A Canonical Evidence-based Approach for Semantic Interoperability in Cross-border and Cross-domain e-Government Services

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ABSTRACT

This paper demonstrates a proof of concept for cross-border information exchange guided by the single digital gateway regulation (SDGR) and once-only principle (OOP). The research systematically investigates the challenges and limitations of existing solutions for semantic interoperability. Furthermore, the concept of canonical evidence is introduced as a tool for the cross-border exchange of structured data automatically with less ambiguity and in compliance with the legal requirements of the selected public services. A design science research approach in an agile set-up is applied in the artefact (canonical evidences) development process. The requirements are elicited based on eight case studies set up in the context of the EU initiative, Digital Europe for all (DE4A). The data models developed in this study are in compliance with the requirements and provisions of a selected set of EU member states. The outcome of the study includes eleven evidence types that could be reusable in executing procedures of respective e-Government services.

CCS CONCEPTS

• **Applied computing** → Computers in other domains; Computing in government.

KEYWORDS

e-Government, Semantic Interoperability, Public service, Automatic exchange of data, Cross-border, Canonical Evidence, Once Only

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1 INTRODUCTION

Digitalization of Public administration and their cross-border collaboration has eventually become mandatory under the European digital agenda, imposed through strategic policy actions such as Single Digital Gateway Regulation (SDGR) [1]. SDGR strategizes establishing a single digital gateway providing access to information, procedures, assistance, and problem-solving services, imposing the obligation on Member States of the European Union (MS) in facilitating access to and completion of online administrative procedures for cross-border businesses and citizens. A core part of the Single Digital Gateway is the once-only principle (OOP) [2], which enables public entities to share citizen data with each other, so that people using any public services in any MS only have to enter their information once, thus increasing efficiently and reducing administrative burden. This means that such cross-border evidence should be able to be processed in any MS, which requires a sound semantic interoperability approach to be put into practice [3] [4].

The current landscape of the Pan-European information exchange and the semantic obligations for such endeavors have been addressed by several recent attempts (e.g., [5] [6]). However, the complexity and heterogeneity at various levels in the underlying ontologies and data models each MS uses in storing citizen data results in a spectrum of issues in cross-border information exchange [7]. Furthermore, the complexity increases when each MS requires to align their national procedures for meaningful and functional cross-border information exchange [8].

In this paper, we investigate the semantic interoperability approaches of the current leading initiatives, and systematically explore the strengths and opportunities of the existing initiatives, as well as the semantic interoperability challenges and limitations. Furthermore, a promising way forward is proposed by addressing these challenges while sustaining the strengths. The new approach is implemented and evaluated in the light of a European H2020 project, Digital Europe for all (DE4A) [9]. Accordingly, the following research questions are addressed:

- What are the strengths, opportunities, and the semantic interoperability challenges and limitations of the current cross-border e-Government solutions?

- How can these challenges be mitigated while sustaining the strengths and opportunities, towards a better provision of cross-border cross-domain e-Government services?

The rest of the paper is organized as follows. Chapter 2 briefs about the existing semantic interoperability solutions and general semantic interoperability requirements. Chapter 3 presents the proposed methodological approach to the semantic layer of the cross-border cross-domain e-Government services, followed by the methodology in Chapter 4 and, implementation and evaluation of the proposed approach in Chapter 5. Finally, the concluding remarks are presented in Chapter 6.

2 BACKGROUND

When there is no need to provide the public service across the borders, there is no need of matching these different criteria among countries; within a national situation, national rules and meanings are known by every competent authority involved in the public service. Therefore, until recently, MS have not deemed necessary to take into consideration the interoperability dimensions as a general policy, particularly the semantic dimension,

In the world of public procurement across borders, European directives provide a common understanding of selection and exclusion criteria and guidelines as requirements for eligibility of tenders. Based on those criteria, each Member State of the European Union (MS) has different ways to prove whether an individual complies with these requirements. For example, in the case of bankruptcy of a business, there may be several ways to prove that the company is bankrupt, based on legal documents from a court, or from data in a public database of suitable tenders, or from a base registry with company data, and so forth. In this cross-border situation, there is needed of a common understanding of shared exclusion and inclusion criteria and evidence to prove their compliance was provided by the European directives on public procurement. However, this common understanding is not provided by Union laws in all the domains involved in the provision of public services; moreover, some public services use to change their criteria frequently to be aligned with new government policies, such as the grants for studying. Hence, the main stand point of the problem when providing public service across borders is the common understanding of each service and related terms in each country.

2.1 Early Attempts

The early attempts of public service interoperability efforts root in the EU funded projects such as Interchange of Data across Administration (IDA I&II) [10] and Interoperable Delivery of European e-Government Services to public Administrations, Business and Citizens (IDABC) [11]. The initiatives of Interoperability Solutions for European Public Administrations (ISA and ISA^2) extend these findings towards focusing on cross-border and cross-sector interoperability [12]. These initiatives, which were later on established as parts of the European Interoperability Framework (EIF) [10], were mainly focusing on the public service interoperability infrastructures, with harmonization and/or definition of concepts and their interrelationships for e-Government services between public administration and citizens or businesses. These concepts that link the administration with citizens and businesses have been developed considering legal, organizational, semantic, and technical dimensions of interoperability. Semantic interoperability has been, at a later stage, developed in compliance with W3C and Semantic Web standards.

Starting from around 2010, critical efforts towards semantic interoperability were driven by the Semantic Interoperability Community (SEMIC) [17], which has the goal of developing solutions for helping European public administrations in performing seamless and meaningful cross-border and cross-domain data exchanges. Since its inception, SEMIC has contributed to the simplification of the environment in which EU MS exchange data for the delivery of electronic public services, addressing the issues and barriers related to semantic interoperability in the EU. Towards the objective to align and agree on common definitions and specifications at the semantic layer for public administrations in MS and EU institutions, SEMIC promotes the use of the following ISA^2 specifications: Core Vocabularies, Asset Description Metadata Schema (ADMS) and DCAT Application Profile for Data Portals in Europe (DCAT-AP) [18].

The e-Government Core Vocabularies (CPSV) [13] -generic concepts for locations, persons, public organizations, public services, and criterion and evidence- aims to offer a technology-neutral, abstract representation of semantic assets to serve as a common denominator of existing public service and base registry models. These core vocabularies provide a “lingua franca” that enables seamless exchange of services and information across different e-Government systems at national, regional, and local levels. However, there is no comprehensive semantic map that covers all the requirements for delivering integrated cross-border public services.

ISA^2 was continuing until 2020, allowing support for digital solutions that enable efficient and effective cross-border and cross-sector public service provisions, beneficial for both citizens and businesses, and the new European Interoperability architecture (EIRA), which is the crucial infrastructure needed to facilitate the process, and releasing new versions of the core vocabularies [13].

2.2 Single Digital Gateway Regulation and Once Only Principle

Approved in December 2018, the Single Digital Gateway Regulation (SDGR) is the first pan-European and cross-domain act of legislation that provides a basis for an EU-wide implementation of the once-only principle (OOP). Article 14 of such regulation requires the implementation of a Once-Only Technical System (OOTS) by December 2023, so public authorities for online procedures may request relevant lawfully issued evidence in an electronic format to the corresponding cross-border issuing authorities through the OOTS.

Nevertheless, there existed prior initiatives that were aimed at exploring the implementation of OOP at a European level. One of the early milestones was PEPPOL [14], which was active from 2008 to 2012 and was aimed at addressing interoperability issues in electronic public procurement. PEPPOL provided a technical framework enabling many-to-many connectivity along with a set of specifications that can be implemented in existing eProcurement solutions. Focusing solely on providing technical solutions and

failing in essence to practically address semantic interoperability, PEPPOL has since evolved into an international non-profit association, OpenPeppol, with more than 100 members from both private and public organizations.

Launched in November 2016, the SCOOP4C project [15] acknowledged the critical barrier in the form of lack of harmonization of data structures and semantics and identified the need for "semantic enablers" to be in place in order to establish semantic interoperability across different institutions. The envisioned enablers would take the form of common standards (taxonomies, controlled vocabularies, thesauri, code lists, etc.) imposed via multilateral agreements, which in itself proved to be a substantial bottleneck in practice.

In the same context, the e-SENS project (2013-2017) [16] provided architecture-driven solutions and technical specifications on the state-of-the-art technologies for strengthening the EU Single Digital market and cross-border e-Government services. Aiming for an interoperable EU-wide infrastructure, e-SENS delivered reusable semantics-enabled building blocks, but solely focused on the semantic interoperability from a legal and official document (evidence, attestation) perspective.

2.3 State-of-the-art Semantic Interoperability Frameworks

Launched in January 2017, the TOOP project [19] developed a criteria-based approach for exchanging evidence as an attempt to introduce semantic interoperability among MS. This approach is based on the SEMIC Core Criterion and Core Evidence Vocabulary (CCCEV) that aims to describe "Requirements" as a broad notion encompassing all forms of requests for information usually for making decisions, and "Evidence" as the data proving or disproving that a Requirement is met by someone or something. Although CCCEV is designed for any domain and machine processing, only eCertis is using it. eCertis [28] is an information system developed by the European Commission to help -without legal binding- business users in providing evidence required in public procurement procedures across the EU for proving the fulfillment of their exclusion and inclusion criteria, as provided by the European Directives for Public Procurement. However, exclusion and inclusion criteria is not generally provided in other domains.

SDGR defines evidence as a general concept, but it does not identify pan-European evidence types or procedural criteria. Therefore, a common understanding of pertinent evidence types, procedural criteria and concepts among EU public bodies is still strongly needed. In an attempt to address these shortcomings, TOOP resulted in a highly sophisticated solution that requires the user to make a significant number of decisions prior to submitting a cross-border evidence request, along with a significant overload to MS for maintaining the detailed metadata required by this solution.

The TOOP solution maps national procedural requirements (information requirements, selection criteria or requirement constraints) between two countries by the definition of SDG general procedural requirements and links between them and the national procedural requirements. The next step is mapping the national evidence types with national criteria that can be proved by such evidence types. The final step is mapping each national evidence type with one or more evidence services offered by national competent issuing authorities; each evidence service can provide either an unstructured document (e.g., PDF), a structured document according to some data schema (e.g., XML) or a set of attributes regarding a predefined concept. Thus, there may be several ways to prove a procedural requirement, because there are several national requirements mapped to an SDG general requirement, several national evidence types for each national requirement, several evidence services for each national evidence type or even several national public authorities that can provide evidence of the same type. The user is requested to disambiguate and select over the multiple possibilities. Due to a lack of a common understanding and also due to potential legal issues in the various countries, tackling this series of mapping and disambiguation issues poses a non-trivial challenge to both competent authorities and users. Despite its shortcomings discussed above, TOOP was the first large-scale project attempting to prove the viability of information exchange across Europe and served as a pilot of the technical viability of this endeavor across the EU.

2.4 Limitations of the Current Approaches

Semantic interoperability solutions and semantic building blocks defined in ISA^2 and other related initiatives provide a promising way forward for the cross-border information exchange. These strengths and opportunities include:

- Technically implemented and validated for completeness of the models – e.g., the semantic layer of TOOP is technically verified using marine and business domains [20]
- Grounded on the existing semantics assets, hence, high reusability
- Emerged from an EU MS wide initiatives (TOOP, SEMIC)
- Aligned with the concepts of OOP and OOTS (Once Only Technical System) [19]

As elaborated in the preceding sub sections, the following challenges and threats are associated with the existing solutions:

- Legal validity of the data models is not fully verified – For e.g., birth of a person should be proved by a certificate issued by a legal verified competent authority in an electronic format with legal value under a national or European law.
- Concepts are too generic and difficult to implement without an involvement of domain and context experts – For e.g., the object person could be a natural person (can be extended also to parent or child in public service data models), or legal person in the business domain.
- Lack of semantic agreement at the administrative level of public service providers – For e.g., the object Address has an attribute, AdminUnitL2, which in some countries can map to the municipality, or some other countries it's a region.
- Lack of emphasis on semantic principles; Semantic questions are typically handled by either technical experts or business experts
- Complexity of solutions and difficulty of implementation at MS level
- Alignment with SDGR requirements and the procedures in the SDGR scope

Therefore, a solution for the above challenges while retaining the strengths of the current solutions is indispensable for efficient cross-border information exchange.

3 THE CANONICAL EVIDENCE-BASED APPROACH

In the Digital Europe for All project (DE4A), semantic interoperability agreements are established through canonical evidence models, specified in close collaboration with domain experts. In principle, canonical evidence is a "Structured data that includes a common set of attributes associated with the evidence type that can be provided in addition to the corresponding lawfully issued evidence -the domestic evidence- with equivalent information" [21]. In other words, canonical evidence is the common set of attributes corresponding to the minimum information required to prove a life or business event (e.g., a proof of birth of a citizen), whose values are provided in a Latin alphabet. This approach allows separating semantic vs legal interoperability, materialized in DE4A via canonical vs domestic evidence. In a nutshell, the starting point is identifying the types of evidence that are issued by public competent authorities and are relevant for procedures under scope, as the SDGR establishes. Then, each evidence type is modelled reusing existing semantic assets, and these common models – known as canonical evidence types – constitute the semantic interoperability agreements for the cross-border exchange of evidence. Under this approach, the only common metadata to provide and maintain is the list of canonical evidence types, along with their common data models, and the mapping between each canonical evidence type and the national evidence services that can provide such canonical evidence. In this last point, DE4A also applies a simplification for using the evidence provided at the highest administrative level when it can also be provided at lower administrative levels, so disambiguation is not needed in this regard, either.

Canonical evidence types are implemented from an ontology defined for the relevant domain. They are used for minimizing the information to be transferred, for the common understanding of such information, and for allowing the automated processing of cross-border evidence. Thus, canonical evidence types are defined taking in account the granularity of the information to provide as evidence, so they can be created and modified over the time as new relevant evidence is found for the procedures that may benefit from the OOP at the EU level.

Because canonical evidence might not have the required legal value, it can be transferred along with the domestic evidence, which does entail legal value, whatever digital format, alphabet, and language the latter is in. In this case, evidence providers are entrusted with the submission of canonical evidence equivalent to the domestic one, since both are automatically obtained from the same base registry. But if there is a legal claim at a later stage, then the equivalence between the canonical and the domestic evidence must be audited.

Competent issuing authorities are therefore responsible for mapping their national evidence and national procedural requirements to the canonical evidence types. In this way, cross-border evidence exchange is based on semantic interoperability agreements (canonical evidence types and their common data models) to facilitate the understanding of cross-border evidence, leaving space for future legal interoperability agreements that provide legal value to canonical evidence. This approach is an implementation of the subsidiarity principle, which seeks to safeguard the ability of the MS to take decisions and action and authorizes intervention by the EU when the objectives of an action cannot be sufficiently achieved by the MS.

What makes the DE4A canonical evidence approach completely affordable is the fact that there already exist various resources and vocabularies that can serve – after appropriate adjustments as needed – for defining cross-border domain-specific ontologies as semantic interoperability agreements in several sectors. Canonical evidence types are just views on these cross-border domain-specific ontologies that allow public authorities to control what information can be exchanged and, thus, avoid obtaining more information than necessary.

Comparing the TOOP criteria-based approach and the DE4A canonical evidence-based approach, the latter requires less effort from competent authorities to maintain common metadata and to understand cross-border evidence. Canonical evidence serves as translation of domestic evidence, so automatic processing is enabled and there is no need of legal translations for civil servants to process the evidence; this is the same approach as for multilingual standard forms of public documents provided by Regulation (EU) 2016/1191. The DE4A implementation of the subsidiarity principle makes pointless to others to know the mapping between national criteria and common criteria, and the mapping between common/national criteria and domestic evidence. Besides, national procedural requirements are usually susceptible to change over time, so they require more maintenance. In the DE4A canonical evidence-based approach, instead of sharing the mapping between domestic evidence and national evidence issuing services, the latter are mapped to canonical evidence types and this is the only metadata to share with cross-border authorities.

4 METHODOLOGICAL APPROACH

The semantic interoperability limitations identified in the current solutions are addressed in the DE4A semantic interoperability approach. These limitations are foreseen as requirements to the new solution. To perform a systematic process, two basic research strategies are followed; 1) a design science approach in an agile methodological setting for the development and evaluation of the artefact; the semantic components (data models for canonical evidence types). 2) Case study is used for elicitation of requirements to evaluation of the solutions. Therefore, in requirement elicitation, not only the limitations identified from the previous attempts, but also the gaps from the case studies set up in this research are taken into account.

4.1 Design Science Approach to Artefact Design and Implementation

Design science research methodology (DSRM) [22] and its principles guided this work. In order to accommodate the methodological perspectives of problem explication, requirement elicitation, and co- design of solutions within the context of use cases, we combine the robust principles of designing a systematic solution to a

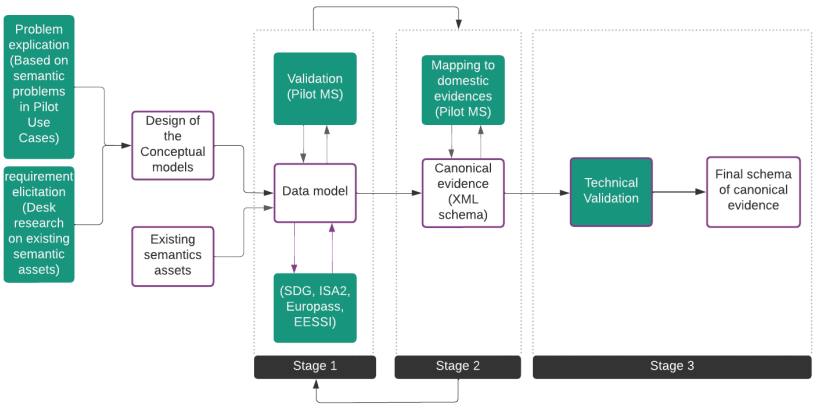


Figure 1: The DSRM based canonical evidence development

Table 1: Pilot use cases

UC#	Description of cross-border service	Countries the models are verified
SA - UC1	Application to public higher education	Spain, Portugal, Slovenia
SA - UC2	Applying for a study grant	Spain, Portugal
SA - UC3	Diploma certificate and professional recognition	Spain, Portugal
DBA - UC1	Starting a business in another country	Austria, Nederland, Romania
DBA - UC2	Doing business in another country	Austria, Nederland, Romania
MA - UC1	Request an address change	Spain, Luxemburg, Romania, Portugal, Slovenia
MA - UC2	Request an extract or copy of civil state certificate	Spain, Luxemburg, Romania, Slovenia
MA - UC3	Request pension information – request pension claim	Spain, Portugal

problem [23] or an artefact, with the soft principles of extracting requirements for such a solution [24]. Combining the two approaches ensures that the resulting artefact is created following a formal scientific procedure, and is grounded in theoretical knowledge that is broad enough to provide diverse perspectives on the problem; accounts for specific real-world considerations and practical demand. In developing the artefacts (the canonical evidence models), an agile approach is followed, as presented in Figure 1. Hence, the data model building and evaluation (stage 1&2) is iterated until each concept is verified with the domain experts in the pilot use cases. The syntactic validation of the canonical evidences is conducted at the final stage of the process.

4.2 Case Study Approach to User-centric Design

For testing the feasibility and adequacy of canonical evidence types in the DE4A semantic layer, a multi-use case approach is followed. In selection of the use cases, the procedures prioritized by SDGR [25] for life events for students, companies and citizens are considered. The pilots focus on 3 domains (cases), Studying abroad (SA), Doing business abroad (DBA), and, Moving abroad (MA). Table 1 below shows the details of the use cases that the canonical models are developed and verified for. The participants of the pilot use cases were the responsible entities of the national teams of OOTS development under SDGR.

5 DESIGN AND IMPLEMENTATION

This section presents the design and implementation of the canonical evidence models for the selected use cases presented in Table 1. For each of the use cases, a number of canonical evidence types (c.f. Section 3) is specified, providing a set of agreed concepts for representing the corresponding information.

5.1 Elicited Requirements

As stated in the preceding section, requirements are elicited based on the requirements for the specific pilot use cases mentioned. Table 2 presents the requirements applicable horizontally to all canonical evidence types, in all the use cases. The more specific requirements for each of the specific use cases are described in detail in a project deliverable of requirement elicitation [26]. The requirements were elicited during frequent co-creation sessions together with the semantic experts, domain experts and MS representatives from each of the DE4A piloting teams, following an agile approach (c.f. Section 4). The prioritization of the requirements complies to MoSCoW (Must Have, Should Have, Could Have, Won't Have) [27].

5.2 Evidence Design and Implementation

Based on the requirements elicited, the canonical evidence types were identified relevant per domain/use case, and modelled, as illustrated in Table 4.

Table 2: Overall requirements for all the canonical evidence types

REQ ID	Description	Priority
CE-GEN-01	All canonical evidence models must rely on existing data exchange standards (e.g., XML/XSD)	M
CE-GEN-02	Reuse of existing evidence models (e.g., SDG) is a prerequisite	M
CE-GEN-03	Reuse of core models (e.g., EDCI, Core Vocabularies, etc.) is required	M
CE-GEN-04	Wherever possible, reuse of existing controlled lists (i.e., code lists) should be adopted	C
CE-GEN-05	Semantic interoperability between evidence items needs to be established based on agreed formats and standards (e.g., W3C-recommended standards)	S
CE-GEN-06	Whenever necessary, multilingual representation of information fields shall be supported	S
CE-GEN-07	The naming of the fields should be in line with the respective naming in the adopted models, in order to maintain uniformity with existing approaches	C
CE-GEN-08	Respective free-text descriptions and documentation shall accompany every field	C

Table 3: Canonical evidence types per use case

Use case	Canonical evidence type	Description
SA	Higher Education Diploma Evidence	Proves that an individual has acquired a higher education diploma
	Secondary Education Completion Evidence	Proves that an individual has completed their secondary education
	Non-Academic Information Evidence	Provides non-academic information about an individual, i.e., household composition and disability (e.g., for the purposes of awarding a scholarship or grant)
DBA	Company Registration Evidence	Provides information for the exchange of evidence of a company
MA	Birth Evidence	Proves the birth of a person
	Marriage Evidence	Proves the marriage between two persons
	Domicile Registration Evidence	Proves that an individual has successfully completed domicile registration in terms of change of address to another EU MS
	Means of Living Evidence	Consists of three sub-types regarding pension, unemployment, and working life benefits

The preliminary concept models were designed by identifying and conceptualizing the fields related to each canonical evidence type. Figure 2 Summaries the top-level concept of each data model (the canonical evidence type), of which, A) Higher Education Diploma Evidence, B) Secondary Education Completion Evidence, C) Non-Academic Information Evidence, D) Means of Living Evidence, E) Birth Evidence, F) Marriage Evidence, G) Domicile Registration Evidence, and, H) Company Registration (Doing business Abroad) Evidence. The fine-grained details of requirement prioritization and concept building is available in an open access public repository[1].

As illustrated in Figure 1, the concept models were validated with the piloting partners for adequacy and applicability, followed by development of the data models for each of the canonical evidence types. In developing the data models, following rules are followed;

(1) Reuse from existing vocabularies (ISA[2], W3C, Europass, etc.), if the concepts (data types) are available.
(2) If a certain concept has multiple meanings (applications), the pilot recommendations are followed, and thereby redefined the data type.
(3) Data types are custom-defined only if the concept is not available in existing vocabularies or in national databases.

The detailed descriptions of the data types, data model development and the final designs of the canonical evidence types (c.f. Table 1) are openly accessible in a GitHub repository[2]. Due to the space limitation of this paper, we present one UML diagram that corresponds to the *Secondary Education Completion Evidence* in Figure 3.

Note that Grade is a custom-defined data type for representing the actual score grade, the grading scheme, along with a short textual explanation. Below is a sample XML excerpt for illustrating its usage:

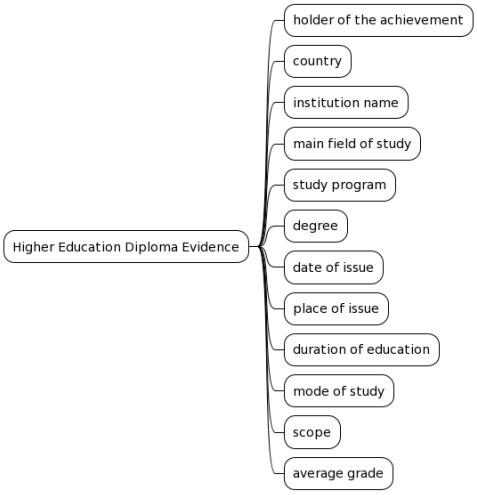
```
<averageGrade schemeID="Percentile" explanation=
"Grading assuming values 0% to 100%, with 100% being the
best">94</averageGrade>
```

The rest of the data models are included in the online repository for public access as given in the Table 4. As a result of iterative process of development of the data models, the concepts in Figure 2 have been changed based on the pilot feedback during Stage 2 of Figure 1. For e.g., at the concept design level *Non-academic information evidence* is conceptualised as Household Income and Household Composition, but during the validation stage (Stage 2)

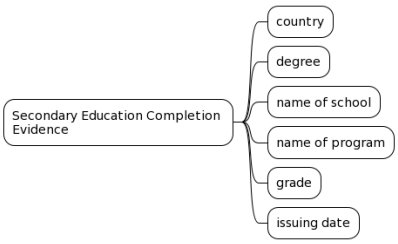
[1] https://wiki.de4a.eu/index.php/Canonical_Evidence

[2] https://github.com/de4a-wp3

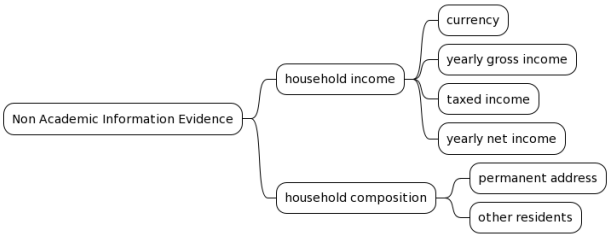
A) Higher education Diploma Evidence



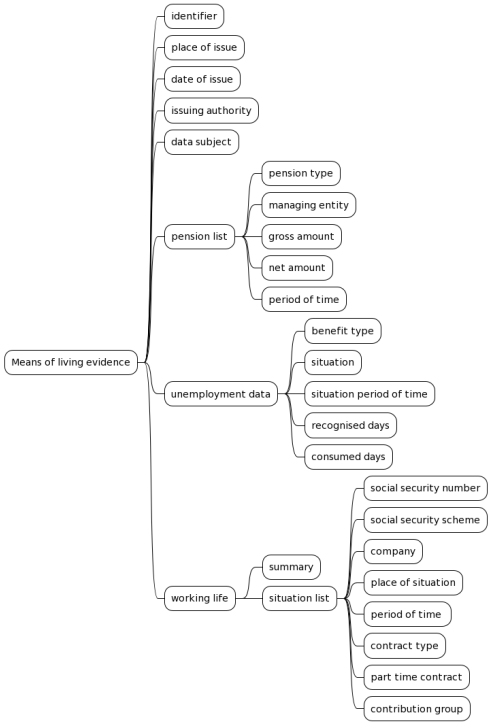
B) Secondary Education Completion Evidence



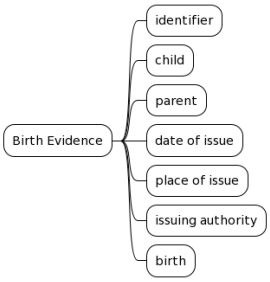
C) Non-academic Information Evidence



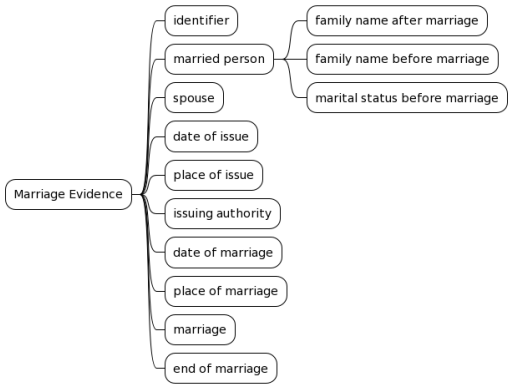
D) Means of Living Evidence



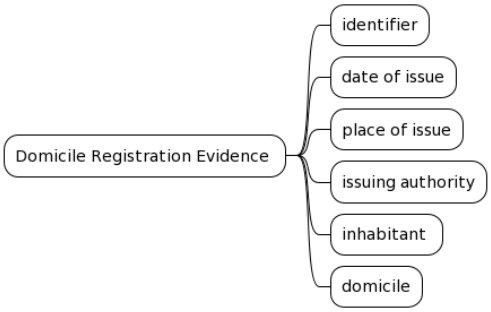
E) Birth Evidence



F) Marriage Evidence



G) Domicile Registration Evidence



H) Doing Business Abroad Evidence

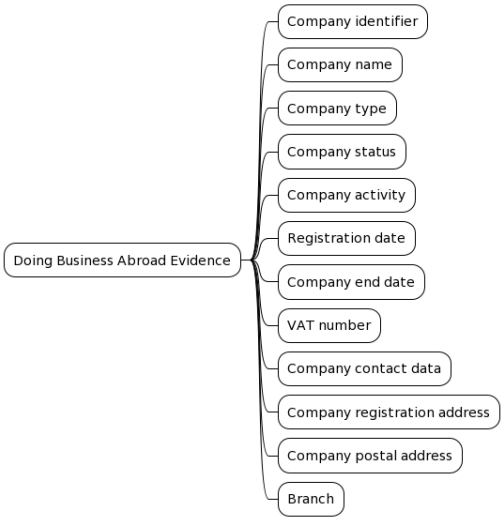


Figure 2: The overview of the fields of the canonical evidences (concept models)

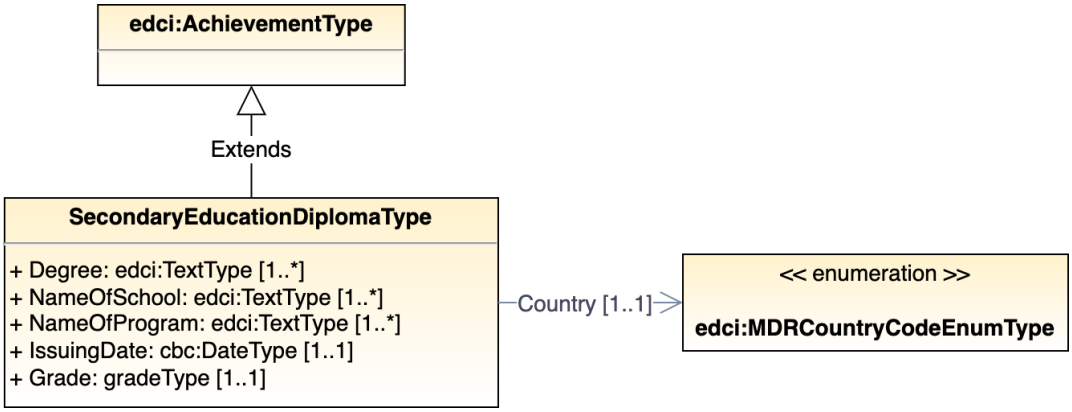


Figure 3: Secondary Education Completion Evidence UML diagram

of the models (c.f., Figure 1), it is identified that Member States cannot provide these data, and therefore suitable alternative concepts (*LargeFamily*, *Disability*) has been recognised.

6 CONCLUDING REMARKS

The canonical evidence-based approach of DE4A project demonstrates how semantic agreements can be established among MS for evidence exchange across borders, with due respect to legal interoperability and the subsidiary principle. This approach is successfully tested with several piloting MS, for eight use cases covered by SDGR. The implemented canonical evidence types can be treated as semantic building blocks that are specific enough for a certain proof of event, e.g., the *birth evidence* can be used with any public procedure that needs a proof of birth of a person. In parallel, the DE4A approach is also addressing the respective challenges such as, e.g., the lack of common code-lists for solving semantic interoperability issues at the EU level.

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Table 4: XML schema for canonical evidences

Use case	Canonical evidence type	XML Schema location
SA	Higher Education Diploma Evidence	https://github.com/de4a-wp3/study_abroad/blob/main/XSD/SA-UC1-13-04-2021.xsd
	Secondary Education Completion Evidence	https://github.com/de4a-wp3/study_abroad/blob/main/XSD/SA-UC1-SecondaryEducationEvidenceType-12-05-2022.xsd
	Non-Academic Information Evidence	Disability:https://github.com/de4a-wp3/study_abroad/blob/main/XSD/SA-UC2-DisabilityEvidenceSample.xml LargeFamily:https://github.com/de4a-wp3/study_abroad/blob/main/XSD/SA-UC2-LargeFamilyEvidenceType-12-05-2022.xsd
DBA	Company Registration Evidence	https://github.com/de4a-wp3/doing_business_abroad/blob/main/doing_Business_abroad_XSD_v0.4%202.xsd
MA	Birth Evidence	https://github.com/de4a-wp3/moving_abroad/blob/main/xsd/_common/birthEvidence-1.7.xsd
	Marriage Evidence	https://github.com/de4a-wp3/moving_abroad/blob/main/xsd/_common/marriageEvidence-1.7.xsd
	Domicile Registration Evidence	https://github.com/de4a-wp3/moving_abroad/blob/main/xsd/_common/domicileRegistrationEvidence-1.7.xsd
	Means of Living Evidence	Pensions:https://github.com/de4a-wp3/moving_abroad/blob/main/xsd/_common/pensionMeansOfLivingEvidence-0.1.xsd Unemployment:https://github.com/de4a-wp3/moving_abroad/blob/main/xsd/_common/unemploymentMeansOfLivingEvidence-0.1.xsd WorkingLife:https://github.com/de4a-wp3/moving_abroad/blob/main/xsd/_common/workingLifeMeansOfLivingEvidence-0.1.xsd

REFERENCES

[1] EUR-Lex: EUR-Lex - 32016R0679 - EN - EUR-Lex, https://eur-lex.europa.eu/eli/reg/2016/679/oj
[2] Once Only Principle, https://ec.europa.eu/cefdigital/wiki/cefdigital/wiki/display/CEFDIGITAL/Once+Only+Principle
[3] Tarmo Kalvet, Maarja Toots, Robert Krimmer: Contributing to a digital single market for Europe: barriers and drivers of an EU-wide once-only principle. Digit. Gov. Res. Gov. Data Age. 1–8 (2018). https://doi.org/10.1145/3209281.3209344
[4] Gerontas, A.: Towards an e-Government semantic interoperability assessment framework. In: Proceedings of the 13th International Conference on Theory and Practice of Electronic Governance. pp. 767–774. Association for Computing Machinery, New York, NY, USA (2020)
[5] Robert Krimmer, Tarmo Kalvet, Maarja Toots, Aleksandrs Cepilovs, Efthimios Tambouris: Exploring and Demonstrating the Once-Only Principle: A European Perspective. Digit. Gov. Res. 546–551 (2017). https://doi.org/10.1145/3085228.3085235
[6] Works, S.: Peppol, http://peppol.eu/
[7] Stani, E., Barthélemy, F., Raes, K., Pittomvils, M., Rodriguez, M.A.: How data vocabulary standards enhance the exchange of information exposed through APIs: the case of public service descriptions. In: Proceedings of the 13th International Conference on Theory and Practice of Electronic Governance. pp. 807–810. Association for Computing Machinery, New York, NY, USA (2020)
[8] Janssen, M., Wagenaar, R.: Developing Generic Shared Services for e-Government. Electron. J. E-Gov. 2, pp31-38-pp31-38 (2004)
[9] European Digital Public Services | London UK | Digital Europe For All, https://www.de4a.eu
[10] Union, P.O. of the E.: CELEX1, Interchange of data between administrations (IDA) programme Contract notice Open procedure, http://op.europa.eu/en/publication-detail/-/publication/98ac8168-03da-4a42-b0d0-77fcb55575f8
[11] EUR-Lex HTML (EN), https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32004D0387R(01)
[12] GERONTAS, A., PERISTERAS, V., TAMBOURIS, E., KALIVA, E., MAGNISALIS, I., TARABANIS, K.: Public Service Models: A Systematic Literature Review and Synthesis. IEEE Trans. Emerg. Top. Comput. 9, 637–648 (2021). https://doi.org/10.1109/TETC.2019.2939485
[13] Homepage | ISA^2, https://web.archive.org/web/20220305115218/https://ec.europa.eu/isa2/home_en
[14] Regulation (EU) 2018/1724 of the European Parliament and of the Council of 2 October 2018 establishing a single digital gateway to provide access to information, to procedures and to assistance and problem-solving services and amending Regulation (EU) No 1024/2012 (Text with EEA relevance.). (2018)
[15] Wimmer, M. a. (1), Marinov, B.(2): SCOOP4C: Reducing administrative burden for citizens through once-only - Vision & challenges. Jusletter IT. (2017)
[16] e-SENS, http://www.esens.eu/
[17] emantic Interoperability Community (SEMIC) | Joinup, https://joinup.ec.europa.eu/collection/semantic-interoperability-community-semic
[18] DCAT Application Profile for data portals in Europe | Joinup, https://joinup.ec.europa.eu/collection/semantic-interoperability-community-semic/solution/dcat-application-profile-data-portals-europe
[19] EC: CEF OOP is progressing on the SDG Once Only Technical System | TOOP.EU, https://toop.eu/node/420
[20] Jaak Tepandi, Eric Grandry, Sander Fieten, Carmen Rotuna, Giovanni Paolo Sellitto, Dimitris Zeginis, Dirk Draheim, Gunnar Piho, Efthimios Tambouris, Konstantinos Tarabanis: Towards a Cross-Border Reference Architecture for the Once-Only Principle in Europe: An Enterprise Modelling Approach. Pract. Enterp. Model. 12th IFIP Work. Conf. PoEM 2019 Luxemb. Luxemb. Novemb. 27–29 2019 Proc. 103 (2019). https://doi.org/10.1007/978-3-030-35151-9_7
[21] Berberidos, C., Syed Iftikhar, H.S., Konstantinidis, E., Karunaratne, T., Guzman, A.R.: D3.3 Semantic Framework – Initial version, https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5d5479650&appId=PPGMS
[22] Cloutier, M., Renard, L.: Design Science Research: Issues, Debates and Contributions. Proj. Proy. Proj. 20, 11–16 (2018)
[23] Peffers, K., Tuunanen, T., Rothenberger, M.A., Chatterjee, S.: A Design Science Research Methodology for Information Systems Research. J. Manag. Inf. Syst. 24, 45–77 (2007). https://doi.org/10.2753/MIS0742-1222240302
[24] Baskerville, R., Pries-Heje, J., Venable, J.: Soft design science methodology. In: Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology. pp. 1–11. Association for Computing Machinery, New York, NY, USA (2009)
[25] EC: Single digital gateway, https://ec.europa.eu/growth/single-market/single-digital-gateway_sv
[26] EC: Single digital gateway, DE4A Consortium: D3.2 Final Requirements for Semantic Assets, https://www.de4a.eu/project-deliverables, (2022)
[27] Waters, K.: Prioritization using moscow. Agile Plan. 12, 31 (2009)
[28] European Commission. eCetis. [En línea] 23 de 05 de 2022. https://ec.europa.eu/tools/ecertis/.