Towards a Systematic Information Governance Maturity Assessment

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ABSTRACT

Information Governance as defined by Gartner is the "specification of decision rights and an accountability framework to encourage desirable behavior in the valuation, creation, storage, use, archival and deletion of information. Includes the processes, roles, standards and metrics that ensure the effective and efficient use of information in enabling an organization to achieve its goals". In this paper, we present assess the maturity of seven project pilots using the Information Governance maturity model based on existing reference documents. The process is based on existing maturity model development methods. These methods allow for a systematic approach to maturity model development backed up by a well-known and proved scientific research method called Design Science Research. An assessment was conducted and the results are presented in this paper, this assessment was conducted as a self-assessment in the context of the EC-funded E-ARK project for the seven pilots of the project. The main conclusion from this initial assessment is that there is much room for improvement with most pilots achieving results between maturity level two and three. As future work, the goal is to analyze other references from different domains, such as, records management. These references will enhance, detail and help develop the maturity model making it even more valuable for all types of organization that deal with information governance.

KEYWORDS

Information Governance, Maturity Assessment, Maturity Model.

1. INTRODUCTION

A Maturity Model consists of a number of entities, including "maturity levels" (often six) which are, from the lowest to the highest, (0) Non Existent, (1) Initial, (2) Basic, (3) Intermediate, (4) Advanced and (5) Optimizing. Each aspect can have its own Maturity Model, which expresses quantitatively the maturity level of an organization regarding a certain aspect. A Maturity Model provides also a way for organizations to see clearly what they must accomplish in order to pass to the next maturity level.

The use of maturity models is widespread and accepted, both in industry and academia. There are numerous maturity models, with at least one for each of the most trending topics in such areas as Information Technology or Information Systems. Maturity models are widely used and accepted because of their simplicity and effectiveness. They can help an organization to understand the current level of maturity of a certain aspect in a meaningful way, so that stakeholders can clearly identify strengths to be built upon and weaknesses requiring improvement, and thus prioritize what must be done in order to reach a higher level. This can be used to show the outcomes that will result from that effort, enabling stakeholders to decide if the outcomes justify the effort.

There are several examples of maturity models currently in use. For example, in software engineering there is the classic Software Engineering Institute Capability Maturity Model Integration also known as the CMMI that has been growing in the last twenty years, already covering a set of aspects regarding products and services lifecycles. In the Information Management domain there also several examples of maturity models such as the Gartner Enterprise Information Management Maturity Model. Other domains where maturity models can be found include management, business process management, energy management, governance and risk management, etc. The previous maturity models are already described and analyzed in [35], where a state of the art on maturity models was performed. We have also noted existing work in the area of a Digital Preservation Maturity Models undertaken by Adrian Brown where the author examines the notion of "trusted" digital repositories and proposes a maturity model for digital preservation, which goal is to enable organizations to assess their capabilities and create a roadmap for developing them to the required maturity level [8], and of Charles Dollar that proposes a Capability Maturity Model to assess digital preservations requirements [9] according to the Open Archival Information System (OAIS) Reference Model (ISO14721 [2]) and Trustworthy Repository Assessment Criteria (TRAC) Standard (ISO16363 [1]). Those maturity models will be analyzed in detail in E-ARK deliverable D7.5.

This paper builds on the knowledge from the maturity models that have been documented in detail in [35], process assessment and assessment in general and focus on assessing the maturity levels of the seven pilots of the E-ARK project:

- Pilot 1: SIP creation of relational databases (Danish National Archives);
- Pilot 2: SIP creation and ingest of records (National Archives of Norway);
- Pilot 3: Ingest from government agencies (National Archives of Estonia);
- Pilot 4: Business archives (National Archives of Estonia, Estonian Business Archives);
- Pilot 5: Preservation and access to records with geodata (National Archives of Slovenia);
- Pilot 6: Seamless integration between a live document management system and a long-term digital archiving and preservation service (KEEP SOLUTIONS);
- Pilot 7: Access to databases (National Archives of Hungary).

This paper is a continuation of the maturity development method presented in [35], and focuses on the three final steps of the development method which are detailed in Section 3. In Section 4 the self-assessment questionnaire used to perform the assessment is detailed. Then, in Section 5, the results of the assessment are detailed and analyzed. Section 6 details the post-assessment feedback questionnaire analysis and conclusions. Finally, Section 7 presents the conclusions of this paper.

2. RELATED WORK

This section details the related work relevant for this paper, namely the maturity model fundamentals and maturity assessment methods. These are essential to understand the remaining of this paper.

2.1 Maturity Model Fundamentals

To evaluate maturity, organizational assessment models are used, which are also known as stages-of-growth models, stage models, or stage theories [23].

The concept of maturity is a state in which, when optimized to a particular organizational context, is not advisable to proceed with any further action. It is not an end, because it is a mobile and dynamic goal [14]. It is rather a state in which, given certain conditions, it is agreed not to continue any further action. Several authors have defined maturity, however many of the current definitions fit into the context in which each a particular maturity model was developed.

In [15] maturity is defined as a specific process to explicitly define, manage, measure and control the evolutionary growth of an entity. In turn, in [16] maturity is defined as a state in which an organization is perfectly able to achieve the goals it sets itself. In [17] it is suggested that maturity is associated with an evaluation criterion or the state of being complete, perfect and ready and in [18] as being a concept which progresses from an initial state to a final state (which is more advanced), that is, higher levels of maturity. Similarly, in [19] maturity is related with the evolutionary progress in demonstrating a particular capacity or the pursuit of a certain goal, from an initial state to a final desirable state. Still, in [20] it is emphasized the fact that this state of perfection can be achieved in various ways. The distinction between organizations with more or less mature systems relates not only to the results of the indicators used, but also with the fact that mature organizations measure different indicators when comparing to organizations which are less mature [21]. While the concept of maturity relates to one or more items identified as relevant [22], the concept of capability is concerned only with each of these items. In [23] maturity models are defined as a series of sequential levels, which together form an anticipated or desired logical path from an initial state to a final state of maturity. These models have their origin in the area of quality [24][25]. The Organizational Project Management Maturity Model (OPM3) defines a maturity model as a structured set of elements that describe the characteristics of a process or product [26][27]. In [28] maturity models are defined as tools used to evaluate the maturity capabilities of certain elements and select the appropriate actions to bring the elements to a higher level of maturity. Conceptually, these represent stages of growth of a capability at qualitative or quantitative level of the element in growth, in order to evaluate their progress relative to the defined maturity levels.

Some definitions found involve organizational concepts commonly used, such as the definition of [29] in which the authors consider a maturity model as a "... a framework of evaluation that allows an organization to compare their projects and against the best practices or the practices of their competitors, while defining a structured path for improvement." This definition is deeply embedded in the concept of benchmarking. In other definitions, such as in the presented by [30] there appears the concern of associating a maturity model to the concept of continuous improvement.

In [31], the maturity models are particularly important for identifying strengths and weaknesses of the organizational context to which they are applied, and the collection of information through methodologies associated with benchmarking. In [32] it was concluded that the great advantage of maturity models is that they show that maturity must evolve through different dimensions and, once reached a maturity level, sometime is needed for it to be actually sustained. In [33] it was concluded that project performance in organizations with higher maturity levels was significantly increased. Currently, the lack of a generic and global standards for maturity models has been identified as the cause of poor dissemination of this concept.

2.2 Maturity Assessment

An assessment is a systematic method for obtaining feedback on the performance of an organization and identify issues that affect performance. Assessments are of extreme importance as organizations are constantly trying to adapt, survive, perform and influence despite not being always successful. To better understand what they can or should change to improve the way they conduct their business, organizations can perform organizational assessments. This technique can help organizations obtain data on their performance, identify important factors that help or inhibit the achievement of the desired outcomes of a process, and benchmark them in respect to other organizations. In the last decade, the demand for organizational assessment are gaining ground with the implementation of legislation that mandate good governance in organizations, such as, the Sarbanes-Oxley Act [7] and the BASEL accords in financial organizations [8]. Moreover, funding agencies are using the results of these assessments to understand the performance of organizations which they fund (e.g., Not for profit organizations, European Commission, Banks, Research institutes) as a means to determine how well organizations are developing the desired outcomes, and also to better understand the capabilities these organizations have in place to support the achievement of the desired outcome.

The result of an assessment effort will be a set of guidelines which will allow for process improvement. Process improvement is a way of improving the approach taken for organizing and managing business processes and can involve also executing improvements to existing systems. There are several examples of process improvement such as compliance with existing legislation. Process improvement often results in process redesign which involves understanding the requirements of a stakeholder and developing processes which meet the stakeholders' expectations. This often means that the existing processes supporting a specific part of business need to be adapted, or even made from scratch to meet the stakeholders' expectations. When the processes need to be made from scratch we are dealing with process reengineering which is a way to introduce radical changes in the business processes of an organization and changes the way a business operates. In this way, process reengineering starts from scratch by determining how the key business activities need to be reengineered to meet stakeholders' expectations. One well known example, is the transition from traditional banking services to on-line banking services.

The ISO/IEC 15504, describes a method that can be used to guide the assessment of organizational processes, which is depicted in Figure 1. The ISO15504 assessment method is composed of seven main steps which are then further detailed in atomic tasks.

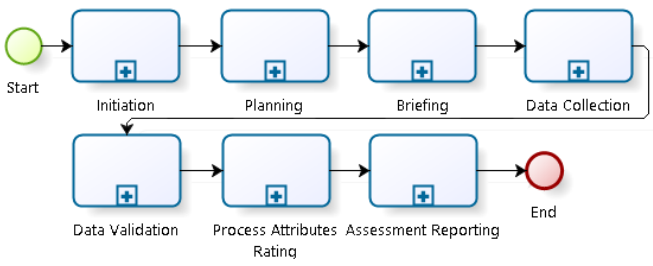

Figure 1. ISO15504 Assessment Process Overview.

3. ASSESSMENT PROCESS

One recurrent criticism of maturity models is that they lack empirical foundation and traceability [7]. The main reason for the criticism is that existing maturity models typically do not follow a theoretical framework or methodology for their development [7]. In fact, there is an absence on literature regarding methods and practices for the design and development of maturity models [7].

One of the most known development model for maturity models is the one from Becker in [4], a procedure based on a scientific research method called Design Science Research (DSR). The well-argued claim of the design procedure [4] is that these fundamental requirements should drive the development of every maturity model. Apart from evaluating well-known models according to these dimensions, the article also delineates a set of steps to correctly develop a maturity model. It depicts which documentation should result from each step, and includes an iterative maturity model development method that proposes that each iteration of the maturity model should be implemented and validated before going to a new iteration. The procedure delineates eight requirements [4], (1) Comparison with existing maturity models is presented and clearly argues for the need of a new model or the adaptation of an existing one; (2) Iterative Procedures are followed to ensure a feedback loop and refinement; (3) The principles, quality and effectiveness behind the design and development effort of a maturity model should pass through an iterative Evaluation step; (4) The design and development of maturity models should follow a Multi-methodological Procedure which use must be well founded; (5) During the development of a maturity model there should be a clear Identification of Problem Relevance so that the problem solution can be relevant to practitioners and researchers; (6) Problem Definition should include the application domain for the maturity model and also detail the intended benefits and constraints of application; (7) There should be a Targeted Presentation of Results regarding the users' needs and application constraints and, (8) The design of a maturity model must include Scientific Documentation, which details the whole process design for each step of the process, as well as, the methods applied, people involved and the obtained results.

One limitation of existing maturity models is that it is not typically not clear which requirements were used for the design and development of the model. In other words, there is a weak or inexistent traceability between the maturity model and the requirements that are used as reference. Consequently, stakeholders that wish to use the maturity model are unable to understand if the model is aligned with current best practices. To address the aforementioned traceability problem the maturity model described in this paper is based in well-known references of IG. Due to the fact that IG is a multi-disciplinary fields that covers several disciplines the range of standards and references documents is vast and include references, such as, the ISO 16363, ISO 20652, ISO 14721, MoREQ 2010, ISO 16175, ISO 23081, ISO 30301, ISO 27001, among others.

The maturity model for information governance, depicted further on in this section, consists of three dimensions:

- **Management:** "The term management refers to all the activities that are used to coordinate, direct, and control an organization." [12]
- **Processes:** "A process is a set of activities that are interrelated or that interact with one another. Processes use resources to transform inputs into outputs." [12]
- **Infrastructure:** "The term infrastructure refers to the entire system of facilities, equipment, and services that an organization needs in order to function."[12]

These dimensions provide different viewpoints of information governance which help to decompose the maturity model and enable easy understanding.

For each dimension we have a set of levels, from one to five, where one show the initial phase of maturity of a dimension and level five shows that the dimension is fully mature, self-aware and optimizing. These levels and their meaning were adapted from the levels defined for SEI CMMI. [13]

In order to assess the E-ARK pilots on their maturity regarding information governance, the project has adopted a self-assessment process. In this self-assessment process, a questionnaire is provided to the organization to be assessed which they complete to the best of their knowledge. Then the results are analysed by the assessment team and an assessment report is provided to the organization. This paper continues the application of the maturity model development method presented in [36] (and reproduced on Figure 2) and focuses on the application of the maturity model on the use cases before the project pilot, i.e. the three last stages of the method. E-ARK Deliverable 7.5 will use the results presented here to further develop and extend the maturity model. Finally, in E-ARK deliverable 7.6 will use the final maturity model to perform a final assessment of the project pilots.

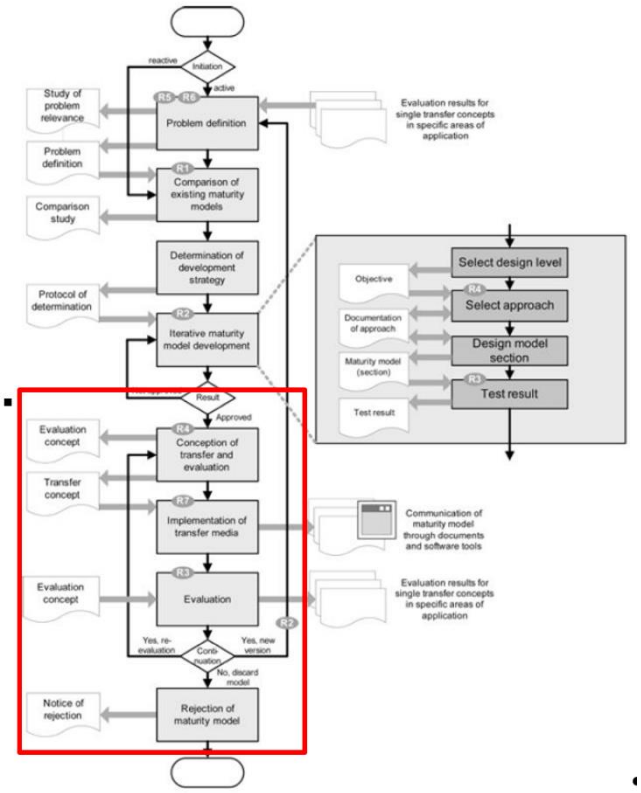

Figure 2. Maturity Model Design Procedure [4]

The concept of transfer and evaluation of the maturity model was defined through the identification of the pilots' capabilities. A capability can be defined as "an ability that an organization, person, or system possesses" that typically requires a combination of "organization, people, processes, and technology" for its realization [3]. The definition of a capability must be implementation-independent, as it might be realized in different ways and measured in different levels of maturity.

Pilot's capabilities were identified through the analysis of [34] which details the E-ARK general pilot model and defines the purpose and processes of each pilot. Five top-level capabilities were defined: Pre-Ingest, Ingest, Archival Storage Preservation, Data Management, and Access. Table 1 depicts the defined

capabilities and its corresponding abilities. As presented in the table, the pilots will have different focus and consequently will aim for different capabilities. For example, pilot 1 and 2 will focus merely on the capabilities of pre-ingest and ingest while other pilots contain the full lifecycle of pre-ingest, ingest, archival storage, data management and access.

The Pre-Ingest capability depicts the abilities to create submission information packages, encompassing the validation and enhancement of a SIP received from producers to create an E-ARK compliant SIP. The assessment of the maturity level must measure these abilities.

The Ingest capability reflects the abilities to create AIPs from the ingested SIPs. As most of the archival solutions available in the market make use of specific archival information packages, a high maturity level will include the creation of the E-ARK AIP from the E-ARK SIP. The Ingest capability also involves the ability to validate the E-ARK SIP received from pre-ingest.

The Archival Storage Preservation capability reflects the abilities to store and preserve the E-ARK AIP on the long term. As the focus of the project is particularly directed towards the processing phases surrounding the archival and preservation of data, the assessment will target the symbolic process of storing the E-ARK AIP.

The Data Management capability represents the ability to manipulate descriptive metadata, allowing the enhancement of existing E-ARK AIP, which will result in new E-ARK AIP.

Finally, the Access capability comprises the abilities to create the DIP, either on a local format or as E-ARK DIP, either on a pre-defined manner (defined as "standard" in the [34]), where the consumer accesses the requested data, or by special request producing a DIP in a local format or as E-ARK DIP, both produced using sophisticated analysis and presentation tools. An aspect to take into consideration, is that even though the pilots focus on a certain capability there might be abilities - a) to r) – that are not relevant in the context of a certain pilot and as result are no piloted.

Based on the capabilities definition the questionnaire was divided into five sections, which identify each capability:

(1) Pre-Ingest,
(2) Ingest,
(3) Archival Storage and Preservation,
(4) Data Management, and
(5) Access.

Using the defined capability model the assessment questionnaire was built by, for each ability, define one or more questions to assess the selected ability then, using the maturity model defined in [35], define the possible answers of the question(s).

The assessment of a particular capability will then evaluate the degree of realization and performance of the people, processes, and technology that comprise that capability.

One aspect to consider is that each question is created independent from all the others and all the questions have the same weight to the maturity level calculation. These questions are detailed in section 4.

4. SELF-ASSESSMENT QUESTIONNAIRE

This section details the self-assessment questionnaire used to assess the E-ARK pilots. The questionnaire is comprised of five capabilities which are detailed in the previous section, then each capability contains a set of questions. Each question is detailed in a table with the following fields:

1. **ID:** Which identifies the number of the question in the overall questionnaire;
2. **Title:** Which depicts the main topic the question refers to;
3. **Question:** Which details the question itself;
4. **Objective:** Which details the objective of that question, what knowledge the question intends to capture;
5. **Notes:** Which either clarifies some aspects and/or terms of the question or details examples of evidence to substantiate the answer for the question;

Table 1. Capability Model and the Pilots

Capability	Ability	Pilots						
		1	2	3	4	5	6	7
Pre-Ingest	a) SIP Content Definition b) Transformation of the Producer SIP to E-ARK SIP c) Local SIP Validation d) Enhancement of the local SIP e) Creation of the E-ARK SIP	F	F	F	F	F	F	F
Ingest	f) Creation of fonds g) Creation of the E-ARK AIP h) Validation of the E-ARK SIP i) Validation of the E-ARK AIP	F	F	F	F	T	F	F
Archival Storage and Preservation	j) Store E-ARK AIP		T	T	T	T	F	T
Data Management	k) Export E-ARK AIP and Descriptive metadata l) Enhance E-ARK AIP and Descriptive metadata			T	F	T	T	
Access	m) Search Data n) Provide Access to Ad-Hoc DIP o) Creation of a Local DIP p) Creation of a E-ARK DIP q) Creation of a Requested Local DIP r) Creation of a Requested E-ARK DIP	T		F	F	F	F	F

F	Focus of the pilot
T	Elements also used/tried within the pilot

6. **Terms:** Which identifies the terms that are detailed in EVOC. EVOC is the vocabulary manager which makes part of the knowledge centre being developed in E-ARK;
7. **Answers:** Which depicts the five possible answers to the question;
8. **Source:** Which details the source from which that specific question originates.

The questionnaire starts by providing an introduction. This introduction provides details on the purpose of the questionnaire, how it will be analysed, and clarifies concepts being constantly used throughout the questionnaire. [36] details the questionnaire that was presented to the respondents.

This questionnaire consists of a set of questions that will be used to determine the maturity level of the E-ARK pilots for each of the five capabilities of the E-ARK General Model. All questions are mandatory.

The answers provided will then be analysed by the Information Governance Maturity Model development team and a report will be issued detailing all the findings of the assessment. The set of assessment reports is available at [36].

The questionnaire uses the following definitions of measurement:

- **No** indicates that there is no procedure or mechanism in place;
- **Ad-hoc** refers to actions performed but not being repeatable in the future, which can be due to the lack, outdate or no use of proper documentation, procedures or mechanisms, and thus leading to different people performing different tasks to achieve the same outcome;
- **Defined** refers the ways to achieve an outcome are supported by defined procedures or mechanisms, and thus leading to the actions performed being capable of being repeated in the future. This level does not give an assurance that the defined procedures or mechanisms are being consistently complied with or assessed;
- **Ad-hoc assessed** means that there is a concern with the assessment of some specific aspects, but that is not performed under a defined process but ad-hoc and when the need arises**;**
- **Consistently assessed** means that there is a concern with the assessment of some specific aspects, and that such is performed continuously, under a defined process, with alerts triggered by a defined set of indicators considering these dimensions, for example:
  - **Completeness**, which focuses on assessing if a procedure performs all relevant steps, aligned with the most recent documented requirements for that;
  - **Effectiveness**, which focus on assessing if the results of a procedure are free of errors and do not require further handling;
  - **Efficiency**, which focus on assessing if a procedure executes with the optimal efforts (for example, if automation is used instead of human effort), in an agreed time period as to avoid bottlenecks on the infrastructure and to minimize the time spent on executing it;
  - **Relevance**, which focus on assessing if the implemented requirements are still relevant for the intended purpose (as legislation change, for example, there is the need to assess if implemented requirements are still relevant).

These are just examples of aspects that need to be measured at higher levels of maturity, there might be further aspects to measure depending on the specific requirements of the pilot.

For each question there is a field respondents can use to provide additional comments, clarifications or a justification to the answer. These comments will be considered by the assessment team when evaluating the answers.

The questionnaire was sent to the pilot owners and was available on-line at http://earksurvey.sysresearch.org. The questionnaire was presented in a set of five tabs, one for each of the capabilities identified. Then in each tab a short description of the capability is presented followed by the questions, objective, notes, terms, answers and a field for comments (shown in Figure 3).

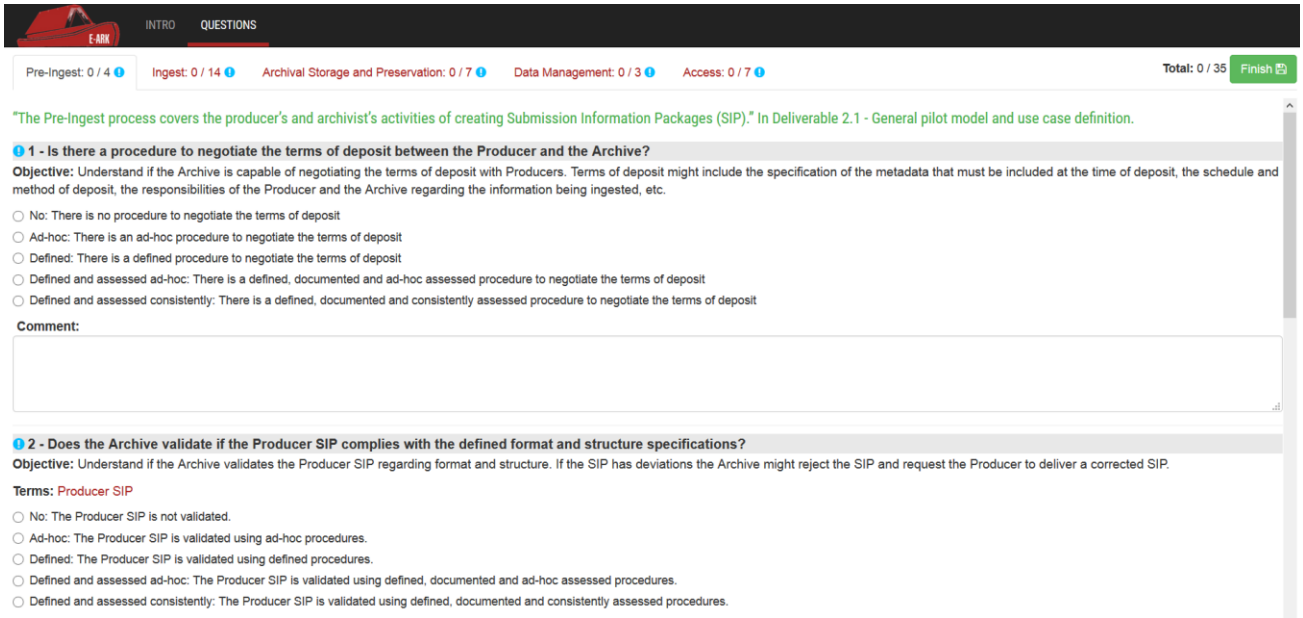

Figure 3. On-line Self-Assessment Questionaire

5. SELF-ASSESSMENT RESULT ANALYSIS

This section details the analysis of the results for each of the E-ARK pilots. For each pilot, in [36], the following is provided:

1. The answer provided for each question;
2. The comments provided in each question, in case there is a comment;
3. The weak points, aspects that should be considered for improvement;
4. The maturity level for each of the capabilities of the questionnaire.

It is important to note that for the purpose of this paper we are only assessing the "Processes" dimension of the Information Governance Maturity Model. This is due to the fact that the E-ARK pilots do not have an organizational background which would allow assessing the other two dimensions. The results are calculated as an average of the maturity levels of the questions for each capability, this average was then rounded down.

In the conclusion of this section there is a comparison and analysis between the pilots, regarding the findings of the self-assessment. Table 2 details the maturity levels of answers provided to each question by each pilot, as well as, the calculated maturity level for each of the capabilities of the questionnaire. For the result of each capability of each pilot there is an associated colour. This colour is linked to Table 1, where blue represents a focus capability and red a capability to be explored. The lack of these two colours means that that capability is not part of the pilot.

The answers provided will then be analysed by the Information Governance Maturity Model development team and a report will be issued detailing all the findings of the assessment. The set of assessment reports are available at http://www.eark-project.com/resources/project-deliverables/46-d72initassess/file.

Figure 4 depicts a comparison between the pilots. Pilot 1 is the one which achieved the best overall results, especially in pre-ingest and access it achieved the best results. Pilot 2 achieved the second best results. However there are still some enhancements to perform in the access capability where it achieved maturity level 2. Despite this fact, the access capability is not the focus in pilot 2. Pilot 7 also shows a high level maturity across the capabilities measured in the assessment. However, as in pilot 2, there are still some important enhancements to perform to the access capability. In pilot 7, the importance of the access capability is considerable due to it being one of the focuses of the pilot.

The other four pilots showed similar results among the capabilities. With some exceptions for pilot 3, where it shows higher maturity levels for pre-ingest and the access capabilities. Another exception is pilot 6 which shows higher maturity levels for ingest and data management capabilities. Pilot 5 did not answer to the questions for the archival storage and preservation and as the result no maturity level was calculated. As this is not the focus capability of the pilot there is no major issue with this fact.

There are still several capabilities at maturity level 1 or 2 for all pilots except pilot 1. These should be addressed as soon as possible to reach at least maturity level 3 for the focus capabilities. This is due to the fact that maturity level 3 is considered an intermediate level between lack of definition of consistency of mechanism and procedures typical of maturity level 1 and 2; and the documentation and assessment of mechanism and procedures typical of maturity level 4 and 5. Maturity level 3 depicts aspects that are consistent and defined throughout the organizational or pilot context and shows a state of change in this context from no definition to improvement. The outcomes of the E-ARK project will help the pilots to reach this maturity level and will also assist other organizations to reach higher levels of maturity and as result improve archival practice.

6. POST-ASSESSMENT FEEDBACK QUESTIONNAIRE

After analyzing and reporting the results of the initial assessment and evaluation, a post assessment questionnaire was developed. This questionnaire allowed pilots to provide feedback to the Information Governance Maturity Model Development Team to promote continuous improvement of the assessment process and the questionnaire used to assess the Information Governance Maturity Model.

For each question there was a three point answer scale, with possible answers of (1) Yes, (2) Partially and (3) No. For each question comments could be provided to detail the answers.

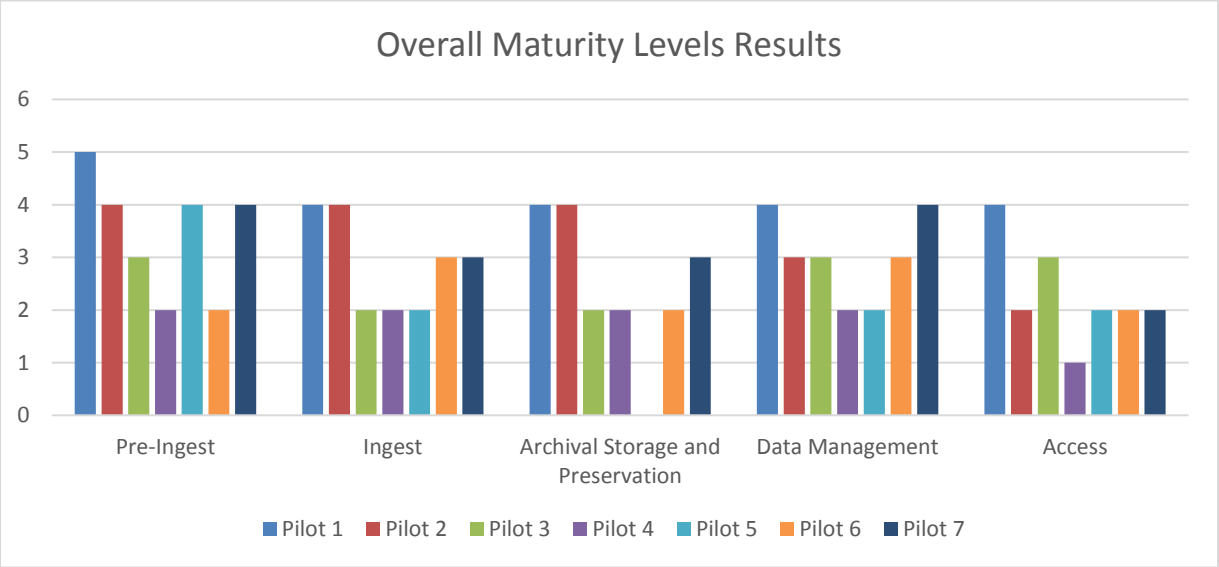

Figure 4. Final Results of the Maturity Levels for All Pilots

Table 2. Final Results of the Answers for All Pilots

Q	Capability / Question Title	P1	P2	P3	P4	P5	P6	P7
Pre-Ingest		**5**	**4**	**3**	**2**	**4**	**2**	**4**
1	Deposit Terms Negotiation	5	5	3	4	5	3	4
2	Producer SIP Validation	5	5	3	2	5	3	4
3	Provenance verification mechanisms	5	5	3	2	5	3	4
4	Enhancement of the Producer SIP	5	1	4	2	3	2	4
Ingest		**4**	**4**	**2**	**2**	**2**	**3**	**3**
5	Creation of fonds	5	1	3	3	-	3	2
6	Ingest SIP verification mechanisms	5	5	3	2	4	5	4
7	Ingest Producer/depositor responses	4	5	4	1	3	3	4
8	Ingest actions and administration processes records	5	5	3	3	5	3	2
9	Legal Rights	5	5	3	1	3	1	3
10	AIP generation procedure	4	4	3	4	1	4	4
11	SIP final disposition documentation	4	5	3	1	3	3	4
12	AIP parsing	1	5	1	1	3	3	4
13	AIP unique identifiers convention	3	5	3	3	3	3	4
14	Preservation Description Information (PDI) acquiring procedures (from a SIP)	5	2	3	2	3	3	4
15	Preservation Description Information (PDI) maintaining procedures	5	5	3	2	3	3	4
16	AIP content information testing procedure	5	2	2	1	-	3	2
17	AIP completeness and correctness	4	5	3	2	3	3	4
18	AIP creation records	4	5	3	3	3	3	4
Archival Storage and Preservation		**4**	**4**	**2**	**2**	**-**	**2**	**3**
19	AIP Storage Procedures	5	5	3	1	-	2	4
20	AIP integrity monitoring	5	5	3	5	-	3	4
21	AIP actions records	5	5	3	2	-	3	4
22	AIP Designated Community Requirements	2	1	1	1	-	1	2
23	Independent mechanism for content integrity checking	4	5	2	2	-	2	4
24	AIP Linking/resolution services	5	2	3	1	-	3	4
25	Tools and resources to provide representation information	5	5	3	2	-	2	4
Data Management		**4**	**3**	**3**	**2**	**2**	**3**	**4**
26	Designated Community information requirements	4	2	3	2	3	3	4
27	Descriptive information association with the AIP	4	5	3	3	3	3	4
28	Bi-directional linkage between the AIP and descriptive information	5	2	3	1	1	3	4
Access		**4**	**2**	**3**	**1**	**2**	**2**	**2**
29	Creation of a DIP	5	1	3	2	3	3	4
30	Access policies	4	1	3	3	3	3	4
31	Access policies compliance	4	1	3	1	2	1	2
32	Access failures and errors	4	5	3	1	1	1	1
33	Access Data Reports	4	-	3	1	3	3	1
34	Access Data Problem/Error Reports	3	1	3	1	2	2	2
35	Access Policies and Procedures	5	5	3	1	3	3	4

Table 4. Overall Results of the Post-Assessment Questionnaire

Aspect	Pilot	Yes	Partially	No
Were the instructions clear and specific?	2	X		
	5	X		
	6	X		
Was the comment box for each question appropriate to complement the answer provided to the question?	2			X
	5	X		
	6			X
Did the assessment cover all the aspects you think that are relevant for Archival Management Practice?	2	X		
	5	X		
	6		X	
Could you relate the aspects being assessed to your pilot context?	2		X	
	5		X	
	6	X		
Did the results of the assessment reflect the current state of affairs in your pilot?	2	X		
	5	X		
	6		X	
Were the assessment results useful as means to check the current state and plan for improvement?	2		X	
	5	X		
	6	X		
Was the assessment a positive experience?	2	X		
	5	X		
	6	X		

This questionnaire was divided into six parts, the first five containing related questions about the different capabilities being assessed. The final part is about overall questionnaire satisfaction. The estimated time require to fill in this questionnaire was 30-40 minutes.

The post-assessment feedback process consists of a set of feedback cycles where in each cycle a limited number of pilots are required to provide feedback. This process allows: (1) to incrementally improve the assessment process, and (2) to manage the pilots' efforts consistently across the last project year. The feedback received from the different pilots was: Pilot 3: Ingest from government agencies (National Archives of Estonia), Pilot 5: Preservation and access to records with geodata (National Archives of Slovenia), and Pilot 6: Seamless integration between a live document management system and a long-term digital archiving and preservation service (KEEP SOLUTIONS).

After analyzing the results of the post-assessment questionnaire the information governance maturity model development team met with the pilots to go over the results of the analysis and address the issues that were detected.

Regarding the overall satisfaction with the assessment, Table 3 details the results of the post-assessment questionnaire questions, related to overall satisfaction with the initial assessment and evaluation. The results are shown for each of the pilots selected to answer the questionnaire.

The results obtained from the analysis of the overall satisfaction with the assessment show that pilots found the assessment a positive experience. However, there are still some aspects to improve, such as the space provided for comments, assessment coverage of information governance and the usefulness of the assessment to plan for improvement. Regarding the comment space, there are already plans to improve this aspect by allowing pilots to include images, and upload documents as a means of providing evidence for the answers given to the questions. Regarding assessment coverage, in the next version of the Information Governance Maturity Model there will new sources of documentation to be analyzed with the purpose of expanding the current coverage of the maturity model. Finally, regarding the improvement plan, we are planning to have the maturity assessment tool provide an improvement plan alongside the maturity assessment results.

7. CONCLUSION AND FUTURE WORK

This paper presented a method to perform a self-assessment of the Information Governance Maturity Model which consists of a toolset consisting of both the maturity model and the self-assessment method which guides the assessment of the state of information governance in organizations as well as provide an improvement path that organizations can follow to enhance their information governance practice.

As future work resulting from this paper, we concluded that current maturity assessment methods focus on highly complex and specialized tasks being performed by competent assessors in an organizational context. These tasks mainly focus on manually collecting evidence to substantiate the maturity level calculation[34]. Because of the complexity of these methods, maturity assessment becomes an expensive and burdensome activity for organizations.

As such, one major area to invest is to develop methods and techniques to automate maturity assessment. Due to **t**he wide spread of modeling practices of business domains, assisted by modeling tools, makes it possible to have access, for processing, to the data created and managed by these tools. Also, the recent state of the art demonstrating how business processes and Enterprise Architecture models in general can be represented as ontologies has raised the potential relevance of the semantic techniques for the automated processing of these models. As such, the objective is to analyze the potential, and the main limitations, of the existing semantic techniques to automate methods for the assessment of Maturity Models through the analysis of an existing model representation of a reality.

There are several examples of models used to represent an organization architecture, such as, Archimate, BPMN or UML. These models are descriptive and can be detailed enough to allow to perform, to some extent, maturity assessment. For example, the collected evidence from an organization can be synthetized into a set of model representations that can then be used when analyzing and calculating the maturity levels.

However, in order for these models to become relevant for maturity assessment there should be a formal representation for both Maturity Models and model representations. One hypothesis is that building on the knowledge of ontologies from the computer science and information science domains, these can be used to represent Maturity Models and model representations. This can be achieved by developing a generic ontology that expresses all these core concepts (or at least a relevant group of them) and relationships among them, as also the rules for a generic maturity assessment accordingly Then, by representing Maturity Models and models representations of concrete organizational scenarios using ontologies we can verify if an organization models representations matches the requirements to reach a certain maturity level using ontology query and reasoning techniques, such as SPARQL and Description Logics inference.

The final objective is thus to identify how these methods and techniques can be used in existing maturity assessment methods, so that they can be proven as relevant to enable the automation of certain aspects of maturity assessment, such as, the maturity level determination. In order to do this, there should be an exploration of what types of analysis can be performed using the information on model representations that is relevant in a maturity assessment effort.

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