A holistic model for assessing organizational interoperability in public administration

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ABSTRACT

Achieving organizational interoperability in public administration is a crucial factor for successful digital transformation, although there are still many challenges and limitations regarding organizational factors. A detailed and comparative review on the evaluation of existing assessment models and tools is provided revealing the need for a holistic assessment. As result of the research, a new model is introduced for organizational interoperability assessment enhancing existing holistic models and corresponding tools with additional attributes. The development process of the new model (MOIA) is presented and the justification of alignment with the corresponding recommendations of the new European Interoperability Framework (EIF) is described. An incremental methodological approach of evaluation waves is followed to assess the additional attributes required to consider barriers and concerns regarding organizational interoperability. The Greek Electronic Public Procurement System (ESIDIS) used as the case study to validate the use of the model and calculate model's attributes weights.

1. Introduction

Enhanced interoperability among public bodies and public and private organizations respectively is of critical importance for building e-Government added value models (Pardo & Tayi, 2007). The integration of government information resources and processes and, thus, the interoperation of independent business system applications is essential to accomplish agile, citizen-centric, accountable, transparent, effective, and efficient government services (Gottschalk, 2009).

To promote the modernization and digitalization of public administrations across the European Union (EU), the European Commission has played a crucial role, deploying an array of political and legislative initiatives, financially supported by various funding programs, to foster digital public administration and interoperability at a Member State level. Prioritizing the digital transformation of the EU has remained a constant challenge in the last two decades, particularly regarding digital public administration and interoperability (European Commission Directorate General for Informatics, 2020).

Interoperability is one of the key aspects at the heart of digital transformation in Europe. From 2017 to 2020, 32 legislative measures were established in 24 countries, 29 covering aspects related to interoperability and cross-border services. These were legislative decisions aimed at developing base registries, interoperability frameworks and architecture, at promoting services fostering the once-only principle, and at promoting access to public information, and cross-border and cross-sectorial cooperation via open data and open government. In this sense, the Single Digital Gateway has been an important step towards more interoperability in Europe, as it fostered the use of the Once-Only Principle and the digitalization of 21 procedures across the EU(European Commission Directorate General for Informatics, 2020).

Interoperability is presented as one of the core priorities in the new Digital Europe Programme 2021–2027 and the corresponding Regulation on its establishment (Official Journal of the European Union, 2021). Several public programs and projects, such as ISA[2] (Interoperability Solutions for Administrations), funded by the European Commission, were executed and observatories on e-Government developments, such as NIFO (National Interoperability Framework Observatory) (https://joinup.ec.europa.eu/collection/nifo-national-interoperability-framewor

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k-observatory) were established.Moreover, several national interoperability strategies, action plans and expert groups were established in the last five years.

Despite recognizing the importance, investments and human effort dedicated to the pursuit of improved collaboration among different organizations, the level of interoperability remains far from adequate. (Rezaei, Chiew, Lee, & Shams Aliee, 2014) identified three main categories of interoperability barriers namely, organizational, conceptual, and technological incompatibility, while the new European Interoperability Framework (EIF) (European Commission, 2017), established by the European Commission, addressed four layers of interoperability: organizational, legal, semantic, and technological.

Many researchers consider organizational interoperability to be a crucial factor for successfully promoting e-Government (Kubicek, Cimander, & Scholl, 2011) (Margariti & Stamati, 2018) (Rauffet, da CUNHA, & Bernard, 2009). Technology may prove the least difficult to address, while the organizational, legal, political, and social aspects may create much more of a challenge, thereby hindering the progress of e-government (Pardo, Nam, & Burke, 2012).

Interoperation in public administration remains an enduring challenge due to organizational differences, such as different organizational structures and management processes (Maheshwari & Janssen, 2012).

Organizational issues are a crucial component of successful digital service projects generally, as moving services online involves redesigning organizational structures and processes according to citizen and business needs, and integrating services across different governmental agencies (European Commission DG DIGIT Directorate General for Informatics, 2020).

Organizational interoperability issues have also been emphasized as a critical factor for the application of the once-only principle. (Krimmer, Kalvet, Toots, Cepilovs, & Tambouris, 2017) reviewed drivers and barriers for the once-only principle and noted that organizational differences create difficulties for public sector bodies attempting to "consolidate their processes and act in a joined-up manner" (Krimmer et al., 2017).

Since organizational interoperability is so important, public administration needs to be guided by an effective assessment approach to identify the gaps, and determine weaknesses and deficiencies, while precisely defining the maturity level of organizational interoperability. All this diagnosing procedure could finally lead to recommendations for improvements or an Interoperability Transition Plan for further adopting and implementing e-Government initiatives (Sarantis, Charalabidis, & Psarras, 2008).

A significant number of surveys and reviews have been proposed in the literature on the existing Interoperability Assessment (INAS) approaches. However, most of these reviews focus on specific properties rather than a general overview of an INAS. The existing surveys do not consider a holistic view of the Interoperability Assessment (da Silva Serapião Leal, Guédria, & Panetto, 2019).

In the context of measurement and evaluation, a holistic assessment means that a more thorough knowledge and understanding of a system can be gained from combining different measures than taking those measures separately. This approach should involve attributes for all types of assessment: Interoperation Potentiality, Interoperation Compatibility and Operational Performance (da Silva Serapião Leal et al., 2019) to provide a holistic proposal.

This research develops a new model for the holistic assessment of organizational interoperability. The model is based on the Interoperability Maturity Model (IMM) (European Commission ISA2, 2016) and the IMAPS tool (European Commission & Directorate General for Informatics, 2020), considering the assessment approach as well of the GIMM matrix (Sarantis et al., 2008). It is further extended and fully aligned with the new EIF, incorporating various organizational attributes from different perspectives evaluated by different stakeholders.

2. Background

Integration, information sharing and interoperability in government have become of major interest (Kubicek et al., 2011). Digital government initiatives face serious challenges, since the required level of interorganizational collaboration and trust is often not supported by existing institutional arrangements, organizational structures, and management processes (Luna-Reyes, Gil-Garcia, & Cruz, 2007). Lack of commonly agreed processes, difficulties in interpreting administrative procedures and legislation, and difficulties in defining authorities and responsibilities are some of the reasons which justify why cross-border and national interoperability have not yet been achieved (Scholl & Klischewski, 2007).

According to Hjort-Madsen, the complexity of organizational aspects of interoperability may surpass the technical issues as public organizations move towards inter-organizational governance (Hjort-Madsen, 2006). Gottschalk describes that interoperability is not only a technical subject, but there is a need to conceptualize the organizational aspects of interoperability. (Margariti & Stamati, 2018) highlight the importance of organizational interoperability in e-Government, along with its relevance to governance, open-data policies, and information sharing. Recent research attempts to clarify and re-conceptualize the layer of organizational interoperability, by introducing an empirically based conceptual framework (Kubicek et al., 2011). The need for redefining organizational interoperability is emphasized as "business process interoperability".

Evaluating the extent of organizational interoperability is necessary to overcome the barriers towards information integration. The evaluation process includes defining metrics to assess the maturity level and then making suggestions for further improvement. The assessment of the maturity level is accomplished with the aid of a maturity model through which an organization can identify its current capability status and its desired capability maturity level (Sarantis et al., 2008).

2.1. Models and frameworks

Various researchers (da Silva Serapião Leal et al., 2019) present interoperability assessment models (Rezaei et al., 2014), frameworks (Kubicek et al., 2011), technology maturity indexes and matrices (Sarantis et al., 2008), as well as methodologies and guidelines that can help an organization achieve the desired interoperability objectives.

The following interoperability maturity models available until 2016, referred in bibliography and used by organizations at national and/or international level:

- LISI (Levels of Information Systems Interoperability) (C4ISR AWG., 1998), which focuses only on the technical issues of interoperability.
- OIMM (Organizational Interoperability Maturity Model) (Clark & Jones, 1999), which extends the LISI model to incorporate the organizational aspect.
- LCIM (Levels of Conceptual Interoperability Model) (Tolk & Muguira, 2003), which focuses on technological and conceptual issues of interoperability.
- EIMM (Enterprise Interoperability Maturity Model) (ATHENA, 2003), which evaluates organizational and conceptual issues of interoperability.

A survey and comparison of the above models concludes that only the OIM deals with organizational interoperability barriers and concerns, though without proposing a specific approach to solve interoperability problems at an organizational level. Furthermore, the study shows that the existing interoperability maturity models (LISI, OIM, LCIM, EIMM) are partial models, only dealing with some aspects of the enterprise interoperability, while an interoperability maturity model covering all areas of concerns and aspects of the enterprise interoperability is still missing (Guédria, Naudet, & Chen, 2008). In addition,

although the models describe the stages, levels, and layers, they do not identify any assessment constructs for measuring and benchmarking organizational interoperability. (Maheshwari & Janssen, 2012) highlight that the existing models consider specific measures to assess the organizational aspects of interoperability.

Having identified, the lack of interoperability as a major obstacle for a successful digital transformation and the gaps in existing assessment models, the European Commission in 2016 introduced a new model, the Interoperability Maturity Model (IMM) (European Commission ISA2, 2016). The IMM was developed within the scope of the ISA^2 program to help public administrations measure the interaction with external entities and organize the efficient provisioning of their public services to other public administrations, businesses and/or citizens. It is based on the vision laid out in the European Interoperability Strategy (EIS) and it is fully aligned with the latest version of the European Interoperability Framework (EIF) (European Commission, 2017).

The new EIF provides specific guidance on how to set up interoperable digital public services. It outlines 50 specific recommendations (European Commission, 2017) to improve governance of public service interoperability activities, establish cross-organizational relationships, streamline processes supporting end-to-end digital services, and ensure that both existing and new legislation do not compromise interoperability efforts. It is worth mentioning that the implementation of the EIF contributes to achieving important initiatives, such as the Digital Single Market Strategy, the eGovernment Action Plan and the Tallinn Ministerial Declaration on eGovernment. Finally, the implementation of the EIF in European countries, and more specifically in the 27 EU Member States, also contributes to the priorities of the Digital Europe Program (European Commission Directorate General for Informatics, 2020).

2.2. Assessment tools

The maturity models and EIF drive the development of the following assessment tools and instruments, which were developed to identify the level of interoperability maturity and suggest specific improvements:

- Government Interoperability Maturity Matrix (GIMM) (Sarantis et al., 2008)
- Measurement instrument (Maheshwari & Janssen, 2012)
- Interoperability Maturity Model and Tool (IMM Full & Lite) (European Commission ISA2, 2016)
- Interoperability Maturity Assessment of a Public Service (IMAPS) tool (European Commission & Directorate General for Informatics, 2020)

Sarantis et al. (2008) introduce the GIMM (Government Interoperability Maturity Matrix) with five levels of maturity, which are identified and closely aligned with the descriptions of the LISI model. Each level of maturity corresponds to a different interoperability level for a set of Interoperability Attributes (IA), providing to a public administration an easy and comprehensive way to evaluate its status and identify areas that need further elaboration and improvement on e-Government. Although a more effective approach considering the assessment of technical, semantic, and organizational interoperability readiness is described, specific measures to assess organizational interoperability are not proposed. Furthermore, the LISI model that was used as a referential model for the matrix is not aligned with EIF's latest version.

A measurement instrument (Maheshwari & Janssen, 2012) for assessing organizational interoperability in practice introduces a set of constructs that correspond to six sublayers of organizational interoperability, therefore, providing a practical approach to assessing and benchmarking the organizational aspects of interoperability. Although this approach is specific, even considering socio-technical aspects on top of interoperability-related governance aspects, it is not related to levels of maturity.

The Interoperability Maturity Model and Tool (IMM Full & Lite) is the evolution of the IMM (Interoperability Maturity Model). It can be used by public administrations to assess interoperability of a public service at all government levels (international, national, regional, and local). The Interoperability Maturity Assessment of a Public Service (IMAPS) tool is an improvement of the IMM tool, aligned with the new EIF adopted in March 2017 (European Commission, 2017). It considers the current interoperability maturity of a digital public service based on a set of defined interoperability attributes and maturity stages. Furthermore, it provides guidelines on how the digital public service can improve interoperability maturity in all four dimensions namely, legal, organizational, semantic, and technical.

Despite having these features, the IMAPS does not include all the required attributes for a complete assessment of organizational interoperability. A study on the interoperability assessment of 98 digital services using the IMAPS tool – performed at the National Centre for Public Administration and Local Government (EKDDA) in Athens, with 16 evaluation groups (370 participants/55 group session leaders) revealed that not all issues are considered and that neither socio-technical attributes nor interoperability-related-governance ones are included in it (Papastylianou, Stasis, Rantos, & Kalogirou, 2020). Moreover, recent legislation issues, such as the General Data Protection Regulation (GDPR), and other policy issues, such as Once-Only Principle, are not considered.

A more recent literature review on interoperability assessment approaches introduced by (da Silva Serapião Leal et al., 2019) suggested that most of the available approaches focus on specific properties and they do not consider a general and holistic view of an INAS (Interoperability Assessment). This literature review was systematic and provided analysis of 71 papers published from 1996 to 2018 in journals (34%), conference proceedings (53%) and technical reports (12%). The systematic literature review uncovered 38 relevant INAS approaches and there was a comparative analysis of the 22 INAS approaches that were applied in a real case study (da Silva Serapião Leal et al., 2019). IMAPS was not analyzed within this review since no publication with a real-case scenario related to this model and tool was available in 2018.

The hypothesis for the following comparative review of models is that a holistic approach of assessment combines different measures for different attributes and from different perspectives. Furthermore, a holistic assessment incorporates different types of assessment, such as Compatibility assessment, Potentiality assessment and Performance assessment, as well as different measurement mechanisms, including qualitative and quantitative methods, while it also includes coverage of different interoperability layers and concerns (da Silva Serapião Leal et al., 2019) (Elmir & Bounabat, 2012) (Table 1).

2.3. Reasoning for a new model and tool

The gap analysis of organizational interoperability, both in theory and in practical, highlights the following issues:

a. The organizational aspects of interoperability may surpass the technical issues (Hjort-Madsen, 2006) and public organizations move towards inter-organizational governance to clarify and reconceptualize the layer of organizational interoperability (Kubicek et al., 2011)

b. According to a recent systematic analysis of existing assessment approaches, a holistic view of the Interoperability Assessment is not considered, while there are few cases based on real scenarios for assessing interoperability in public administration (da Silva Serapião Leal et al., 2019)

c. More specific measures are needed to assess the organizational aspects and attributes of interoperability in different maturity levels (Guédria et al., 2008)

d. In the context of measurement and evaluation, a holistic assessment means that a more thorough knowledge and understanding of a

Table 1
Comparison of assessment model and tools.

Model/Tool	Organizational layer	New EIF alignment	Type of assessment			Measurement mechanisms		Scoring vector on organizational maturity level of a digital service
			Compatibility	Potentiality	Performance	Qualitative	Quantitative	
LISI			Yes	No	Yes	No	Yes	No
OIM	x		Yes	No	No	Yes	No	No
LCIM			Yes	No	No	Yes	No	No
EIMM	x		Yes	No	Yes	Yes	No	No
IMM	x	x	Yes	Yes	Yes	Yes	Yes	No
IMAPS	x	x	Yes	Yes	Yes	Yes	Yes	No
GIMM	x		Yes	Yes	No	Yes	No	No
Measurement Instrument	x		Yes	No	No	Yes	Yes	No

system can be gained from combining different measures than taking those measures separately (Nicholson, 2004)

e. A holistic interoperability assessment incorporates different types of assessment (Compatibility, Potentiality and Performance) and different measurement mechanisms (Qualitative and Quantitative), while it also provides coverage of different interoperability layers and concerns (da Silva Serapião Leal et al., 2019) (Da, Leal, Guédria, & Panetto, 2019; Luiz Alcântara Castilho Venâncio et al., 2018).

f. The IMAPS tool is generic and holistic, combining different perspectives and different measures. It is suggested, though, that further specialization and extension is needed, since there are issues that have not been considered (Papastylianou et al., 2020).

Considering the above mentioned, our research develops a Model for Organizational Interoperability Assessment(MOIA) and its corresponding Tool for Organizational Interoperability Assessment(TOIA), for the holistic assessment of organizational interoperability. The MOIA model deployed the assessment model introduced by (Margariti, Anagnostopoulos, Papastilianou, Stamati, & Angeli, 2020) which is fully based on the holistic IMM model, the IMAPS tool and the GIMM matrix assessment approach. The initial model is further extended with more attributes, which are assessed for their relevance and reliability through several development cycles, according to a methodological approach based on the analysis of assessment of real-case scenarios from public administration. The objective is to improve organizational interoperability by combining different measures from different perspectives and from different evaluators.

The MOIA model proposes a discrete approach to assess organizational interoperability maturity and provide specific measures to assess the organizational aspects and attributes of interoperability in different maturity levels with qualitative and quantitative measurement mechanisms. Furthermore, statistics results are provided for multiple services per attribute and per section, with the capability of comparative analysis between digital services over time regarding the maturity level of organizational interoperability.

In applying the MOIA model decision-makers in public administrations can obtain a thorough understanding of their organization, they can respond to problems more quickly from a preexisting environment of evaluation and, finally, they can propose specific improvements.

3. Methodology

3.1. Model and tool development process

The development of the new model for the holistic assessment of organizational interoperability was achieved through the following waves:

3.1.1. Wave I – initial model

The initial model, fully aligned with EIF, was based on IMM and IMAPS and was combined with GIMM matrix approach (Sarantis et al., 2008). The initial model was further enhanced with attributes that either emerge from literature or satisfy current needs and new guidelines. The development of the initial model also consisted of the following stages:

1. Enhancement with new attributes, justification, and phenomenological categorization (Connell et al., 2018) in sections for segmentation reasons.
2. Development of assessment model based on a new matrix with interoperability attributes defined in lines and corresponding levels of maturity defined in columns.
3. Creation of a tool as a questionnaire, where each question concerns a specific attribute, and each available answer corresponds to fulfilling the interoperability attribute according to levels of the maturity model (Appendix Questionnaire −1).
4. Assessment of the maturity level of organizational interoperability for 43 Digital Services in the Greek Public Sector of various administrative levels (municipal, regional, national) and policy areas with the aid of the new tool.
5. Pilot implementation of the assessment model during a training course at the National Centre for Public Administration and Local Government in Athens.
6. Analysis of the evaluation process data with Analytical Hierarchical Process Method (AHP) (Luiz Alcântara Castilho Venâncio et al., 2018; Saturno, Ramos, Polato, Deschamps, & de Freitas Rocha Loures, E., 2017) to validate the relevance and the reliability of attributes and sections of the model. The AHP structure is *modeled as a decision tree* in which the goal, in this case, is the assessment of maturity level of organizational interoperability. The second level of the decision tree includes the Sections of interoperability assessment, each of which corresponds to several Interoperability Attributes (IA) of the next level. The fulfillment level of each IA corresponds to specific levels of maturity.
7. Evaluation of validity and reliability of organizational interoperability assessment tool (questionnaire) with the aid of the most widely used Cronbach's alpha method a (Cronbach, 1951).

3.1.2. Wave II - new model development

The methodology process includes the following stages:

1. Selection of the initial reference assessment model and of the attributes proposed.
2. Enhancement with new attributes and categorization in sections, based on the face validity approach (Connell et al., 2018).
3. Compatibility assessment of the new attributes and corresponding sections regarding their relevance with the EIF recommendations on organizational interoperability.
4. Extension of the initial model by combined attributes and maturity levels of the IMM and development of the MOIA model.
5. Creation of the new TOIA tool (Appendix Questionnaire – 2).
6. Qualitative assessment: Consultation and remote interviews with domain experts. Selection of the specific team based on the representation of the basic roles involved in a digital service (policy

officers, designers, developers, managers, executive officers), wider reflection of views, control of subjectivity and better interpretability (Farmakis, 2015). The nominal group technique (Sink, 1983) (McMillan et al., 2016) was used to find the priorities of proposal attributes and make the first decision.

7. Quantitative assessment of 10 actual Digital Public Services with the extended model and tool for 26 attributes and 9 sections by domain experts.
8. Analysis of the Qualitative and Quantitative assessment.
9. Incremental model development – iteration of stages 2, 3, 4, 5 for incorporating the proposals (Appendix Questionnaire – 3).

3.1.3. Wave III - model evaluation and integration

1. Evaluation of the MOIA model with 34 different attributes and 9 sections
2. Qualitative and Quantitative Assessment of organizational interoperability of the Greek e-Procurement Information system (ESIDIS) with eight (8) domain experts.
3. Analysis of the assessment with the AHP method (ranking the 34 attributes and 9 sections) and calculation of the weighted averages.
4. Integration of MOIA model for a holistic assessment approach of organizational interoperability.

The stages in the development process of the MOIA model are presented in the following methodological diagram (Fig. 1).

3.2. The model and the tool process development

3.2.1. Initial model

The initial model introduced by (Margariti et al., 2020) was selected as the reference model. Additionally, the organizational attributes proposed by domain experts during the initial development process were selected to enhance the initial model and tool.

3.2.2. Model enhancement with new attributes and categorization in sections

The organizational interoperability attributes, old and new ones, were categorized into sections for segmentation reasons. A description for sections is depicted in the following table: (Table 2).

3.2.3. Model compatibility assessment with EIF

The compatibility assessment of the attributes was conducted regarding their relevance to the EIF recommendations on organizational interoperability. The organizational attributes identified at a previous stage of the development process and included in the IMM/IMAPS model and tool were considered compatible with the EIF by design (European Commission & Directorate General for Informatics, 2020), while for the new ones a compatibility assessment was conducted considering the APPENDIX provided at the end of the paper.

3.2.4. Model extension

An extended model was developed after the integration of the new interoperability attributes (IA) and their categorization in sections. The extended model is presented with a matrix in which the IA are defined in lines while the five (5) levels of the maturity model (IMM) are defined in
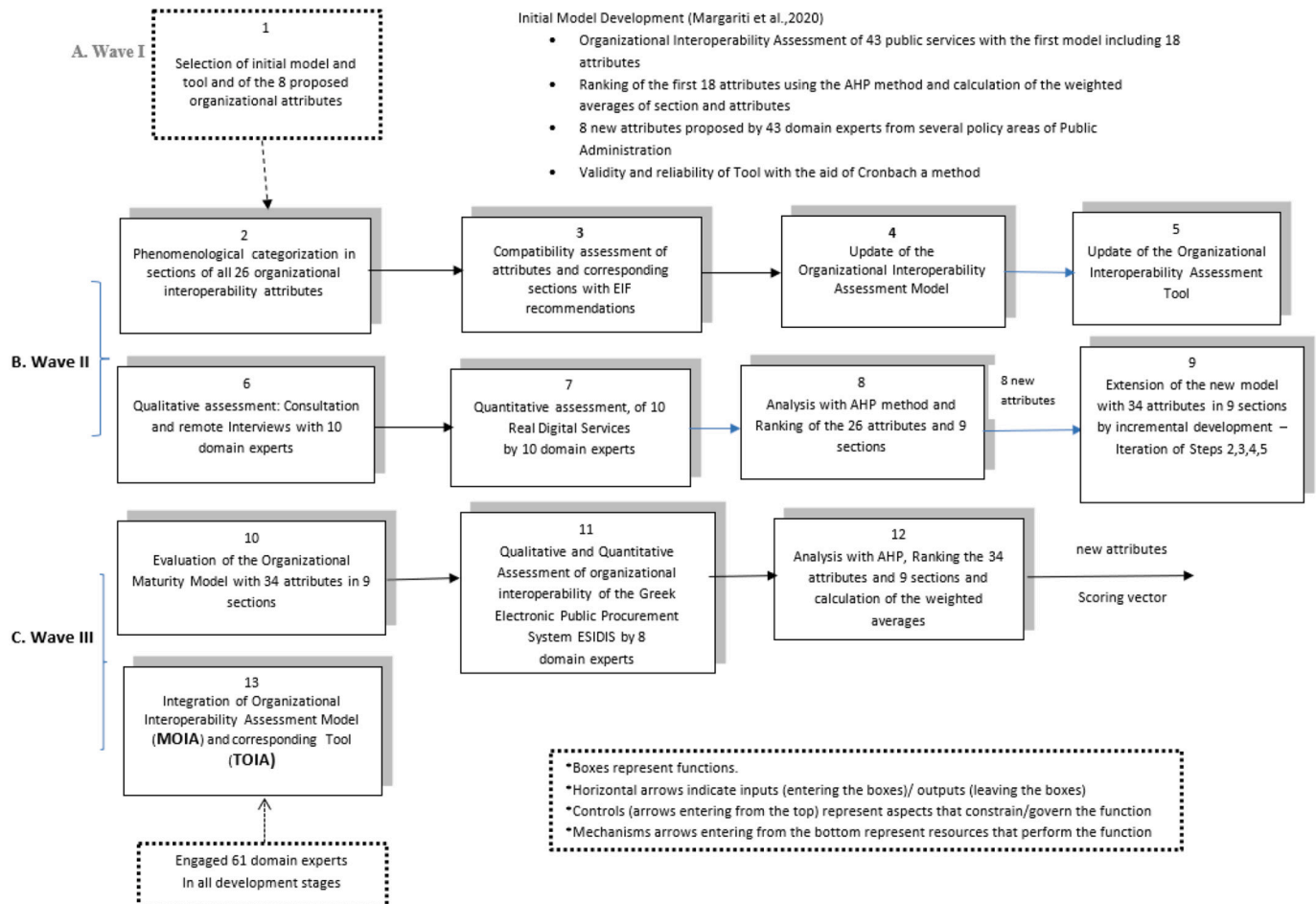

Fig. 1. Methodological diagram.

Table 2
Interoperability Sections Description

	Sections	Description
A	Design Process	Design Process (good practices, design patterns and design principles) is an important factor for the development of interoperable services as well as for the successful transformation of a heterogeneous organization to an interoperable system.
B.	Government Process Alignment	Alignment regarding intergovernmental processes contributes significantly to the achievement of organizational interoperability and consequently comprises an important metric
C	Compatibility with European policies and regulations (EIF, GDPR)	The maturity level of organizational interoperability regarding a digital service can be measured considering the compatibility with GDPR guidelines, recommendations of European Interoperability Framework and other relevant policies.
D	Interaction with users	An important factor on assessing organizational interoperability is the interaction with users including attributes such as user feedback, service level agreements, procedural transparency, and assistance service provision.
E	Service Consumption	The consumption of services in the development process of a digital service is a metric for the maturity assessment of organizational interoperability
F	Reusability of service	The potentiality to reuse a service for the development of a new digital service is an indicator of organizational interoperability maturity level.
G	Interoperability at national-international level	The accomplishment of organizational interoperability is a crucial factor for cross-border interoperability and incorporates attributes such as availability of service at National Single Digital Gateway, Multilingualism, and implementation of Once Only Principle
H	Change Management	Change management is an important metric for assessing the organizational interoperability and it comprises staff training and structure restructuring
I	Governance	An effective Governance contributes significantly to the achievement of organizational interoperability while it incorporates attributes such as collaboration, coordination, interaction with knowledge bases.

columns. The grade of fulfillment of an IA corresponds to a specific level of maturity in the organizational interoperability dimension.

3.2.5. Creation of tool

The TOIA tool (Appendix Questionnaire–2) is an extended version of the initial structured questionnaire. It incorporates all 26 organizational interoperability attributes aggregated in 9 sections.

3.2.6. Model qualitative assessment

The consultation phase was carried out in the form of remote meetings via WebEx, with a focus group of ten domain experts. Additional interviews were used to record in-depth the service processes regarding their organizational interoperability. During the interviews, the new tool was used for exploring service organizational experiences. The similarities and differences observed in the participants' comments were also analyzed and prioritized based on group decision methods.

New attributes regarding alignment with the most recent European regulations and guidelines around interoperability (SDG regulations, new interoperability strategy) as well as national legislation were

considered by domain experts. The following table presents the representation of authorities and roles (Table 3).

3.2.7. Model quantitative assessment

The above-mentioned focus group of ten (10) domain experts assessed ten (10) corresponding Digital Public Services with the TOIA tool. The digital services assessed included: Simplification and digitalization of teachers hiring procedure, Certificate of family status, Criminal Record, National Registry of Public websites and applications, electronic document handling system, Digital Academy, Digital declaration, Public Procurement e-Notification, Taxpayer Service, and e-paravolo.

3.2.8. Analysis of the qualitative and quantitative model assessment

Analysis of the data gathered from the qualitative and quantitative evaluation was performed and ranking of the 26 attributes and 9 sections by the domain experts was conducted. The following table presents the **8 new attributes** arising from the qualitative process of model assessment. Furthermore, justification is provided to specify their added value (Table 4).

3.2.9. Incremental model development

3.2.9.1. Stage 1: model enhancement and categorization of attributes.
The categorization of all 34 attributes (26 attributes of the initial model plus the 8 new organizational attributes arising from the previous wave of model enhancement) in 9 sections is presented in the following table (Table 5)

3.2.9.2. Stage 2: model compatibility assessment with EIF.
The following table presents the compatibility assessment for the 34 organizational attributes regarding their relevance with the EIF recommendations on organizational interoperability (Table 6).

3.2.9.3. Stage 3: model extension.
An extended model and tool were developed after the integration of all 34 interoperability attributes presented in the following matrix (Table 7).

3.2.9.4. Stage 4: creation of the TOOL.
The TOIA tool with the form of a questionnaire is extended to incorporate questions for the 34 attributes as well as to include the ranking for both attributes and sections

Table 3
Public authority/roles.

Public authority / sector	Role
Ministry of Digital Governance **Directorate of Digital Strategy**	Policy officer
Ministry of Digital Governance **Directorate of e-Government** **Department of eGovernment and Interoperability**	Developer
Ministry of Digital Governance **Directorate of National Single Digital Gateway**	Head of Department
Ministry of Digital Governance **Directorate of Digital Strategy** **Department of Web Accessibility**	Policy officer
Ministry of Digital Governance **General Secretariat of Information Systems of Public Sector**	Project Manager
Ministry of Digital Governance **General Secretariat of Information Systems of Public Sector** **Department of Interoperability and e-services**	Policy officer
Ministry of Digital Governance **Directorate of Projects Directorate of Projects**	Policy officer
Ministry of Development & Investment **General Secretariat of Commerce**	Project Manager
Independent Authority for Public Revenue	Project Manager
DG Digit / Directorate of Informatics / Interoperability Sector	Interoperability Expert

Table 4
Organizational interoperability attributes justification.

Attributes	Justification
Compatibility with National Digital Strategy	It is crucial to achieve alignment with national digital strategy.
Compliance with SDG regulations	The compliance with Single Digital Gateway regulations is a crucial index for assessing the level of organizational interoperability.
Availability of digital service at National Single Digital Gateway	The availability of a digital service at the National Single Digital Gateway incorporates business process alignment and consequently proves the accomplishment of organizational interoperability at national level
Interoperability Learning Profiles	The adoption of specific interoperability learning profiles that Interoperability Academy introduces during the training process is important for the achievement of organizational interoperability. Professionalization policies at national level are essential to ensure skills, knowledge, and integrity around interoperability.
Metadata Standards of Service	Current European guidelines around interoperability consider definition of metadata standards for a digital service a crucial factor for the organizational interoperability
Service Evaluation and Metrics	A service evaluation process and the availability of specific service metrics and indexes provide a high level of organizational interoperability. Outcome indicators (cost per service, number of users, response Time etc.), efficiency indicators, contribution to the digital transformation index
Assistance Service	The availability of an assistance service process should be considered as an important index for assessing the maturity level of organizational interoperability. e.g. If users are still confused about which rules apply or have trouble with a procedure, they will be guided to the EU or national assistance service most suited to address their problem
Compatibility with Accessibility Guidelines and relative standards	It is important that the digital service is aligned with all these guidelines the web accessibility legislation introduces so it is an index for assessing organizational interoperability

(Appendix Questionnaire – 3).

4. Application

4.1. The Greek Electronic Public Procurement System

The Greek Electronic Public Procurement System (ESIDIS) (www.eprocurement.gov.gr) was selected as a case study for the assessment of organizational interoperability with the MOIA model. This implementation is a large-scale real-world scenario and includes all the features needed to conduct a holistic assessment of organizational interoperability, since it comprises multiple and complex processes, different actors, and many subsystems.

ESIDIS provides general and horizontal digital services in procurement for all public administrations and local government agencies. It is a very significant system, applicable to the financing procedure of every procured project. Furthermore, it is a system providing cross-border services aligned with European standards, with a national and international geographical coverage.

According to statistics for the year 2020, retrieved from the official website of ESIDIS, 20,891 economic operators were registered from 2013 until the end of 2020, originating from 51 different countries. More than 117,374 bids from 12,193 economic operators have been

Table 5
Interoperability attributes (IA) per section.

Attributes	Sections
(A1) Procurement criteria	Design Process (A)
(A2) Specification Process	
(A3) Design methodology	
(A4) Collaboration	
(A5) Best practices	
(A6) Compatibility with Accessibility Guidelines and Relevant Standards	
(B1) Compatibility with intergovernmental legislation issues	Government Process Alignment (B)
(B2) Certification	
(B3) Business Process Modelling	
(B4) Compatibility with National Digital Strategy	
(C1) Compatibility with EIF	Compatibility with European policies and regulations (EIF, GDPR) (C)
(C2) Compatibility with GDPR	
(C3) Compliance with SDG regulations	
(D1) Procedural transparency	Interaction with users (D)
(D2) User Feedback	
(D3) Service level Agreements	
(D4) Assistance Service	
(E1) Service Consumption	Service Consumption (E)
(F1) Reuse and sharing	Reusability of service (F)
(F2) Cataloguing	
(F3) Metadata Standards of Service	
(G1) Once-Only Principle	Interoperability at national-international level (G)
(G2) Cross border service delivery	
(G3) Multilingualism	
(G4) Availability at National Single Digital Gateway	
(H1) Staff restructuring	Change Management (H)
(H2) Training	
(H3) Interoperability Learning Profiles	
(I1) Coordination	Governance (I)
(I2) Interaction with NIFO	
(I3) Accessibility to EI Knowledge Base	
(I4) Service Evaluation and Metrics	
(I5) Dissemination	
(I6) Exploitation of dedicated to interoperability financial resources	

submitted since the end of 2020.

More than 20 digital services are consumed to produce the final digital service. An orchestration of authorities, roles, procedures, users, and services is included to provide the final services to citizens and organizations. Reusability of provided services is also one of the important features of ESIDIS.

The owner of the ESIDIS system is the General Secretary of Information Systems of Public Sector (GSISPS), under the Greek Ministry of Digital Governance (MoDG). The system covers the procurement lifecycle needs and requirements by offering services at several levels, from planning, aggregation and tendering to payment and execution, and for all actors in the procurement chain, from Contracting Authorities to Economic Operators (EO) and Supervising Structures.

Therefore, its purpose is to submit, schedule and approve requests, assign notice procedure, sign, and execute contracts for the supply of goods, provision of services and public works with the use of fully electronic means supported by business intelligence tools. A significant goal of the system is to modernize the procurement process, by delivering an integrated, faster, and more effective procurement approach. Higher internal and external visibility is also achieved by enhancing transparency and competition. ESIDIS enables all public sector entities to communicate electronically during the procurement process, increasing efficiencies and reducing costs by providing interoperable digital services (Magina, 2013).

The Greek System for Electronic Public Procurement (ESIDIS) is composed of 11 subsystems: 1) Central Electronic Public Procurement Registry (KIMDIS) 2) Submission, Modification, Reporting Unified Procurement Program (EPP) 3) Submission, Modification,- Reporting

Table 6

Interoperability attributes (IA) combatibility assessment.

Attributes	IMM/IMAPS organizational attributes	Compatibility with EIF organizational Recommendations	Sections
(A1) Procurement criteria	*		Design Process (A)
(A2) Specification Process	*		
(A3) Design methodology		# Recommendation 28	
(A4) Collaboration		# Recommendation 20	
(A5) Best practices		# Recommendation 28	
(A6) Compatibility with Accessibility Guidelines and Relevant Standards		# Recommendation 21	
(B1) Compatibility with intergovernmental legislation issues		# Recommendation 26	Government Process Alignment (B)
(B2) Certification		# Recommendation 21	
(B3) Business Process Modelling	*		
(B4) Compatibility with National Digital Strategy		# Recommendation 20	
(C1) Compatibility with EIF			Compatibility with European policies and
(C2) Compatibility with GDPR		# Recommendation 21	regulations (EIF, GDPR) (C)
(C3) Compliance with SDG regulations		# Recommendation 21	
(D1) Procedural transparency	*		Interaction with users (D)
(D2) User Feedback	*		
(D3) Service level Agreements	*		
(D4) Assistance Service		# Recommendation 20	
(E1) Service Consumption	*		Service Consumption (E)
(F1) Reuse and sharing	*		Reusability of service (F)
(F2) Cataloguing		# Recommendation 23	
(F3) Metadata Standards of Service		# Recommendation 28	
(G1) Once-Only Principle		# Recommendation 22	Interoperability at national-international level (G)
(G2) Cross border service delivery	*		
(G3) Multilingualism		# Recommendation 21	
(G4) Availability at National Single Digital Gateway		# Recommendation 20	
(H1) Staff restructuring		# Recommendations 26/25	Change Management (H)
(H2) Training		# Recommendation 26	
(H3) Interoperability Learning Profiles		# Recommendation 26	
(I1) Coordination		# Recommendation 25	Governance (I)
(I2) Interaction with NIFO		# Recommendation 23	
(I3) Accessibility to EI Knowledge Base		# Recommendation 28	
(I4) Service Evaluation and Metrics		# Recommendation 21	
(I5) Dissemination		# Recommendation 20/26	
(I6) Exploitation of dedicated to interoperability financial resources		# Recommendation 20	

Unified Health Procurement Program (EHPP) 4) e-Tendering (RFQ) process 5) Management and execution of contracts 6) Business Intelligence 7) Electronic Workflow Management & Document Management 8) Electronic Protocol 9) Supplier Registry 10) System Interoperability 11) Central Internet Portal of Public Procurement (Magina, 2013).

The following figure presents the ESIDIS components (Fig. 2).

The following figure presents the ESIDIS services (Fig. 3).

4.2. Assessment of organizational interoperability

Both qualitative and quantitative techniques have been used to evaluate the specific field of public e-procurement as a case study. Furthermore, a pilot survey was conducted on the specific field. Indicative services from Greek Electronic Public Procurement System ESIDIS, such as e-procurement, e-notification and e-ESPD, all of which fall within the scope of public procurement, were examined to evaluate the organizational structure, procedures, relations, coordination, and other organizational aspects at all levels.

A focus group of eight (8) domain experts at national level of public administration in Greece and relevant stakeholders from the private sector provided feedback using the new model for holistic assessment of organizational interoperability in the ESIDIS case study. The specific group of domain experts was selected based on the representation of the basic roles in the development and management of ESIDIS, as well as on the requirement of the in-depth know-how of the ESIDIS case study datasets (Sink, 1983) (McMillan et al., 2016) (Table 8).

4.3. Analysis of the assessment process data

The analysis of the assessment process data was performed with the Analytic Hierarchy Process (AHP) method. In the following table, the equations for the calculation of weighted averages, both for attributes and sections, are presented (Table 9).

Considering the above equations concerning the calculation of weighted average for each attribute and section of our model, the scoring vector is generated as follows:

Scoring vector $= \sum (score\ of\ section_i * Ws_i)$.

Score of section$_i$ $= \sum score\ of\ attribute_i$

Score of attribute$_i$ $= (Score\ of\ answer_j) * Wa_i\ where\ j = 1...5\ \forall\ level\ of\ maturity$

Scoring vector $= \sum \sum [(score\ of\ answer_j * Wa_i) * Ws_i]$

4.4. Ranking and weighted averages

The assessment of ESIDIS organizational interoperability, ranked the 34 attributes and 9 sections of the MOIA model. The weighted averages for both attributes and sections were calculated as follows (Tables 10 and 11).

5. Discussion

The MOIA model consists of 34 attributes, aligned with the EIF recommendations, and introduces a holistic approach to organizational interoperability, providing qualitative and quantitative measurements for the consideration of concerns and barriers around the organizational

Table 7

Organizational interoperability maturity assessment services matrix.

IA \ IMM levels	Ad hoc (1)	Opportunistic (2)	Essential (3)	Sustainable (4)	Seamless (5)
Design Process (A)					
(A1) Procurement criteria	No standards in procurement		Partially, standards -based procurement		Fully, standards -based procurement
(A2) Design methodology	No, design processes have not been used at all		Partially, best practice based designed processes		Fully, design approaches-based process transformation
(A3) Specification Process	Closed specification process		Stakeholders have been invited once	Stakeholders have been invited periodically (frequently)	Open specification process
(A4) Collaboration	No, working groups was not established				Yes, working groups with members from all stakeholders were established
(A5) Best practices	No, best practices have not been used at all		Partially, best practice based digital services		Fully, best practice based digital services
(A6) Compatibility with Accessibility Guidelines and Relevant Standards	No, there is no compliance at all		Partially, some guidelines and standards have been adopted		Fully, all guidelines and standards have been adopted
Government Process Alignment (B)					
(B1) Compatibility with intergovernmental legislation issues	No		Partly		Yes
(B2) Certification	No, there is no certification procedure available				Yes, there is a certification procedure available
(B3) Business Process Modelling	No BMP		Ad hoc BMP	Standards-based BPM	Standards-based and collaborative BPM
(B4) Compatibility with National Digital Strategy	No		Partially		Yes
Compatibility with European policies and regulations (EIF, GDPR (C)					
(C1) Compatibility with EIF	No		Partly		Yes
(C2) Compatibility with GDPR	No		Partly		Yes
(C3) Compliance with SDG regulations	No		Partly		Yes
Interaction with users (D)					
(D1) Procedural transparency	No procedural transparency		Partly procedural transparency		Full procedural transparency
(D2) User Feedback	No User Feedback channel		Physical Feedback channel	Digital Feedback channel	Digital Feedback channel and insight into others' feedback
(D3) Service level Agreements	No		SLAs without monitoring		Monitored SLAs and corrective action
(D4) Assistance Service	No				Yes
Service Consumption (E)					
(E1) Service Consumption					
Reuse and sharing (F)					
(F1) Reuse and sharing	None	One answer chosen	Two answers chosen	Three answers chosen	All answers chosen
(F2) Cataloguing	No				Yes
(F3) Metadata Standards of Service	No				Yes
Interoperability at national-international level (G)					
(G1) Once-only Principle	No				Yes, provision of diverse data only once in contact with public administrations
(G2) Cross border service delivery	Restrictions towards foreigners				Restrictions towards foreigners
(G3) Multilingualism	None		Partially		Fully
(G4) Availability at National Single Digital Gateway	No				Yes
Change Management (H)					
(H1) Staff restructuring	No		Yes, there was partly staff restructuring		Yes, there was fully staff restructuring
(H2) Training	No				

(continued on next page)

Table 7 (*continued*)

| IA \ IMM levels	Ad hoc (1)	Opportunistic (2)	Essential (3)	Sustainable (4)	Seamless (5)
					Yes, all employees involved were trained
(H3) Interoperability Learning Profiles	No				Yes
Governance (I)					
(I1) Coordination	No				Yes
(I2) Interaction with NIFO	No				Yes
(I3) Accessibility to European Interoperability Knowledge Base	No		Yes, but not in a systematic way		Yes, there is a department following up all European issues around interoperability
(I4) Service Evaluation and Metrics	No		Yes, but not in a systematic way		Yes, there is a service evaluation process along with metrics
(I5) Dissemination	No				Yes, there is a dissemination system
(I6) Exploitation of dedicated to interoperability financial resources	No		Yes, but not a dedicated one		Yes, there is a dedicated department authorized
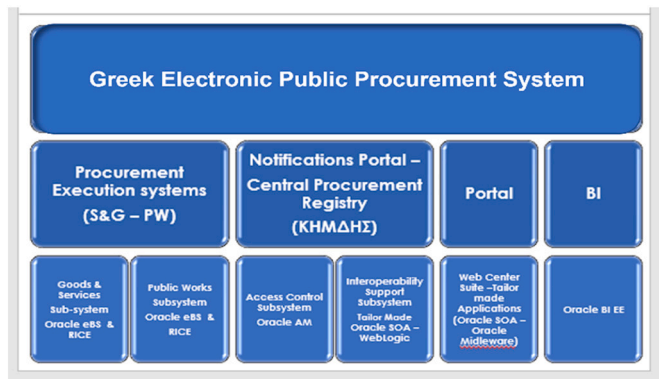
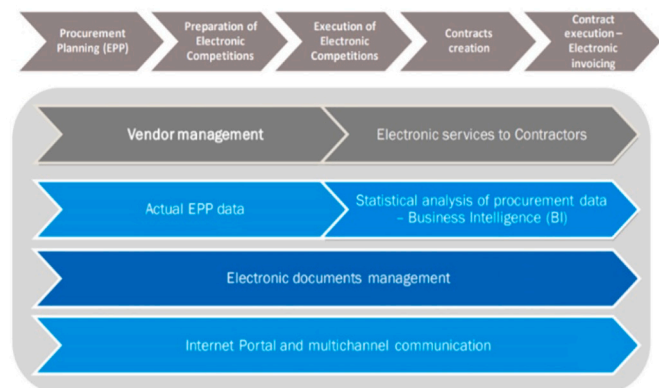**Fig. 2.** ESIDIS business systems application landscape.

Fig. 3. ESIDIS services.

layer of interoperability.

The domain experts suggest that the MOIA model not only considers the business process issues for such a large-scale digital implementation, but also other important concerns, such as the need for coordination and collaboration between the different stakeholders, the need for organizational structures and definition of responsibilities to achieve horizontal governance, as well as the need for training, assistance service, change management and funding issues. These attributes satisfy the general perception for effective management of an implementation incorporating interoperability in four dimensions: technical, semantic,

Table 8
Public/private sector domain experts.

Public / private sector	Digital service	Role of participants
Directorate for Management, Development & Support of the Greek Electronic Public Procurement System ESIDIS	(ESIDIS)	Director
Directorate for Management, Development & Support of the Greek Electronic Public Procurement System (ESIDIS) **Department of Development and Technical progress**		Head of Department
Directorate for Management, Development & Support of the Greek Electronic Public Procurement System (ESIDIS)		Executive officer
Directorate for Management, Development & Support of the Greek Electronic Public Procurement System (ESIDIS) **Department of Technical operation**		Head of Department
Directorate for Management, Development & Support of the Greek Electronic Public Procurement System (ESIDIS) **Department of User Training and System Support**		Head of Department
General Secretariat of Financial Policy General Account Office		Executive officer
Intrasoft International		Project Manager of ESIDIS implementation
University of Piraeus Department of Digital Systems		Professor, expert at e-procurement systems

Table 9
The calculation of weighted averages.

Domain Experts j Attributes i	Grade of domain experts for each attribute per section	Sum of grades per attribute	Weighted average of each attribute per section
	a_{ij}	$X_i = \sum a_{ij} \ \forall i$	$Wa_i = (x_i / \sum x_i)$

Domain experts j Section i	Grade of domain experts for each section	Sum of grades per section	Weighted average of each section
	S_{ij}	$Z_i = \sum S_{ij} \ \forall i$	$Ws_i = (z_i / \sum z_i)$

Table 10
Weighted averages of attributes per section.

Organizational Interoperability Attribute (OIA)	Weighted average	Weight percentage
Section A		
(A1) Procurement criteria	0.158798280	16%
(A2) Specification Process	0.188841202	19%
(A3) Design methodology	0.167381974	17%
(A4) Collaboration	0.158798283	16%
(A5) Best practices	0.163090129	16%
(A6) Compatibility with Accessibility Guidelines and Relevant Standards	0.163090129	16%
Section B		
(B1) Compatibility with intergovernmental legislation issues	0.297029703	30%
(B2) Certification	0.217821800	22%
(B3) Business Process Modelling	0.257425743	26%
(B4) Compatibility with National Digital Strategy	0.2277228	22%
Section C		
(C1) Compatibility with EIF	0.338983051	34%
(C2) Compatibility with GDPR	0.322033898	32%
(C3) Compliance with SDG regulations	0.338983051	34%
Section D		
(D1) Procedural transparency	0.27619048	28%
(D2) User Feedback	0.22857143	23%
(D3) Service level Agreements	0.23809524	24%
(D4) Assistance Service	0.257142857	25%
(E1) Service Consumption		
Section F		
(F1) Reuse and sharing	0.307692308	31%
(F2) Cataloguing	0.307692300	31%
(F3) Metadata Standards of Service	0.384615385	38%
Section G		
(G1) Once-Only Principle	0.240384615	24%
(G2) Cross border service delivery	0.298076923	30%
(G3) Multilingualism	0.221153846	22%
(G4) Availability at National Single Digital Gateway	0.240384620	24%
Section H		
(H1) Staff restructuring	0.350000000	35%
(H2) Training	0.40000000	40%
(H3) Interoperability Learning Profiles	0.25000000	25%
Section I		
(I1) Coordination	0.19254658	19%
(I2) Interaction with NIFO	0.16149070	16%
(I3) Accessibility to EI Knowledge Base	0.14285714	14%
(I4) Service Evaluation and Metrics	0.16770190	17%
(I5) Dissemination	0.16770186	17%
(I6) Exploitation of dedicated to interoperability financial resources	0.16770186	17%

Table 11
Weighted averages of sections.

Organizational interoperability sections	Weighted average	Weight Percentage
A		
Design Process	0.11264822	11%
B		
Government Process Alignment	0.11462451	11%
C		
Compatibility with European policies and regulations	0.13043478	13%
D	0.10869565	
Interaction with users		11%
E		
Service Consumption	0.08695652	9%
F		
Reusability of service	0.09881423	10%
G		
Interoperability at national-international level	0.12845850	13%
H		
Change Management	0.10079051	10%
I		
Governance	0.11857708	12%

mobility between different information systems, as well as legislation issues such as the eIDAS regulation. Attributes reflecting the need for **political commitment** and **institutional arrangements** as well as the need for specific job profiles are also necessary within a model for holistic organizational interoperability assessment of any digital service or implementation in general.

Considering the limitations of the ESIDIS domain-specific case study , further assessment of the MOIA model could be conducted, incorporating more horizontal aspects of organizational interoperability, such as these covered by the Greek governmental portal of single digital gateway (GOV.gr). GOV.gr provides a total of 1400 digital services, under anintegrated user-centric infrastructure, interconnecting with corresponding authorities and relevant stakeholders.Furthermore, since the calculation of attribute weights is based on the specific application of the methodology in Greek cases and on specific Greek experts' opinion, it could be applied in cross-border cases involving more experts to validate its use and refine the weights.

6. Conclusions and further research

Organizational interoperability is an efficient factor for accomplishing effective, integrated, and transparent intergovernmental services, and is believed to be strongly related to IT governance. Moreover, the public sector considers it a key prerequisite to applying open data policies and, therefore, providing open data services.

According to recent comparative surveys, none of the existing frameworks, maturity models and assessment tools that are presented in the literature provide a holistic approach to concerns and barriers for assessing organizational interoperability.

The MOIA model provides a comprehensive approach to diagnose the current situation and plan further improvements in organizational interoperability, by combining different measures from different perspectives. It is based on the IMM model, IMAPS tool and the GIMM matrix. It is further extended with more attributes, that either emerge from literature or satisfy current needs and new guidelines around interoperability, and which are fully aligned with the EIF.

The MOIA model, incorporating 34 different attributes categorized in 9 different sections, provide a more holistic perception of what organizational interoperability represents. This is achieved by introducing concerns and issues not only on the business process area, but also by proposing attributes reflecting the need for institutional arrangements, political commitment and definition of organizational structures and responsibilities within public authorities, as well as the

organizational, and legal.

Additionally, to the above evaluation, both public sector experts on e-procurement and relevant stakeholders from the private sector confirmed that the implementation of the ESIDIS could be more effective in case that the new model had been considered in the initial stages of the system's development. Nevertheless, its holistic approach, providing specific measurable aspect of all attributes, can still give added value by helping them to identify weaknesses and incompatibilities in a more precise and quicker way than preexisting evaluation process.

According to the e-procurement experts' feedback, further extension of the MOIA model could introduce new attributes covering concerns such as **technological neutrality** to easily foster changes, **data**

need for coordination and collaboration among different stakeholders.

The development process for the MOIA model spanned over several stages and was based on a concrete and reliable methodology, using both qualitative and quantitative methods for assessment. Specifically, all attributes were categorized in sections, compatibility assessment of all attributes regarding their relevance with the EIF recommendations was conducted, and organizational interoperability assessment of more than 50 real digital services from various policy areas of public sector and from various administrative levels was performed by more than 60 different domain experts, representing relative roles regarding the design, development and management of interoperable digital services. Furthermore, at the first wave of development the tool consistency and reliability were assessed. The Cronbach alpha internal consistency coefficient was calculated for all the selection questions related to the evaluation of the process and is satisfactory (a > 0.8). Indicatively, in one section the rate in Cronbach's Alpha = 0.997 calculated by SPSS. Therefore, the internal consistency of the questionnaire's questions and the reliability of the evaluation tool are concluded.

A pilot implementation at the National Centre of Public Administration and Local Government (EKDDA) was also included, while the final assessment of the MOIA model all 34 attributes and 9 sections were conducted by eight (8) different domain experts from the public and private sector, within a large-scale digital implementation from the Greek public administration around the e-procurement domain. Furthermore, the AHP method was used for analyzing the assessment process data (ranking of relevance and significance of attributes and sections, definition of their weighted averages and generation of a scoring vector).

The additional attributes, introduced during the data analysis of the ESIDIS assessment will further enhance the MOIA model. An additional wave refers to an extensive quantitative assessment of the final MOIA model with the 4 additional attributes. Furthermore, more cases from different domains as well as cross-border ones involving more experts will be used to refine the weights of the methodology. and to escalate the validity of the MOIA model. The validity and reliability of the new Tool for organizational interoperability assessment TOIA will also be assessed.

Appendix A. Appendix

EIF Organizational Recommendations	Description
# Recommendation 20	Ensure holistic governance of interoperability activities across administrative levels and sectors
# Recommendation 21	Put in place processes to select relevant standards and specifications, evaluate them, monitor their implementation, check compliance, and test their interoperability
# Recommendation 22	Use a structured, transparent, objective and common approach to assessing and selecting standards and specifications. Consider relevant EU recommendations and seek to make the approach consistent across boarders
# Recommendation 23	Consult relevant catalogues of standards, specifications and guidelines at national and EU level, in accordance with your NIF and relevant DIFs, when procuring and developing ICT solutions
# Recommendation 25	Ensure interoperability and coordination over time when operating and delivering integrated public services by putting in place the necessary governance structure
# Recommendations 26	Establish interoperability agreements in all layers, complemented by operational agreements and change management procedures
# Recommendation 28	Document your business processes using commonly accepted modelling techniques and agree on how these processes should be aligned to deliver a European public service

NIFO Retrieved from https://joinup.ec.europa.eu/collection/nifo-national-interoperability-framework-observatory.

Questionnaire - 1. Retrieved from https://docs.google.com/forms/d/18ppAPPVEuDx9OXGUg6_YqF8QxgBA4gIQ_xdnxoQwhII/edit.

Questionnaire - 2. Retrieved from https://docs.google.com/forms/d/1MJ9sgX909t_ZwS1brlC6zy07hDWFhGdDLOVPmchDegI/edit.

Questionnaire - 3. Retrieved from https://docs.google.com/forms/d/1SLzQ-ty7LceCGl5Wcx9xq4SHcV4keEVt3Ee94SwTAno/edit.

Appendix B. Supplementary data

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