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D 2.4 – Linking the BoK for GI and EO to other BoKs

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Work package / Task:

WP2 – Developing and operationalizing a Body of Knowledge for GI and EO

T2.4 – Linking the BoK for GI and EO to other BoKs

Short Description:

This report covers the following topics:

- It identifies all potential initiatives maintaining, or planning a BoK relevant for the BoK for GI and EO;
- It analyses in detail the content of the identified BoKs, selecting concepts that could/should be used/reused in the BoK for GI and EO;
- It analyses the methods and technologies used to update and manage these BoKs;
- It summarizes the exchange of experience and ideas for developing and maintaining a BoK occurred with other communities;
- It identifies conditions on access to and use of other BoKs, in terms of technical solutions for linking to or loading content from these other BoKs into the BoK for GI and EO.

Keywords:

BoK, link with other BoKs.

Dissemination Level		
PU	Public	x
RE	Restricted to other programme participants (including Commission services and project reviewers)	
CO	Confidential, only for members of the consortium (including EACEA and Commission services and project reviewers)	

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2.1	31.10.2019	G. Martirano, A. Vercillo, L. Bilotti (EPSIT)	Reviewed after the second QA loop Final version.	Incorporated the (few) changes proposed during the second QA loop.

Executive Summary

The report presents the methodology designed and applied to perform a content-wise detailed analysis of other Body of Knowledge (BoKs) and to identify candidate BoKs containing concepts that can be re-used in the context of the BoK for GI and EO. The methodology is based on the identification of overlaps and gaps among the content of other BoKs and the content of the GIS&T BoK reported in EO4GEO UJI (Universitat Jaume I) Webpage (http://eo4geo.uji.es/) and assumed as the only content of the BoK for GI and EO currently available. Regarding how to use the methodology to identify candidate concepts to be used/re-used in the context of the BoK for GI and EO, two knowledge areas present in one of the other BoKs analysed have been proposed as possible new knowledge areas in the BoK for GI and EO, filling-in a possible gap identified in the GIS&T BoK.

Regarding the possibility to technically link the content of the BoKs analysed with the BoK for GI and EO, the different conditions for access to and use of the other BoKs have been reported, most of them showing very limited possibilities of technical links.

An analysis of the governance and business models of the other BoKs has been also made and reported.

An excel file named BoKs_matrix.xlsx, containing all the details of the analyses made on the other BoKs, is annexed to this report and constitutes and integral part of it.

The results of the proposed methodology open-up the possibility and the opportunity to continue to use the methodology in the future, e.g. to analyse possible additional other BoKs, to deepen the analysis of some of the overlapping concepts already identified (for instance, to better investigate similarities and complementarities), to identify additional candidate concepts to be used/re-used in the BoK for GI and EO.

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Acronyms

Acronym	Description
BABOK	Business Analysis Body of Knowledge
BizBoK	Business Architecture Body of Knowledge
DAMA BOK	Data Management Body of Knowledge
EABOK	Enterprise Architecture Body of Knowledge
EITBOK	Enterprise Information Technology Body of Knowledge
EO	Earth Observation
GEOINT BOK/GEOINT EBK	Geospatial Intelligence Essential Body of Knowledge
GI	Geographic Information
GIS&T BoK	Geographic Information Science and Technology Body of Knowledge
ICT BoK	The European Foundational ICT Body of Knowledge
KA	Knowledge Area
PMBOK	Project Management Body of Knowledge
ProdBoK	Product Management and Marketing Body of Knowledge
SEBOK	Systems Engineering Body of Knowledge
SWEBOK	Software Engineering Body of Knowledge
SWX	Software Extension to the PMBOK

Glossary

- **Body of Knowledge (BoK)** is the complete set of concepts and relations between them, that make up a professional domain, (in this case the BoK for GI and EO) and the related skills as defined by the relevant learned society or a professional association.

1. Introduction

1.1. EO4GEO project

EO4GEO is an **Erasmus+ Sector Skills Alliance** gathering **26 partners from 13 EU countries**, most of which are part of the **Copernicus Academy Network**. Be they from academia, public or private sector, they are all active in the education and training fields of the space / geospatial sector. The project is also supported by a strong group of Associated Partners mostly consisting of associations or networks active in space/geospatial domain. The project started on January 1st, 2018, upon approval by the EU Education, Audiovisual and Culture Executive Agency (EACEA) and runs over four years.

EO4GEO **aims to help bridging the skills gap in the space/geospatial sector** by creating a strong alliance of players from the sector/community reinforcing the existing ecosystem and **fostering the uptake and integration of space/geospatial data and services**. EO4GEO will work in a **multi- and interdisciplinary** way and apply innovative solutions for its education and training actions including: case-based and collaborative learning scenarios; learning-while-doing in a living lab environment; on-the-job training; co-creation of knowledge, skills and competencies; etc.

EO4GEO will define a long-term and sustainable strategy to fill the gap between supply of and demand for space/geospatial education and training taking into account the current and expected technological and non-technological developments in the space/geospatial and related sectors (e.g. ICT). The strategy will be implemented by: creating and maintaining an ontology-based Body of Knowledge for the space/geospatial sector based on previous efforts; developing and integrating a dynamic collaborative platform with associated tools; designing and developing a series of curricula and a rich portfolio of training modules directly usable in the context of Copernicus and other relevant programmes and conducting a series of training actions for a selected set of scenario's in three sub-sectors - integrated applications, smart cities and climate change to test and validate the approach. Finally a long-term Action Plan will be developed and endorsed to roll-out and sustain the proposed solutions

For more information on the project please visit http://www.eo4geo.eu/about-eo4geo/.

1.2. Objectives of the work package

The work package 2 "Developing and operationalising a Body of Knowledge for GI and EO" has the following specific objectives:

- To identify experts in the field of Earth Observation and related technologies and add them to the existing network of GI S&T experts.

- To revise and fine-tune the method and procedures for updating the existing BoK for GI S&T.
- To analyse the outputs and outcomes from WP1 with regard to new concepts to be added to the BoK or existing concepts to be revised.
- To add, modify and enrich the content of the BoK and extend it with new Knowledge Areas where appropriate.
- To discuss among the experts and with the broader GI and EO communities the proposed changes.
- To analyse how other existing BoKs could be linked or integrated, such as the PMBOK or the ICT BoK.
- To investigate how soft knowledge, skills and competencies and STEM topics can/should be handled and integrated in the BoK.
- To prepare a consolidated version of the BoK for GI & EO within the existing BoKWiki.

1.3. Objectives of the task

BoKs are important references for a structured representation of knowledge and skills. In the EO4GEO project context, external BoKs represent the opportunity to enrich the BoK for GI and EO with concepts already covered by other external BoKs.

In this framework, the objective of the task 2.4 was to identify the relevant concepts existing in external BoKs that can be reused in the context of the BoK for GI and EO. This will allow to strengthen the GI and EO curricula with knowledge about concepts that nowadays are required by an increasing number of GI and EO related jobs. Furthermore, the possibility of linking the BoK for GI and EO with external BoKs will be investigated from the technical perspective. If successful, this would allow to link with other BoKs without integrating concepts from those BoK physically in the BoK for GI and EO.

In particular, the following activities are foreseen:

- Identify potential external BoKs relevant for the BoK for GI and EO;
- Analyse in detail the methods and technologies used to update and manage these BoKs;
- exchange experiences and ideas with other communities for developing and maintaining a BoK;
- Analyse in detail the content of the identified external BoKs: selecting concepts that could/should be used/reused in the BoK for GI and EO;

- Find the appropriate technical solutions for linking to or loading content from these external BoKs into the BoK for GI and EO;
- Test one or more methods to make the links or load the content and describe the results of this testing.

1.4. Purpose of the document

The main purpose of the report is to describe the methodology designed to perform a content-wise detailed analysis of other BoKs and to identify candidate BoKs containing concepts that can be re-used in the context of the BoK for GI and EO and to describe the outcomes of the analysis made on the other BoKs. The report also contains a description of how these BoKs are maintained and managed from the technical perspective and how the link or re-use could work (or not if not feasible).

In this report, a concrete proposal of concepts to be integrated is also developed, but beyond the identification of these concepts, the main achievement reported was to set up a working methodology related to the BoKs analysis and possible integration. This methodology takes into account the difficulties faced as the BoKs analysis was developed and points at the criticalities related to the other BoKs in terms of their accessibility, comparability, contents, structure, maintenance and technical linking.

1.5. Structure of the document

Section 2 describes the methodology used to analyse the other BoKs, describing the criteria the analysis was based on and the following steps adopted.

Section 3 contains a deep description of the analyses made, providing more details of the several steps executed.

Section 4 describes the main results of the analysis, subdivided into two sub-chapters, each of them describing one type of the achieved results: (i) identification of concepts that could/should be reused in the BoK for GI and EO and identification of linking methods, (ii) identification of options for BoK planning and maintenance.

Section5 contains considerations related to the objectives.

Section 6 contains the conclusions.

Annex 1 (an excel file named ‘BoKs_matrix.xlsx’) contains all the details of the analyses made.

2. Methodology

In the analysis carried out, a particular attention was given to the BoKs content, on the hypothesis that the task objectives necessarily required a content-oriented perspective.

The methodology being developed consisted of different levels of analysis of the BoKs content, starting from a summary analysis of what was immediately available in the BoKs websites and then making more in-depth analyses. This approach was forced by the fact that most of the BoKs analysed didn't provide much content. However, as the investigation became deeper, the number of BoKs analysed in more detail decreased. In this way, a selection of BoKs based on the possible relevance of their content was carried out and a deeper analysis was made.

To carry out the activities required within this task, first of all it was necessary to identify the BoKs worth to be analysed, from the content-oriented perspective, in order to find possible candidate content to be used/reused in the BoK for GI and EO.

The criterion used in this preliminary phase was the necessity to identify the BoKs that are closer to the thematic area of reference considered by the BoK for GI and EO. This preliminary evaluation of 'content proximity' was made at a generic level, considering the BoKs name and other few additional information immediately found.

In this way, twelve candidate BoKs were identified.

After this recognition, a summary analysis of the BoKs content, authors and conditions for access and use was made by exploring the BoKs websites. This analysis was more concentrated on the 'external conditions' rather than on the internal content, due to the circumstance that not all the BoKs initially selected were accessibile or had websites providing sufficient information. Some of the BoKs were, ideed, completely inaccessibile, blocking therefore any kind of analysis.

This aspect forced the selection of BoKs based on the accessibility of their content. In particular eight BoKs whose websites were providing some information were identified.

Only in a second phase the content of these eight BoKs was analysed. In particular, this step was carried out by exploring and analysing the websites and the BoK guides, when available in full text.

At this point, it was possible to notice some overlapping between the content analysed, that should be taken into account. Moreover, very preliminary considerations on possible reuse were possible.

After these steps, the content-oriented approach suggested to concentrate on the actual content of the GIS&T BoK, reported in EO4GEO UJI Webpage (http://eo4geo.uji.es/) and assumed as the

only content of the BoK for GI and EO currently available, in order to identify possible relationships between its content and the BoKs previously studied and to create a reference against which identify overlapping/missing concepts provided by other BoKs.

The belief was that, to understand if some contents from the other BoKs should/can be used/reused in the BoK for GI and EO, it was important to compare the possible new content with the concepts already contained in the GIS&T BoK. Only in this way it was possible to identify concepts currently missing and therefore possibly added in the framework already present. Regarding the overlapping concepts, a possible deeper analysis of similarities and completmentarities was not done, but, thanks to the clear identification of the overlapping concepts, it can be easily done in the future, if needed.

Following this methodology, the comparison led to identify some BoKs that, due to the proximity of their content to the GIS&T BoK content, appeared compatible with it and, consequentely, should be candidate to integration in the the BoK for GI and EO. Therefore, the number of the BoKs candidate to be used/reused in the BoK for GI and EO was reduced to four.

After that, a deeper analysis of these BoKs was carried out, and one BoK, the DAMA BoK, was selected as an example to show how the methodology can be applied to identify candidate concepts to be used/re-used on the BoK for GI and EO. Besides the possibility to integrate concepts currently missing in the GIS&T BoK, the choice was mainly driven by the fact that DAMA BoK is more ”industry-oriented” rather than “academy-oriented”, as stated in the documentation available, therefore strenghtening the idea to contribute to provide skills closer to the labour market.

It is to be highlighted that the analysis of the BoKs allowed to detect that they don’t have always the same structure. In fact some of them are subdivided into Knowledge Areas, concepts and subconcepts (as the GIS&T BoK), but others have a completely different structure. This is a crucial foreward to understand that a particularly in-depth comparison of BoKs contents can’t be automatic, but it is necessary to make another step, consisting in the alignment of the BoKs structure to make the contents comparable.

As claryfied at the beginning of this section, the described analysis is a result of a content oriented approach.

To meet the others task objective (in particular, the identification of all potential initiatives maintaining or planning a BoK relevant for the BoK for GI and EO, the analysis on the methods and technologies used to update and manage these BoKs, the exchange of experience and ideas

for developing and maintaining a BoK conducted with other communities, and the identification of appropriate technical solutions for linking these other BoKs to the BoK for GI and EO), a change of perspective was needed. It shouldn't be a content-oriented approach anymore, so the selections previously made were no longer taken into account in this phase and all the twelve BoKs initially identified were analysed again.

The approach needed for this analysis required to compare the experiences of the bodies that have already built a BoK, in order to highlight similar challenges and to learn some lessons.

Therefore, the BoKs websites were explored again, aiming this time to learn lessons from similar experiences in terms of BoK planning, updating and managment.

As a further step, in order to have direct contact with these bodies, e-mails (and some reminders) were sent to the people responsible for BoKs creation and maintenance in different communities, in order to exchange experience and ideas. The aim was also to investigate with them possible technical solutions for linking or loading content from these BoKs into the BoK for GI and EO.

3. Analysis

3.1. BoKs content analysis

The initial part of the work consisted in analysing twelve BoKs, identified between those which are closer to the thematic area of reference. These selected BoKs are:

- The European Foundational ICT Body of Knowledge
- The EITBOK - Enterprise Information Technology Body of Knowledge
- The Business Analysis BOK (BABOK)
- Business Architecture Body of Knowledge (BizBoK)
- Data Management BOK (DAMA DMBOK)
- Enterprise Architecture BOK (EABOK)
- Product Management and Marketing Body of Knowledge (ProdBOK)
- Project Management BOK (PMBOK)
- Software Extension to the PMBOK (SWX)
- Software Engineering BOK (SWEBOK)
- Systems Engineering BOK (SEBOK)
- GEOINT Essential Body of Knowledge (GEOINT EBK).

The goal was to understand how these BoKs are structured and to identify overlaps among their content.

During the initial analysis, the focus was on some relevant aspects. First of all, the attempt to collect source information related to the BoKs' content was put in place (e.g.: websites, official guides and other written material). Furthermore, the contact points of the BoKs' authors and information on the condition for access and use was taken into consideration.

To do that the 'All' spreadsheet of the 'BoKs_matrix.xlsx' Excel file was filled in, in which the twelve selected BoKs were listed, collecting for each of them the following information: reference website, source of information, number of Knowledge Areas, BoK's author, condition for access and use, contact information (screenshot of 'All' spreadsheet shown in Figure 1).

It is to be highlighted that in the next figures are shown screenshots of very large spreadsheets, with the intention to illustrate the methodology. For the readability of the screenshots it is recommended to zoom-in and/or to consult directly the annexed excel file.

BoK Ider	Link	Source info	Number of Knowle Area	Authors	Conditions for access and use	Contact info	Preliminary considerations o linking/re-use
The European Foundational ICT Body of Knowledge	http://www.digitaleurope.org/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core_Download&EntryId=925&language=en-US&PortalId=0&TabId=353	The European Foundational ICT Body of Knowledge (pdf)	11	CEPIS, Council of European Professional Informatics Societies; European e-Skills Association; BCS, The Chartered Institute for IT; CIGREF; Club Dirigenti Tecnologie dell'Informazione.	© European Union, 2015. All rights reserved. Certain parts are licensed under conditions to the EU. Reproduction is authorised provided the source is acknowledged.	For more information: European Commission, Directorate General Internal Market, Industry, Entrepreneurship and SMEs Unit for Key Enabling Technologies and Digital Economy André Richier – Principal Administrator E-mail: Andre.Richier@ec.europa.eu Permission to reprint or republish this material for commercial must be obtained from IEEE by writing to the IEEE Intellectual Property Rights Office, 445 Hoes Lane, Piscataway, NJ 08854-4141 or pubs-permissions@ieee.org	Information systems add value to an organization, aimed at establish a sound business strategy. Different applications of ICT in various sectors. Quality, security and architecture. Sharing and storing information.
The EITBOK - Enterprise Information Technology Body of Knowledge	http://eitbok.wiki.org/Main_Page	Wikipedia website	6	IEEE Computer Society (http://www.computer.org/web/pebf). Contribution of members of the following organizations: Business Architecture Guild; Council of European Informatics Society (CEPIS); Canadian Information Processing Society (CIPS); Data Management Association (DAMA); European Union Directorate-General for Enterprise and Industry; Federation of Enterprise Architecture Professional Organizations; International Institute of Business Analysis (IIBA); Information-technology Promotion Agency, Japan (IPA); SFIA Foundation; Software Engineering Institute	Copyright © 2017 IEEE. All rights reserved. Educational or personal use of this material is permitted without fee provided such copies 1) are not made for profit or in lieu of purchasing copies for classes, and that this notice and a full citation to the original work appear on the first page of the copy and 2) do not imply IEEE endorsement of any third-party products or services.	IEEE Computer Society Offices Washington, DC Office 2001 L Street N.W., Suite 700 Washington, DC 20036-4928 Phone: +1-202-371-0101 FAX: +1-202-728-9614 -- Membership membership@computer.org -- Website webmaster@computer.org Browser Support Information Other Questions? help@computer.org	Aligns EIT with the enterprise's business. Facilitates organizational change, transformation, and agility
Business Analysis BOK	https://www.iiba.org/standards-and-	The website provides little information. Full guide	6	International Institute of Business Analysis 115 George Street	©2019 International Institute of Business Analysis.	Mailing Address: International Institute of Business Analysis 115 George Street, Suite 509 Oakville, ON L6J 0A2 Canada Phone / Email: Main Number: 1647-426-3735 Toll Free Number: 1-866-789-4422 Phone Option #	Focus on lifecycle information design, from inception to retirement. Focus on

Figure 1: Screenshot of 'All' spreadsheet: it contains details about reference website, source of information, number of Knowledge Areas, BoK's author, condition for access and use, contact information, related to the twelve selected BoKs, subject to the initial analysis.

The conditions for access and use, in particular, helped to divide the twelve selected BoKs into two categories: the accessible ones and the BoK's that are inaccessible or come with websites that provide limited information.

After this first classification, it appeared that eight BoKs out of twelve could be subject to deeper analysis thanks to their accessibility conditions. In particular, they are: the ICT BoK, the EIT BoK, the BABoK, the BizBoK, the DAMA BoK, the EABoK, the SEBoK and the GEOINT BoK. The

content of the websites or guides (when available) was analysed highlighting the overlap among the Knowledges Areas referred to in the mentioned BoKs.

In particular, after the analysis of the available materials, an Excel spreadsheet for each of the BoKs examined was filled-in. Every spreadsheet includes a chart that lists the Knowledge Areas and the concepts in which they are subdivided, with the relative descriptions. Eight spreadsheets containing a different amount of information were completed, depending on the available material. A screenshot of the 'ICT BOK' spreadsheet is shown in the Figure 2.

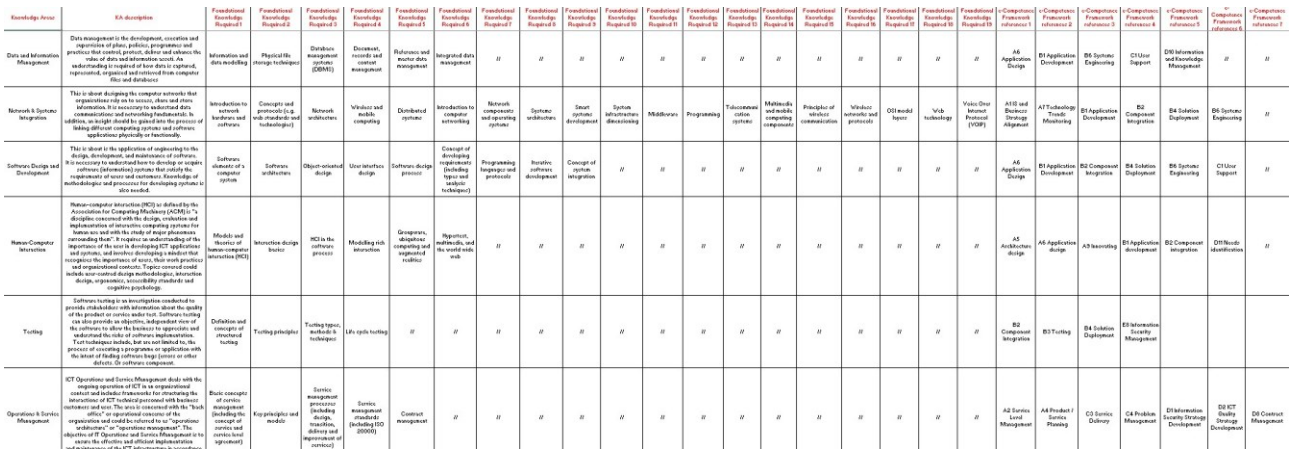

Figure 2: Screenshot of 'ICT BOK' spreadsheet: the Excel spreadsheet contains the list of Knowledge Areas and concepts that constitute the ICT BoK, with the relative descriptions

As a further step, the BoKs content was compared and a table was filled-in to highlight the overlap among them. The background colour of the cells in the first row and column help to associate the Knowledge Areas in the first column to the BoKs listed in the first row (see Figure 3). For example, the cells with orange background colour in the first column represent the KAs of the ICT BoK. The cells filled-in with YES in the same row identify the overlaps.

Knowledge Areas	ICT BOK	EIT BOK	BABOK	BizBok	DAMA DMBOK	EABOK	SEBOK	GEOINT EBK
ICT Strategy & Governance	YES	YES	YES	YES		YES		
Business and Market of ICT	YES							
Project Management	YES							
Security Management	YES	YES			YES	YES		
Quality Management	YES	YES			YES			
Architecture	YES	YES			YES			
Data and Information Management	YES							
Network and Systems Integration	YES				YES			
Software Design and Development	YES							
Human Computer Interaction	YES							
Testing	YES							
Operations and Service Management	YES							
Enterprise	YES	YES						
Strategy and Governance	YES	YES	YES	YES	YES	YES		
Change Initiatives		YES		YES				
Interoperability		YES			YES			
Security	YES	YES			YES	YES		
Quality	YES	YES						
Disaster Preparedness		YES						
Operations and Support		YES						
Ethics		YES						
Business Analysis Planning and Monitoring			YES					
Elicitation and Collaboration			YES					
Requirements Life Cycle Management			YES					
Strategy Analysis	YES	YES	YES	YES		YES		
Requirements Analysis and Design Definition			YES					
Solution Evaluation			YES					
Stakeholders				YES		YES		
Policies, Rules, Regulations				YES				
Capabilities				YES				
Vision, Strategies & Tactics	YES	YES	YES	YES				
Organization				YES		YES		

Figure 3: Screenshot of 'KNOWLEDGE AREAS' spreadsheet: a table which highlights the overlap among the Knowledge Areas related to the analysed BoKs

This analysis allowed to make preliminary considerations about the re-use of the information examined. What emerged was that the content of ICT BoK, EIT BoK, DAMA BoK, due to the many overlaps identified, and GEOINT BoK, due to the presence of geospatial-related concepts, was more likely to meet the needs of this task. Therefore, the attention was focused on these four BoKs.

After this step, the actual content of the GIS&T BoK was analysed, in order to identify overlaps and gaps between the BoKs previously selected and the BoK constituting the building block of the BoK for GI and EO, at least for the GI part, being the EO part still under development at the moment of the execution of the task T2.4.

A brief comparison was initially made, useful to point out that the GIS&T BoK actually has some similarities with ICT BoK, EIT BoK, DAMA BoK, BizBoK and GEOINT BoK.

Among them, DAMA BoK seemed to be the one that most likely could integrate and complement the actual content of GIST BoK. Its structure and focus on data management in fact proved to receive great interest, primarily by the private sector involved in new data-driven technologies and processes, and therefore could be a useful supplementing item for the BoK for GI and EO.

This phase was completed by filling in the 'GIST' spreadsheet, with the description of the identified GIS&T Knowledge Areas, the list of its concepts and some preliminary considerations on the similarities with the BoKs previously analysed (see Figure 4).

Knowledge Areas	Description	Subconcepts	Connection with other BoKs/Knowledge Areas
Geocomputation	At the first international conference on `GeoComputation` held at Leeds University in 1996, a new research agenda on geographical analysis and modelling was launched under the title `The art and science of solving complex spatial problems with computers`. Geocomputation in short. Geocomputation covers a wide range of theories and methods aiming at studying complex spatio-temporal problems, which are difficult to analyse and model applying traditional spatial analytical and statistical methods due to data complexity and computational demands. As a rather new research agenda, Geocomputation is still seeking to define the field conceptually, although much efforts have been done. Being closely related to computational science, Geocomputation benefits from the still increasing performance in information and communication technology allowing geoprocessing to utilise parallel computing and distributed cloud computing. However, the close connection to computational science also requires frequent discussion on adopting new related topics like Big Data and Linked Data to the Geocomputation research agenda. Geocomputation has a very strong connection to Knowledge Area AM â¡ Analytical methods. Skills in computer programming are generally needed to effectively apply most of the methods and tools under the Geocomputation headline.	1) Theory of Geocomputation and complex systems; 2) Spatial simulation modelling; 3) Artificial Intelligence and Data Mining.	This Knowledge Area contains elements similar to those considered in GEOINT BoK, which describes the knowledge necessary to ensure the various elements and approaches of GIS and analysis are properly understood in order to successfully capture, store, manage, and visualize data that is linked directly to a location. GEOINT BoK also describes the knowledge necessary to synthesize technical, geographic and intelligence information, and eventually to acquire, manage, retrive and disseminate data to facilitate integration, analysis and synthesis of geospatial information. Furthermore, GEOINT BoK considers the use of cartographic and visualization principles to generate products that represent information about the physical environment.
Cartography and Visualization	Cartography and visualization primarily relate to the visual display of geographic information. This knowledge area addresses the complex issues involved in effective visual thinking and communication of geospatial data and of the results of geospatial analysis. This knowledge area reflects much of the domain of cartography and visualization, although some concepts and skills in these areas can be found in other knowledge areas. For example, the process of visualization encompasses aspects of analysis as well as cartography. Specifically, visualization is currently being reformulated as visual analytics in the context of homeland security.	1) Map production; 2) Data considerations; 3) History and trends; 4) Design principles; 5) Usability; 6) Graphic representation techniques.	
Web-based GI	This knowledge area is about Web Based Geographic Information management aspects and therefore it was given the name "Web Based GI" or "WBG" in short. It is implied by this name that the differentiating factor for this KA is the "Web". One must then be able to answer the questions like "What functions do we delegate to the Web?" or "how WBGI is different from the traditional GI?" Sticking to the functions of a GIS, which are inserting (adding), storing, manipulating, analysing and presenting the data, there is not a single system for effecting all these tasks anymore but the Web itself. For instance, there is no single database and its known-to-its users-definition, anymore but many different stores and many different definitions. Similarly, many different manipulation, analysis and presentation options compared with the options offered by a single or limited number of systems of traditional GI. In general, Web provides the means of leveraging distributed "resources" like data, information, or software. It is a "collaboration medium" . A collaboration that enables rapid production or decision making. A collaboration that certainly introduces new dimensions to traditional GI handling. This is the justification of proposing this KA in addition to the KAs of the original BoK. For the mentioned collaboration to happen, data or any other type of a resource have to accessible on the Web. This means that it should have a Web "address" and a "definition" that is understandable either by "human" or "machine". "Machine understandable definitions" refers to the dimension of "semantics" and "ontologies" which are also included under this KA. When one talks about publishing resources then "catalogue services" and more importantly "discovery" dimension comes into the scene. On the other hand, "Linked Data (LOD)" and "Open Data", highly popular recent trends and two of the above mentioned dimensions of Web GI have also been covered under this KA. Like the other dimensions of Web GI, both LD and OD aspects must be known to GI communities with differing degrees of expertise. The concepts of "interoperability" and "Spatial Data Infrastructure (SDI)", hot topics of GI communities for many years, have been thought to be dealt with under this KA as well with the justification that "Web GI" is a much broader concept than SDI. This is by the fact that SDI refers to a much narrower content and context of "collaboration" then Web GI. Therefore,	1) Application development via Web services composition; 2) Resource Definition; 3) Resource Discovery; 4) Web Application development elements; 5) Web services; 6) Resource Publishing; 7) Spatial data infrastructures.	This Knowledge Area contains elements similar to those considered in ICT BoK such as informations about data management, designing the computer networks, application of engineering to the design, development, and maintenance of software. Web-based GI KA contains elements similar to those considered in DAMA BoK as well, such as informations about data governance, about the process of discovering, analyzing, representing and communicating data requirements in a precise form called the "data model", about the design, implementation and support of stored data to maximize its value, and about processes related to the movement and consolidation of data within and between data stores, applications and organizations.

Figure 4: Screenshot of 'GIST' spreadsheet: it contains the description of the identified GIST Knowledge Areas, the list of the concepts that compose them and some preliminary considerations on the similarities with the previously analysed BoKs

Then a more detailed comparison was made, between Knowledge Areas and concepts of GIS&T BoK and DAMA BoK.

To do that, it was necessary to try to align the structures of the GIS&T BoK and of the DAMA BoK, which are different. In fact, the content of the DAMA BoK's guide is divided into Knowledge Areas, but no concepts or sub concepts were immediately identifiable. A thorough analysis of the description of the Knowledge Areas was made, to extrapolate some contents that could be used for a detailed comparison with the GIS&T BoK.

This process of extrapolation allowed to fill in the 'DAMA DMBOK - KA-subconcepts' spreadsheet with the schematization of the DAMA content according to the usual taxonomy, composed by Knowledge Areas, concepts and sub concepts. Then the DAMA BoK concepts were compared with the GIS&T BoK concepts to better identify the overlaps, colouring the cells containing overlapping concepts. The background colours used are the same colours used to represent the Knowledge Areas of the GIS&T BoK in http://eo4geo.uji.es/ website, e.g. green for Data modelling, Storage and Exploitation; pink for Web based GI, purple for GI and Society. This analysis showed that five DAMA BoK Knowledge Areas (identified by the 5 different colours) are strongly overlapping with GIST's content (see Figure 5).

Data Governance	Data Architecture	Data Modeling and Design	Data Storage and Operations	Data Security	Data Integration and Inoperability	Document and Content Management	Reference and Master Data	Data Warehousing and Buisness Intelligence	Metadata Management	Data Quality
Data Governance Defining	Data Architecture Practice	Data Modeling Planning	Database Technology Management	Data Security Requirements	Planning and Analysis	Lifecycle Management Planning	Master Data Management (MDM) Activities	Requirements Understanding	Metadata Strategy	High Quality Data Definition
Readiness Assessment	Data Architecture Integration	Data Modeling Construction	Databases Management	Data Security Policy	Data Integration Solutions Design	Lifecycle Management	Reference Data Activities	DW/BI Definition and Maintenance	Metadata Requirements	Data Quality Strategy
Discovery and Business Alignment	Data Architecture Tools	Data Modeling Review	Database Administrators Tools	Data Security Standards	Data Integration Solutions Development	Publishing and Content Delivering	MDM Tools And Techniques	DW and Data Marts Development	Metadata Architecture	Critical Data and Business Rules Identification
Organizational Touch Points	DA Tools and Techniques	Data Modeling Maintenance	Tools and Techniques	Data Security Tools and Techniques	Implementation and Monitorin	Tools and Techniques	//	Data Warehouse Population	Metadata Creation and Maintenance	Initial Data Quality Assessment
Data Governance Strategy	//	Data Modeling Tools	//	//	Data Integration Tools and Techniques	//	//	Business Intelligence Portfolio Implementation	Metadata Query, Report and Analysis	Potential Improvements Identification
Data Governance Operating Framework	//	//	//	//	//	//	//	Data Products Maintenance	Metadata Tools and Techniques	Data Quality Goals Identification
Goals, Principles and Policies	//	//	//	//	//	//	//	DW Tools and Techniques	//	Data Quality Operations Development
Data Management Projects	//	//	//	//	//	//	//	//	//	DQ Tools and Techniques
Organizational Change	//	//	//	//	//	//	//	//	//	//
Issue Management	//	//	//	//	//	//	//	//	//	//
Regulatory Compliance Requirements	//	//	//	//	//	//	//	//	//	//
Data Governance Implementation	//	//	//	//	//	//	//	//	//	//
Data Standards and Procedures	//	//	//	//	//	//	//	//	//	//
Business Glossary	//	//	//	//	//	//	//	//	//	//
Architecture Groups Coordination	//	//	//	//	//	//	//	//	//	//
Data Asset	//	//	//	//	//	//	//	//	//	//
Data Governance Embedding	//	//	//	//	//	//	//	//	//	//

Figure 5: Screenshot of 'DAMA DMBOK - KA-subconcepts' spreadsheet: it contains the schematization of the DAMA content according to the usual taxonomy, composed by Knowledge Areas, concepts and sub concepts. The colours of the cells highlight the overlaps with the GIST's content.

The result of this step was to identify the content of some DAMA BoK Knowledge Areas which is not included in GIS&T BoK. Among them, two Knowledge Areas which contain relevant

information, potentially useful to be added to the GIS&T BoK, were selected: Data Quality and Data Security.

Their content was extrapolated and structured in the '1st proposal - DATA SECURITY' spreadsheet and the '2nd proposal – DATA QUALITY' spreadsheets, in accordance with the usual taxonomy, providing concepts and sub-concepts, with the related descriptions (see Figure 6).

Data Security			
Data Security includes the planning, development, and execution of security policies and procedures to provide proper authentication, authorization, access, and auditing of data and information assets. The sepcifics of data security (which data needs to be protected, for example) differ between industries and countries. Nevertheless, the goal of data security practice is the same: to protect information assets in alignment with privacy and confidentiality regulations, contractual agreements, and business requirements. These requirements come from: 1) stakeholders: organizations must recognize the privacy and confidentiality needs of their stakeholders, including clients, patients, students, citizens, suppliers, or business partners. Everyone in an organization must be a responsible trusteee of data about stakeholders; 2) government regulations: government regulations are in place to protect the interests of some stakeholders. Regulations have different goals. Some restrict access to information, while others ensure openness, transparency, and accountability; 3) proprietary business concerns: each organization has proprietary data to protect. An organization's data provides insight into its customers and, when leveraged effectively, can provide a competitive advantage. If confidential data is stolen or breached, an organization can lose competitive advantage; 4) legitimate access needs: when securing data, organizations must also enable legitimate access. Business processes require individuals in certain roles be able to access, use, and maintain data; 5) contractual obligations: contractual and non-disclosure agreements also influence data security requirements. For example, the PCI Standard, an agreement among credit card companies and individual business enterprise, demands that certain types of data be protected in defined ways (e.g., mandatory encryption for customer passwords). Effective data security policies and procedures ensure that the right people can use and update data in the right way, and taht all inappropriate access and update is restricted. Understanding and complying with the privacy and confidentiality interests and needs of all stakeholders is in the best interest of every organization. Client, supplier and consituent relationships all trust in, and depend on, the responsible use of data.			
Concepts	Concepts Description	Subconcepts	Subconcepts Description
Data Security Requirements	It is needed the capacity to distinguish between business requirements, external regulatory restrictions, and the rules imposed by application software products. In fact, while application systems serve as vehicles to enforce business rules and procedures, it is common for these systems to have their own data security requirements over and above those required for business processes. These requirements are becoming more common with packaged and off-the-shelf systems. It is also necessary to verfy if they support organizational data security standards as well.	Business Requirements	To implement data security within an enterprise it is necessary to understand the business requirements. The business needs of and enterprise, its mission, strategy and size, and the industry to which it belongs define the degree of rigidity required for data security. For example, financial and securities enterprises in the US are highly regulated and required to maintain stringent data security standards. In contrast, a small-scale retail enterprise may choose not to have the same kind of data security function that a large retailer has, even though both of them have similar core business activities. It is very important to analyze business rules and processes to identify security touch points, and understand that every event in the business workflow may have its own security requirements. Data-to-process and data-to-role relationship matrices are useful tools to map these needs and guide definition of data security role-groups, parameters, and permissions. It is needed to plan to address short-term and long-term goals to achieve a balanced and effective data security function.
		Regulatory Requirements	In the Information Age an organization cannot fail to deal with a growing set of laws and regulations. The necessary skills to face ethical and legal issues include the knowledge aimed at creating a central inventory of all relevant data regulations and the data subject area affected by each regulation. It is recommanded to add links to the corresponding security policies developed for compliance to these regulations and the controls implemented. It is important to know how to manage and maintain this inventory, since regulations, policies, required actions, and data affected will change over time.
Data Security Policy	It is necessary to know how to create data security policies based on business and regulatory requirements. A policy is a statement of a selected course of action and high-level description of desired behavior to achieve a set of goals. Data security policies should describe behaviors that are determined to be in the best interests of an organization that wishes to protect data. For policies to have a measurable impact, they must be auditable and audited. Corporate policies often have legal implications. Failure to comply with a corporate policy might have a negative legal ramifications eafter a data breach. To define security policy it is necessary that IT security administrators, Security Achitects, Data Governance committees, Data Stewards, internal and external audit teams, and the legal department, collaborate. Data Stewards must also collaborate with all Privacy Officers and business managers having data expertise, to develop regulatory category Metadata and apply proper security classifications consistently. All data regulation compliance	Security Policy Contents	It is important to know how to create different levels of policy, in order to govern behavior related to enterprise security. Some examples of different levels of policy are: Enterprise Security Policy (global policies for employee access to facilities and other assets, email standards and policies, security access levels based on position or title, and security breach reporting policies); IT Security Policy (directory structures standards, password policies, and an identity management framework); Data Security Policy (categories for individual application, database roles, user groups, and information sensivity). Employees need to understand and follow security policies. It is important to develop security policies so that the required processes and the reasons behind them are clearly defined and achievable. Compliance should be made easier than non-compliance. Policies need to protect and secure data without stifling user access. Security policies should be in a format easily accessible by the suppliers, consumers, and other stakeholders. They should be available and maintained on the company intranet or a similar collaboration portal. Data security policies, procedures, and activities should be periodically reevaluated to strike the best possible balance between the data security requirements of all stakeholders.

Figure 6: Screenshot of '1st proposal - DATA SECURITY' spreadsheet: it contains the schematization of the DATA SECURITY content according to the usual taxonomy, composed by concepts and sub concepts, and their descriptions, learned from DAMA BoK

When structuring the DAMA BoK information to suite the GIS&T BoK content, rather than simply listing some concepts, it was made the effort to take into account the skills needed to match the demand of an enterprise, to facilitate the identification of job profiles.

3.2. Governance model analysis

After BoKs' content, the focus was moved on BoKs governance model, aiming at identifying all potential initiatives/models for BoK planning and maintenance.

The BoKs identified at the beginning of the content-wise analysis were analysed again, exploring their websites, aiming at learning lessons from similar experiences. As a further step, an e-mail (and then some reminders) were sent to the people responsible for the BoKs' creation and maintenance.

In particular, the asked questions were:

- which governance model was put in place for the long-term sustainability of the BoKs (e.g. fee-based membership, revenues from BoK-related sales),
- which re-use conditions have been applied for a possible link to/integration of parts of the BoKs in the BoK for GI and EO.

After this effort, the content extracted from the BoKs' websites and acquired from the replies received by e-mail was structured in the 'Governance & Business Models' spreadsheet (see Figure 7).

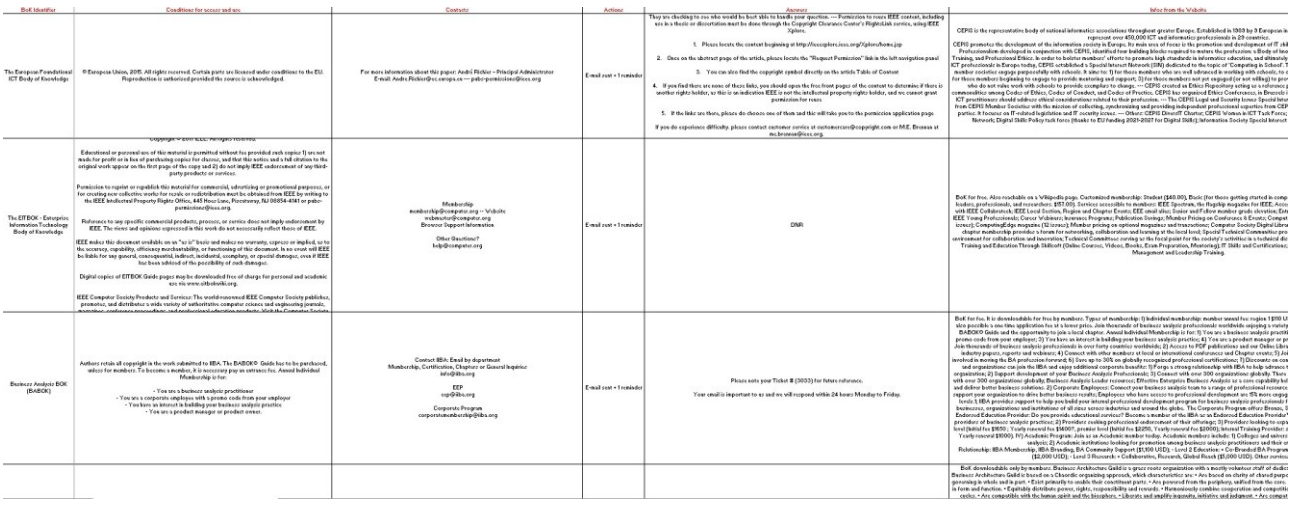

Figure 7: Screenshot of 'Governance & Business Models' spreadsheet: it contains the content extracted from the BoKs' websites and acquired from the answers at the sent e-mail.

The information provided in the websites and in the replies received by e-mail allowed to summarize the organisational framework of the BoKs analysed.

It emerges that most of the BoKs consist of a pdf file. In certain cases, the BoK access and download is free (e.g. EITBOK, SWEBOK and SEBOK, built by IEEE and made available also on a Wikipedia page). In other cases, the BoK is downloadable for fee and/or is available as a service connected to a membership (e.g. BABOK, BizBok, DAMABOK).

The creation of a membership is very common among the bodies that build BoKs. Individuals or companies interested in developing work relationships and training opportunities can join the membership by paying an annual fee. Being a member provides some exclusive services or services at better conditions, most of them related to training (e.g. access to training material, e-learning, access to group discussions, discount to endorsed conferences). In general, different kind of membership are possible, with different costs and benefits in proportion.

It also emerges that the long-term maintenance of the BoK and services provided by the different bodies are based on the voluntary contribution of experts/members and/or members fees. .

4. Results

This methodology allowed us to obtain two types of results:

- identification of concepts contained in DAMA BoK that could/should be reused in the BoK for GI and EO and identification of linking methods
- Identification of options for BoK planning and maintenance.

4.1. Identification of concepts that could/should be reused in the BoK for GI and EO and identification of linking methods.

The first type of analysis was focused on the BoKs content in order to identify concepts to integrate/complement the BoK for GI and EO.

The comparison made among the selected BoKs and also the comparison among them and the GIS&T BoK led to the identification of one BoK with content possibly candidate for use/re use: the DAMA BoK Its structure and focus on data management in fact proved having great interest, primarily by the private sector involved in new data-driven technologies and processes, and should be a useful supplementing item for the BoK for GI and EO.

In particular the content of some DAMA's Knowledge Areas which are not included in GIS&T BoK was identified. Among them, two Knowledge Areas which contain relevant information, useful to be added to the GIS&T BoK were identified: Data Quality and Data Security.

Their content and structure were extrapolated into two proposals for integration, organized in accordance with the usual taxonomy (Knowledge Areas, concepts, subconcepts).

By contacting directly the responsible persons for DAMA BoK, the reuse conditions applicable for a possible link to/integration of parts of the DAMA in the BoK for GI and EO were investigated.

The information collected show some opportunities along with some issues.

An integration of contents is possible under these conditions: if a sentence or two is quoted, proper attribution is required. If more than a few sentences, it would need to go through the permission process with DAMA International.

Moreover, the DAMA team suggested that, if the decision to further investigate any possible use of DAMA BoK components will be taken, the EO4GEO team should collaborate with DAMA team to avoid the risk of possible misuse of DAMA BoK components out of the context they were designed for.

DAMA team highlighted two possible issues:

- DAMA BoK exists only in a PDF version, so the possible linking method should be investigated taking this aspect into account.
- After DAMA BoK was built, some contents have evolved. The latest version of DAMA BoK does not reflect that evolution or the improved interactions between the Knowledge Areas. Furthermore, no updating is in view.

If the decision of a possible use of DAMA BoK content is reached, the first issue could be overcome, for example, if the PDF will have a DOI (Digital Object Identifier), to refer to in the BoK for EO and GI.

4.2. Identification of options for BoK planning and maintenance.

Exploring the BoKs websites and exchanging information via e-mail with other communities allowed to summarize the organisational framework of the BoKs analysed.

It emerged that most of the BoKs consist of a pdf file. In certain cases the BoK access and download is free (e.g. EITBOK, SWEBOK and SEBOK, built by IEEE and made available also on a Wikipedia page). In other cases the BoK is downloadable for fee and/or is available as a service connected to a membership (e.g. BABOK, BizBok, DAMABOK).

The creation of a membership is very common among the bodies that build BoKs. Individuals or companies interested in developing work relationships and training opportunities can join the membership by paying an annual fee. Being a member provides some exclusive services or services at better conditions, most of them related to training (e.g. access to training material, e-learning, access to group discussions, discount to endorsed conferences). In general, different kind of membership are possible, with different costs and benefits in proportion.

5. Discussion

The results of the content-wise analysis was presented during the progress meeting in Leuven at the end of June 2019, raising interest among the project partners.

But, despite the deep level of detail achieved during the analysis of the other BoKs and their comparison with the GIST BoK, the very limited possibility to technically link the other BoKs is eventually hindering any use/re-use option. Indeed the manual integration of concepts of other BoKs in the BoK for GI and EO is not considered as a viable option by the partners responsible for the development of the BoK for GI and EO.

Finally, the investigations made regarding the governance and business models of the other BoKs provided information useful also for long term sustainability.

6. Conclusions

- A methodology to analyse other BoKs potentially candidate to provide content to be used/re-used in the BoK for GI and EO was designed and implemented.
- Twelve other BoKs were identified and eight of them deeply analysed content-wise and compared with the GIST BoK, in order to identify overlaps/gaps.
- Two Knowledge Areas (and related concepts) of the DAMA BoK were selected as possible supplementing item for the BoK for GI and EO, but with the only purpose to show how, with an example, to use the results of the analysis to identify candidate components of other BoKs for reuse in the BoK for GI and EO.
- An analysis of the conditions for access and use of the other BoKs was conducted, in order to identify the possibility to technically link the candidate concepts of the other BoKs in the BoK for GI and EO. The emerged very limited possibility to technically link the other BoKs is eventually hindering any use/re-use option, unless a manual integration will be considered as a viable option.
- The governance and business models of the twelve BoKs was investigated, providing information useful also for long term sustainability .