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Executive Summary

This deliverable details the maturity model for information governance which will be used to assess the E-ARK Project use cases. The method that guides the application of this maturity model will then be detailed in deliverable 7.5, scheduled to be submitted in January 2017.

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 process can have its own Maturity Model, which expresses quantitatively the maturity level of an organization regarding a certain process. 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 wide spread and accepted, both in industry and academia. There are numerous maturity models, 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 easily help understanding the current level of maturity of a certain aspect in a meaningful way, so that stakeholders can clearly identify strengths and weaknesses requiring improvement, and thus prioritise 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 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. However, existing Maturity Models provide weak or no traceability to their requirements hindering the capability of organizations to understand: (1) if the maturity models are aligned with current best practices or (2) if they are fit for the purpose of the assessment.

E-ARK projects focus on harmonizing currently fragmented solutions that support Archives services, especially in regard to Ingest, Archival Preservation and Dissemination of information. E-ARK solutions will be tested in an open pilot in various national contexts, using existing, near-to-market tools, and services developed by partners. In this deliverable, we create an Information Governance Maturity Model to enable the assessment of the use cases of the project, before and after the pilot. The Maturity Model focus on the most relevant references for Archival services especially those that are being improved in the context of the project.

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1. Introduction

Maturity models were first introduced due to different viewpoints from the executive vice president and the Information Technology (IT) Manager, in 1974 Nolan proposed four stages of growth for the IT department [1]. The model proposed by Nolan was composed of three types of growth (1) computer applications, (2) personnel specialization and (3) formal management techniques and organization. For each of these types he proposed four stages of growth that were represented by an s-curve as depicted in Figure 1. The four stages of growth are (1) Initiation, (2) Expansion, (3) Formalization and (4) maturity.

Stage 1 Cost-reduction accounting applications	Stage 2 Proliferation of applications in all functional areas	Stage 3 Moratorium on new applications; emphasis on control	Stage 4 Data-base applications
Payroll	Cash flow	Purchasing control	Simulation models
Accounts receivable	General ledger	Scheduling	Financial planning models
Accounts payable	Budgeting		On-line personnel query system
Billing	Capital budgeting		On-line customer query system
	Forecasting		On-line source data entry (e.g., cost collection, order entry)
	Personnel inventory		
	Order processing		
	Sales		
	Inventory control		

Figure 1. Nolan's Four Stages of Growth [2]

Nolan was a scholar at the Harvard University when he first published the four stages of growth, He then left Harvard and created a company Nolan, Norton & Co. where he further refined his work. Nolan's work was the first significant model for what IT planning is and how we can do it. It started as theories about computer systems in organizations which were then linked to organizational management and innovation theories. Then McFarlan [3], who was working with Nolan in Harvard, released the phases of assimilation in 1983. McFarlan's phases of assimilation proposal was a set of four phases, (1) Identification & Initial investment, (2) Experimentation & Learning, (3) Control and (4) Widespread technology transfer [4]. These phases were based on the assumptions that at different points in the Information Systems (IS) technology evolution the balance between planning pressures would shift, and planning would have different purposes in each of these shifts, so he identified four phases of technology assimilation, each with its own challenges.

Sullivan, Earl and Galliers further continued the evolution of Stages theories. These authors come from the organizational and management side of IS and, as with Nolan, these theories have gone through various iterations over time. These authors initially combined Nolan and Mcfarlan approaches but then developed their own specialized approach by focusing on the "organizational alignment" approach.

The Sullivan's model [5] reviewed the existing IS planning models in several major US companies and concluded that there are two key determinants of IS planning success (1) Infusion, which focus on the impact and importance of IS and (2) Diffusion, which focus on the decentralization and spread of IS. The effectiveness of the planning procedures is a correlation between these two factors and the type of planning approach.

Earl's Model was developed from Sullivan's Models, focusing on planning and organizational maturity in regard to planning while trying to give a more specific direction on what actions and organization should be taking at each of the five phases. [6] The five phases are (1) The organizations lacks IS resources and experience, (2) The IS department lacks understanding of the business and where IS can contribute, (3) Growing demand for IS creates a need for prioritization and control, (4) Business units starts to seek to use IS for competitive advantage and (5) IS becomes a key aspect of organizational business planning and directions. [7]

Galliers developed another version of the Earl's approach and has as its key organizational elements the strategy, structure, systems, staff, style, skills and goals [8] and has six stages of IS growth and maturity (1) Ad Hocracy, (2) Starting the foundations, (3) Centralized dictatorship, (4) Democratic dialectic and co-operation, (5) Entrepreneurial opportunity and (6) Integrated harmonious relationships.

These models vary in focus as to what the stages relate to. For example, Nolan's models depicted stages in level of experience in using IS and IT, while McFarlan and Sullivan stages related to the organizational impact of IT. Finally, Earl and Galliers depict stages in organizational maturity for IS planning and management. The stages models were the fathers of the current well known maturity models.

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 process can have its own Maturity Model, which will express quantitatively the maturity level of an organization regarding a certain process. A Maturity Model also provides 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 wide spread and accepted, both in industry and academia. There are numerous maturity models, 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 to understand the current level of maturity of a certain aspect in a meaningful way, so that stakeholders can clearly identify strengths and weakens requiring improvement, and thus prioritise 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.

Despite the numerous advantages of maturity models, one common criticism is that existing models lack empirical foundation and reality [46]. The fact is evidenced by the absence of theoretical frameworks and methodologies for the design and development of maturity models [46]. Consequently, maturity models tend to reflect the views of the stakeholders responsible for its creation on a specific problem. Although that does not nullify the value of maturity models it hinders its applicability since stakeholders are unable to (1) understand the requirements and views reflected on the maturity model and consequently (2) determine if the maturity model is suitable for purpose of their assessment. The problem is intensified by the lack or unsatisfactory documentation of existing maturity models [46].

The E-ARK Project focuses on harmonizing currently fragmented solutions that support Archives services, especially in regard to Ingest, Archival Preservation and Dissemination of information. In order to understand the value and applicability of E-ARK solutions, those will be tested in an open pilot in various national contexts, using existing, near-to-market tools, and services developed by partners. The goal of the work package this deliverable is part of is to assess the value and alignment of E-ARK solutions to existing best practices. This deliverable aims to develop an

Information Governance Maturity Model that will allow the assessment of the use cases of the project, before and after the pilot. Taking into consideration the criticism described above, the maturity model will be designed using an existing development method that will enhance the traceability between the requirements and the model itself.

2. Terms and Definitions

This section contains the definitions used throughout this deliverable. Most of the definitions come from SEI CMMI [32] due to the fact that this is one of the most detailed and formal documents containing all the definitions for maturity models and maturity models assessment.

Maturity: "The extent to which an organization has explicitly and consistently deployed processes that are documented, managed, measured, controlled, and continually improved. Organizational maturity can be measured via appraisals." [32]

Capability Maturity Model: "A model that contains the essential elements of effective processes for one or more areas of interest and describes an evolutionary improvement path from ad hoc, immature processes to disciplined, mature processes with improved quality and effectiveness." [32]

Capability Level: "Achievement of process improvement within an individual process area. A capability level is defined by appropriate specific and generic goals for a process area." [32] Another definition from ISO/IEC 15504, "a point on the six-point ordinal scale (of process capability) that represents the capability of the process; each level builds on the capability of the level below." [40]

Maturity Level: "Degree of process improvement across a predefined set of process areas in which all goals in the set are attained." [32]

Process: "A set of interrelated activities, which transform inputs into outputs, to achieve a given purpose. The terms process, sub-process and process element form a hierarchy with process as the highest, most general term, sub-processes below it, and process element as the most specific. A particular process can be called a sub-process if it is part of another larger process. It can also be called a process element if it is not decomposed into sub-processes. This definition of process is consistent with the definition of process in ISO 9000, ISO 12207, ISO 15504, and EIA 731." [32]

Process Area: "A cluster of related practices in an area that, when implemented collectively, satisfies a set of goals considered important for making improvement in that area." [32]

Assessment: "An examination of one or more processes by a trained team of professionals using an appraisal reference model as the basis for determining, at a minimum, strengths and weaknesses." [32]

Process Assessment: "A disciplined evaluation of an organizational unit's processes against a Process Assessment Model." [40]

3. Maturity Model Development Method

As described above, one recurrent criticism of maturity models is that they lack empirical foundation and traceability [46]. The main reason for the criticism is that existing maturity models typically do not follow a theoretical framework or methodology for their development [46]. In fact, there is an absence on literature regarding methods and practices for the design and development of maturity models [46].

One of the most known development model for maturity models is the one from Becker in [41], a procedure based on a scientific research method called Design Science Research (DSR). The well-argued claim of the design procedure [41] 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 is depicted in Figure 2 (below). It delineates eight requirements (R1 – R8) [41]:

1. R1 – **A 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. R2 – **Iterative Procedures** are followed to ensure a feedback loop and refinement;
3. R3 – The principles, quality and effectiveness behind the design and development effort of a maturity model should pass through an iterative **Evaluation** step;
4. R4 – The design and development of maturity models should follow a **Multi-methodological Procedure** which use must be well founded;
5. R5 – 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. R6 – **Problem Definition** should include the application domain for the maturity model and also detail the intended benefits and constraints of application;
7. R7 – There should be a **Targeted Presentation of Results** regarding the users' needs and application constraints;
8. R8 – 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.

This deliverable is structured according to the different stages of the development method proposed by Becker [41]. Therefore, Section 4 describes the problem in focus and compares existing maturity models, and section 5 describes the development strategy and the resulting maturity model. It is important to notice that this deliverable focus only on the first four stages of the method regarding the development of the maturity model. Deliverable 7.2 will focus on the application of the maturity model on the use cases before the project pilot, i.e. the next three stages of the method. Deliverable 7.5 will iterate the development of the maturity model based on the application results to improve and extend the maturity model. Finally, deliverable 7.6 will apply the final version of the maturity model after the project pilot.
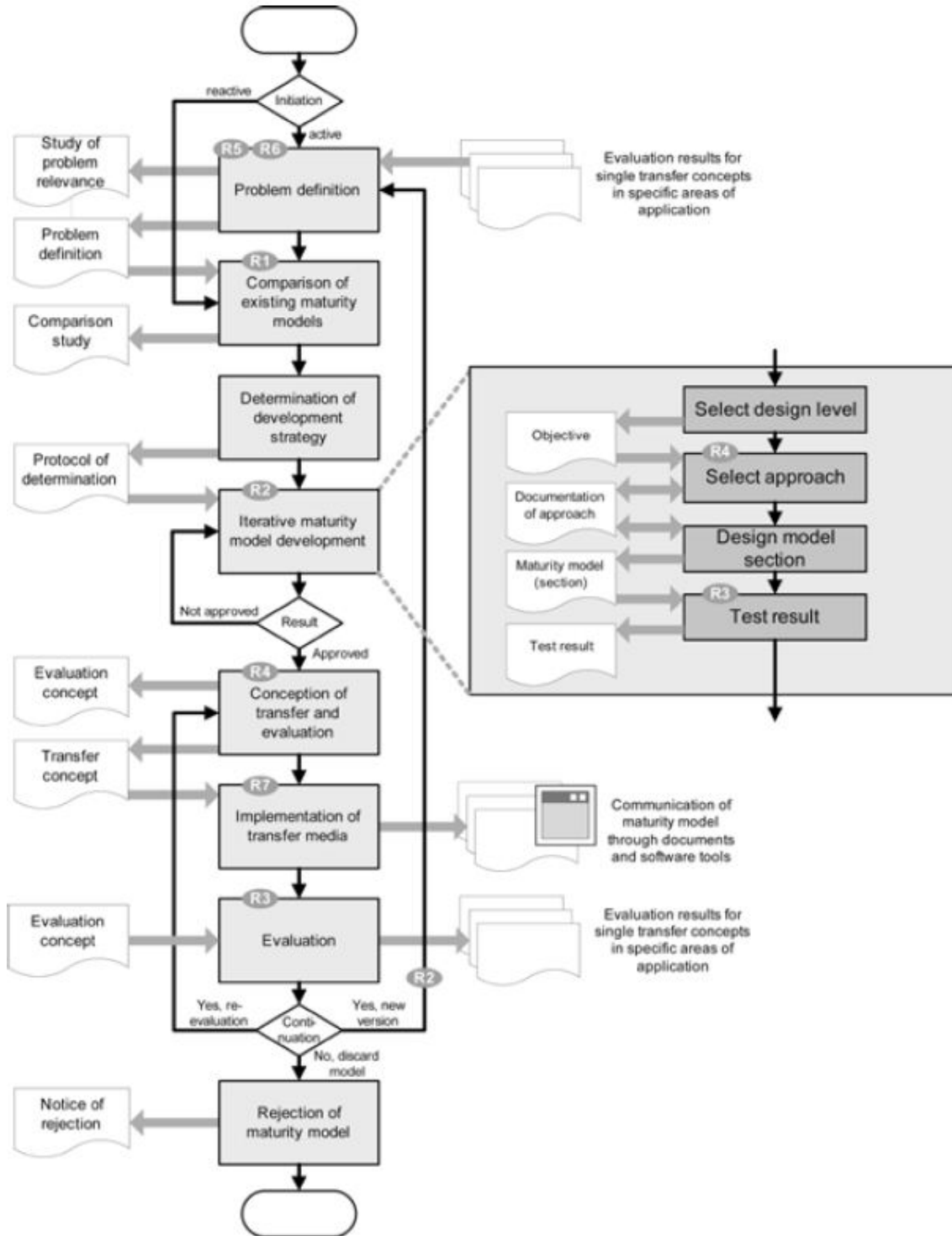
Figure 2 .Maturity Model Design Procedure [41]

4. Information Governance Maturity Models

According to ISO 38500 [47], Governance is "the system by which organizations are directed and controlled". In other words, Governance is the set of policies, processes, activities, rules, etc. that direct, manage and act on an organization. One of most known fields of Governance is IT Governance - the governance of IT systems and resources. In fact, the rising interest and the proliferation of IT Governance references has led to definition of similar fields such as Information Governance (IG). IG is an emerging term used to define the multi-disciplinary field of effectively and efficiently manage information. In fact, IG covers either in whole or in part many sub-disciplines such as Content Management, Document Management, Records Management, Digital Asset Management, Risk Management, among others.

E-ARK project focus on three major processes of an archive: Ingest, Archival Preservation and Dissemination of information. One can say that E-ARK project focus on a sub-discipline of IG – Archival Management. The maturity model developed in this deliverable focus on Archival Management. However, the deliverable takes into account that Archival Management is only a subset of IG and others exists. Therefore, it compares existing maturity models on the various subsets of Information Governance. Additionally it also analyse generic and well-known maturity models to identify and understand the basic principles behind those models. Each maturity model is described by the following information:

- (Short) **Description** of the model;
- **Aim** and purpose of the model;
- **Scope** of the model;
- **How to assess** (apply) the model;
- **Term used to name the Attributes** of the model;
- The **Attributes** of the model; and
- A summary of the levels of the maturity model;

4.1. Generic Process Maturity

This sections analyses generic maturity models for process improvement. In theory, this models can be used to improve processes independently of the domain and context of those processes.

4.1.1. OMG Business Process Maturity Model

Description: The Open Management Group (OMG) created the Business Process Maturity Model (BPMM) in 2008 to address the following five challenges of enterprise systems success (1) The lack of standards for appraisal of the maturity of the business process workflows and the lack of methods for identifying process weaknesses and the risks they pose for achieving business goals and successfully deploying projects; (2) The lack of methods for the appraisal of the alignment between how tasks are performed and how they are described in model representations of process workflows; (3) The unawareness of the extent to which growth and acquisitions have resulted in multiple ways of performing similar tasks; (4) The lack of methods for the appraisal of a supplier's capability for delivering outsourced IT and other business services within the parameters defined in a proposal or contract; and (5) The lack of guidance on how to implement the foundations of business processes required in order to guarantee organizational agility and lower operating costs [[9]].

Aim: Improve the success of business process management implementations in organizations by guiding business process improvement programs, assessing the risk of developing and deploying applications, assessing the supplier's capability and benchmarking.

Scope: Generic for Business Process Management.

How to Assess: Not specified.

Term used to name of the Attributes: Process Areas.

Attributes (30): Organizational Improvement Planning; Organizational Performance Alignment; Defect and Problem Prevention; Continuous Capability Improvement; Organizational Innovative Improvement; Organizational Improvement Deployment; Organizational Common Asset Management; Organizational Capability and Performance Management; Product and Service Process Integration; Quantitative Product and Service Management; Quantitative Process Management; Organizational Process Management; Organizational Competency Development; Organizational Resource Management; Organizational Configuration Management; Product and Service Business Management; Product and Service Work Management; Product and Service Preparation; Product and Service Deployment; Product and Service Operations; Product and Service Support; Organizational Process Leadership; Organizational Business Governance; Work Unit Requirements Management; Work Unit Planning and Commitment; Work Unit Monitoring and Control; Work Unit Performance; Work Unit Configuration Management; Sourcing Management; Process and Product Assurance.

Table 1. Summary of the OMG Business Process Maturity Model levels

Number	Level	Description
1	Initial	Business processes are performed in inconsistent and sometimes adhoc ways with results that are difficult to predict.
2	Managed	The work is stabilized within local units to ensure it is performed in a repeatable way. Despite this, units performing similar tasks are using different procedures.
3	Standardized	Processes begin to emerge, based on information collected from best practices.
4	Predictable	The capabilities delivered by standard processes are used and provided to the units. Process performance is managed using statistical analysis and can be measured during intermediate states of a process.
5	Innovating	Improvement actions for the processes are focused on closing gaps between the organization's current capability and the capability necessary for the organization to meet its goals.

4.1.2. Gartner BPM Maturity Model

Description: Gartner created a Business Process Management (BPM) maturity model in an attempt to show organizations where they are positioned in relation to the critical success factors of a successful BPM implementation [10]. This maturity model consists of six phases and details the critical success factors for each phase, the competencies needed, the challenges and the triggers that make an organization transition from one phase to another.

Aim: Raise awareness of the current implementation of BPM in organizations.

Scope: Generic for Business Process Management.

How to Assess: Not specified.

Term used to name of the Attributes: Critical Success Factors.

Attributes (6): Strategic Alignment; Culture and Leadership; People; Governance; Methods; Information Technology.

Table 2. Summary of the Gartner BPM Maturity Model levels

Level	Name	Description
0	Acknowledge Operational Inefficiencies	The organization monitors and measures the business activities
1	Process Aware	The organization models and analyzes business processes. It also establishes process performance metrics and identifies process owners and the overall governance structure.
2	Intraprocess Automation and Control	There is a direct link from process model and rules to execution. There is a comparison of alternatives motivated by a variety of optimization techniques in real time. There is also integration between activity-based accounting and process steps.
3	Inter-process Automation and Control	There is realignment between process and market strategy. There is process automation and control across the organizations, the clients and partners.
4	Enterprise Valuation Control	There is a business performance framework that links the valuation of the business and process execution. There are goal-driven processes.
5	Agile Business Structure	There is a culture of innovating new businesses, products and services through and agile business structure.

4.1.3. Business Process Maturity Model (BPMM)

Description: The Business Process Maturity Model (BPMM) provides a roadmap for organizations and adapts to the process areas for different business processes [17]. The BPMM aids the organizations to set priorities for improving their Business Process Management practices by using an established strategy and achieving the capability necessary to achieve its business strategy. The BPMM also helps analyse whether the processes meet stakeholders needs and expectations comparing the current maturity level to the desired level by performing gap analysis. The BPMM is based on many elements of the Key Performance Areas (KPAs) of CMM/CMMI, IS12207 and IS15288.

Aim: Regarding business process management, compare the maturity of an organization to the industry standard.

Scope: Generic for Business Process Management.

How to Assess: Not specified.

Term used to name of the Attributes: Elements.

Attributes (4): Focus of KPAs; Measurement & Analysis; Monitoring & Control; Organizational Process Improvement.

Table 3. Summary of the Business Process Maturity Model (BPMM) levels

Level	Name	Description

1	Initial	The process is monitored and controlled in an ad-hoc way.
2	Management	The process is not defined or partially defined; process performance is measured partially; Process Performance is monitored and controlled for a work unit; Performance data is not used for process improvement.
3	Defined	The process is defined; process and mechanism performance is measured for the whole organization; Process performance is monitored and controlled for the whole organization; Partial performance data is used in an ad hoc way for process improvement.
4	Quantitatively Managed	Process Performance is measured quantitatively; Process performance is controlled systematically; Performance data is used in an ad-hoc way for process improvement.
5	Optimizing	Process Performance is monitored and controlled in a proactive way; Performance data is systematically used to improve and optimize the process.

4.1.4. Software Engineering Institute Capability Model Integration (CMMI)

CMMI is divided into three constellations, which can be applied to different kinds of organizations. A constellation is "a collection of components that are used to construct models, training material, and appraisal materials in an area of interest." [31] There are two constellations in CMMI 1.3, (1) Development [31], which supports organizations that develop products and (2) Acquisition [32] which supports an organization in getting products or services from external suppliers. There is also material to another constellation, Services [33], which is intended to support organizations that primarily deliver services rather than products. This analysis will focus on the development constellation of CMMI.

Description: The Capability Maturity Model Integration (CMMI) was developed in sponsorship by the US Department of Defense teamed up with the National Defense Industrial Association (NDIA). Then in 2000, the Software Engineering Institute (SEI) at Carnegie Mellon University created a stewardship to produce the first integrated CMMI models, with the companion appraisal and training material. In the year 2002 the CMMI version 1.1 was released, then in 2006 the version 1.2 was released and in 2010 version 1.3 was released. The CMMI Suite contains information and guidance to help an organization improve its processes. The CMMI models are composed of two kinds of materials, (1) Materials that help in the evaluation of organization processes, which provides essential information to the management, support and technical activities and (2) Materials which help improve process performance, which provides information which can be used to increase the capability level of an organization's activities.

Aim: The main objectives of CMMI are to reduce the cost of implementing several process improvement models for each disciple are accomplished by the eliminating inconsistencies, reducing duplication, increasing clarity and understanding, providing common terminology, providing consistent style, establishing uniform construction rules [30].

Scope: Generic for Process Improvement

How to Assess: SEI developed a complementary document to assess CMMI. This document is SCAMPI for CMMI. SCAMPI stands for Standard CMMI Appraisal Method for Process Improvement. This document contains a very detailed method to use for appraisal using CMMI. It covers the whole assessment cycle from planning and preparing the assessment to the packaging and archiving of the appraisal assets used.

Term used to name of the Attributes: Process Areas.

Attributes (22): Causal Analysis and Resolution; Configuration Management; Decision Analysis and Resolution; Integrated Project Management; Measurement and Analysis; Organizational Process Definition; Organizational Process Focus; Organizational Performance Management; Organizational Process Performance; Organizational Training;

Product Integration; Project Monitoring and Control; Project Planning; Process and Product Quality Assurance; Quantitative Project Management; Requirements Development; Requirements Management; Risk Management; Supplier Agreement Management; Technical Solution; Validation; Verification.

Table 4. Summary of the Software Engineering Institute Capability Model Integration (CMMI) levels

Level	Name	Description
1	Initial	The process is unpredictable, weakly controlled and reactive.
2	Managed	The process is specific for a certain process and is still reactive.
3	Defined	The process is now defined for the whole organization and is proactive.
4	Quantitatively Managed	The process is now measured and controlled.
5	Optimizing	The process focus is now on continuous improvement.

4.1.5. ISO/ IEC 15504

Description: The ISO/IEC 15504 [39] was born as the "Software Process Improvement and Capability Evaluation" (SPICE) [38] in 1993. The acronym is still used today by the user groups of the standard and in the title of the annual conference. ISO 15504 is a reference model for maturity models that consist of capability levels that consist of the process attributes and further consist of generic practices. The standard is divided into nine components or parts which are, (1) Concepts and introductory guide; (2) A model for process management; (3) Rating processes; (4) Guide to conducting assessment; (5) Construction, selection and use of assessment instruments and tools; (6) Qualification and training of assessors; (7) Guide for use in process improvement; (8) Guide for use in determining supplier process capability; and (9) Vocabulary.

Aim: Determine the organization's current capabilities for delivering software and IT systems. Benchmark organizations.

Scope: Generic for Process Improvement

How to Assess: The standard provides a detailed assessment process in Part 3. [40] This assessment guides the whole assessment, from initiation to reporting.

Term used to name of the Attributes: Process Groups.

Attributes (9): Acquisition Process Group; Supply Process Group; Engineering Process Group; Operation Process Group; Management Process Group; Process Improvement Process Group; Resource and Infrastructure Process Group; Reuse Process Group; Support Process Group.

Table 5. Summary of the ISO/ IEC 15504 levels

Level	Name	Description
0	Incomplete Process	The process is not implemented. If implemented, the process does not achieve the purpose. There is little or no evidence of achievement of the process purpose.
1	Performed Process	The process is implemented and achieves its purpose.
2	Managed Process	The process is implemented and managed, which means that it is planned, monitored and enhanced. The inputs and outputs are defined, controlled and maintained.

3	Established Process	The process is now implemented using a defined process that includes guidelines to define the process and deploying it.
4	Predictable Process	The process now operates within defined limits, can be measured and controlled.
5	Optimizing Process	The process is now continuously improved to achieve current and future business goals.

4.2.   Information Governance

This sections analyses IG maturity models. As described above, IG is a multi-disciplinary field therefore the models analysed also represent disciplines that are considered relevant to IG..

4.2.1. Digital Asset Management (DAM) Maturity Model

Description: The DAM maturity model builds on the ECM3 maturity model [23]. This model was developed having in mind that the successful implementation of DAM in organizations goes beyond the use of technology. It requires a holistic approach which includes people, systems, information and processes. This maturity model provides a description of where an organization is, where does it need to be so that it can perform gap analysis and comprehend what it needs to do to achieve the desired state of DAM implementation. To assess the DAM ecosystem of an organization the DAM maturity model is divided into 15 dimensions that are structured into four categories.

Aim: Improve the success rate of DAM projects in organizations by providing a way of assessing the current state of the current implementation, as well as, an improvement path for enhancement of DAM.

Scope: Information Governance, more specifically Digital Asset Management.

How to Assess: There is a description on how to do a self-assessment. It should begin by identifying the stakeholders who identified the need for DAM and can advocate in favor of it. Then, a set of questionnaires must be created and administered to each of the stakeholders identified. Then the levels can be determined using the answers to the questionnaires.

Term used to name of the Attributes: Categories / Dimensions.

Attributes (4/15): People (Technical Expertise; Business Expertise; Alignment); Information (Asset; Metadata; Reuse; Findability; Use Cases); Systems (Prevalence; Security; Usability; Infrastructure); Processes (Workflow; Governance; Integration).

Table 6. Summary of the Digital Asset Management (DAM) Maturity Model levels

Level	Name	Description
1	Ad-Hoc	Ad-hoc approaches to DAM, unorganized, with no policies in place. There are no reuse procedures and instead of using existing digital assets people choose to recreate them. Organizational needs are unstructured and there is no value applied to user scenarios. There are exceptional or no procedures for asset lifecycle. Regarding Governance, there are no procedures in place. There is no intentional integration.
2	Incipient	There is casual technical expertise, business expertise and alignment. Metadata management is inconsistent, as well as, reuse of existing assets. Asset discovery is incipient with search engines being used and indexing started. Use cases requirements are gathered at the project-level. There are incipient security measures in place, being

3	Formative	system-specific. Single platform tools with no customization are being used. There are some informal workflows, some policies and formal procedures. Integration is not planned although there are some forced integrations between systems and processes.
3	Formative	There is demonstrated technical and business expertise, as well as, alignment. Assets are centralized. Metadata obeys to organizational vocabulary in use. There is a reuse strategy of assets. Asset discovery is improved, indexing is complete, and vocabulary terms are used to refine metadata. Requirements are now gathered at the program-level. There are efforts to combine and adopt DAM across the organization. There are centralized security controls. There is some degree of multi-platform support. There is informal Business-IT coordination. There are workflows in place with limited automation. Regarding governance, there are structure and codification guidelines for defining procedures. Integration vision is complete and there is understanding of the common standards.
4	Operational	There is operational technical and business expertise, and there is organized knowledge transfer. Regarding alignment, there are collaborations between organizational units to improve assets management. All new assets types are registered and linked to standards and best practices. Regarding metadata, there are taxonomies and assets types are registered and related. There is a reuse strategy for all assets. There is a federated search mechanism. Assets use cases are structured organized and prioritised. Security controls are enforced across the organization at the asset level. There is remote multi-platform that collects feedback from users. Change management and governance are integrated which leads to proactive implementations. There are automated processes for both systems and organizational units. Policies and procedures are disseminated and enforced. Responsibility and ownership is accepted. The integration visions uses defined and documented paradigms.
5	Optimal	Technical and business expertise is optimal and helps in understanding and participating in forecasting of future DAM needs and capabilities to improve future asset value. Alignment is optimal as there is preemptive use and enhancement of DAM capabilities to reveal present and prospect asset value. Assets are prepared and authorized for use and reuse. Assets are being used to manage metadata, there is enterprise taxonomy and metadata is complete and embedded with the asset. There is discovery of new uses for the assets past the original aim. Asset search and classification is a central service. There is a framework in place to define, measure and manage existing and new use cases. Security is implemented and enforced throughout the organization. There is a multilingual, multi-platform system in place. Workflows are standard practice with performance indicators in place. There is proactive refinement of governance procedures. Integration occurs in real time and is seamless.

4.2.2. Enterprise Content Management (ECM) Maturity Model

Description: In order to efficiently deploy ECM solutions organizations need to plan and develop a comprehensive strategy. That strategy must encompass the human, information and systems aspects of ECM [24]. If we look from a practical view, organizations cannot deal with all the ECM challenges at the same time. As such organizations need to enhance their ECM implementation step-by-step wise, by following a roadmap for ECM improvement. This maturity model provides the tools to build this roadmap by providing the current state of ECM implementation as well as a roadmap to reach the required maturity level.

Aim: Build a roadmap for ECM improvement, in a step-by-step fashion ranging from basic information collection and simple control to refined management and integration.

Scope: Information Governance, more specifically, Enterprise Content Management.

How to Assess: No assessment method described, the way of getting the current level is done by the organization itself by checking if the organization possesses all the requirements for a given level regarding a specific dimension.

Term used to name of the Attributes: Categories / Dimensions.

Attributes (3/13): Human (Business Expertise; IT; Process; Alignment); Information (Context/Metadata; Depth; Governance; Re-Use; Findability); Systems (Scope; Breadth; Security; Usability)

Table 7. Summary of the Enterprise Content Management (ECM) Maturity Model levels

Level	Name	Description
1	Unmanaged	Content is not managed formally. There are distributed share drives, documents are stored in local hard drives. There is redundant data; content discovery is not possible which results in people need to create the same content over and over.
2	Incipient	Particular sets of content are managed through projects driven approaches. There are redundant products being used, although insufficiently applied and not commonly used.
3	Formative	There is an inventory of content. Plans, policies and procedures are in place, although still in the implementation phase. There are several projects in development although might fail due to the absence of a strategy. Information lifecycle management principles are being implemented.
4	Operational	There is universal content management across the organization, although it is scattered through several systems. There are retention schedules. There is a decision on what content is excluded from management. There is collaborative content management in place.
5	Pro-Active	Content management is available across the organization and is a shared service. The organization can implement new technologies such as digital asset management as a result of a flexible architecture in place. Information management issues and the business drivers are fully understood.

4.2.3. Research Data Management (RDM) Maturity Model

Description: The research data management (RDM) maturity model was developed by the school of information studies at the university of Syracuse in the USA. It is based on the number and name of levels of CMMI, as well as, the principles of each level. It makes several references throughout the levels to CMMI and contains five levels spread among five key process areas specific to RDM. RDM has become a treading topic in data management as increased importance from government agencies, such as, the US National Science Foundation. These funding agencies are raising the issue of maintaining good RDM practices for the projects that are funded by them.

Aim: Raise awareness on RDM among research projects, such as, small science projects. Provide a conceptual model upon which policies, practices, and performance/impact assessment for FDM can be based.

Scope: Information Governance, more specifically Research Data Management.

How to Assess: Not specified.

Term used to name of the Attributes: Key Process Areas.

Attributes (5): Data Management in general; Data acquisition, processing and quality assurance; Data descriptions and representation; Data dissemination; Repository services and preservation.

Table 8. Summary of the Research Data Management (RDM) Maturity Model levels

Level	Name	Description
1	Initial	RDM focuses on projects, and there are no goals or practices defined. Also, there are no defined Processes, and if defined they are not stable. Organization is immature regarding processes, as individuals perform these intuitively. Skills and knowledge is low, often from students. Personnel changes might endanger RDM.
2	Managed	RDM still focuses on projects and has a reactive nature. There are processes at the project level, with policies and procedures. There is a RDM plan, however new projects mean that the existing processes, policies and procedures have to be redeveloped. Also, sharing between projects is difficult due to the different practices and processes among projects.
3	Defined	RDM processes have a proactive nature and are documented for the whole organization; these can then be specifically tailored to different projects. These processes include inputs, standards, work and validation procedures, as well as, compliance criteria. Organizations at this level can employ the similar metadata standards across projects.
4	Quantitatively Managed	RDM processes are now quantitatively measured; these have established "quantitative objectives for quality and process performance" [27][31]. These objectives are based on RDM user requirements and goals. The quantitative management of RDM processes means that there is better forecast of process performance as this is measured through "statistical and other quantitative techniques" [27][31].
5	Optimizing	The focus is now on continuously improve the RDM processes, by identifying weaknesses and defects and addressing them in a proactive manner.

4.2.4. Gartner Enterprise Information Management Maturity Model

Description: Enterprise Information Management (EIM) is defined by Gartner as the organizational commitment to "structure, secure and improve the accuracy and integrity of enterprise information; solve semantic inconsistencies across boundaries and; support the objectives of enterprise architecture and the business strategy" [13]. Before organizations begin to implement this commitment they must first identify the current state of the information management practices and then plan to further improve these practices. Gartner proposes six phases of maturity regarding EIM. Where in level 0 there are no EIM activities in place and in level 5 EIM is fully implemented in the organization. The main aim of using maturity phases for implementing EIM in organizations is that EIM cannot be implemented as a single project as it requires an ongoing building of skills and awareness that must occur in iterative phases.

Aim: Raise awareness of the current state of EIM practices in organizations and provide a list of actions to improve to the next level.

Scope: Information Governance, more specifically Information Management.

How to Assess: It provides examples on how to get questions from the maturity criteria. However, it does not provide a method or guidelines for assessment using this maturity model.

Term used to name of the Attributes: No attributes defined.

Attributes (0): No attributes defined.

Table 9. Summary of the Gartner Enterprise Information Management Maturity Model levels

Level	Name	Description
0	Unaware	IT and Business Leaders are educated on the value EIM and the risks of not having it in place in the organization.
1	Aware	Strategies to align EIM with Enterprise Architecture and other activities are drafted.
2	Reactive	Top management recognizes the need for EIM; the business case for EIM is prepared.
3	Proactive	The business case for EIM is now presented to management and other relevant stakeholders.
4	Managed	The information management activities and resources from the various departments are compiled and linked to the EIM strategy for the organization. EIM should now be regarded as a service instead of a project. There must be a balanced scorecard for information management.
5	Effective	Technical controls and procedures are in place to guarantee that there isn't a false sense of security on the EIM procedures in place, as these can easily turn ineffective due to business changes.

4.2.5. Records Management Maturity Model

Description: This maturity model was created by JISC infoNet and stands as a self-assessment tool for higher education institution in England and Wales [22]. It is based on a code of practice and its aim is to help in the compliance with this code although it is independent from the code and the future plans are to continue development and enhancement independent from this code.

Aim: Help higher education institutions to assess their current approach on records management in regard to recommendations issued by the United Kingdom government and benchmark against other similar organizations.

Scope: Information Governance, more specifically records management.

How to Assess: Self-assessment using a spreadsheet, consisting of statements for each of the nine sections. Users should choose the level that best suits the organization for each statement.

Term used to name of the Attributes: Section.

Attributes (9): Organizational arrangements to support records management; Records management policy; Keeping records to meet corporate requirements; Records systems; Storage and maintenance of records; Security & access; Disposal of records; Records created in the course of collaborative working or through out-sourcing; Monitoring and reporting on records management.

Table 10. Summary of the Records Management Maturity Model levels

Level	Name	Description
0	Absent	There is no evidence of awareness of the need to have a strategic approach to records management.
1	Aware	There are uncoordinated efforts to improve records management in reaction to identified issues.
2	Defined	Efforts are now coordinated in an attempt to enhance records management organization-wide.
3	Embedded	There is effective records management which is fully unified within the organization's

		strategic and operational activities.

4.2.6. Stanford Data Governance Maturity Model

Description: This maturity model is based on the Data Governance Program from Stanford and is centered on the institution as it was developed having in mind the goals, priorities and competences of Stanford. It focuses on both the foundations and the project aspects of data governance and measures the core data governance capabilities and development of the program resources [20]. The foundation aspects are Awareness, Formalization and Metadata. The project components are Stewardship, Data Quality and Master Data; this enables the maturity model to measure the effectiveness of the data governance concepts application on funded projects. The data governance maturity model is divided into dimensions namely people, policies and capabilities. It consists of a five level maturity grid for each of the foundation aspects and project components making a distinction to each dimension for every one of the aspects and components. The name for each of the maturity levels is not described in this model and is depicted in Table 11 as "-".

Aim: Measure the foundational aspects and project components of the Stanford's Data Governance program.

Scope: Information Governance, more specifically data governance.

How to Assess: It contains a catalogue of both qualitative and quantitative metrics that are used to calculate the maturity level.

Term used to name of the Attributes: Dimensions.

Attributes (3): People; Policies; Capabilities.

Table 11. Summary of the Stanford Data Governance Maturity Model levels

Level	Name	Description
1	-	There is limited awareness of data governance, policies are not documented. There are no defined roles. Metadata is not collected consistently.
2	-	Management is aware of the data governance program. There are data governance roles and responsibilities defined and agreed upon. There is metadata on structured data and best practices are collected and available.
3	-	Knowledge workers are aware of the data governance program and management understands how data governance impacts each unit of the organization. Common data policies are documented and available. There are some roles that support data governance needs and individuals understand their responsibilities.
4	-	Management understands the long-term goals of the data governance program and their role to attain them, they also promote the program. Knowledge workers understand the benefits and impacts of data governance in their units. Data policies are managed through a common system available to stakeholders on a selective basis. Roles are organized into schemas. Metadata collection and validation responsibilities are assigned to specific people.
5	-	Management and knowledge workers fully understand their roles in the data governance program, as well as, their contribution to the attainment of the long-term goals of the program. There is history of all data policies which are managed through a common system available to all stakeholders. The data governance organizational schemas are maintained as defined, there are regular meetings and activities are documented. There is a dedicated metadata management group, which aim is to enhance metadata capabilities.

4.2.7. Information Governance Maturity Model

Description: This maturity model builds on the generally accepted recordkeeping principles developed by ARMA. The principles provide high-level guidelines of good practice for recordkeeping although they do not go into detail to the implementation of these principles and do not have further details on policies, procedures, technologies and roles. The point of this maturity model is to address this gap by detailing what a successful implementation of information governance is at different levels of maturity. It consists of five maturity levels for each of the principles [25].

Aim: Help organizations understand the standards, best practices and regulatory requirements that enclose information governance, so that they can understand what are the successful information governance characteristics at differing levels of maturity.

Scope: Information Governance.

How to Assess: There are a series of steps to assess the current maturity level and identify the desired level. These steps are not formal and consist of simple statements of what to do without defined guidance on how to perform the steps.

Term used to name of the Attributes: Principles.

Attributes (8): Accountability; Transparency; Integrity; Protection; Compliance; Availability; Retention; Disposition.

Table 12. Summary of the Information Governance Maturity Model levels

Level	Name	Description
1	Sub-standard	Information Governance is not addressed or is addressed ad-hoc. Organizations at this level might not meet legal or regulatory inspection.
2	In Development	Information governance is starting to be recognized in the organization as essential to meet legal, regulatory, and business requirements. Organizations at this level are still susceptible to legal or regulatory inspection due to incomplete practices.
3	Essential	An organization at this level has the essential requirements necessary to meet the legal, regulatory and business requirements. There are clear policies and procedures. Process implementation takes into consideration the improvement of Information Governance. Organizations at this level might miss substantial opportunities for restructuring business and improve cost controls. These organizations are compliant, at a minimum, with legal and regulatory scrutiny.
4	Proactive	There is a proactive information governance program in place throughout the organization and there is continuous improvement of information governance. Information governance concerns are took in consideration when taking business decisions. These organizations meet legal and regulatory requirements and are compliant with good practices.
5	Transformational	Information governance is embedded into the business infrastructure and process. Legal and regulatory responsibilities are routine. Information governance is seen as a way to contain costs, gain competitive advantage, and improve the services provided.

4.3.   IT Governance

As described above, IT Governance is responsible for the rising of several fields such IG. Additionally, IG comprises all policies, processes, activities, rules, etc. that support the governance of information. Among those processes are the

governance of IT systems and resources related to IG such as, for example, records management systems or content management systems.

4.3.1. Business-IT Alignment Maturity Model

Description: Business-IT alignment implies applying IT in a relevant, timely and appropriate way that in in line with business needs, goals and strategy. It has been one of the main concerns of both business and IT experts and there is even a field dedicated on this problem, Enterprise Architecture. Its relevance has been further elevated by evidence that IT can influence and enhance industries and markets. [11]

Aim: Raise awareness of the alignment between business and IT in an organization.

Scope: Generic for any organization that uses IT in their business.

How to Assess: There is an assessment process to evaluate an organization, but there are no details on it.

Term used to name of the Attributes: IT-business alignment criteria.

Attributes (6): Communications Maturity; Competency/Value Measurement Maturity; Governance Maturity; Partnership Maturity; Scope & Architecture Maturity; Skills Maturity.

Table 13. Summary of the Business-IT Alignment Maturity Model levels

Level	Name	Description
1	Initial/Ad-Hoc process	Business and IT lack understanding; there are some technical measurements on competency and value. There are no formal processes, cost center and no reactive priorities. There is a conflict between IT and business as business sees IT as a cost of doing business. There is a traditional scope and architecture based on emails and accounting. Regarding skills, the IT takes risk and there is little reward. There is technical training.
2	Committed Process	There is limited business and IT understanding. Regarding value and competency there is functional cost efficiency. Governance is tactical at the functional level and occasionally responsive. IT is emerging as business asset and process enabler. The scope and architecture is based on transactions and the skills differ across functional units.
3	Established Focused Process	There is good understanding between IT and business. Regarding competency and value there is some cost effectiveness and a dashboard is established. Regarding Governance there is a relevant process across the organization. IT is seen as a business asset and process driver. Regarding scope and architecture, IT is integrated across the organizations. It is seen as an emerging value service provider and there is balanced technology and business hiring.
4	Improved/Managed Process	IT and Business are bonded/unified. Regarding competency and value IT is seen as cost effective, and is dashboard managed. In the governance aspect, IT is managed across the organization. IT enables and drives business strategy. The scope and architecture is integrated with partners. IT and business share risk and rewards.
5	Optimized Process	There are informal and pervasive communications. Value is extended to external partners. Governance is integrated across organizations and partners. There is an IT-business co-adaptive partnership. The scope and architecture evolves with partners. There are education, careers and rewards across the organization.

4.3.2. The IT Service CMM

Description: The objectives of the IT Service CMM are to allow providers to assess their capabilities of delivering IT services and provide guidelines and phases/levels for improvement of their IT service capability. In order to accomplish these goals the IT Service CMM measures the capability of the IT service processes implemented in the organization. [12]

Aim: Raise awareness of the current IT Service capabilities and provide an improvement path for organizations.

Scope: Providers delivering IT Services.

How to Assess: Not described.

Term used to name of the Attributes: Process Areas.

Attributes (21): Subcontract Management; Service Tracking and Oversight; Service Delivery Planning; Service Commitment Management; Service Quality Assurance; Event Management; Configuration Management; Problem Management; Resource Management; Intergroup Coordination; Training Program; Organization Process Focus; Organization Process Definition; Organization Service Definition; Service Delivery; Integrated Service Management; Quantitative Process Management; Service Quality Management; Process Change Management; Problem Prevention; Technology Change Management.

Table 14. Summary of the IT Service CMM levels

Level	Name	Description
1	Initial	The process of delivering IT service is ad hoc, and sometimes chaotic. Only few processes are defined and success relies on individual effort.
2	Repeatable	There are basic service management processes established. There is some degree of repeatability based on past experience.
3	Defined	IT service processes are documented, standardized and integrated in standard service processes. All the services provided by the organization use approved, personalized versions of the standard service processes used by the organization.
4	Managed	There are meticulous measurements for the IT service delivery process and service quality. Service processes and delivered processes are controlled quantitatively.
5	Optimizing	Process improvement is continuous and made possible by using quantitative feedback techniques from both the processes and innovative ideas and technologies.

4.3.3. Asset Management Maturity Model

Description: This maturity model originated from an evaluation in the Netherlands to investigate how asset managers deal with long-term investment decisions [21]. This evaluation took into consideration organizations that control infrastructures, such as, networks, roads and waterways and focus on the strategy, tools, environment and resources. The maturity model consists of five maturity levels and is detailed through four dimensions.

Aim: Understand how asset managers deal with long-term investment decisions and provide an improvement path for organization to improve the long-term investment decisions.

Scope: Management, specifically a subset of management entitled asset management.

How to Assess: An interview protocol is provided which consists of eleven questions in total, two or three for each of the dimensions.

Term used to name of the Attributes: Dimensions / Category.

Attributes (4): Strategy; Tools; Environment; Resources.

Table 15. Summary of the Asset Management Maturity Model levels

Level	Name	Description
1	Initial	Strategy and goals do not exist and are not agreed. Tools are used occasionally and there is no communication of uncertainty. Regarding the environment, answers are sought in an ad-hoc way. There is no separate funding for replacement.
2	Repeatable	Management has not defined a plan and there is no responsibility assignment. There is a small set of tools being used, and uncertainty is occasionally communicated. Regarding the environment, occasionally there are external parties who are consulted. There are funds for replacement of assets that are regularly deployed.
3	Defined	There are procedures at the organization unit level to set both policies and goals for asset management. Also at the organizational unit level, there are standard tools being used. Regarding the environment, there is a standard the unit level on how to negotiate with third parties. There is a way to allocate funds for replacement of assets.
4	Managed	The processes and responsibilities between organizational units are set. Standard methods and techniques are being used organization-wide. Uncertainties are shared and discussed. Regarding the environment, there are protocols to negotiate with external parties organization-wide. There is an allocation method for asset replacement funds which is implemented throughout the organization.
5	Optimizing	Management fully supports polices and strategy; and asset management is integrated in the organization. Tools used for asset management are continuously improved, updated and communicated. Uncertainties are now shared with business partners. Regarding environment, there is a coordination with policy makers and business partners. The method for allocation of resources is now flexible and oriented to future use.

4.3.4. COBIT 4.1 Maturity Model[1]

Description: This maturity model follows the approach from the Software Engineering Institute CMMI. However the implementation differs considerably from CMMI that focuses on engineering principles for software development. The model provides a generic scale, which is then specialized for each one of the 34 COBIT 4.1 processes. This maturity model enables management to easily place the organization on the maturity scale of six levels and understand what is necessary to improve to the next maturity level if needed [26].

Aim: Enable the comparison of an organization's current implementation of IT processes against industry standards, as well as, the identification of needed maturity improvement.

Scope: IT Management.

How to Assess: Either using the ISO15504 assessment method or using the COBIT's Process Assessment Model. There are IT goals and metrics that define what is expected from IT and how to measure it; then there are process goals and

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[1] The newest version of COBIT (COBIT5) does not provide a maturity model. Instead it adopts the ISO/IEC 15504 maturity model described in section 3.1.5.

metrics that define what processes must achieve and how to measure it; and finally there are activity goals and metrics the detail what should happen within each process and how to measure it.

Term used to name of the Attributes: Attributes.

Attributes (6): Awareness and Communication; Policies, Plans and Procedures; Tools and Automation; Skills and Expertise; Responsibility and Accountability; Goal Setting and Measurement.

Table 16. Summary of the COBIT 4.1 Maturity Model levels

Level	Name	Description
0	Non-existent	There are no IT processes implemented and this issue has not been recognized.
1	Initial/Ad hoc	The lack of process definition is recognized as an issue that needs to be addressed. Despite this there are no standard processes, there are instead ad hoc approaches in an individual basis that is unrepeatable. Management is not organized.
2	Repeatable but intuitive	There are comparable procedures being performed by different individual for the same task. No formal training and communication of procedures is in place. Knowledge is concentrated on individuals, which results in errors.
3	Defined Process	There are standardized and documented processes, which are communicated across the organization through training. Process deviation will most likely not be detected.
4	Managed and Measurable	Process compliance and monitoring is in place and takes action when processes are not working effectively. There is constant improvement of processes and contains good practice procedures. There is limited tools and automation.
5	Optimized	Processes now fully integrate good practices, based on continuous improvement and maturity modeling examples from other organizations. Workflows are automated in an integrated way by IT, which provides tools that enable the organization to adapt quickly to changes.

4.3.5. IT Capability Model Framework (IT-CMF)

Description: Initially developed by Intel's IT division, the IT capability maturity framework (IT-CMF) is now owned by the Innovation Value Institute (IVI) consortium based in NUI, Maynooth, Ireland [28]. IVI and Intel continue to work closely on joint development of the IT-CMF but now this activity happens under the support of the Intel Labs Europe (iLE) rather than Intel IT division. IVI's membership spans academic, industry, consulting, analyst, and professional bodies around the world. More than 200 companies around the world currently use the IT-CMF. It consists of four main pillars that can viewed as process areas that are then decomposed into critical capabilities (CCs) [29].

Aim: Enable better management and continual development of an organization's IT capability to deliver higher business value. It consists of four inter-related strategies for improving IT capability, identifying and prioritizing opportunities, reducing costs, and optimizing the business value of IT investments.

Scope: IT Management.

How to Assess: There are two types of assessment, a preliminary first assessment consisting of a questionnaire that can be filled on-line. There is a second type of assessment where a competent assessor that possesses a certification goes to the organization and performs an in-depth assessment of the organizations IT processes.

Term used to name of the Attributes: Main Pillars.

Attributes (4): Managing IT like a business; Managing the IT budget; Managing IT for business value; Managing the IT Capability.

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Table 17. Summary of the IT Capability Model Framework (IT-CMF) levels

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Level	Name	Description
1	Initial	Management of CCs at this level is ad-hoc & based on individual efforts with no systematic improvement attempts.
		IT may be viewed somewhat negatively as a necessary expense whose return on investment is hard to measure. Budget planning is almost non-existent.
2	Basic	Some effort has gone into understanding the IT landscape. This may be documented informally or in silos. Some tactical-level shared-thinking is beginning to emerge but not on a joined-up, organizational or strategic basis.
		IT is viewed as a "cost center" and seen simply as a technology supplier to the business. Focus is on predictable IT service performance and total cost of ownership.
3	Intermediate	Formal organization-wide documented processes are in place to help understand the IT landscape. It is often possible to identify & address gaps.
		IT is viewed as a "service center" and a technology expert. There is a systematic approach to cost reduction. Return on investments are easier to measure and are based clearly on individual business cases.
4	Advanced	Well-established, effective and proven processes exist, which yield a comprehensive picture of the IT landscape. Efficiency is evident; gaps are systematically identified and pro-actively addressed. IT is aligned to business strategies.
		IT is viewed as an "investment center". As a strategic business partner, IT engages actively in long-term strategic budget planning to meet the needs of the organization.
5	Optimizing	IT is enabling and influencing future business strategies. Documented IT processes are optimized for efficiency and regularly reviewed.
		IT is viewed as a "value center" and a core competency of the organization.

4.3.6. Group IT Controlling (GITC) Maturity Model

Description: GITC focuses on performing IT controlling to business groups. IT controlling involves using management accounting techniques to the IT domain. These techniques can be calculating the business value of IT, the costs, quality, functionality, as well as, time to delivery. [34][35][36] Applying these techniques to business groups results in GITC which applies these techniques across organizations pertaining to a certain group. This model was developed by the Institute of Information Management at the University of St. Gallen and uses the Design Science Research Method throughout the whole development. This method takes into consideration both the practical and scientific approaches to the maturity model development by following a maturity model development method [41], which is based on Design Science Research and will be described further on in section 5.

Aim: Enable cross-industry benchmarking, as well as, providing an instrument to assess the current state of GITC in organizations and a way to identify improvement opportunities.

Scope: IT Management.

How to Assess: An assessment procedure or method is not described. However, there are succinct examples of how the authors performed an assessment using the framework of Frank [37], as well as, expert interviews.

Term used to name of the Attributes: Dimension / Sub-dimension

Attributes (3/6): Strategy; Process; Information System / Group-wide standardized terms and methodologies; Controlling objects; Utilization of core controlling processes; Repetition of core controlling processes; Data Integration; Data quality.

Table 18. Summary of the Group IT Controlling (GITC) Maturity Model levels

Level	Name	Description
0	GITC not existing	GITC is not in place in the organization.
1	GITC prepared	No standardized terms or methodologies. No performance indicators. No process for IT cost and performance. Data is collected in an ad-hoc basis. No data quality assurance.
2	GITC engaged	Basic standardized terms. GITC focuses on financial performance. There is monitoring of IT costs and performance. Data is collected manually. Basic data quality assurance.
3	GITC established	Standardized terms and basic methodologies. In addition to financial, non-financial performance indicators are also used. There are processes to monitor and plan IT cost and performance. Data collection is partly automated. Quality assurance now takes into consideration various organizational units.
4	GITC managed	Standardized terms and methodologies aligned across organizations. Financial and non-financial performance indicators are balanced. There are processes to plan, monitor, and steer IT cost and performance. Data collection is fully automated. Quality assurance now takes into consideration various systems.
5	GITC optimized	Standardized terms and methodologies aligned and adjusted across organizations. Objects controls are reviewed frequently according to stakeholders' objectives. IT cost and performance, planning, monitoring and steering are continuously improved and aligned. Data collection is fully automated and continuously optimized. Data quality is continuously improved and measured.

4.4.   Risk Management

Risk Management is a vital component of Governance. Governance, Risk Management and Compliance (GRC) is a discipline that defends that in order to effectively manage an organization it is necessary to align the practices of GRC.

4.4.1. Risk Maturity Model

Description: This maturity model was created to address the gap found on the implementation of risk management in organizations. Despite there being unanimity on the relevance of risk management, successful implementations of risk processes in organizations are sparse [19]. This maturity model consists of four maturity levels which are then linked to four attributes detailing specific criteria for culture, process, experience and application.

Aim: Provide a framework to which organizations that are implementing formal risk management or wish to improve their current approach can benchmark their current state of risk management practice.

Scope: Generic to Risk Management.

How to Assess: Self-assessment questionnaire.

Term used to name of the Attributes: Attributes.

Attributes (4): Culture; Process; Experience; Application.

<p align="center">Table 19. Summary of the Risk Maturity Model levels</p>

Level	Name	Description
1	Naïve	The organization does not recognize the need for risk management. There is no approach to deal with uncertainty. Management processes are reactive and repetitive. There is no effort or just little effort to learn from the past and prepare to the future.
2	Novice	There are a minimal number of individuals testing risk management. There is no generic approach to uncertainty being used. The organization is now aware of the benefits of risk management; however there is an ineffective implementation which hinders the realization of the full benefits.
3	Normalized	Risk management is now a routine business process. Most, if not all projects, have now implemented risk management. Generic risk processes are formalized. The benefits of risk management are understood across the organization, but are not always achieved.
4	Natural	The organization has a risk-aware culture and there is proactive risk management business-wide. Risk information is actively used in order to improve business processes and obtain a competitive edge. There is now emphasis on opportunity management, the positive approach to risk.

4.5.   Software Engineering Governance

Software Engineering Governance is another subset of Governance that is defined as the set of structures, processes and policies by which and organization manage and control software.

4.5.1. Documentation Process Maturity Model

Description: The Documentation Process Maturity Model is a way of describing in terms of process maturity, capability and practices the way that an organization generates system documentation in a software development process. [14] This maturity model contains four maturity levels and provides an assessment method for the assessment of the maturity level. A level four maturity represents an ideal implementation of the documentation process in an organization. The model and assessment method were based and influence by the SEI CMMI as there are key practices, indicators and challenges identified for each of the four levels of the model [31]. The assessment process consists of a questionnaire delivered to each member of the software project team that takes 30 minutes to fill. Then, the answers are used to create an assessment report which shows the current maturity level, as well as, the identification of improvement points and challenges to improve to the next level.

Aim: Raise awareness on the importance of well-established and complete documentation processes and procedures for software engineering projects.

Scope: Generic for Software Engineering.

How to Assess: This maturity model provides an assessment method using 30 minutes interviews with an entire software development team .

Term used to name of the Attributes: No attributes defined.

Attributes (0): No attributes defined.

Table 20. Summary of the Documentation Process Maturity Model levels

Level	Name	Description
1	Ad-hoc	There is chaos and variability, documentation is not a high priority.
2	Inconsistent	There is a documentation policy or standards; there is a mechanism to check that the required documentation is done and there is adherence to the defined documentation policy or standards.
3	Defined	There is a defined process for the creation of documents; there are methods to assure the quality of documentation; there is an assessment of the usefulness of documentation.
4	Controlled	There are measures and analysis of documentation process quality and usefulness; there is a process improvement feedback loop.

4.5.2. Metrics Based Verification and Validation Maturity Model (MB-V2M2)

Description: Software verification and validation (V&V) is the process of checking whether a software product conforms to its specification and whether the software does what the user wants. [16] Despite V&V being a process that has been in use for ages, many organizations still struggle and sometimes fail to implement a comprehensive verification and validation process. Having this in mind, MB-V2M2 aims at providing (1) a set of steps and activities to improve the V&V process; (2) precise V&V maturity models; (3) a method to assess the V&V maturity; (4) measurements to determine the efficiency of improvement activities and (5) metrics to track and control the execution of improvement actions and focus process improvement. [15]

Aim: Create an understanding of what a sound V&V process is, how should V&V process improvement be organized and implemented. Raise awareness of the risks of not having a sound V&V process in place.

Scope: Generic for Software Engineering.

How to Assess: A number of checklists have been developed to assess the maturity level.

Term used to name of the Attributes: Fundamental Factors.

Attributes (4): People; Technology; Process; Organization.

Table 21. Summary of the Metrics Based Verification and Validation Maturity Model levels

Level	Name	Description
1	Initial	V&V shows that software products work. V&V is performed in an individual and ad-hoc way when time allows and only after coding. V&V works by finding and correcting issues, there is a lack of resources, tools and trained staff.

2	Repeatable	Basic V&V practices are in place but still works as a detection of defects. V&V is performed by executing code but is now achieved in a systematic and managed way.
3	Defined	V&V is embedded into the development life cycle. V&V now verifies the requirements defined in the specification documentation using a defined and repeatable process, documented in methods, standards and procedures. V&V now starts at the requirements phase and is recognized as a profession having a training and career development plan.
4	Managed & Aligned	V&V practices are measured and aligned and is considered as a quality measurement of software products. V&V is controlled using measurements and statistical analysis.
5	Optimizing	V&V is now a full-fledged software product quality control. It is modernized, clear, managed and a repeatable process. V&V is continuously improving. V&V now prevents defects from occurring. Costs, efficiency, and effectiveness are now quantitatively measured.

4.5.3. Model-driven Development (MDD) Maturity Model

Description: The MDD Maturity model is a model that aims at helping organizations introduce MDD. It builds from the fact that several organizations have successfully applied MDD as reported by the Open Management Group [18]. Despite the findings of this report, introducing MDD methods and tools is not a simple task. Implementing MDD in an organization requires organizational change in processes and the overall culture. The purpose of this maturity model is to help organizations in the implementation of MDD by providing an improvement path that organizations can follow to improve their MDD implementation [18]. This improvement path consists of five levels. Each level is then associated to practices, which are activities both specific to MDD and general to software engineering. Each level is also associated with MDD elements which are the artefacts used in MDD, such as, models, transformations, tools and documentation. This maturity model is in line with CMMI and although independent from CMMI it works as complement to it.

Aim: Help organizations implementing MDD so that they reach a level where there are reusable models being used in development.

Scope: Generic for Software Engineering.

How to Assess: Not explicitly described. The assessment method is not described, however the assessment will be based in two aspects, for each maturity level, (1) whether the practices and elements are present and (2) whether the elements attributes have the values consistent with the maturity level being assessed.

Term used to name of the Attributes: MDD Practices.

Attributes (3): Engineering; Project Management; Support.

Table 22. Summary of the Model-driven Development (MDD) Maturity Model levels

Level	Name	Description
1	Ad-hoc Modelling	Modelling activities are occasionally used or not used. Individuals may use some models for their own work. There are no policies or common understanding to these models. There are no specific goals on modelling activities or artefacts.
2	Basic MDD	Modeling techniques are identified. The Technical model are defined. Code and documentation is generated from the technical model. The code is completed in order to comply with all the requirements. At a project level modelling tools are selected based on the project objectives.

3	Initial MDD	A business model is defined. Transformations from the Technical model to text are defined. There is separation from generated and non-generated code. Models are checked for well-formed rules; metrics are defined, gathered and analyzed. At a project level, a workflow is defined for the MDD projects and modelling activities coverage is decided. There are repositories for models and transformations. Measures of the modelling activities are defined, gathered and analyzed.
4	Integrated MDD	An architecture centric metamodel is defined. The domain model is defined. Transformations from the business model to the technical model are defined. Models are simulated. There is a separation from the technical models of the product and the system.
5	Ultimate MDD	Domain specific languages are defined. The metamodels are continuously validated and improved. Transformations from the domain model to the business model are defined. There is a model-based Validation and Verification. Strategic MDD elements are established and maintained.

4.6. Comparison of existing maturity models

From the previous analyses we can conclude that the selected maturity models do not detail the development method used, apart from the GITC Maturity Model [35]. The method is the same as the one described in [41] and in section 3 of this document. Additionally, we can reach the conclusion that there are several attributes being used. If we look at the models that are based on the SEI CMMI they all use process areas as attributes. Process areas are aggregations of processes according to their objective.

However other maturity models use other attributes, such as, dimensions. Dimensions are different viewpoints of the maturity model subject. For example, the COBIT 4.1 Maturity Model has six dimensions that evaluate IT Processes from different viewpoints, such as, tools and automation or plans and procedures.

The conclusion is that maturity models do not use a single attribute, many even use more than one attribute, such as, dimension and sub-dimensions when the maturity model subject is too complex and needs to be further decomposed.

Despite this, the attributes have three objectives: (1) Decompose the Maturity Model into easily understandable sections; (2) Aggregate several business processes into process areas that aggregate processes meeting the same business goal and (3) Provide different viewpoints of the maturity level.

We can also conclude that maturity models use different maturity levels. There is no standard number of maturity levels. Despite this, when maturity models are based or follow the SEI CMMI they often use the same five levels used by it and even try to maintain the same maturity level guidelines used by CMMI.

Other models use a number of maturity levels deemed relevant for the maturity model subject which vary from four to six, based on the maturity models analysed. The ones that use four levels, in line with Nolan's four stages, do not reference it, so our conclusion is that despite having the same number of levels/stages they are not basing their work in Nolan's four stages. There are also models that use level 0. This level usually depicts that there is complete lack of maturity and there lacks even the perception of the need of the maturity model subject. In conclusion, maturity models can use various quantities of maturity levels, according to the maturity model subject. The ones based on SEI CMMI usually use the five levels. There are also maturity models that use level 0.

5. A Maturity Model for Information Governance

This section focuses on the development strategy used for developing the maturity model for information governance. 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 deliverable in 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:

- **ISO 16363:** Space data and information transfer systems – Audit and certification of trustworthy digital repositories;
- **ISO 20652:** Space data and information transfer systems -- Producer-archive interface -- Methodology abstract standard;
- **ISO 14721:** Space data and information transfer systems – Open archival information system – Reference model;
- **MoREQ 2010:** Model Requirements for the Management of Electronic Records;
- **ISO 11442:** Technical product documentation – Document management;
- **ISO 13008:** Information and documentation – Digital records conversion and migration process;
- **ISO 15489:** Information and documentation – Records management;
- **ISO 16175:** Information and documentation – Principles and functional requirements for records in electronic office environments;
- **ISO 17068:** Information and documentation – Trusted third party repository for digital records;
- **ISO 18128:** Information and documentation – Risk assessment for records processes and systems;
- **ISO 23081:** Information and documentation – Managing metadata for records;
- **ISO 30300:** Information and documentation – Management systems for records – Fundamentals and vocabulary;
- **ISO 30301:** Information and documentation – Management systems for records – Requirements;
- **ISO 38500:** Corporate governance of information technology;
- **ISO 27001:** Information security management.

Since E-ARK project focus on Archival services and processes, in this deliverable we will focus on Archival references namely the **Trustworthy Repositories Audit & Certification (TRAC/ISO16363)** and the **Producer-Archive Interface Methodology Abstract Standard (PAIMAS/ISO20652)**. The former provides is a checklist to assess the trustworthiness of digital repositories based on the OAIS model [44]. The final version of TRAC was published in 2011, it contains 108 criteria that are divided into three main sections: Organizational Infrastructure; Digital Object Management; and Infrastructure and Security Risk Management. A successor version of TRAC, a standard for Trusted Digital Repositories (TDR), was published in February 2012 as the ISO 16363:2012 standard [43]. The latter, PAIMAS is an OAIS-based standard that describes the interface between Producers, i.e. the stakeholders responsible for the creation of the information, and the Archive.

It is important to note that the selected references are essential and enough to assess the use cases of the project since their focus is precisely the processes that are being improved in E-ARK (Ingest, Archival Preservation and Dissemination). However, it is the goal of the project to extend the Maturity Model by including other reference

requirements from others standards and documents. That extension will be included and described in detail on deliverable D7.5: "A Maturity Model for Information Governance – final version."

This sections describes the maturity dimensions and levels that are used for the E-ARK Information Governance Maturity Model. As described in section 3.6., existing maturity models differ regarding to dimensions and levels. For our maturity model we decided to use the dimensions described in ISO9001 and to base our levels on the ones defined in SEI CMMI. The former were selected due to their broader scope making them suitable for wider fields such as the one of IG. The latter were selected due to the fact that are well-known tested and used levels. In fact, most of the analysed maturity models used the same levels as the ones from SEI CMMI.

5.1.1. Dimensions

The E-ARK Maturity Model for IG, consists of three dimensions:

- **Management:** "The term management refers to all the activities that are used to coordinate, direct, and control an organization. In this context, the term management does not refer to people. It refers to activities. ISO 9000 uses the term top management to refer to people." [42]
- **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. Processes are interconnected because the output from one process becomes the input for another process. In effect, processes are "glued" together by means of such input output relationships." [42]
- **Infrastructure:** "The term infrastructure refers to the entire system of facilities, equipment, and services that an organization needs in order to function. According to ISO 9001, Part 6.3, the term infrastructure includes buildings and workspaces (including related utilities), process equipment (both hardware and software), support services (such as transportation and communications), and information systems." [42]

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

5.1.2. Levels

For each dimension a set of levels is defined, from one to five, where level shows 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 based on the levels defined for SEI CMMI. [31]

5.1.2.1. Level 1 (Initial)

At maturity level 1, information governance practice is viewed as something which is a 'good thing' but is ad hoc and chaotic. The organization usually does not provide a stable environment to support information governance. Success in these organizations depends on the competence of the people in the organization and not on the use of proven procedures. Practices are not documented and are not shared even within departments. This leads to variable levels of success in managing information assets. In spite of this chaos, maturity level 1 organizations often provide services that work, but they frequently exceed the budget and schedule documented in their plans. Maturity level 1 organizations are characterized by a tendency to over-commit, abandon proven practices in a time of crisis, and be unable to repeat their successes.

5.1.2.2. Level 2 (Managed)

At maturity level 2, the information governance procedures are planned and executed in accordance with locally-defined policies; the procedures employ skilled people who have adequate resources to produce controlled outputs; involve relevant stakeholders; are monitored, controlled, and reviewed; and are evaluated for adherence to their procedures descriptions. The discipline reflected by maturity level 2 helps to ensure that existing procedures are retained during times of stress. When these procedures are in place, these are performed and managed according to their documented plans. Also at maturity level 2, the status of the services are visible to management at defined points (e.g., at major milestones, at the completion of major tasks). Commitments are established among relevant stakeholders and are revised as needed. Services are appropriately controlled and satisfy their specified descriptions, standards, and procedures.

5.1.2.3. Level 3 (Defined)

At maturity level 3, information governance procedures are well characterized and understood, and are described in standards, processes, tools, and methods. The organization's set of standard procedures, which is the basis for maturity level 3, is established and improved over time. These standard procedures are used to establish consistency across the organization. A critical distinction between maturity levels 2 and 3 is the scope of standards, process descriptions, and procedures. At maturity level 2, the standards, process descriptions, and procedures can be quite different in each specific iteration. At maturity level 3, the standards, process descriptions, and procedures for a project are tailored from the organization's set of standard procedures to suit a particular project or organizational unit and therefore are more consistent except for the differences allowed by the tailoring guidelines. Another critical distinction is that at maturity level 3, procedures are typically described more rigorously than at maturity level 2. A defined process clearly states the purpose, inputs, entry criteria, activities, roles, measures, verification steps, outputs, and exit criteria. At maturity level 3, processes are managed more proactively using an understanding of the interrelationships of process activities and detailed measures of the process, its work products, and its services. At maturity level 3, the organization further improves its procedures.

5.1.2.4. Level 4 (Quantitatively Managed)

At maturity level 4, the organization and projects establish quantitative objectives for quality and process performance and use them as criteria in managing projects. Quantitative objectives are based on the needs of customers, end users, and organization. Quality and process performance is understood in statistical terms and is managed throughout the life of projects. Specific measures of performance are collected and statistically analysed. When selecting which aspects to measure and analyse, it is critical to understand the impact of these aspects on achieving the objectives for quality and process performance. Such an approach helps to ensure that monitoring using statistical and other quantitative techniques is applied to where it has the most overall value to the business. Performance baselines and models can be used to help set quality objectives that help achieve business objectives. A critical distinction between maturity levels 3 and 4 is the predictability of performance. At maturity level 4, the performance of projects and selected aspects is controlled using statistical and other quantitative techniques, and predictions are based, in part, on a statistical analysis of fine-grained data.

5.1.2.5. Level 5 (Optimizing)

At maturity level 5, an organization continually improves its procedures based on a quantitative understanding of its business objectives and performance needs. The organization uses a quantitative approach to understand the variation inherent in procedures and the causes of outcomes. Maturity level 5 focuses on continually improving performance through incremental and innovative procedures and technological improvements. The organization's quality and performance objectives are established, continually revised to reflect changing business objectives and

organizational performance, and used as criteria in managing improvement. The effects of deployed improvements are measured using statistical and other quantitative techniques and compared to quality and performance objectives. The project's defined procedures, and supporting technology are targets of measurable improvement activities. A critical distinction between maturity levels 4 and 5 is the focus on managing and improving organizational performance. At maturity level 4, the organization and projects focus on understanding and controlling performance at the procedures level and using the results to manage projects. At maturity level 5, the organization is concerned with overall organizational performance using data collected from multiple projects. Analysis of the data identifies shortfalls or gaps in performance. These gaps are used to drive organizational procedures improvement that generates measureable improvement in performance.

5.2.   ISO16363 and ISO20652 Mapping

This section details the mappings between the ISO16363 and ISO20652 and the dimensions and levels of the Information Governance Maturity Model. Using these mappings organizations can position themselves in the maturity levels by checking if they meet the required criteria for a certain level and dimension. One important aspect to have in consideration is the lack of mappings to levels 1, 2 and 5 of the Information Governance Maturity Model. Level 1 depicts a complete lack of documented and repeatable procedures in information governance, as such, that means that there are no criteria to be evaluated at this level. Level 2 depicts an organization where there is understanding of the need for information governance however procedures are informal, non-repeatable and performed by individual. As such, there might be some procedures in place that are in line with the criteria depicted in this section however as these are not properly formalized and defined these do not meet the level 3 specifications. For level 5, none of the standards depicted here have criteria for this level as it is characterized by top of the line procedures that often are not included in any standard and just in research papers. Organizations at this level fulfil all the levels below 5 which means that their procedures are formally defined and measured.

5.2.1. ISO16363

The ISO 16363 details the recommendation to audit and certificate trustworthy digital repositories. It contains a set of criteria divided into four major areas, (1) Organizational Infrastructure, (2) Digital Object Management, (3) Digital Object Management, and (4) Infrastructure and Security Risk Management. This standard uses the same terminology as found in the ISO14721, the Open Archival Information System (OAIS) standard. The criteria detailed in the ISO16363 are useful to provide assessment criteria for the Information Governance Maturity Model. As such, the criteria in the ISO16363 were mapped to the dimensions and levels of the maturity model and are detailed in the subsections below. One aspect to take into consideration is that the fulfilment of the criteria of ISO16363 is not to be considered as all that is needed to reach a certain level. In this first version of the maturity model also the ISO20652 criteria must be taken into consideration.

5.2.1.1.   Management

This section presents the mapping of the ISO16363 to the management dimension of the Information Governance Maturity Model. The source of criteria for this dimension was adopted from the organizational infrastructure section of the ISO16363. The section reference is depicted so that traceability between these mappings and the ISO16363 are maintained. Levels 1 and 2 were not mapped to the ISO16363 as this standard criteria correlates to the level 3 and 4 where procedures and documents are formally defined and in level 4 also measured.

Table 23. ISO16363 Mapping to the management dimension and levels of the Information Governance Maturity Model (based on [43])

Level	ISO16363 Section	Criterion
3	3.1.1	The organization has a mission statement that reflects a commitment to the preservation of, long term retention of, management of, and access to digital information.
3	3.1.2	The organization has a Preservation Strategic Plan that defines the approach the organization will take in the long-term support of its mission.
3	3.1.2.1	The organization has an appropriate succession plan, contingency plans, and/or escrow arrangements in place in case the organization ceases to operate or the governing or funding institution substantially changes its scope.
4	3.1.2.2	The organization monitors its organizational environment to determine when to execute its succession plan, contingency plans, and/or escrow arrangements.
3	3.1.3	The organization has a Collection Policy or other document that specifies the type of information it will preserve, retain, manage, and provide access to.
3	3.2.1	The organization has defined the adequate skills and experience that staff must possess to fulfil the duties that it needs to perform.
4	3.2.1	The organization has appointed staff with adequate skills and experience to fulfil the duties that it needs to perform.
3	3.2.1.1	The organization has identified the duties that it needs to perform.
4	3.2.1.1	The organization has established the duties that it needs to perform.
4	3.2.1.2	The organization has the appropriate number of staff to support all functions and services.
3	3.3.1	The organization has defined its Designated Community and associated knowledge base(s) and shall have these definitions appropriately accessible.
3	3.3.2	The organization has Preservation Policies in place to ensure its Preservation Strategic Plan will be met.
3	3.3.2.1	The organization has mechanisms for review, update, and ongoing development of its Preservation Policies as the repository grows and as technology and community practice evolve.
3	3.3.3	The organization has a documented history of the changes to its operations, procedures, software, and hardware.
3	3.3.4	The organization commits to transparency and accountability in all actions supporting the operation and management of the repository that affect the preservation of digital content over time.
3	3.3.5	The organization has defined its information integrity measurements.
4	3.3.5	The organization has collected, tracked, and appropriately provided its information integrity measurements.
3	3.3.6	The organization has committed to a regular schedule of self-assessment and external certification.
3	3.4.1	The organization has short- and long-term business planning processes in place to sustain the repository over time.
3	3.4.2	The organization has defined financial practices and procedures.
4	3.4.2	The organization has financial practices and procedures which are transparent, compliant with relevant accounting standards and practices, and audited by third parties in accordance with territorial legal requirements.
4	3.4.3	The organization analyses and reports on financial risk, benefit, investment, and expenditure (including assets, licenses, and liabilities).
3	3.5.1	The organization has and maintains appropriate contracts or deposit agreements for digital materials that it manages, preserves, and/or to which it provides access.
3	3.5.1.1	The organization has contracts or deposit agreements which specify and transfer all necessary preservation rights, and those rights transferred are documented.
3	3.5.1.2	The organization has defined all appropriate aspects of acquisition, maintenance, access, and

		withdrawal in written agreements with depositors and other relevant parties.
3	3.5.1.3	The organization has written policies that indicate when it accepts preservation responsibility for contents of each set of submitted data objects.
3	3.5.1.4	The organization has policies in place to address liability and challenges to ownership/rights.
4	3.5.2	The organization tracks and manages intellectual property rights and restrictions on use of repository content as required by deposit agreement, contract, or license.

5.2.1.2. Infrastructure

This section presents the mapping of the ISO16363 to the infrastructure dimension of the Information Governance Maturity Model. The source of criteria for this dimension was adopted from the infrastructure and security risk management section of the ISO16363. The section reference is depicted so that traceability between these mappings and the ISO16363 is maintained. Levels 1 and 2 were not mapped to the ISO16363 as this standard criteria correlates to the level 3 and 4 where procedures and documents are formally defined and in level 4 also measured.

Table 24. ISO16363 Mapping to the infrastructure dimension and levels of the Information Governance Maturity Model (based on [43])

Level	ISO16363 Section	Criterion
3	5.1.1	The organization has identified and manages the risks to its preservation operations and goals associated with system infrastructure.
4	5.1.1.1	The organization has employed technology watches or other technology monitoring notification systems.
4	5.1.1.1.1	The organization has hardware technologies appropriate to the services it provides to its designated communities.
4	5.1.1.1.2	The organization has documented procedures in place to monitor and receive notifications when hardware technology changes are needed.
4	5.1.1.1.3	The organization has documented procedures in place to evaluate when changes are needed to current hardware.
3	5.1.1.1.4	The organization has procedures, commitment and funding to replace hardware when evaluation indicates the need to do so.
4	5.1.1.1.5	The organization has software technologies appropriate to the services it provides to its designated communities.
4	5.1.1.1.6	The organization has documented procedures in place to monitor and receive notifications when software changes are needed.
4	5.1.1.1.7	The organization has documented procedures in place to evaluate when changes are needed to current software.
3	5.1.1.1.8	The organization has procedures, commitment, and funding to replace software when evaluation indicates the need to do so.
3	5.1.1.2	The organization has adequate hardware and software support for backup functionality sufficient for preserving the repository content and tracking repository functions.
3	5.1.1.3	The organization has mechanisms to detect bit corruption or loss.
3	5.1.1.3.1	The organization has procedures to record and report to its administration all incidents of data corruption or loss.
3	5.1.1.3.1	The organization has procedures defined to repair/replace corrupt or lost data.
3	5.1.1.4	The organization has defined procedures to record and react to the availability of new security updates based on a risk-benefit assessment.
3	5.1.1.5	The organization has defined procedures for storage media and/or hardware change (e.g.,

		refreshing, migration).
3	5.1.1.6	The organization has identified and documented critical processes that affect its ability to comply with its mandatory responsibilities.
3	5.1.1.6.1	The organization has a documented change management process that identifies changes to critical processes that potentially affect the repository's ability to comply with its mandatory responsibilities.
3	5.1.1.6.2	The organization has a documented process for testing and evaluating the effect of changes to the repository's critical processes.
3	5.1.2	The organization has documented procedures on how to manage the number and location of copies of all digital objects.
3	5.1.2.1	The organization has documented mechanisms in place to ensure any/multiple copies of digital objects are synchronized.
4	5.2.1	The organization maintains a systematic analysis of security risk factors associated with data, systems, personnel, and physical plant.
3	5.2.2	The organization has implemented controls to adequately address each of the defined security risks.
3	5.2.3	The organization has defined roles, responsibilities, and authorizations related to implementing changes within the system.
3	5.2.4	The organization has suitable documented disaster preparedness and recovery plan(s), including at least one off-site backup of all preserved information together with an offsite copy of the recovery plan(s).

5.2.1.3. Processes

This section presents the mapping of the ISO16363 to the processes dimension of the Information Governance Maturity Model. The source of criteria for this dimension was adopted from the digital object management section of the ISO16363. The section reference is depicted so that traceability between these mappings and the ISO16363 is maintained. Levels 1 and 2 were not mapped to the ISO16363 as this standard criteria correlates to the level 3 and 4 where procedures and documents are formally defined and in level 4 also measured.

Table 25. ISO16363 Mapping to the processes dimension and levels of the Information Governance Maturity Model (based on [43])

Level	ISO16363 Section	Criterion
3	4.1.1	The organization has identified the Content Information and the Information Properties that the repository will preserve.
3	4.1.1.1	The organization has a procedure(s) for identifying those Information Properties that it will preserve.
3	4.1.1.2	The organization has a record of the Content Information and the Information Properties that it will preserve.
3	4.1.2	The organization has specified the information that needs to be associated with specific Content Information at the time of its deposit.
3	4.1.3	The organization has specifications enabling recognition and parsing of the SIPs.
3	4.1.4	The organization has mechanisms to verify the identity of the Producer of all materials.
3	4.1.5	The organization has an ingest process which verifies each SIP for completeness and correctness.
3	4.1.6	The organization obtains sufficient control over the Digital Objects to preserve them.
3	4.1.7	The organization provides the producer/depositor with appropriate responses at agreed

		points during the ingest processes.
3	4.1.8	The organization has contemporaneous records of actions and administration processes that are relevant to content acquisition.
3	4.2.1	The organization has for each AIP or class of AIPs preserved by the organization an associated definition that is adequate for parsing the AIP and fit for long-term preservation needs.
3	4.2.1.1	The organization is able to identify which definition applies to which AIP.
3	4.2.1.2	The organization has a definition of each AIP that is adequate for long term preservation, enabling the identification and parsing of all the required components within that AIP.
3	4.2.2	The organization has a description of how AIPs are constructed from SIPs.
3	4.2.3	The organization has documented the final disposition of all SIPs.
4	4.2.3.1	The organization follows documented procedures if a SIP is not incorporated into an AIP or discarded and shall indicate why the SIP was not incorporated or discarded.
3	4.2.4	The organization has and uses a convention that generates persistent, unique identifiers for all AIPs.
3	4.2.4.1	The organization has uniquely identified each AIP within the repository.
3	4.2.4.1.1	The organization has unique identifiers.
3	4.2.4.1.2	The organization has assigned and maintained persistent identifiers of the AIP and its components so as to be unique within the context of the organization.
3	4.2.4.1.3	Documentation describes any processes used for changes to unique identifiers.
3	4.2.4.1.4	The organization is able to provide a complete list of all unique identifiers and do spot checks for duplications.
3	4.2.4.1.5	The system of identifiers is adequate to fit the organization's current and foreseeable future requirements such as numbers of objects.
3	4.2.4.2	The organization has a system of reliable linking/resolution services in order to find the uniquely identified object, regardless of its physical location.
3	4.2.5	The organization has access to necessary tools and resources to provide authoritative Representation Information for all of the digital objects it contains.
3	4.2.5.1	The organization has tools or methods to identify the file type of all submitted Data Objects.
3	4.2.5.2	The organization has defined tools or methods to determine what Representation Information is necessary to make each Data Object understandable to the Designated Community.
3	4.2.5.3	The organization has access to the requisite Representation Information.
3	4.2.5.4	The organization has tools or methods to ensure that the requisite Representation Information is persistently associated with the relevant Data Objects.
3	4.2.6	The organization has documented processes for acquiring Preservation Description Information (PDI) for its associated Content Information and acquire PDI in accordance with the documented processes.
3	4.2.6.1	The organization has documented processes for acquiring PDI.
4	4.2.6.2	The organization executes its documented processes for acquiring PDI.
3	4.2.6.3	The organization has defined procedures to ensure that the PDI is persistently associated with the relevant Content Information.
3	4.2.7	The organization has defined procedures to ensure that the Content Information of the AIPs is understandable for their Designated Community at the time of creation of the AIP.
3	4.2.7.1	The organization has a documented process for testing understandability for their Designated Communities of the Content Information of the AIPs at their creation.
4	4.2.7.2	The organization executes the testing process for each class of Content Information of the AIPs.
3	4.2.7.3	The organization has defined procedures to bring the Content Information of the AIP up to the required level of understandability in case it fails the understandability testing.
3	4.2.8	The organization verifies each AIP for completeness and correctness at the point it is created.
3	4.2.9	The organization has provides an independent mechanism for verifying the integrity of the organizations' collection/content.

3	4.2.10	The organization has contemporaneous records of actions and administration processes that are relevant to AIP creation.
3	4.3.1	The organization has documented preservation strategies relevant to its holdings.
4	4.3.2	The organization has mechanisms in place for monitoring its preservation environment.
4	4.3.2.1	The organization has mechanisms in place for monitoring and notification when Representation Information is inadequate for the Designated Community to understand the data holdings.
4	4.3.3	The organization has mechanisms to change its preservation plans as a result of its monitoring activities.
3	4.3.3.1	The organization has mechanisms for creating, identifying or gathering any extra Representation Information required.
4	4.3.4	The organization provides evidence of the effectiveness of its preservation activities.
3	4.4.1	The organization has specifications for how the AIPs are stored down to the bit level.
3	4.4.1.1	The organization has defined procedures to preserve the Content Information of AIPs.
4	4.4.1.2	The organization actively monitors the integrity of AIPs.
3	4.4.2	The organization has contemporaneous records of actions and administration processes that are relevant to storage and preservation of the AIPs.
3	4.4.2.1	The organization has procedures for all actions taken on AIPs.
3	4.4.2.2	The organization has documented procedures that enable to demonstrate that any actions taken on AIPs were compliant with the specification of those actions.
3	4.5.1	The organization has specified the minimum information requirements to enable the Designated Community to discover and identify material of interest.
3	4.5.2	The organization captures or creates the minimum descriptive information and ensures that it is associated with the AIP.
3	4.5.3	The organization maintains bi-directional linkage between each AIP and its descriptive information.
3	4.5.3.1	The organization maintains the associations between its AIPs and their descriptive information over time.
4	4.6.1	The organization complies with Access Policies.
3	4.6.1.1	The organization has defined procedures to log and review all access management failures and anomalies.
3	4.6.2	The organization has policies and procedures that enable the dissemination of digital objects that are traceable to the originals, with evidence supporting their authenticity.
3	4.6.2.1	The organization records and acts upon problem reports about errors in data or responses from users.

5.2.2. ISO 20652

The ISO 20652 details the Producer-Archive Interface Methodology Abstract Standard, which describes the structure of interactions between an Archive and an Information Producer. It defines the method to perform the initial contact between the producers and archive until the first objects are received and validated by the archive. This section details the mapping of the phases and specific aspects of the phases and the maturity dimensions and levels. One aspect to take in consideration is that ISO 20652 focus on new projects with producers, as such, organization much comply with this criteria for all projects currently ongoing. Also, there must be a policy and procedures to comply with these criteria for all new producers that begin a project with the archive. For this standard there were no criteria mapped to the management and infrastructure dimensions due to the fact that the method this standard defines is related to the pre-ingest phase of an archive. The pre-ingest phase can be viewed as a process which begins with a new project from a producer and is finalized with the ingestion and validation of the first object in the archive. As such, ISO20652 was mapped to the processes dimension.

Table 26. ISO20652 Mapping to the dimensions and levels of the Information Governance Maturity Model (based on [45])

Dimension	Level	Phase	Criterion
Processes	3	Preliminary Phase	There are Feasibility studies performed.
	3		There is a Preliminary definition of the scope of the project.
	3		There is a draft of the SIP definition.
	3		There is a Draft Submission Agreement.
	3		There is Summary document on the feasibility of the Producer-Archive Project.
	3		There is a Final Decision on proceeding to the formal definition phase which might be approved or might stop the project.
	3		There is an estimate of required Resources.
	3	Formal Definition Phase	There is a complete SIP design.
	3		There are precise definitions of the digital objects to be delivered.
	3		The Submission Agreement is completed.
	3		There are contractual transfer conditions.
	3		Restrictions on access are defined.
	3		A delivery Schedule is defined.
	3		There is a data Dictionary. Note: "A formal repository of terms used to describe data." [45]
	3		A formal Model is defined. Note: A formal model "contains a definition of the objects to be delivered that is as precise and non-ambiguous as possible." [45]
	3		The Information Objects to ingest are defined.
	3	Transfer Phase	There is evidence of transfer of the SIP from the Producer to the Archive.
	3		There is evidence of preliminary processing of the SIP by the Archive.
	3	Validation Phase	There is evidence of validation processing of the SIP by the Archive.
	3		There is evidence that producers receive a validation object.

5.3.   Maturity Table

This section details the maturity table for the Information Governance Maturity Model. A maturity table consists of a table that crosses maturity levels with the maturity dimensions and characterized each dimension in each level. Due to size restriction, the maturity table was decomposed into three sections for each of the dimensions of the maturity model. Then each of the section for the dimensions is divided in five section one for each level of the dimension. Table 27 maps each of the dimension and level to the appropriate section to facilitate understanding.

Table 27. Information Governance Maturity Grid Section Mapping

	Level 1	Level 2	Level 3	Level 4	Level 5
Management	5.3.1.1	5.3.1.2	5.3.1.3	5.3.1.4	5.3.1.5
Processes	5.3.2.1	5.3.2.2	5.3.2.3	5.3.2.4	5.3.2.5
Infrastructure	5.3.3.1	5.3.3.2	5.3.3.3	5.3.3.4	5.3.3.5

5.3.1. Management

This section details the meaning of each of the maturity levels for the management dimension of the Information Governance Maturity Model.

5.3.1.1.   Level 1 (Initial)

Management is unpredictable; the business is weakly controlled and reactive. The required skills for staff are neither defined nor identified. There is no planned training of the staff.

Key aspects of level 1:

1.   There is no recognition of the need for information governance;
2.   There is no definition of skills;
3.   There is no training plan for staff.

5.3.1.2.   Level 2 (Managed)

There is awareness of the need for effective management within the archive. However, there are no overall policies defined. The required skills are identified only for critical business areas. There is no training plan, however training is provided when the necessity arises.

Key aspects of level 2:

1.   Informal awareness of the need for information governance;
2.   No policies in place;
3.   Required skills not identified for all business areas;
4.   Training of staff is performed on demand.

5.3.1.3.   Level 3 (Defined)

The documentation, policies and procedures that allows for effective management are defined. There is documentation of skill requirements for all job positions within the organization. There is a formal training plan defined; however it is not enforced.

Key aspects of level 3:

1.   Documentation is defined;
2.   Policies and procedures are formally defined;
3.   Skill requirements are formally defined;
4.   There is a formal training plan in place
5.   The training plan is not assessed to guarantee correct application.

5.3.1.4.   Level 4 (Quantitatively Managed)

The organization monitors its organizational environment to determine when to execute its policies and procedures.

Skill requirements are routinely assessed to guarantee that the required skills are present in the organization. There are procedures in place to guarantee that a skill is not lost when staff leaves the archive. There is a policy for knowledge sharing of information within the organization that is described in the training plan. The training plan is also assessed routinely.

Key aspects of level 4:

1. Policies and procedures are measured to guarantee correct application;
2. Staff skills are routinely assessed;
3. There are procedures in place to guarantee that there is no loss of skills;
4. Training plan is routinely assessed.

5.3.1.5. Level 5 (Optimizing)

Standards and best practices are applied. There is an effort for the organization to undergo assessment for certification of standards. The organization is seen as an example of effective management among its communities and there is continuous improvement of all management procedures. There is encouragement of continuous improvement of skills, based both on personal and organizational goals. Knowledge sharing is formally recognized in the organization. The organization staff contributes to external best practice.

Key aspects of level 5:

1. Application of standards and best practices;
2. Effort on assessment to get standards certification;
3. Organization is recognized as exemplary among its communities;
4. Continuous improvement is embed in the organization;
5. Continual improvement of skills;
6. Knowledge sharing is part of the organizational culture;
7. Staff contributes to external best practice.

5.3.2. Processes

This section details the meaning of each of the maturity levels for the processes dimension of the Information Governance Maturity Model.

5.3.2.1. Level 1 (Initial)

Ingest, Archival Preservation and Dissemination of content are not done in a coherent way. Procedures are ad-hoc and undefined, the archive may not even be prepared to ingest, archive and disseminate content.

Key aspects of level 1:

1. Ingest, Archival and Dissemination procedures are not defined;
2. There is no way to assess if the organization is prepared to ingest, archive and disseminate content.

5.3.2.2. Level 2 (Managed)

There is evidence of procedures being applied in an inconsistent manner and based on individual initiative. Due to the fact that the processes are not defined, most of the times the applied procedures cannot be repeated.

Key aspects of level 2:

1. There is evidence of ingest, archival and dissemination practices in place;
2. Practices are inconsistent, based on individual expertise;
3. There is no guarantee that the procedures applied can be repeated.

5.3.2.3. Level 3 (Defined)

The Ingest, Archival and Dissemination processes are defined and in place. For ingest, is defined which content the archive accepts and how to communicate with producers, the creation of the Archival Information Package is defined as well as the Preservation Description Information necessary for ingesting the object into the archive. For archival, preservation planning procedures are defined and the preservation strategies are documented. For dissemination, the requirements that allow the designated community to discover and identify relevant materials are in place, and access policies are defined.

Key aspects of level 3:

1. Ingest, archival and dissemination processes are formally defined and in place;
2. For ingest:
    a. The content the archive accepts is defined;
    b. The way to communicate with producers is defined;
    c. The steps to generate the Archival Information Package are defined;
    d. The necessary Preservation Description Information is defined;
3. For archival:
    a. Preservation planning procedures are defined;
    b. Preservation strategies are documented;
4. For dissemination:
    a. Designated Community requirements for discoverability are defined;
    b. Access Polices are defined.

5.3.2.4. Level 4 (Quantitatively Managed)

The Ingest, Archival and Dissemination processes are actively managed for their performance and adequacy. There are mechanisms to measure the satisfaction of the designated community. There are procedures in place that measure the efficiency of ingest, archival and dissemination processes and identify bottlenecks in these processes.

Key aspects of level 4:

1. Ingest, Archive and Dissemination processes are measured for:
    a. Performance;
    b. Adequacy;
2. Mechanisms to measure the satisfaction of the designated community are in place;
3. Bottlenecks are identified and corrected for ingest, archival and dissemination.

5.3.2.5. Level 5 (Optimizing)

There is an information system that allows for process performance monitoring in a proactive way so that the performance data can be systematically used to improve and optimize the processes.

Key aspects of level 5:

1. Process performance measurement is performed by an information system without human interaction;
2. There is predictive analysis of process performance to detect bottlenecks before these occur;
3. Processes are continuously improved and optimized.

5.3.3. Infrastructure

This section details the meaning of each of the maturity levels for the infrastructure dimension of the Information Governance Maturity Model.

5.3.3.1. Level 1 (Initial)

The infrastructure is not managed effectively. Changes in the infrastructure are performed in a reactive basis, when there is hardware/software malfunction or it becomes obsolete. There are no security procedures in place. The organization reacts to threats when they occur.

Key aspects of level 1:

1. Infrastructure not managed;
2. Changes in the infrastructure are done in reaction to malfunction or obsolescence;
3. No security procedures in place;
4. Organization reacts to threats when these occur as there are no security procedures.

5.3.3.2. Level 2 (Managed)

There is evidence of procedures being applied to manage the infrastructure. There is awareness of the need to properly define the procedures that allow for effective management of the infrastructure that supports the critical areas of the business. There are security procedures in place. However, individuals perform these procedures in different ways and there is no common procedures defined.

Key aspects of level 2:

1. Undefined procedures are being applied;
2. There is awareness of the need to define procedures for managing the infrastructure;
3. Undefined security procedures are being applied;
4. Different procedures are performed by different people;
5. Most procedures being performed are not repeatable.

5.3.3.3. Level 3 (Defined)

Infrastructure procedures are defined and in place. There are technology watches/monitoring, there are procedures to evaluate when changes to software and hardware are needed, there is software and hardware available for performing backups and there are mechanisms to detect bit corruption and reporting it. Security procedures are defined and being applied in the organization. The security risk facts are analysed, the controls for these risks are identified and there is disaster preparedness and recovery plans.

Key aspects of level 3:

1. Procedures are in place and defined;
2. There are technology watches and monitoring;
3. Procedures are defined to evaluate when changes in software and hardware are needed;
4. There is software and hardware available for performing backups;
5. There are mechanisms defined to detect bit corruption and reporting it;
6. Security procedures are defined and applied;
7. Security Risks are identified and analysed;

8. A disaster preparedness plan is defined;
9. A recovery plan is defined.

5.3.3.4. Level 4 (Quantitatively Managed)

There are procedures in place that actively monitor the environment to detect when hardware and software technology changes are needed. The hardware and software that support the services are monitored so that the organization can provide appropriate services to the designated community. There are procedures in place to record and report data corruption that identify the steps needed to replace or repair corrupt data. The security risk factors are analysed periodically and new controls are derived from these risk factors. There are procedures to measure the potential efficiency of these controls to treat the security risk factors identified. Disaster preparedness and recovery plans are tested and measured for their efficacy.

Key aspects of level 4:

1. There are procedures in place to monitor the software and hardware environment;
2. Hardware and software performance is monitored to ensure designated community satisfaction;
3. Data corruption is recorded, reported and analysed;
4. Risk factors are analysed periodically and new controls are defined;
5. There are procedures to measure the potential efficiency of the risk controls;
6. . Disaster preparedness and recovery plans are tested and measured.

5.3.3.5. Level 5 (Optimizing)

There is an information system that monitors the technological environment and detects when changes to hardware and software are needed and reacts to it by proposing plans to replace hardware and software. There is also a system that detects data corruption and identifies the necessary steps to repair the data and acts without human intervention. To allow for continuous improvement there are also mechanisms to act upon when the hardware and software available no longer meets the designated community requirements. There is an information system that manages security and policy procedures and the disaster and recovery plans which allows for continual improvement. There is a security officer that is a recognized expert in data security.

Key aspects of level 5:

1. An information system monitors the technological environment;
2. An information system detects when changes to hardware and software are needed;
3. An information system proposes plans to replace hardware and software;
4. There is a system that detects data corruption and identifies the necessary steps to repair the data and acts without human intervention;
5. There are mechanisms in place to act upon when the hardware and software available no longer meets the designated community requirements;
6. An information system manages security and policy procedures, as well as, the disaster and recovery plans.
7. The organization has a security officer in its staff that is a recognized expert in data security.

6. Conclusions

This deliverable presents the fundamentals of a maturity model for Information Governance that follows a DSR development method and is based on requirements defined in standards. The maturity model developed in this deliverable focus on the Archival references namely the **Trustworthy Repositories Audit & Certification (TRAC/ISO16363)** and the **Producer-Archive Interface Methodology Abstract Standard (PAIMAS/ISO20652)**. The selected references are essential and enough to assess the use cases of the project since their focus is precisely the processes that are being improved in E-ARK (Ingest, Archival Preservation and Dissemination). However, it is the goal of the project to extend the Maturity Model by including other reference requirements from others standards and documents. That extension will be included and described in detail on deliverable D7.5: "A Maturity Model for Information Governance – final version."

This deliverable focuses only on the first four stages of the development method (see section 2) that concentrate on the design and development of the maturity model. To use this maturity model an organization first needs to position itself in the maturity matrix in each of the dimensions. This step is called self-assessment. The self-assessment consists of following a series of predetermined steps in which the organization answers a series of questionnaires that will result in the determination of a maturity level. Deliverable 7.2 will focus on the development and application of the self-assessment that will be used on the use cases before the project pilot. This constitutes the next three stages of the development method. Deliverable 7.5 will iterate the development of the maturity model based on the application results to improve and extend the maturity model. Finally, deliverable 7.6 will conduct a new self-assessment using the final version of the maturity model after the project pilot. Table 28 defines the focus of each deliverable based on the development method and represents the maturity model roadmap.

Table 28 Roadmap of the maturity model development and application according to project deliverables

Deliverable	Problem Definition	Comparison of existing maturity models	Determination of development strategy	Iterative maturity model development	Conception of transfer and evaluation	Implementation of transfer media	Evaluation
D7.1: A Maturity Model for Information Governance – initial version [Deliverable date: M12]	Focus	Focus	Focus	Focus			
D7.2: Initial Assessment and Evaluation [Deliverable date: M18]				To be used	Focus	Focus	Focus
D7.5: A Maturity Model for Information Governance – final version [Deliverable date: M36]	To be used	To be used	To be used	Focus			
D7.6: Final Assessment and Evaluation [Deliverable date: M36]				To be used	Focus	Focus	Focus

- Focus of the deliverable
- To be used in the deliverable

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