Section 4 provides the requirements of input to the definition of the OpenAIRE Guidelines for Repository Managers (to be produced in WP3-T3.3), Section 5 describes how the data model could be extended so as to support collaborative refinement of the data.

2 Data definition

2.1 Detailed description

Project Result (or Result) A project Result is described by a result *kind* (e.g., publication, research data, software product), a *type*, which depends on the given kind (e.g., for publications we have "article", "book", "manual", etc.), a *date of creation*, a *description*, a *publisher*, a *language*, a *createdFrom* property (specifying how the Result was created, fully by an end user, by claiming it from DRIVER, from the relative DOI, etc), an *original identifier* (empty if the object is fully typed in by a user), a list of *keywords*, an *access mode* (e.g., license to access the result) and an *embargo end-date* (empty if the access kind does not imply an embargo). A Result is associated with (*i*) the set of its Authorships, (*ii*) the set of its Instances, if any (which can be located at different Data Sources), and (*iii*) the Projects which co-funded the research underlying the Result. **Note**: the property *access mode* can have one of the following values: "open access", "restricted" or "embargo". If it is "embargo", the field *embargo end-date* contains the date after which the publication becomes open access.

Organizations An Organization is described by a *legal short name*, a *legal name*, a *legal status*, an *URL of its web site*, an *URL of the logo*, a *country of origin*, and a *location* (longitude, latitude, and time zone). An Organization is associated with (*i*) the set of Data Sources, if any, of which the Organization is responsible for, (*ii*) if any, with the Persons authoring a Result while begin affiliated with such Organization, and (*iii*) for all Projects of which it is a participant, with the respective Participant entity.

Persons A Person is described by a *name*, a *surname*, a *nationality*, and a *gender*. A Person is associated to zero (if not an author of Results in OpenAIRE) or more Authorships and, for all Projects in which he/she acted as contact person, with the respective Participant entity.

Participants A Participant is a formal beneficiary of funds within a Project. It is uniquely identified by a *beneficiary number*, assigned at the time the participant is granted the project by the EC (typically of the kind: 1,2,3,4,etc, where 1 is assigned to the project coordinator), and is characterized by being or not the "coordinator" of the project it participates. A Participant is always associated to its Project and to the Organization and relative contact Person playing the role of Participant.

Authorships An Authorship describes the fact that one Person has authored one Result while being affiliated with one Organization, if available. As such, an Authorship is associated to the Person, to the Result and, possibly, to the Organization.

Instances An Instance represents the combination of the Web Resources associated with a Result and the Data Source where such Web Resources are stored. As such, an Instance is described by the *original unique identifier* (e.g. DOI if the Result is a publication) of the Result at the original Data Source. Furthermore, an Instance is associated with the Result, to the relative Data Source and, if any, to a list of Web Resources. Constraint: if the Result is of kind "publication", the Instance must be associated to at least one Web Resource, relative to the payloads of the publication.

Data Sources A Data Source is described by an *official name*, an *English name*, a *URL of its web site*, an *URL of the logo*, an *URL of the deposition page* of the repository, an *email of the technical contact*, a *typology of source* (e.g., OAI-PMH, OAI-ORE, FTP, Web Site), *location* (longitude, latitude and time zone), a flag *OpenAIRE Compliant*, a *status of compliancy* (under validation, waiting for harvesting, harvested), and an *access information*

package, i.e., an XML text bearing the information needed to access the specific source: for example, an OAI-PMH URL and an OAI-Set, if source typology is OAI-PMH, or an FTP address with login and password, if source typology is FTP. Moreover, repository information taken from OpenDOAR is kept for display reasons: *description*, *total number of items*, the *date of such calculation*, and *content type*, *language* and *subjects* of the repository publications. A Data Source is associated with (*i*) the set of Instances relative to Results available to OpenAIRE that are located at the Data Source and (*ii*) with the set of Organizations responsible for the Data Source. ***Note***: OpenDOAR will be the authoritative source for data source (i.e., repository) information in OpenAIRE. This means that the OpenAIRE system will keep its database up to date by synchronizing with the OpenDOAR system (ID of OpenDOAR will be used as IDs of data sources). Repository managers willing to signal their repository is compliant with OpenAIRE will have to find their repository in this list, flag it as OpenAIRE Compliant and complete or change the available properties where needed. From that point on, the updated repository information will not be overridden by synchronization actions with OpenDOAR. Note that if the repository is not available in the list, hence not in OpenDOAR, the repository manager will have to include it in OpenDOAR first to be included in OpenAIRE.

Web Resources A Web Resource is described by *its unique URL*. A Web Resource is associated to the Instance of the Result of which it contains relevant content.

Projects A Project is described by a *title*, an *acronym*, a *web site*, an *EC project web site* (e.g., the project page at CORDIS), a *grant_agreement_number*, a *start_date* and an *end_date*. To these, we add a *project call identifier*, a flag *SC39* which tells whether or not the project is subjected to clause 39, and a list of *Keywords*. A Project is associated with (*i*) the set of Participants participating to the Project, (*ii*) the set of Results whose research was co-funded by the Project, (*iii*) the Contract Types (e.g., Coordination and Supporting Action, I3) it conforms to, and (*iv*) the Subdivisions (e.g., FP7-ENERGY, FP7-INFRASTRUCTURES) under which it is funded.

EC Projects classification

The entities described below mirror the CORDIS classification scheme (see Figure 1), accessible at the address http://cordis.europa.eu/fp7/info-programmes_en.html.

A **Funding Programme** is an EC funding programme (e.g., FP7), here characterized by an *identifier*, a *name* and an *acronym* as provided by the EC. A Funding Programme is associated with one or more **Specific Programmes** (e.g., Capacities, Cooperation, Ideas and People, JRC), here characterized by an *identifier*, a *name* and an *acronym*. In turn, a Specific Programme is associated with one or more **Subdivisions** (e.g., research infrastructures), here characterized by an *identifier*, a *name* and an *acronym*. Finally, **Contract Types** (e.g., supporting and coordination actions, eContentPlus, I3, IP), characterized by an *identifier*, a *name* and an *acronym*, are associated to zero, one or more Projects.

- *Funding Programmes*: e.g., FP7
  - *Specific Programmes*: e.g., Capacities, Cooperation, Ideas, People, Euratom direct, Euratom indirect
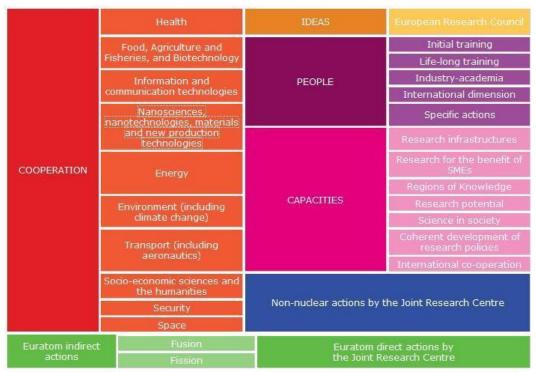   - *Subdivisions*: e.g., research infrastructures, Energy, Initial Training

Figure 1 - CORDIS Classification Scheme: Specific programmes
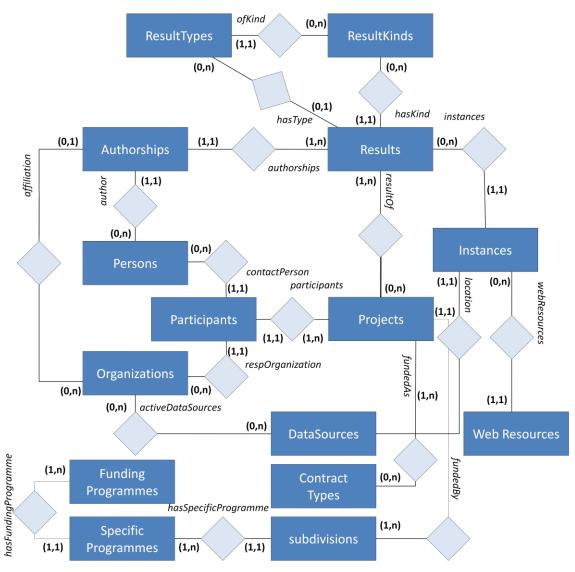
2.2 **Entity-Relationship model**

Figure 2 – OpenAIRE Entity-Relationship model

Table 1 reports the attributes and the named associations for the classes in the E-R schema in Figure 2.

Table 1 – E-R Schema: class properties

Persons	Authorships	Instances
• Name • Surname • Nationality ➜ author[-1] 　(0 or N Authorships) ➜ contactPerson[-1] 　(0 or N Participants)	➜ authorships[-1] 　(1 Results) ➜ author 　(1 Persons) ➜ affiliation 　(0 or 1 Organizations)	• Unique_identifier (URI) ➜ instances[-1] 　(1 Results) ➜ location 　(1 Data Source) ➜ webResources 　(0 or N Web Resources)
Organizations	Results	Projects
• Legal short name • Legal name • Legal status • Web site URL • Logo URL	• Title • Date of publication (optional) • Description • Publisher (optional) • Language	• Web site • Grant_agreement_number • Call_identifier (optional) • Acronym • Title

• Country of origin
• Longitude, Latitude, Time zone
➔ affiliation^{-1}
  (0 or N Authorships)
➔ activeDataSources
  (0 or N Data Sources)
➔ respOrganization^{-1}
  (0 or N Participants)
	• Access mode
	• Embargo end-date (optional)
	• Keywords
	• createdFrom {OpenAIRECompliantRepo, DOI, enduser, DRIVER, ecc}
	• Original identifier
	➔ hasKind
	  (1 ResultKinds)
	➔ hasType
	  (1 ResultType) (optional)
	➔ authorships
	  (1 or N Authorships)
	➔ instances
	  (0 or N Instances)
	➔ resultOf
	  (1 or N Projects)
	
	Constraints:
	• The *hasType* entity, if specified, must be in the association *relatedTypes* of the entity *hasKind*
	• *createdFrom* must have value *OpenAIRECompliantRepo* when the Data Source entity that is associated to the Result via an Instance (if such an Instance exists) has the field *OpenAIRECompliant* with value "True"
		• Start_date
		• End_date
		• SC39
		• Keywords
		➔ participants
		  (1 or N Participants)
		➔ resultOf^{-1}
		  (0 or N Results)
		➔ fundedBy
		  (1 Subdivisions)
		➔ fundedAs
		  (1 or N Contract Types)
		
		Derived properties:
		• Duration (from start_date and end_date)
		• EC_Project_Website(from grant_agreement_number)

Participants
• Beneficiary_number
• Coordinator
➔ participants^{-1}
(1 Projects)
➔ contactPerson
(1 Persons)
➔ respOrganization
(1 Organizations)
	Data Sources
	• Official name
	• English name (optional)
	• Web Site URL
	• Deposition page URL (optional)
	• Logo URL
	• Contact email
	• Longitude, Latitude, Time zone
	• OpenAIRECompliant
	• Typology (e.g., OAI-PMH, OAI-ORE, FTP)
	• Access Info Package (XML)
	• OD_description (optional)
	• OD_numberOfItems (optional)
	• OD_numberOfItemsDate (optional)
	• OD_subjects (optional)
	• OD_policies (optional)
	• OD_languages (optional)
	• OD_contentTypes (optional)
	➔ location^{-1}
	  (0 or N Instances)
	➔ activeDataSources^{-1}
	  (0 or N Organizations)
		Web Resources
		• Web Resource URL
		➔ webResources^{-1}
		  (1 Instances)

Funding Programmes • Identifier • Name • Acronym ➔ hasFundingProgramme^{-1}	**Specific Programmes** • Identifier • Name • Acronym ➔ hasSpecificProgramme^{-1}	**Subdivisions** • Identifier • Name • Acronym ➔ hasSpecificProgramme

(1 or N Funding Programmes)	(1 or N Subdivisions) ➔ hasFundingProgramme (1 Funding Programme)	(1 Specific Programmes) ➔ fundedBy^{-1} (1 or N Projects)
Contract Types • Identifier • Name ➔ fundedAs^{-1} (0 or N Projects)	**Result Kinds** • Name ➔ ofKind^{-1} (0 or N ResultTypes)	**Result Types** • Name ➔ ofKind (1 ResultKinds)

2.3 Relational Schema

The relational schema in Figure 3 is obtained as a normalized transformation from the E-R class schema in Figure 2.
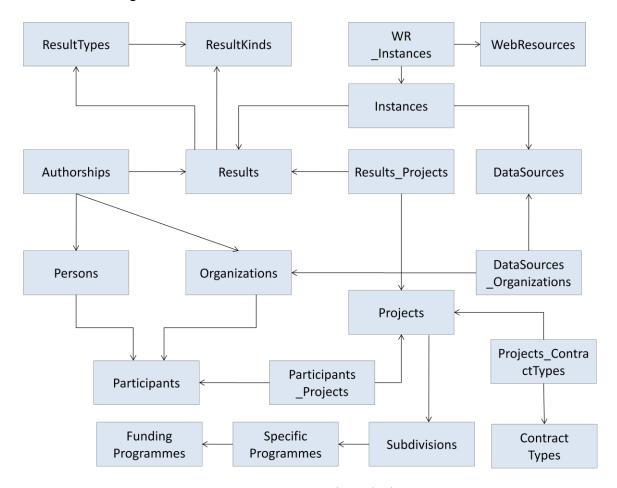

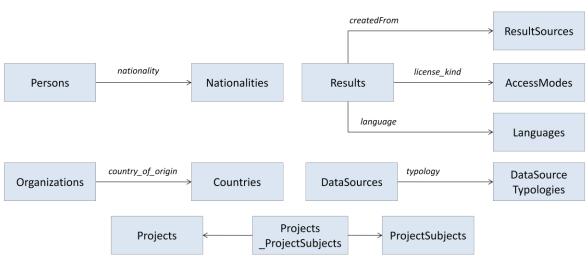*Figure 3 – OpenAIRE Relational Schema*

Figure 4 – Controlled Vocabularies Relational Schema: "vocabulary tables"

Figure 4 introduces the tables representing controlled vocabularies in the E-R schema, namely *vocabulary tables*. A vocabulary table has a structure of the form (key, value) is introduced whenever a controlled vocabulary needs to be managed. Currently, vocabularies are: Nationalities (of people), Result Kinds (categories of results, e.g., publication, research data, software product), Result Types (dependent on ResultKinds, for publication for example: article, book, manual, etc), Countries and Languages (possibly taken from ISO standard), Access Modes (described in the introduction), Data Source typologies (e.g., institutional repository, web site) and Project Subjects (taken from an authoritative list of subjects, to be provided by the EU: for example the seven research areas of the Pilot).

It is to be considered whether "vocabulary tables" should referred to from other tables by only using the primary key or by using the pair (key,value) in order to optimize searches (*tech*: no join query needed) and enable full-text search on values.

Finally, the "vocabulary tables" defined in this document may be subject to changes in the future: other attributes may be added to such tables, thereby extending the notion of vocabulary to that of an authority file, or new vocabularies be added (e.g., publisher). The trade-off stands in the balance between having clean and precise data and the effort required to keep a consistent and meaningful authoritative vocabulary of terms.

Table 2 – Relational schema: tables structure

Persons	Authorships	Instances
• personID: PK • name: string • surname: string • nationality: FK Nationality(nationalityID) (optional)	• authorshipID: PK • result: FK Results(resourceID) • author: FK Persons(personID) • affiliation: FK Organizations(organizationID) (optional)	• instanceID: PK • unique_identifier: String • datasource: FK dataSources(DataSourceID) • resource: FK Results(ResultID)
Web Resources	**Web Resources_Instances**	**Organizations**
• webResourceID: PK • file_URL: "URL" String	• webResourceID: PK FK Web Resources(fileID) • instanceID: PK FK Instances(manifestationID)	• organizationID: PK • legal_short_name: String • legal_name: String • legal_status: String • web_site_URL: String • logo_URL: String (optional)

		• country_of_origin: FK Countries(countryID)
Results • resultID: PK • title: String • publication_date: Date (optional) • description: String • publisher: String (optional) • original_identifier: String (optional) • createdFrom: FK ResultSources(name) • hasKind: FK ResultKinds(resourceKindID) • hasType: FK ResultTypes(resourceTypeID) (optional) • language: FK Languages(languageID) • access_mode: FK Access_Modes(accessModeID) • embargo_end_date: Date • keywords: String	**Projects** • projectID: PK • web_site: "URL" String • EC_project_website: "URL" String • grant_agreement_number: String • call_identifier: String (optional) • acronym: String • title: String • start_date: Date • end_date: Date • SC39: Boolean (default False) • fundedBy: FK Subdivisions(subdivisionID)	**Participants** • ParticipantID: PK • Beneficiary_number: Integer • Coordinator: Boolean (default False) • Project: FK Projects(projectID) • Organization: FK Organizations(organizationID) • Person: FK Persons(personID) (optional)
DataSources • datasourceID: PK • official_name: String • English_name: String (optional) • web_site_URL: "URL" String • deposition_page_URL: "URL" String (optional) • logo_URL: String • contact_email: "email" String • longitude: Number • latitude: Number • time zone: String (optional) • OpenAIRECompliant: Boolean (default False) • typology: FK DataSourceTypologies(datasourceTypologyID) • access_info_package: "XML" String • OD_description: String (optional) • OD_numberOfItems: String (optional) • OD_numberOfItemsDate: String (optional) • OD_subjects: String (optional) • OD_policies: String (optional) • OD_languages: String (optional) • OD_contentTypes: String (optional)	**DataSources_Organizations** • datasource: PK FK DataSources(datasourceID) • organization: PK FK Organizations(organizationID)	**Results_Projects** • result: PK FK Results(resultID) • project: PK FK Projects(projectID)
ResultSources • name: PK String	**FundingProgrammes** • fundingProgrammeID: PK String • name: String • programme_acronym: String	**SpecificProgrammes** • specificProgrammeID: PK String • name: string • specificProgramme_acronym: String

		• hasFundingProgramme: FK FundingProgrammes(fundingProgrammeID)
Subdivisions • subdivisionID: PK String • name: string • subdivision_acronym: String • hasSpecificProgramme: FK SpecificProgrammes(specificProgrammeID)	**ContractTypes** • contractTypeID: PK String • name: string	**Projects_ContractTypes** • project: PK FK Projects(projectID) • contractType: PK FK ContractTypes(contractTypeID)
ResultTypes • resultTypeID: PK String • name: String • ofKind: FK ResultKinds(resultKindID)	**ResultKinds** • resultKindID: PK String • name: String	**DataSourceTypologies** • datasourceTypologyID: PK String • name: String
ProjectSubjects • projectSubjectID: PK String • name: String	**Projects_ProjectSubjects** • project: PK FK Projects(projectID) • project_subject: PK FK Project_Categories(projectCategoryID)	**Nationalities** • nationalityID: PK String • name: String
Countries • countryID: PK String • name: String	**AccessModes** • accessModeID: PK String • name: String	**Languages** • languageID: PK String • name: String

3 User management

In this section we extend the OpenAIRE relational database with tables allowing for the management of a set of Users which may have a number of Roles and, after having registered, may "create" a number of Results in the database, by fetching them from different kinds of sources or by manually ingesting them. Figure 5, shows the relationships between the tables whose properties are listed in Table 3. The "email" was chosen as primary key to follow the indication of D-NET user profiles, with which the table will be synchronized.

Table 3 - Database extension: User management in OpenAIRE, tables and properties

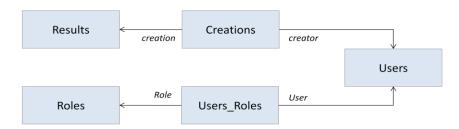| **Users** • email: PK String • firstName: String (optional) • secondName: String (optional) • institution: String (optional)	**Creations** • creation: PK FK Results(resultID) • creator: PK FK Users(email) • dateOfCreation: Date • lastUpdateDate: Date	**Roles** • name: PK String
Users_Roles • role: PK FK Roles(name) • user: PK FK Users(email)		

Figure 5 – Database extension: User management in OpenAIRE, tables and relationships

4 Implications for the definition of OpenAIRE Guidelines

This section analyzes the OpenAIRE data model and identifies some of the requirements the model may impose to OpenAIRE repository managers. As such, it will serve as input to the definition of OpenAIRE Guidelines for Repository Managers.

Based on the OpenAIRE data model and on the OpenAIRE system requirements, in order to facilitate the automatic ingestion process of metadata records relative to publications from the repositories to OpenAIRE, the following requirements were identified:

1) The repository should implement an OAI-PMH interface (OpenAIRE provides a suite for managing harvesting and aggregation of a federation of OAI-PMH conformant repositories);

2) The repository should export an OAI-PMH set (possibly with an OpenAIRE-flavored name, such as "EC_Project_Results") whose metadata records correspond to the publication results of interest to OpenAIRE; if such a set is not available, an alternative way of selecting records of interest to OpenAIRE should be provided (e.g., a special metadata field allowing for direct or indirect identification of such records)

3) Information about funding projects and licenses of the publications should come along with the bibliographic metadata: repository managers should find ways to "enrich" their Dublin Core records with new fields, in particular:

   - *access_mode*, mandatory (possibly values from the OpenAIRE controlled vocabulary "AccessKinds")

   - *embargo_end_date*, mandatory when *access_mode* = "embargo"

   - *project*, mandatory sequence (values from the OpenAIRE vocabulary obtained by projection of the attribute *projectID* of the table Projects)

   - *unique identifier*, optional (the unique identifier of the publication at its original repository, different from the value expected in *dc:identifier*, see below)

4) Some of the Dublin Core fields should be mandatory or optional based on their correspondence with the OpenAIRE properties for Results of typology "publication". Similarly, values of the DC fields should possibly, not mandatorily, adhere to the OpenAIRE vocabularies to which the corresponding properties adhere. Alternatively, if values of such fields are provided according to different vocabularies, a mapping onto the matching OpenAIRE vocabulary values should be provided. Some examples are:

   - *dc:title*, mandatory

   - *dc:creator*, mandatory sequence

   - *dc:description, mandatory*

   - *dc:identifier, mandatory sequence* (the URL of the file, in the style of DRIVER Guidelines)

   - *dc:subject, optional sequence*

   - *dc:publisher, optional*

- *dc:language, optional (possibly values from the OpenAIRE controlled vocabulary "Languages")*

- *dc:type, optional (possibly values from the OpenAIRE controlled vocabulary "ResourceTypes" of ResourceKind="Publication")*

5 Collaborative refinement of the Information Space

The OpenAIRE Web Site enables registered users to access and modify the Information Space in order to add, remove clean or enrich its content. The Information Space structure is conceived to enable a growing process of data quality improvement, so as to construct and grow authority files for persons, results, organizations, data sources and projects. This process is based on trust of registered users, whose corrective actions are double-checked by administrators, and supported by automatic tools for identification of duplicates.

In this scenario, actions from registered users should be recorded and limited to those that are reversible by administrators; actions from administrators should also be recorded, but can be irreversible. Different technical solutions are possible and will be discussed at the time of implementing the Information Space.