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The Flemish Research Discipline Classification Standard: A Practical Approach

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Abstract: In 2010, a study was performed by the Flemish universities in cooperation with the Flemish Interuniversity Council (VLIR) on the administrative burden of research reporting in Flanders, Belgium. One of the most prominent observations of this study (Peters and Lambrechts 2011) consisted of the redundancy that occurs both in preserving, classifying and reporting research information to different stakeholders in a region as small as Flanders. In response to this study, the Flemish government assigned the Centre for Research & Development Monitoring (ECOOM) with the task to: 1) develop a research discipline classification standard for the Flemish region that could serve all existing use purposes; 2) effectuate the implementation of this research classification standard by all Flemish stakeholders; and, 3) prevent data loss when classification schemes would be converted. This paper discusses the background, creation and implementation of the Flemish Research Discipline Classification Standard.

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1.0 Introduction

In Flanders, researchers have to report on their research activities to their host institutions and to the funding agencies that fund their research via projects, scholarships, grants or other funding mechanisms. The same accounts for the host research institutions and funding agencies that have to report to governmental agencies (e.g., Flemish Interuniversity Council (VLIR), Flemish Research Information Space (FRIS)) on their institutional research portfolio and policies. Although all these reports contain information about the research activities of the same (group of) researchers, whether or not at an aggregated level, they generally differ in the format and classification scheme that is requested, thereby placing an enormous administrative burden on the Flemish researchers, research institutions, agencies and organizations.

Although many efforts have been undertaken in the past decade to digitize and automate the research administration processes by every single institution and agency, these have been counterbalanced by the introduction of new administrative requests coming from new insights in, for example, the field of ethics or animal care. Due to this proliferation of administrative processes and procedures, the Flemish universities and the Flemish Interuniversity Council decided in 2010 to outline the reporting obliga-

tions of the research community in Flanders and to propose recommendations on how the administrative burden on researchers could be reduced. Moreover, for the first time in Flanders, the entire framework of processes, procedures and workflows involved in research reporting was bundled in the "Report on Simplification of Research Reporting in Flanders" (Peters and Lambrechts 2011). This report describes the formal reporting obligations of the entire Flemish research landscape and compares their specific requirements with regards to the requested data, data types, formats and classifications. In addition, the data sources that contain different kinds of research information as well as the workflows whereby each particular kind of information is fed into a number of different Flemish research data systems were described. Finally, information of the accompanying validation processes was described. By bringing all these pieces of information together, the report formally demonstrated the existence of a high degree of redundancy in reporting on research information in Flanders. Peters and Lambrechts therefore, formulated a number of recommendations to the Flemish research community to tackle this redundancy and to evolve to a more efficient and harmonized manner of research administration. As a general recommendation, the report prompted all Flemish stakeholders to engage in a sustainable collaboration and to join forces to reduce the administrative burden put on the research community at the benefit of science and the society. Reduction of research administration is only possible when all stakeholders in the research community communicate and exchange their available research information using the same language. As a second recommendation, the report stated that the efficiency of research administration would improve significantly when the research classifications used in Flanders would be harmonized into a single research classification standard, i.e., only one standard for classifying research according to research disciplines. As every stakeholder in Flanders was operating on research classification schemes that are customized to their own needs, researchers had to categorize their research activities based on a different classification scheme for every research report.

To accommodate the recommendations of this report, the Flemish government, the Flemish Centre for Research & Development Monitoring (ECOOM) and the Flemish universities joined forces to harmonize the research administration processes. First, forces were joined to transform the Flemish Research Information Space portal (https://www.researchportal.be) into a Flemish open data store that collects research information in a single, central platform and that allows the stored data to be used for multiple purposes, including research reporting. A collective, centralized Flemish data platform of research information is, however, only informative when the collected and exchanged data are complete and accurate, but even more importantly, it also requires the agreement of all stakeholders on a common semantic interpretation of the data concepts that are being used. That is, the semantic harmonization of data concepts is essential to obtain data that are comprehensible and transparent to all stakeholders in order to be aggregated or used for a wide variety of purposes. Therefore, the Flemish government and universities, under the supervision of ECOOM, semantically harmonized the content of the data concepts that are fed into the FRIS research portal.

As a third accommodation to the recommendations of the report of Peters and Lambrechts the various stakeholders in Flanders (i.e., the Flemish funders and governmental authorities) prompted to harmonize the research classification schemes in Flanders into semantically defined standards for research reporting. These standards would not only further reduce the administrative burden on the research community but would at the same time ameliorate the quality of research reporting. The first phase of the harmonization process focused on the classification of research activities into research disciplines. In this paper, the methodology for creating the Flemish standard for classifying research into research disciplines is described and an overview of its roadmap to implementation is provided.

2.0 Research discipline classifications in Flanders

2.1 Research reporting obligations

Anno 2011, four different research discipline classification schemes were used in Flanders to characterize the disciplinary expertise of researchers, research organizations and projects. European regulations, Flemish decrees or guidelines from authorities determined which research discipline classification scheme had to be used.

In brief, the European Commission advises the research community worldwide to make use of the guidelines and standards proposed in the *Frascati Manual* (OECD 2015) to report on Research and Development indicators. At the start of the creation of the Flemish Research Discipline Standard, the revised Field of Science and Technology (FOS) classification scheme (OECD 2007) was considered as the standard for reporting to European governmental instances. In Flanders, the revised FOS classification was used to report on the science disciplines of the Flemish research population to the OECD Research and Development Statistics (RDS).

Within Flanders, the decree of the Flemish government on the regulations for the preparation of the annual report of the universities in the Flemish Community prescribes the data categories that need to be reported using research

disciplines (Vlaams Ministerie van Onderwijs en Vorming. 2000). Research projects are, therefore, reported to the Flemish government using the FRIS/IWETO discipline classification scheme, while data on the research input (research funds and staff) as well as the output have to be aggregated using the scientific disciplines of the VLIR discipline classification scheme.

Finally, in order to request research funds from the Research Foundation - Flanders (FWO), Flemish researchers have to use the FWO discipline classification scheme to specify their own expertise as well as the main focus of the grant proposal and to report back to the FWO on the obtained results of the research carried out through this funding.

2.2 Characteristics of existing research classifications

In order to create a Flemish standard for classifying research information objects into research disciplines, the characteristics of the research classifications that were used at that moment in time in Flanders, i.e., the revised FOS, FRIS/IWETO, FWO and VLIR discipline classification schemes were studied.

The OECD Fields of Science and Technology (FOS) classification scheme, published in the Frascati Manual (OECD 2002), was originally developed by the OECD Working Party of National Experts on Science and Technology Indicators (NESTI) as an international standard to classify research and development (R&D) units and resources based on the disciplinary field of their content. The FOS classification scheme was updated and revised in 2007 because of the emergence of new technology fields (e.g., ICT, biotechnology and nanotechnology), was renamed as the revised FOS classification scheme and was published as an annex to the Frascati Manual of 2002 (OECD 2007). In 2015, the revised FOS classification list was updated and renamed into the Fields of Research and Development (FORD) classification list (OECD 2015). The FORD classification scheme (as well as the revised FOS classification scheme) consists of two hierarchical levels comprising six and forty research disciplines respectively at the first and second hierarchical level and is used to report to European organizations such as Eurostat, OECD or other European agencies.

The FRIS/IWETO classification list is an update of the Inventory of the Scientific and Technological Research in Flanders (IWETO) discipline classification scheme, that was originally designed in the nineties by the former FWO based on the international code schemes that were used in that period. The IWETO classification scheme was used for reporting information on research projects to the Flemish government, and was gradually updated, independently of the Research Foundation—Flanders, based on the gaps that were reported to the Department Economy, Science and Innovation of the Flemish government. The IWETO discipline classification list was renamed into the FRIS/IWETO classification list, thereby pointing towards its key role in the FRIS portal. The FRIS research portal makes use of the FRIS/IWETO classification list to classify information on researchers, research organizations and research projects based on their discipline. The last version of the FRIS/IWETO discipline classification list consists of three hierarchical levels, comprising five, forty-nine and 339 disciplines, respectively.

The FWO discipline classification scheme originates from the IWETO discipline classification scheme. Over the years, the IWETO discipline classification scheme was adjusted by the FWO, independently from the IWETO discipline classification scheme, in order to accommodate to the gaps in the discipline classification list that were reported to the FWO and to limit the disciplines to only those fields that qualify for FWO funding. In 2010, an attempt was made to harmonize and update the adjusted FWO and IWETO discipline classification schemes into a single and updated classification list. However, due to a lack of resources, this attempt failed and only the FWO discipline classification scheme received a significant update. The FWO discipline classification scheme has been used by the Research Foundation—Flanders to report to the Flemish government on which disciplines have been funded over the years. Additionally, this classification list is used by the FWO in the project review process to match research project proposals to researchers with a matching field of expertise. The last version of the FWO discipline classification scheme consists of three hierarchical levels, comprising five, forty-one and 1,029 disciplines respectively.

The VLIR discipline classification scheme is a scheme that is owned and governed by the Flemish Interuniversity Council (VLIR). This classification scheme is based on the twenty-nine scientific disciplines that are listed in the Flemish Decree on the annual reporting obligations of the universities in Flanders (Vlaams Ministerie van Onderwijs en Vorming. 2000). This classification scheme has, however, been adjusted, i.e., three disciplines have been split-up and two new disciplines were added, thereby creating a non-hierarchical classification scheme consisting of thirty-four disciplines. The VLIR discipline classification scheme is used for reporting on scientific personnel to the Flemish government.

3.0 Towards a Flemish research discipline classification standard

Based on the reporting obligations, characteristics and use purposes of these research discipline classification schemes,

the framework for the Flemish Research Discipline Standard was created.

3.1 Scope

In the first phase, the scope of the Flemish research discipline standardization project was determined by the key stakeholders that make use of discipline classifications, i.e., FWO, VLIR and FRIS. These stakeholders agreed that the Flemish Research Discipline Standard, the standard classification scheme that would be used by all stakeholders in Flanders to classify research activities, should meet the following criteria:

1) cover research fields for all research activities performed in Flanders;
2) be hierarchical, in order to guarantee the level of granularity that every stakeholder needs with regards to their use purposes;
3) be enriched with semantic descriptions for all disciplines in order to ensure a comprehensible terminology for all potential users;
4) is provided with concordance tables to all the discipline classification schemes that were in use at that time in Flanders as well as to the FORD classification scheme, in order to prevent historical data loss and to meet the reporting requirements to European authorities and organizations.

3.2 Creation of the Flemish research discipline classification standard

After analyzing the Flemish research discipline classification schemes, (inter)national research discipline classifications were studied. The classifications of the surrounding countries were incorporated in the analyses and specific efforts were made in order to include at least one research discipline list per continent in order to overcome regional and political influences. Altogether sixteen (inter)national research discipline classification schemes were evaluated on their uses, purposes and characteristics and were later merged into the draft research discipline classification scheme (Table 1).

One list in particular, i.e., the Fields or Research classification scheme of the Australian and New Zealand Standard Research Classification (ANZSRC) version 2008, was particularly interesting as this list is based on OECD revised FOS classification (OECD 2007), yet adds an additional level of granularity. Furthermore, the list contains built-in mechanisms that could potentially be used to identify new and emerging research fields.

Based on the structural characteristics of the ANZSRC - FOR, the Flemish Research Discipline Standard was further drafted. First, the number of hierarchy levels was determined in accordance with the different use purposes of the standard. That is, the standard should allow for reporting to the European authorities, the Flemish authorities, but

Research discipline classification	# Hierarchical levels	Geographical area
ANZSRC – FOR[1]	3	Australia & New Zealand
CASRAI[2]	3	America
CSC[3]	2	China
FAPESP[4]	2	Brazil
RSA-RF[5]	2	Africa
ERC[6]	2	Europe
OECD – FOS/FORD[7]	2	Europe
ANVUR[8]	3	Italy
SSD[9]	4	Italy
ÖFOS[10]	3	Austria
RAE[11]	1	UK
REF[12]	1	UK
NWO[13]	2	The Netherlands
FWO[14]	4	Flanders
FRIS[15]	3	Flanders
VLIR[16]	1	Flanders

Table 1. Overview and characteristics of the analyzed international research classification schemes.

should also allow for the visualization of the research fields of a researcher's organization and even an individual researcher. In this way, four hierarchical levels were proposed to the Steering Committee "Research Disciplines" that consisted of members of the key stakeholders (i.e., FWO, VLIR and FRIS) as well as representatives of the universities, higher education institutions and other research institutions, and that was specifically appointed for taking strategic decisions. After approval of the four hierarchical levels, the first hierarchical level was filled with terms of the revised FOS classification (OECD 2007) as this level would be used to report to the European authorities. For the remaining three hierarchical levels, the list was first populated with disciplines originating from the revised FOS (OECD 2007) and ANZSRC-FOR discipline classification schemes. In the next step, disciplines that were identified as seemingly missing research fields during a gap analysis of the sixteen research discipline schemes or that were previously reported to the key stakeholders, were added. The draft research discipline list was then presented to the Steering Committee "Research Disciplines" and approved for evaluation by experts in the various research fields.

3.3 Expert evaluation

The evaluation of the composed draft research discipline classification list occurred, following the process formally approved by the Steering Committee "Research Disciplines." That is, the list was first evaluated by the FWO expert group; secondly, the key stakeholders' opinions were consulted and finally the list was reviewed by expert (groups) within the respective research fields. The order of this procedure was dictated by the fact that the FWO expert group, at that point in time, was the only Flemish group that already had expertise in reviewing research disciplines, based on the update of the FWO discipline classification scheme in 2010. As such, the FWO expert groups provided valuable information, even on different political and regional interpretations that might influence the content of the research discipline classification scheme. Second, in line with the principles of organizational warrant (Zeng 2005), the key stakeholders were consulted and asked to provide feedback on whether the proposed terms were acceptable in the jargon of their organization. This consultation additionally stimulated the engagement of the stakeholders in the establishment of a Flemish standard for research disciplines and in the validation of the draft research discipline classification scheme. Moreover, the expert databases of the Flemish stakeholders were consulted in order to identify relevant experts for reviewing the granularity of the research discipline list, the terminology used as well as for identification of potential overlaps and gaps. Subsequently, in line with the concept of cognitive proximity, researchers with a similar knowledge base, e.g., a similar professional background and a common understanding, were consulted (Hautala 2011). In total, 453 experts were addressed to review their research field, out of which 293 provided us with useful feedback. On some occasions the experts addressed submitted our review questions to their respective societies in order to get an even more generalized view. The overall review process resulted finally in a research discipline list of four hierarchical levels, consisting of seven, forty-two, 382 and 2,866 research discipline codes respectively. For a more detailed description of the Flemish Research Discipline Standard, see Vancauwenbergh and Poelmans (2019).

3.4 Semantics

In the next step, definitions were added to the terms used for denoting the research disciplines. Although at first glance, the meaning of a research discipline might seem obvious, it was observed during the exercise that a wide range of semantic misinterpretations existed amongst stakeholders. First, the expertise that one has with regards to the respective research field depends on their cultural and professional background (Hautala 2011) as well as on their acquaintance with the jargon used within specific research communities (Zeng 2005). This highly influences the interpretation of the terms being used. Second, political and philosophical influences also have a role in the specific meaning of a term for an individual. Third, the role that one has towards the use of the terminology also determines subtle, yet important differences in the way the terminology is perceived by an individual. In order to ensure a perfect understanding of the terminology used, we extended the project towards the inclusion of clear, yet detailed definitions that give the potential users of the Flemish Research Discipline Standard a clear view of what is contained when a term is used, including what is excluded from it.

As a starting point, definitions that were available in online sources, e.g., in professional literature, Wikipedia or other online sources, were formulated. Then scientific experts were consulted for evaluating the definitions in relation to the research fields included in a particular area, but also in relation to the overall Flemish Research Discipline Standard. By going through iterative cycles of semantic reconciliation in which domain experts collaboratively capture business semantics (Van Grootel et al. 2009), the definitions were optimized to provide all potential users with clear insights in the meaning of the terminology and thus the research fields. For every single discipline used in the Flemish Research Discipline Standard, a definition was formulated. The thus-composed classification scheme was then submitted to the Steering Committee "Research Disciplines" who formally approved the resulting classification scheme. Next, the classification scheme was submitted to the

ECOOM Steering Committee, that contains members of the key stakeholders (i.e., FWO, VLIR, FRIS/IWETO), including representatives with decision-making rights of the Flemish universities. The ECOOM Steering Committee formally approved the Flemish Research Discipline Standard on 13 December 2017, after which the list was made available under a Creative Commons Attribution-NonCommercial 4.0 license on the FRIS research portal (https://researchportal.be/en). The Standard can be retrieved via SOAP webservices in CERIF-XML, which is an extension of the Common European Research Information Format (https://www.eurocris.org/cerif/main-features-cerif). Furthermore, the ECOOM Steering Committee agreed to start the implementation at the Flemish stakeholders.

4.0 Concordance schemes

The development of a new classification scheme requires accountability for aspects such as interoperability of data encoded by one or more of the original classification schemes and data encoded with the Flemish Research Discipline Standard. The development and implementation of concordance schemes is a widely used method to achieve semantic interoperability of existing classification schemes (Zeng 2019). In the field of knowledge organization, concordance mapping essentially involves imposing equivalence, i.e., conceptual and hierarchical relationships between terms or concepts in different classification systems (Doerr 2001). It is known that the mapping quality that can be achieved is best when the two classification schemes have an equal scope, specificity and granularity (Zeng 2019, ISO 25964-2:2013). The development of concordance schemes with the Flemish Research Discipline Standard was thus expected to be a challenging process since the original classification schemes differ with regard to their use, purpose, structure and granularity and hence differ in their lexical, semantic and structural features. Due to this complexity, concordance mappings were performed manually and were based on a set of predefined requirements. First, to ensure data consistency upon the transition between classification schemes, concordance mapping should be possible in two directions, i.e., forward (from old to new classification scheme) and a backward (from new to old classification scheme) mapping. Second, all disciplines were required to be mapped upon at least one discipline, in order to ensure complete interoperability between data and prevent data loss.

In order to establish a concordance scheme for the Flemish Research Discipline Standard to the key stakeholders' research discipline schemes (i.e., FWO, VLIR, FRIS/IWETO), tables mentioning the various mappings for each concordance scheme were drafted. These mappings were based on the co-occurrence of terms, or part of terms within both classification lists. In addition, definitions were used to check for co-occurrence of words as they often contained valuable information in the form of highly relevant terms or synonyms to denote research fields. The thus-composed draft concordance schemes were then fed back to the experts who fine-tuned the schemes using their domain knowledge. This allowed for the correction of some erroneous mappings that were originally proposed, based on the co-occurrence of highly similar terms, but that were not representing identical research fields. Furthermore, the domain experts identified identical research fields that were denoted with different terminology in multiple classification lists. The resulting concordance schemes were then submitted to the Steering Committee "Research Disciplines" for formal approval of the list and, secondly, for obtaining the formal commitment of the Flemish stakeholders to use these concordance schemes as a means of uniform data transition in Flanders.

At first glance, the stakeholders thought the concordance schemes would provide them with mappings where each term of an existing classification list would result in exactly one new term. In reality, however, mappings were observed to be more complex. In terms of equivalence mappings, described in the ISO 25964-2:2013 standard, different forms of simple and compound equivalence were observed (Doerr 2001). This complexity was largely due to the different level of granularity between the lists, as well as within a single existing list. This granularity difference was largely a reflection of the experts involved in establishing the existing lists, i.e., some existing disciplines were defined very detailed, while others remained at a rather high level of granularity. In contrast, explicit attention was paid in the creation process of the Flemish Research Discipline Standard in order to guarantee a uniform overall representation of all research fields.

In addition, the level to which concordance mappings were established also had an influence on the percentage of 1-n mappings. In general, more 1-n mappings occurred as the level of the Flemish Research Discipline Standard became more granular. For example, the disciplines present in the FWO classification scheme largely reflected the granularity of the disciplines at the third level of Flemish Research Discipline Standard. Mapping of the FWO disciplines to the second level of the Flemish Research Discipline Standard resulted in 11% of 1-n mappings, mapping of the FWO disciplines to the third level resulted in 19% of 1-n mappings, and mapping of the FWO-code to the fourth level resulted in 37% of 1-n mappings. For the FRIS/IWETO classification scheme, the number of 1-n mappings was even larger, since this list only entails 393 disciplines in total. The disciplines present in the FRIS/

IWETO classification scheme also largely reflect the granularity of the disciplines at the third level of Flemish Research Discipline Standard. Mapping of the FRIS/IWETO disciplines to the second level of the Flemish Research Discipline Standard resulted in 27% of 1-n mappings, while mapping to the third level resulted in 45% of 1-n mappings. Finally, the disciplines of the VLIR classification scheme largely reflected the granularity of the disciplines at the second level of Flemish Research Discipline Standard. Mapping of the VLIR disciplines to the second level of the Flemish Research Discipline Standard resulted in 38% of 1-n mappings, while mapping of the VLIR disciplines to the third level resulted in 91% of 1-n mappings.

5.0 Implementation

Once the concordance mappings were created, stakeholders could start implementing the Flemish Research Discipline Standard in their organizational databases.

One of the first adopters of the Flemish Research Discipline Standard was the Research Foundation—Flanders. This agency has used the Flemish Research Discipline Standard since September 2018 in order to specify the research fields of grant proposals. This enables the Research Foundation—Flanders in finding well-positioned reviewers for the grant proposal, but also allows the administrative characterization of these proposals, which allows them to report this information at an aggregated level to the Flemish government. Moreover, the Research Foundation—Flanders also provides this information to the host institutions of the grantees, which in turn have to report this information to the FRIS-research portal on the level of a single project, as soon as possible upon the receipt of this information. The swift adoption of the Research Foundation—Flanders thereby indirectly put pressure on the host institutions to adopt the Flemish Research Discipline Standard into their own database systems at the same pace and even more, on the Department of Economy, Science and Innovation to ensure a simultaneous transition. Finally, the participation of all Flemish stakeholders further confirmed the decision of the VLIR to adopt the Flemish Research Discipline Standard as well. Altogether, this domino-effect demanded the establishment of a steering group in order to discuss business- and technical related issues that arose upon implementation of the Flemish Research Discipline Standard. Based on the fruitful cooperation we had within the Steering Group "Research Disciplines," it was decided to extend this committee with all stakeholders that had to deliver research information to the FRIS-portal, which would allow for the discussion of common problems with all stakeholders having to implement the Flemish Research Discipline Standard. As each stakeholder uses different database systems, as well as different processes to govern the discipline list within the systems, individual implementation roadmaps were drafted by each stakeholder. However, every stakeholder was confronted with similar problems upon implementation.

5.1 Business rules

First, institutions had to define the granularity level to which researchers, research projects and organizations should be reported. Based on the existing reporting obligations and in agreement with the key stakeholders (i.e., FWO, VLIR and the FRIS-team), the granularity was set to level four (i.e., the highest degree of detail) for active researchers and newly obtained research projects, and to level three for existing research organizations. As the databases of the stakeholders as well as the FRIS-portal also contained historical information, business rules were written that defined the level of granularity to which these historical objects had to be defined as the new Flemish Research Discipline Standard contains a higher degree of granularity compared to the existing lists, which unavoidably leads to an additional work load to grasp the information by the information providing institutions. The resulting business rules were thus a compromise between the FRIS-team that wanted to have as much as possible information being described in the highest degree of granularity and the information providing institutions that had to transform the classification scheme and that wanted to reduce the additional work load accompanied with the transformation of historical research information objects. In brief, the existing codes attached to researchers and organizations that were not active anymore in 2017, could be transformed to level two codes of the Flemish Research Discipline Standard. As "research projects" is one of the most often viewed categories on the FRIS-portal, it was decided to be more stringent. That is, research projects ending in 2015 could be transformed to level two codes of the Flemish Research Discipline Standard, thus having a larger proportion of projects that had to be provided with more details. After approval, all business rules were translated to validation rules that could be easily interpreted by computers in order to validate the information sent to the FRIS portal.

Secondly, as the Flemish Research Discipline Standard contains research disciplines at a more detailed level of granularity; this reopened the existing discussion on how to display a researcher's expertise to the public, for instances through web portals. Even more, by going into the details of these discussions, most host providing institutions decided also to review the governance and processes behind the preservation of a person's research field.

Finally, the transition of the existing research discipline classification lists into the Flemish Research Discipline

Standard also initiated the discussion on the revision of the Flemish research reporting obligations. While agreements in between the universities will be made in the current transition phase towards the Flemish Research Discipline Standard, the future adaptation of the decrees will be a more laborious trajectory.

5.2 Technical impact

The implementation of the Flemish Research Discipline Standard obviously also had an enormous impact on the different database systems and web portals of all stakeholders involved. First, the databases had to be updated with the new research discipline standard, and the information contained had to be transformed according to the new business as well as the derived validation rules. Second, all stakeholders wanted to implement a module that allowed for searching through the Flemish Research Discipline Standard in a hierarchical manner or, additionally, by keyword search via the terminology and definitions that are accompanying the standard. Third, the Flemish Research Discipline Standard had to be integrated in web portals of the stakeholders and the Flemish Research Information Space. The latter implementation not only involves the mere inclusion in the web interface but also includes the incorporation of the agreed validation rules in the so-called FRIS-R³ environment that is used in order to exchange and validate information before this is transmitted to the FRIS-portal. In addition, as agreed in the FRIS-framework this also includes the retrieval of the Flemish Research Discipline Standard via SOAP-services by the broad public as the FRIS-portal acts as an open data portal. Furthermore, the Flemish Research Discipline Standard is also contained in the Data Governance Centre software of Collibra® (https://ewi.collibra.com/vocabulary/a102aac6-28b6-432b-ba15-87a83e07e27a#tbt-tabbar-content=terms&tbt-tabbar-meta=comments&view=4d85af7a-16db-46c8-8496-3ff8c76e4b90), as this allows for a dynamic and governed management of the standard as well as the corresponding concordance mappings.

6.0 Towards a discipline classification standard in Flanders: advantages and disadvantages

Hence, from 2019 on, reporting on disciplinary research activities in Flanders will operate based on a standard discipline classification scheme. This transition will be beneficial for the entire research community. Researchers will be able to identify their field of expertise based on a single discipline classification scheme instead of reclassifying their expertise depending on the stakeholder to which one must report. In addition, by providing definitions describing the semantic borders of each discipline, the used terminology in the context of research disciplines in Flanders will be harmonized within the research community, in the field of research administration and policy as well as in the interaction between these parties. Hence, research administration and policy organizations will implement a single, semantically enriched discipline classification scheme in their databases, allowing institutions and organizations to link the disciplinary classification of different data concepts (e.g., persons, organizations, projects, etc.) directly without making use of conversion schemes in an intra- as well as interorganizational context.

The transition from a diversity of discipline classification schemes to a standard classification system will increase the efficiency of registering and reporting on research activities in the entire Flemish research community. Moreover, as the Flemish Research Discipline Standard contains a hierarchical code system, an automated detection of higher hierarchical levels can be deduced based on the code, which can be used in order to efficiently re-use this information for reporting purposes, which occurs at these higher hierarchical levels. Researchers will thus only have to select the codes of their expertise once, preferably at the most relevant granular level, and consequently these codes can be reused for reporting on any level that is requested. Furthermore, as the Flemish Research Discipline Standard is directly linked to the FORD classification scheme, the use of this standard hence allows for direct reporting to European and other international authorities. At the same time, the standard brings on two additional layers of granularity compared to the FORD-list, thereby providing a solution when a more detailed image needs to be obtained of the research landscape. This places the Flemish Research Discipline Standard in a unique position as the standardization of discipline classification schemes beyond local and country borders is currently trending and many peers are looking for more granular extensions of the FORD-scheme.

A change in data registration does, however, also entail some restrictions. That is, to convert the data that has been encoded with disciplines from a former discipline classification scheme, concordance mappings are applied. The concordance mappings do however not map 1-on-1 from one classification scheme to another. In the process of data transformation, 1-on-n mappings will occur, leading to duplicated data and even more problematically, unless all mapped data points are subjected to expert evaluation, to erroneous mappings. This data registration problem will inherently lead to a breakpoint in any kind of data analysis or evaluation of evolutions that began before the moment that the Flemish Research Discipline Standard was implemented. To limit the impact of these restrictions, quality assurance and monitoring of the converted data are abso-

lutely necessary. In addition, this effect is characteristic for the transition phase and will level out over time.

Notwithstanding these pitfalls, standardization is a necessary step towards interoperable data on research activity on a national as well as on an international level. The interoperability afforded by standards enables new forms of knowledge exchange through which research information can be shared within governments, between governments and higher education institutions, between governments and citizens and between any other relevant party. (International Telecommunication Union 2010). In this context, standardization plays a crucial role in the externalization of research activities to the specialist as well as to the broad public.

7.0 Conclusion

Altogether, the Flemish Research Discipline Standard was developed based on the principles of classification governance (Vancauwenbergh et al. 2016) that allows for the reporting of research information (i.e., persons, projects, organization) at an aggregated level to authorities and is at the same time able to characterize an individual's research portfolio. This Flemish Research Discipline Standard is currently being implemented by the various Flemish stakeholders in the data processes, databases as well as in web portals. In the overall process, specific attention has been paid to the uniform transition of historical data by means of fixed concordance schemes used by all stakeholders. Although the implementation of the first version of the Flemish Research Discipline Standard is almost in place, the standard, together with other research discipline lists worldwide, will be monitored and updated in order to maintain the quality of the list as well as to keep it in line with the dynamics of the research world.

Notes

1. ANZSRC – FOR, Australian and New Zealand Standard Research Classification – Fields of Research (http://www.abs.gov.au/Ausstats/abs@.nsf/Latestproducts/4AE1B46AE2048A28CA25741800044242?opendocument)
2. CASRAI, Consortia Advancing Standards in Research Administration Information
3. CSC, China Subject Categories, (http://old.moe.gov.cn//publicfiles/business/htmlfiles/moe/moe_834/201104/116439.html)
4. FAPESP, Fundaçáo de Amparo Á Pesquisa do Estado de Sáo Paulo (http://ipscience-help.thomsonreuters.com/inCites2Live/filterValuesGroup/researchAreaSchema/fapespBrazil/fapespSchema.html)
5. RSA-RF, Republic of South Africa Research Fields
6. ERC, European Research Council, (https://erc.europa.eu/sites/default/files/document/file/erc%20peer%20review%20evaluation%20panels.pdf)
7. OECD (2015). Frascati Manual 2015: Guidelines for collecting and reporting data on research and experimental development, The measurement of scientific, technological and innovation activities, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264239012-en
8. ANVUR, Agenzia Nazionale di Valutazione del Sistema Universitario e della Ricerca (https://www.cun.it/documentazione/academic-fields-and-disciplines-list)
9. SSD, Settore scientifico disciplinare (http://www.miur.it/UserFiles/115.htm)
10. ÖFOS, Österreichische Systematik der Wissenschaftszweige (http://bartoc.org/de/node/1094)
11. RAE, Research Assessment Exercise (http://www.rae.ac.uk/aboutus/uoa.asp)
12. REF, Research Excellence Framework (https://www.ref.ac.uk/2014/panels/unitsofassessment)
13. NWO, Nederlandse Organisatie voor Wetenschappelijk Onderzoek (https://www.nwo.nl/en/funding/funding+process+explained/research+fields)
14. FWO, Fonds voor Wetenschappelijk Onderzoek, http://www.fwo.be/media/236854/Disciplinecodes-ENG.pdf
15. FRIS, Flanders Research Information Space
16. VLIR, Vlaamse Interuniversitaire Raad

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