



D4.14 Pilots Final Evaluation Report

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List of Acronyms

Abbreviation / acronym	Description
AS4	Applicability Statement 4
BRIS	Business Registers Interconnection System
CA	Certification Authority
CEF	Connecting Europe Facility
DBA	Doing Business Abroad
DC	Data Consumer
DE	Data Evaluator
DE4A	Digital Europe for All
DP	Data Provider
DPO	Data Protection Officer
DO	Data Owner
Dx.y	Deliverable number y, belonging to WP number x
EBSI	European Blockchain Services Infrastructure
EC	European Commission
EDCI	Europass Digital Credentials Infrastructure
EESI	Electronic Exchange of Social Security Information
EHEA	European Higher Education Area
eIDAS	Electronic Identity and Trust Services
EIF/EIRA	European Interoperability Framework/Reference Architecture
ESSIF	European Self-Sovereign Identity Framework
EUDI	European Digital identity (Wallet)
FGPV	Fine Grained Powers Validation
GDPR	General Data Protection Regulation
IM	Intermediation
ISA2	Interoperability solutions for public administrations, businesses and citizens
KPI	Key Performance Indicator
MA	Moving Abroad
MOR	Multilingual Ontology Repository
MoU	Memorandum of Understanding
MS	Member State
MVP	Minimum Viable Product
OOP	Once-Only Principle
OOTS	Once-Only Technical System
SA	Studying Abroad
SDG(R)	Single Digital Gateway (Regulation)
SMART	Specific, Measurable, Achievable, Relevant and Time-Bound
SME	Small and Medium Enterprises
SMP	Service Metadata Publisher

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Abbreviation / acronym	Description
S&N	Subscription & Notification
SSI	Self-Sovereign Identity
TLS	Transport layer Security
UC	Use Case
UML	Unified Modelling Language
URL	Uniform Resource Locator
USI	User-Supported Intermediation
VC	Verifiable Credentials
WP	Work Package
XSD	XML Schema Definition

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Executive Summary

This is the final deliverable of the task of DE4A's "Cross-border Pilots for Citizens and Business and Evaluation", corresponding to the Final Evaluation of the achievements and results obtained through the piloting phases -with respect to pilot and project objectives- by the three DE4A Pilots: Studying Abroad (SA), Doing Business Abroad (DBA) and Moving Abroad (MA).

The Final Evaluation acts as an ex-post strategic point at the end of the project, having already assessed in the Mid-Term Evaluation the solidness of pilots' respective set-ups towards execution of running phase activities and their ability to proof concepts and practical outcomes from other technical work packages and to realize tangible benefits¹ (see D4.13 67[24]). It focuses on assessing the three pilots in their achieved stage of most complete evolution and maturity for planned respective extended scopes, realised during their last phase of piloting which covered a period starting in October 2022 and running into the first 3-4 months of 2023 (DE4A project extension). It leverages as well on the accumulated body of results, achievements and findings coming from the first iteration (from February to July 2022), when a first Minimum Viable Product was piloted as well with real users (in the case of SA and DBA pilots), and the first results and lessons were gathered by all pilots (a more comprehensive description of the methodological approach followed was already provided in section 2 of D4.13 [24]).

For each pilot, Final Evaluation assessment is based on evidence from pilots' Final Running Phase reports (D4.4, D4.8, D4.12) validated with additional feedback from pilot leaders and in some cases partners. Such evidence comprises and feeds on specific results and achievements measured over time (two piloting iterations with real users in case of SA and DBA pilots and a common running phase for MA Pilot) obtained through:

- a) pre-established quantitative and qualitative (in most cases targeted) S.M.A.R.T.² metrics acting as Key Performance Indicators, logically grouped under pilot-specific Success Criteria addressing different benefits for pilot end-users as well as administrative and MS stakeholders.
- b) pilot-provided interpretations over substantive evidence and stakeholder feedback, that contextualise results with additional information of relevance for a more complete evaluation (i.e. conditionings shaping pilots' execution).
- c) observed follow-up of the Mid-term Evaluation recommendations that were provided at the end of the first phase of piloting, aimed to maximize pilot's overall impact in terms of tangible benefits along the relevant dimensions of pilots' Use, Value and Learning (for Adoption).

In the previous evaluation, pilots' capacity to carry out in realistic conditions interoperable cross-border services based on Once-Only and Digital by default principles was already confirmed: this has now been further verified with over 25 cross-border combinations (12 in SA, 10 in DBA, 4 in MA³) between 8 MS. Realising such combinations to also validate DE4A OOP common semantic and technical components, has been made possible thanks to DE4A's implementation of multi-pattern architecture approach, comprising 5 patterns: Intermediation (IM), User Supported Intermediation (USI), Verifiable Credentials (VC), Subscription & Notification and special case of 'Push'-like pattern linking domicile registration and deregistration procedures. It is worth acknowledging that piloted

¹ Mid-term Evaluation examined for this purpose (i) adherence to Use, Value and Learning pilot principles based on objective facts and findings, (ii) consistency of defined pilot goals with respect to overall pilot definition and DE4A objectives and (iii) clear and consistent relation between goals, success criteria and quantitative and qualitative metrics with availability of means to collect results (e.g. feedback forms and questionnaires for users and authorities). All pilots were found to demonstrate high levels of awareness of and actual adherence to piloting principles, with sound establishment of a benefits-driven logic that included sound selection of success criteria linked to pilot goals and definition of related qualitative and quantitative metrics.

² Specific, Measurable, Achievable, Relevant, Timely.

³ At the moment of writing this deliverable.

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combinations with real users have fully matched those planned in the case of SA Pilot and in case of DBA pilot have been significantly close to those planned. The case of MA Pilot is different as it has had to cope with serious shifts in participation of its partners and with organisational issues internal to MS, leading to frequent plans re-adjustment and need to work in a best-effort approach resulting in a reduction of combinations that could be piloted or technically tested.

As a crucial element in the last phase of piloting, satisfaction from end-users with different aspects of cross-border pilot Use has been consolidated (including in MA Pilot that didn't previously offer findings and metrics in this regard):

- ▶ In SA Pilot 75-80% of students were satisfied or very satisfied with duration of the procedures, the control in managing own credentials, security, language support and the required effort, whereas clarity and simplicity of the procedures and occasional errors and interruptions were also reported as less appreciated aspects (key steps of Explicit Request and Preview have received either positive appreciation or no specific feedback).
- ▶ In DBA pilot company representatives appreciated most the immediateness, ease/simplicity and speed for completing electronic procedures without having to spend time collecting and uploading evidence documents nor about mandates (time and effort savings), also finding very adequate the mechanisms to validate entitlement to represent a company (powers validation) and not showing special/conscious consideration of Explicit Request and Preview steps.
- ▶ In MA Pilot, end-users appreciated most the overall user experience with procedures, language, clarity of the procedures and communication as well as simplicity and reduced effort to effectively complete all aspects of the procedure, with good perception as well on overall duration and perceived security and data protection (being in control of evidence exchanged across borders).

Also a very notable increase in the number of end-users piloting DE4A services, reaching 200% in SA Pilot and 280% in DBA pilot with respect to users in the first iteration. Combined totals between iterations of 52 + 104 students (SA), 6 + 17 company representatives (DBA) and 28 testing citizens in MA pilots' unique iteration, meaning that over 200 end-users have tested DE4A services launched across running phases.

In realising their success criteria and respective goals, the pilots have contributed to general DE4A objective to reinforce trust in public institutions and to unleash positive impacts for efficiency gains and reduction of administrative burden, costs and barriers in cross-border public services. This has been verified with significant findings for administrative burden reduction:

- ▶ In SA pilot 20-30 minutes are saved by DEs for each student in Validation of Higher Education Diplomas, 15 minutes are saved per student by Slovenian Higher education DOs in record matching, and very large time savings are confirmed for student end-users who could previously spend days waiting for their applications to Higher Education courses and grants to be processed due to evidence checks and error corrections and the reduction from days / weeks and can now access and complete fully online such procedures in only a few minutes.
- ▶ In DBA pilot few minutes (2 minutes at best) are necessary for companies to apply for a business service in another country and savings of up to hundreds of person hours per year have been estimated for each Data Evaluator using OOTS in conjunction with eIDAS and powers validation mechanism especially when extended to all relevant procedures offered in these portals.
- ▶ In MA pilot 2-5 minutes for citizens to authorise exchange of pieces of evidence needed when moving to another country (birth and/or marriage certificates) or to register a domicile in a foreign destination country and have this event trigger de-registration of their domicile in their home country (with pushing of new domicile evidence by the destination country).

MS competent authorities rated with high values aspects of: fitness to purpose of canonical models, trustworthiness and quality of the data for the needs of eProcedures, the significant effort reductions achieved to process evidence received with less errors (from a baseline without DE4A of days or weeks), the ease of implementation of Explicit Request and Preview, the effectiveness of record

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matching, and the suitability and usefulness of DE4A patterns and components for the purposes of the pilot and satisfaction with technical, legal and semantic support throughout piloting activities.

DE and DO competent authorities, as well as MS agencies responsible for Once-Only infrastructure, also assessed the expected cost-benefit balance taking into account efforts to configure, deploy and integrate with common components for multi-pattern evidence exchange: in SA pilot all DEs and DOs confirmed benefits will outweigh costs of customizing and integrating procedure portals and data services with less clear results for MS teams responsible for the common OOTS infrastructure; in DBA pilot all DEs also positively assessed the benefits expected when compared to the costs whereas DOs expressed a more neutral balance; finally, MA Pilot also confirmed positive cost-benefit balance from DEs, DOs and MS sides.

MS also provided relevant details of efforts spent to deploy and integrate common components (Connector, SMP) and to carry out the necessary customizations in the DE and DO endpoints: in DBA pilot average effort to integrate Connector averaged to some 31 person days while overall DE and DO customization and integration efforts were respectively around 87 and 62 person days whereas in SA Pilot Connector deployment took respectively around 7 and 16 person days respectively and DE and DO average customization and integration efforts are considerable lower with 34 and 52 person-days in case of USI pattern (with only 8 and 10 person days needed for Verifiers and Issuers adaptation in case of VC pattern). MA Pilot offers cost assessments that are in-between those of the other 2 pilots with 16 person days for Connector deployment, DE customization varying between 31.5 and 40 person days and DO customization between 34.5 and 45 person days (except in Slovenia where DO overall effort peaked to 93 person days). Possibly, differences are due to variations in local MS environments and because SA pilot re-assessed efforts during second iteration where accumulated experience made a difference for deploying new versions of common components and re-adapting endpoints.

General recommendations from the Mid-term evaluation, which included revisiting feedback forms considering increased knowledge elicitation on user satisfaction or issues detected, also relying on other enhanced results collections mechanisms, in particular interviews and where possible logs, have been generally well followed. Similarly, recommendations related to results collection and analysis from public administration users (e.g. more precise formulation of achieved administrative simplification and burden reductions; possibilities to extract more knowledge from logs and other results collection mechanisms) and finally recommendations aiming to consolidate, structure and safeguard lessons learnt also maximizing impact on stakeholders for future adoption, are seen to be followed in general though at varying degrees.

Lessons learnt address a rich and wide range of topics and challenges (between 20-30 per pilot) of interest for EC and MS stakeholders implementing the SDG OOTS, exploring synergies with initiatives like eIDAS EU Digital Identity Framework or that will participate in initiatives for public services modernisation with a longer-term perspective.

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1 Introduction

1.1 Purpose of the document

The main purposes of this document are three-fold:

- ▶ To present **the updated methodological perspective for iterative evaluation** of DE4A pilots aimed at benefits realisation. The scope of the Final Evaluation (the focus of this deliverable resulting from the finalisation of pilots' iterations) is presented together with the key common questions that structure and orient it.
- ▶ To deliver the actual outcome of the evaluation from an ex-post perspective, covering the comprehensive assessment of (i) the **development and evolution of pilots over time and between piloting phases** (progress from Minimum Viable Product to final extended scopes) and (ii) the **final fulfilment of pilot goals based on pilot results and findings**, structured along pilot metrics and success criteria organised by different types of pilot users' perspectives and consolidated in respective pilot final running phase reports, including follow-up of Mid-term Evaluation specific recommendations for pilots' improvement.
- ▶ To provide **evaluation conclusions**, both common between pilots and related to each pilot, relevant in relation to sustainability and future adoption beyond DE4A itself.

The **outcomes of this deliverable** are of interest:

- ▶ **Internally, to DE4A partners** that have been involved in, or supporting, the piloting activities and the work packages for which pilots realise and proof concepts, components and solutions;
- ▶ **Externally, to a more general audience of stakeholders** similar to those involved in the pilots (competent authorities, public agencies, end users) and in particular the wider community engaged in the Single Digital Gateway implementation and longer-term horizons for European public services interoperability solutions.

1.2 Structure of the document

The deliverable is structured as follows⁴:

- ▶ **Chapter 1** – The current section that describes the **purpose and structure of the document**.
- ▶ **Chapter 2** introduces the multiple **aims and methodological pillars of the final evaluation**, focused on fulfilment of pilot functional and business goals with evidence-based benefits realization logic over reported results for qualitative metrics grouped under pilot-specific success criteria and technical common criteria and quantitative, and related to common piloting principles re-organised from the perspectives of pilot users (Use, Value) and Learning (lessons for Adoption).
- ▶ **Chapters 3, 4 and 5** provide the **outcomes-based (final pilot results) assessment of pilot progress against planned scope** (evolution from MVP to final extended scopes), how they have realised **benefits for different levels of pilot users** and an **assessment of the follow-up of Mid-term Evaluation recommendations**
- ▶ Finally, **Chapter 6** summarizes the **final evaluation conclusions and overall considerations of DE4A piloting relevance** in the wider context of DE4A over-arching pilots' objectives.

⁴ Note: the structure of this deliverable has been revised with respect to previous Mid-term Evaluation deliverable, devoting a specific chapter to each of the pilots to deliver for each of them a thorough evaluation assessment analysis following a common structure.

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2 Aims, methodological pillars of final evaluation and cross-cutting aspects of final pilots' iteration

In this section, the **overall goals and specific methodological approach followed for the final evaluation phase** of DE4A pilots are provided. For readers interested in the more complete overview of the DE4A pilots' evaluation 2-phase methodology and goals defined and implemented in task 4.4 "Evaluation methodology and reporting", please refer to Section 2 of D4.13 [24].

2.1 Aims of the Final Evaluation

The DE4A pilots integrate and help to **validate in realistic conditions**, with direct involvement of real users and public administration eGovernment stakeholders in DE4A MS, a significant number of **relevant building blocks**: the DE4A Common Components and the DE4A Semantic Framework and Toolkit, developed in other technical work packages of the project to realize technical and semantic interoperability. Thus, pilots generate with their results **knowledge and hands-on experience for the EC and the Member States** on key **Use, Value and Learning for Adoption dimensions**⁵. This is of direct relevance for these stakeholders as they enter a decisive phase of the SDG (online procedures and OOTS) implementation, integration, deployment and testing. Thus, DE4A pilots act as 'the proof of the pudding' for **cross-border interoperability of DE4A's OOTS**⁶, resulting from the integration of the different semantic and technical interoperability Building Blocks with national OOTS components and endpoints, following "application collaborations" specified in respective Solution Architectures for the multi-pattern interoperability architecture the project as a whole advocates for, towards the implementation of **European public service interoperability solutions in light of the SDGR with a mid-term future time horizon in mind of 2025+**. Inasmuch as the private sector is also a relevant stakeholder (as users of the SDG OOTS as exemplified by DBA pilot and as providers of specific services/technology in the context of SDG implementation and evolution), it also benefits from the research, achievements and knowledge delivered by DE4A.

DE4A pilots' evaluation judges **whether the pilots fulfil their respective business and technical goals** providing a practical **cross-border realisation for their stakeholders of the concepts implemented in DE4A**, including those delivered in other work packages towards the joint outcome of the Action, in this way helping to ensure the fulfilment of the DE4A objectives. These objectives are in the case of piloting activities those *"of reinforcing trust in public institutions' transparency and protection of users' information and to unleash multiple qualitative and quantitative positive impacts in terms of efficiency gains and reduction of administrative burden, costs and barriers in cross-border public services through substantiation of the innovation and transformative technologies potential and the use of stakeholder expertise"*.

DE4A's Final Evaluation of the three pilots (Studying Abroad, Doing Business Abroad and Moving Abroad) assesses at the end of the project the **finally achieved and consolidated results provided in**

⁵ For example, pilots have generated a better understanding of challenges that MS face for implementing the SDG OOTS, providing strong bases for positive influence in the process leading to the Implementing Regulation on technical specifications for SDG OOTS and where the evidence exchange pattern adopted very clearly matches the DE4A USI pattern.

⁶ DE4A has implemented, with direct implication of participating MS and Germany, a project instance of Once-Only Technical System (supporting realization of Intermediation, User Supported Intermediation and Subscription & Notification patterns), based on DE4A's common technical and semantic components and re-using the same EU-supported building blocks (eDelivery, eIDAS eID) foreseen in SDG OOTS. Much of the experience gained in designing, building, integrating and piloting the OOTS used in the project is highly relevant for MS for getting ready to integrate with SDG OOTS (acknowledging differences with respect to design of specific components specified in the Implementing Regulation which result from a difference in timing between DE4A's project plan which had to have its technical framework ready considerably earlier with respect to SDG time plan).

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final reporting deliverables of each of the pilots corresponding to different use cases and cross-border combinations, running them with **real end-users in realistic environments** and supported by multi-national and multi-disciplinary teams from the participating DE4A MS. In conjunction with the Mid-term Evaluation assessment, it consolidates the **assessment of pilots' ability to proof concepts and practical outcomes from other technical work packages** is addressed (DE4A's semantic and common components).

Both evaluations assess, at the end of each of the respective piloting phases, the achieved results as reflected in pilot reports against pilot and project objectives. Thus, and together with the Mid-Term Evaluation, the Final Evaluation completes evaluation work in DE4A from a process standpoint, providing an ex-post strategic check-point corresponding to the completion of planned pilot iterations, once pilots have also reached maturity in their evolution towards an extended scope in terms of functional validation of features in the context of DE4A solution architectures for evidence exchange patterns, pilot-specific use cases and/or cross-border combinations for involved MS.

The final evaluation assesses the progress and success of the three pilots at their completion in relation to planned scopes and goals, also taking the perspective of whether pilots' realised outcomes can be adequate for supporting sustainability and adoption of DE4A (analysis of actual roads forward for DE4A services in the context of human-centric Public Administration Services in the EU is covered in D6.3 [25]).

In this regard, the assessed results also contribute to the **wider sustainable impact realisation of DE4A**, in support of Digital Government strategic policies and principles, specifically the Single Digital Gateway (SDG) and the ongoing **realization of the Once-Only and Digital-by-default Principles**, as envisaged by the **SDG Once-Only Technical System (OOTS)**. In DE4A, MS had a fundamental role in driving the project, in defining the needs and the design of cross-border solutions with key participation along technical and semantic experts in technical work packages implementing common Building Blocks⁷ that they integrated with national systems for the pilots (see pilot planning deliverables D4.2 [1], D4.6 [2] and D4.10 [3]). Further to this, it is the hands-on experience of MS in DE4A accumulated from integrating and piloting cross-border solutions in the respective pilot domains that can **bring high tangible value to the wider community of the SDG, in particular to other MS not participating in DE4A** that need to also fulfil SDGR (Art. 14) obligations, and which cooperate with each other and with the EC in the SDG Coordination Group and OOTS Sub-groups. This value has already been successfully verified with **Germany's observer role in DE4A and German-Dutch pilot**⁸.

2.2 Methodological Pillars of the Final Evaluation

The common and general methodology applied and followed throughout all piloting activities, from pilot's inception and planning to execution and evaluation, aims to **maximize the realisation of benefits towards sustainable adoption** and adheres to common piloting principles of Use, Value and Learning⁹, closely aligned with the respective perspectives of different categories of pilot users: from **different types of end-users** that actually tested cross-border pilot services (such as **students, company representatives and citizens** depending on the pilot) to the different **public administration users** (such as evidence requesters and providers respectively in charge of online eProcedure portals and authoritative data sources, MS teams in charge of common national components relevant for the OOTS, staff from university student departments processing application to studies and grants, etc.). This approach provides a suitable framework for pilots to:

- ▶ Measure over time their results and achievements (**Metrics**)

⁷ See https://wiki.de4a.eu/index.php/Second_phase

⁸ The German-Dutch pilot that was a side-activity outside of the formal activities of the project is not part of this evaluation.

⁹ Benefits logic methodology is based on international standards, and it has been successfully applied in previous Large-Scale Pilots such as STORK 2.0.

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- ▶ Group results and information in a structured and consistent way (**Success and Technical Common Criteria**)

Furthermore, it allows to structure pilot activities and results over 3 major principles:

- ▶ **Use: Consider the expectations and actual feedback of pilot experience of pilot end-users**
- ▶ **Value: Analyse the perceived benefits also from perspective of different pilot users**
- ▶ **Learning for Adoption: Boost the value of the lessons learnt for different stakeholders**

The Benefits Logic approach was introduced in Section 2 of the pilot Planning Deliverables (D4.2 [1], D4.6 [2], D4.10 [3]), and readers are referred to a summary of it in Section 2 of D4.13 [24] that explains the key piloting principles and the bidirectional trail linking objectives to metrics through criteria.

As was also the case for the Mid-term Evaluation, the Final Evaluation is performed with a relative outsider's position in the project, aiming to abstract from internal conditionings or internal pilot activities (including project management or pilots coordination) for delivery of independent advice based on an objective fact base of results collection and analysis which are carried out by pilots themselves as part of their activities at the end of the final piloting period (see D4.4 [26], D4.8 [27] and D4.12 [28]). It is carried out in close collaboration with pilot leaders as an integral and natural part to make the evaluation process effective and efficient, i.e. addressing different clarifications for pilot findings in final reports). A draft of the present report was also shared with the pilot leaders for review in terms of its correctness and completeness.

DE4A's Final Evaluation, as in the case of the Mid-term evaluation, is based upon **traceable and evidence-based findings** with a retrospective approach that encompasses the **previously provided recommendations to each pilot** in order to improve their solid execution and the maximization of findings and lessons learnt, thus increasing their overall positive impact towards their potential future adoption in related undertakings. In this regard, particular focus is put on **accumulated/final achievements and findings for the different interoperability aspects** (technical, semantic, organisational and legal), as covered from the perspective of every pilot, in particular regarding **lessons learnt on interoperability barriers/issues encountered in cross-border piloting** and pragmatic solutions found or recommended to overcome them. For the assessment of pilots' overall progress, specific consideration is given to aspects that are concrete to each pilot, while considering as well cross-cutting and common aspects across the pilots.

Evaluation of end-users' and institutional stakeholders' perception of usability and value is related to monitoring activities performed by the pilots: they pivot on **evidence captured during the respective running phases through** specifically designed **questionnaires** (see Annexes of Pilot Planning deliverables) **and interviews** particularly addressed in the second iteration, consolidated by the pilots in their final running phase reports.

When focusing on the Final Evaluation of the pilots, it builds on the work addressed in the Mid-term Evaluation (see chapter 3 of D4.13 [24]), e.g. the assessment with regard to coherency, completeness and correctness of the pilot plans (D4.2 [1], D4.6 [2] and D4.10 [3]) to focus on the realisation of pilot benefits.

Adding to this, the Final Evaluation assesses the **fulfilment of the pre-defined pilot goals and their contribution to the overall project (DE4A) objectives, considering the overall progress of the pilots until the completion of the final running phase**, namely examining the final pilot results as reported in deliverables D4.4 [26], D4.8 [27] and D4.12 [28] "Final Running Phase Reports"). In this regard, the Final Evaluation can be seen to address this **fundamental question** for each pilot:

Did the progress of the pilot relate sufficiently to the complete scope, and did it yield the outcomes that were expected vis-à-vis pilot objectives (realized final outcomes vs planned) contributing to the DE4A overall sustainability and sectorial adoption?

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Regarding the complete scope, each pilot covers the piloting of two different iterations¹⁰:

- ▶ Minimum Viable Product with an initial pilot running phase (February 2022-July 2022) and
- ▶ Extended and final pilot implementations running phase piloting (October 2022-April 2023).

While the *Mid-term Evaluation* delivered common and especially pilot-specific *progress assessment from the first iteration of piloting* and also providing specific *recommendations* for improvement until the end of the project, the *Final Evaluation* assesses the **final results of the pilots in their second and final iteration vis-à-vis promised results** and is therefore an evaluation of the **development of the pilots over time**: from Minimum Viable Products approach to the extended scope and fuller realisation of their respective operational set-ups, results and goals. It does so with **increased emphasis on the Adoption dimension** and the extent to which pilots' final outcomes contribute to the overall sustainability strategy of DE4A. Lessons learnt consolidated by the pilots in their final reports as well as **success stories** are also a major aspect considered in the current evaluation as much of the pilots' future legacy and contribution to DE4A sustainability depends on the knowledge building achieved in this dimension, leveraging the unique orientation of DE4A towards real-life piloting.

Pilots were also expected to address as much as possible the recommendations in the Mid-term evaluation report during the final iteration for the different use cases and combinations that could be finally launched. Such recommendations were given to the pilots to help them correct or prevent the recurrence of different issues where possible and to strengthen the maximization of realised benefits to widen the basis for longer-term impact generation. Specific assessment of the **follow-up by the pilots of the recommendations** is provided further below in each of the respective pilots' subsections on "Results and findings".

In the figure below the respective targets of both evaluations and the common elements involved are depicted, results for the satisfaction of metrics and success criteria as well as pilot principles such as Use and Value or lessons learnt are provided for the Final Evaluation structured in relation to the perspectives of the multiple types of users mentioned at the beginning of this section:

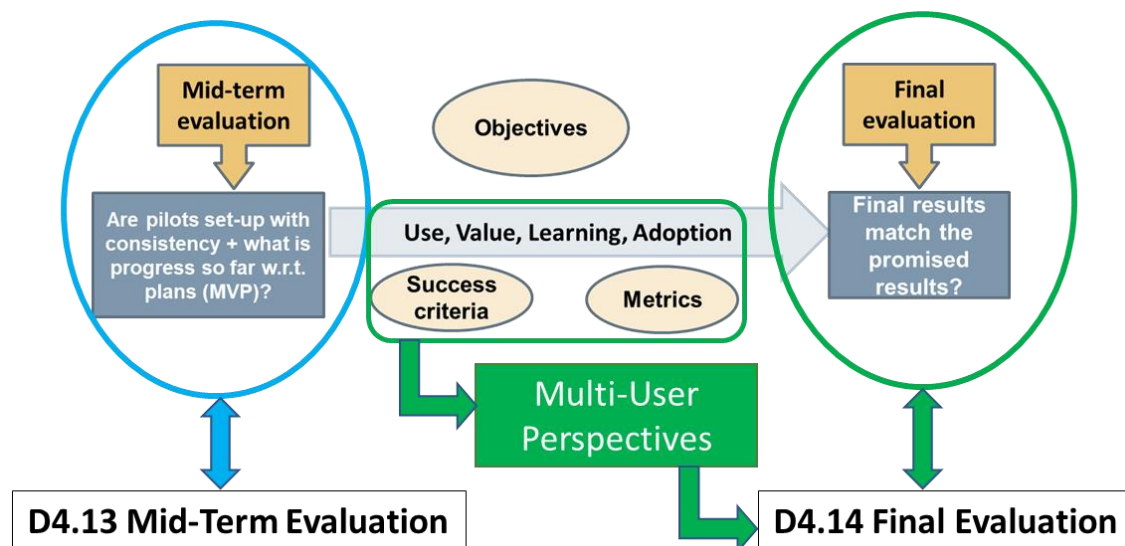


Figure 1: DE4A Mid-term and Final Evaluation

¹⁰ The scope of each iteration has been defined for each pilot in Pilot Planning deliverables, updated in Initial Running Phase reports and confirmed in Final Running Phase reports.

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2.3 Cross-cutting aspects of DE4A pilots' final iteration

The next three chapters address a question that is broad in its scope: *Did the progress of the pilot relate sufficiently to the complete scope? Or, in other words, did the execution of the pilots yield the outcomes that were expected vis-à-vis pilot objectives (realized final outcomes vs planned) contributing to DE4A overall sustainability and sectorial adoption?* It is to be noted that the focus is on actual achievements and results generated by the pilots during their running phases (D4.13 also covered the assessment of pilots' consistency in their setting-up that included planning and other preparatory activities).

During the second iteration, MS updated their OOTS infrastructure (Data Requestors - DRs, Data Transferors - DTs) while pilot-specific Data Consumers and Data Providers adapted procedure and evidence portals, and data services (Data Evaluators, Data Owners), testing connectivity and cross-border exchange of evidence types for different combinations between MS in new version of DE4A Playground¹¹. They did so following different **updates**, key to elicit intrinsically valuable findings and substantiate Learning for Adoption and resulting in high-profile piloting with real users through the use of real-life services and solutions in realistic environments as specifically defining features of DE4A pilots:

- ▶ the **final DE4A common components and building blocks**: namely, DE4A Information Exchange Model¹², new versions of DE4A Connector, commons, core schemas and code lists enabling among other functions multi-evidence exchange and improved flows for USI pattern, new versions of Authority Agent enabling improved flow and user experience in VC pattern, updated logging and error messages and dynamic discovery through nationally deployed SMP and updated central IAL¹³,
- ▶ **Multilingual Ontology Repository** including UX extensions for DEs (Explicit Request) and DOs (Preview)¹⁴ and **updated / additional canonical evidence models for the second iteration**¹⁵:
 - SA Pilot: Extension of higher education diploma canonical evidence with an average grade element, provision and support of additional canonical evidence types in UC#1 (proof of completion of secondary education) and UC#2 (large family evidence, disability evidence)¹⁶
 - DBA Pilot: Business Event Catalogue¹⁷ for S&N pattern (previously defined CompanyRegistration evidence model can be found here: https://wiki.de4a.eu/index.php/Company_Registration_Canonical_Evidence)
 - MA Pilot: Domicile Deregistration evidence (other models previously defined are available here: https://wiki.de4a.eu/index.php/Canonical_Evidence)

¹¹ DE4A Playground: https://wiki.de4a.eu/index.php/Playground#Iteration_2

¹² [https://wiki.de4a.eu/index.php/DE4A_Information_Exchange_Model_\(IEM\)](https://wiki.de4a.eu/index.php/DE4A_Information_Exchange_Model_(IEM))

¹³ DE4A common components and building blocks are available in DE4A publicly available code repository: <https://github.com/de4a-eu>

¹⁴ <https://github.com/de4a-eu/MOR>

¹⁵ https://wiki.de4a.eu/index.php/Canonical_Evidence

¹⁶ DE4A pilots evidence canonical models are respectively defined here:

https://wiki.de4a.eu/index.php/Higher_Education_Diploma_Canonical_Evidence,

https://wiki.de4a.eu/index.php/Secondary_Education_Diploma_Canonical_Evidence,

https://wiki.de4a.eu/index.php/Disability_Canonical_Evidence, https://github.com/de4a-eu/study_abroad/blob/main/XSD/SA-UC2-LargeFamilyEvidenceType.xsd

and all XSD models can be found here:

https://github.com/de4a-eu/study_abroad

¹⁷ See https://wiki.de4a.eu/index.php/DBA_2nd_iteration_Solution_Architecture#Configuration_of_business_events and [https://wiki.de4a.eu/index.php/Use_Case_%22Doing_Business_in_Another_Member_State%22_\(DBA_UC2\)](https://wiki.de4a.eu/index.php/Use_Case_%22Doing_Business_in_Another_Member_State%22_(DBA_UC2))

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- ▶ **improved interaction patterns** (USI with new way of user redirection and multi-evidence, VC with highly optimised steps for users interacting with Issuers and Verifiers through Mobile User Agent application) or additional ones (S&N).

During the second and final iteration of piloting, from October 2022 to February/March/April 2023¹⁸, it can generally be observed that the different experienced organizational and technical difficulties tended to stabilise and were manageable, allowing to generally achieve high levels of piloting in terms of planned cross-border combinations and increase in the number of users for Studying Abroad and Doing Business Abroad pilots, whereas impact was still high in Moving Abroad pilot and resulted in fewer combinations launched. More in detail:

- ▶ In the case of **Studying Abroad**, it can be observed that the number of combinations very significantly expanded from originally 2 launched for the Diploma Recognition use case to 8 launched and 3 functioning combinations (also covering already the other 2 use cases and all 3 piloting MS) already in the first iteration and reaching the totally envisaged 12 launched combinations with the participation of 6 Data Evaluators/Verifiers and 6 Data Owners/Issuers in the second and final iteration (6 combinations in “Application to public higher education”, 2 in “Applying for a study grant”, and 4 in “Diploma recognition”)¹⁹. Applying several strategies to mitigate and deal with infrastructure delays in the run-up to the launch of use cases and combinations, all combinations were successfully launched and piloted in all cases with real users notwithstanding some limitations that led to the use of test evidence (80% of Portuguese students and 60% of Slovenian students in “Application to public higher education” Use Case, or for disability and large family while Spanish students used real academic data but anonymized and bound to the personal data of a test credential) or test eIDs (60% of Slovenian, 80% of Portuguese and all Spanish users) due to general problems for students that typically don’t have their eIDAS-based authentication means activated and/or don’t remember the second authentication factor (PIN) or specific issues (complex registration process at Slovenian Central Authentication System over which DE4A partners had no control). The growth in the number of students as main end-users of the pilot, with a twofold increase with respect to the first iteration, denotes a noteworthy improvement notably and directly for the Use and Value results allowing to measure which aspects of piloted procedures were most or less appreciated as well as their duration in different use cases taking into account extended piloting scope delivered to users in terms of functionality (e.g. multi-evidence, updated/new evidence models) and optimizations for USI and VC exchange patterns. This has had a positive impact as well on a more thorough assessment of the pilot results from public administration users’ perspective, and to generate success stories and Lessons learnt over 12-month effective piloting in total, with a focus on Adoption allowing to assess the overall fulfilment of pilot objectives between both iterations.
- ▶ In the case of **Doing Business Abroad**, 8 DE/DO combinations had initially been planned with the 4 piloting MS²⁰ for the first use case that enables starting a business in another MS, of which 2 combinations were successfully launched and executed between 2 MS with full powers validation in the first piloting period and three new combinations were successfully piloted in the second iteration for that same use case, resulting in a total of 3 combinations using Full Powers validation with real data and 3 combinations with Fine Grained Powers Validation also with real data, (a 300% increase and 75% of all possible combinations implemented). Furthermore, the second iteration focused as well on the piloting of the second use case (“Doing business in another Member State”)

¹⁸ In case of DBA Pilot, piloting finished in February 2023, whereas in case of SA Pilot Piloting finished in March and April 2023 respectively.

¹⁹ The only caveat was a continued lack of resources at the SI-MIZŠ to implement VC Issuer, but the pilot effectively dealt with this by using the University of Maribor’s reference implementation of the VC Issuer for the Diploma’s recognition Use Case (through this, UM students could download real diplomas in the form of verifiable credentials to their mobile phones).

²⁰ Not considering combinations with Belgium who withdrew at the start of Y2 of the project.

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with a total of 5 combinations launched and piloted with simulated notifications of business events in non-production environments (from a total of 6 DE/DO combinations originally envisaged, 83%). An increase in number of end users was also confirmed in the second iteration as the number of interviewed company representatives was increased from 6 (those that piloted with real data) to 13 (with 4 more in the pilot additionally carried out with Germany as DE4A Observer MS) in the second iteration to whom the pilot was demonstrated.

The piloted combinations have allowed to successfully prove in realistic environments (i.e. with real data in case of NL and RO and near real data in case of AT) the use cases in scope of both iterations and the Intermediation and S&N evidence exchange patterns that were implemented for them. This either involved real electronic procedures as in the NL for Starting a business by companies from other MS or with simulated but life-like procedures (in case of the Use Case of Doing business in another Member State, notifications were simulated to prevent having to depend on companies actually merging, moving on going bankrupt during the pilot phase as such events may not have happened during the limited duration of the second iteration).

- ▶ In the case of **Moving Abroad**, several factors need to be considered which have affected the pilot:
 - Leaving of 3 partners after the 1st year of the project (BOSA from Belgium-that was also pilot leader), DIGST from Denmark and Skatteverket from Sweden resulting in reduction of 3 MS and thus less possible combinations. While this was mitigated with partner SU taking over the pilot's coordination, the use case on information on pensions and labour status (pensions, unemployment and working life information) had to be finally dropped as PT partner that was going to pilot with Spain also left the Consortium during the third year.
 - The planning choice to focus initially only on 3 Member States (Luxembourg, Spain, Portugal) to implement the corresponding endpoints and evidence exchange infrastructure for launching initial combinations and the fact that only one (Luxembourg) had the role of DC, combined with significant and persistent organisational / technical issues in this MS with impact on readiness for integration of its systems with DE4A OOTS, prevented de facto any combination to be launched during the first piloting window, with only limited opportunities to test interoperability in test environments (Connectathons), somewhat mitigated with involvement of Slovenia as DP (a positive development not initially planned). As no combinations could be launched until October 2022, MA Pilot only provided in its Initial Phase Report (D4.11 [6]) limited feedback Value (e.g. usefulness of DE4A patterns and components) and Learning results from competent authorities in the 3 mentioned MS but not any metrics results for Use dimension and the Mid-term Evaluation and recommendations were only based on this restricted set of initial inputs.
 - The combinations potentially available for the unique running phase of MA Pilot (October 2022-April 2023) were affected by other limitations related to resource availability and national project priorities: Slovenia could only take DP role for UC#1 and UC#2 and Romania only DC role for UC#1. Internal resource and prioritisation issues finally prevented Romanian DE integration with DE4A OOTS preventing 4 combinations from being piloted, including Multilingual Ontology Repository (MOR) functionality for Explicit Request (although Spain was able to integrate MOR for the Preview in their DO). While Luxembourg devoted more resources to achieve integration of its DE with DE4A OOTS especially for UC#1 (including also new Deregistration sub-use case) internal complexity continued and piloting of combinations with real users from that MS could not happen. Instead, the Luxembourg DE with Portugal DO combination for Change of Address (Registration and Deregistration) was aimed for only at Playground level. Thus the only combinations piloted were Spanish DE – Slovenian DO for procedure requiring birth and marriage (multi-evidence) exchange (UC#2) with 20 users and Spanish DE – Portuguese DO for Domicile Registration (UC#1) with 8 users. Finally Spanish DE - Slovenian DO for same Domicile Registration sub scenario was also technically achieved on Playground level in April 2023 thanks to ES adapting their DE portal to request and Preview Domicile evidence.

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Essentially sharing the same infrastructure (common components and semantic framework) with the IM pattern, the SA and MA pilots using USI pattern are a good example of testing in realistic conditions and with real users its suitability for Life Events having as users students and citizens in general, where the user support at DP side to implement successful record matching and obtain approval through the Preview mechanism for the exchange of evidence (while the data still resides in the sphere of the DP) greatly increases the transparency of the exchange and serves to increase the certainty and trust on the part of the DP when data is to be shared across borders.

While the question of the statistical relevance of end-user's feedback (given the pilots' engaged user bases) is legitimate, it has been mitigated through the **more than doubling of the number of students and company representatives testing across the different combinations and use cases of SA and DBA pilots**. But it is the novelty of the **pioneering piloted solutions in terms of innovation** for realizing OOP and fully online and user friendly procedures, that has to be considered as a prominent breakthrough enabled by DE4A. Feedback from a limited universe of **real pilot users exposed to such groundbreaking solutions** for the first time is clearly of high relevance as well as pilots gain through their perceptions valuable understandings on the strengths and aspects to improve in real production conditions. Similarly, the number of competent authorities is limited to those from participating MS in different combinations, but their **experience in addressing technical, semantic, organisational and governance issues is still highly relevant to other MS which must soon address similar issues in order to implement the OOTS of the SDGR** and, in fact, **feedback from DE4A MS has been highly influential** in the SDG Coordination Group, SDG specialised work packages and the process to produce the Implementing Regulation on OOTS technical specifications.

In the second iteration, a new feature has been piloted as well by SA and MA pilots with USI pattern²¹: **simultaneous exchange of multiple evidence instances** (under a single request) from the Data Consumer which brings the system further closer to realistic scenarios under the SDG and is important to ease burdens on end-users and bring administrative simplification further by orders of magnitude.

Some commonly provided **recommendations** to the 3 DE4A pilots were given in the Mid-term evaluation to every pilot and are summarised below²², :

- ▶ **Reinforce and safeguard pilot knowledge as a key DE4A outcome, especially for lessons learnt and Value findings, leveraging possibilities for this purpose through the DE4A Wiki** (updating details about the second iteration) **and pilots' final reports**. Lessons learnt can be valuable for example for future related efforts in the context of SDG OOTS implementation and can include for example assessment of different issues solved with support from the "Common Component Design & Development" work package (e.g. found during Connectathons with use of second iteration "Playground" components both with mock, test and piloting endpoints), advice from the "Legal and ethical compliance and consensus building" work package, etc.
- ▶ **Further investigation with DEs and DOs to detail better the achieved degree of administrative simplification** is also an important aspect to continue to address in the second iteration.
- ▶ **Reinforce the relation with "Sustainable impact and new governance models" work package to provide feedback useful for better understanding of requirements for future sustainability of Member States investments**. This refers to the accumulated experience and lessons learnt by MS teams integrating releases of DE4A common components as well as experience from DE and DO authorities for adaptations in endpoints for integration with patterns and use cases used in the

²¹ This feature is also enabled through the DE4A Connector in IM pattern, but DBA pilot only needed to exchange the CompanyRegistration evidence (or business events information). See: https://wiki.de4a.eu/index.php/User-supported_intermediation_pattern_communication_diagram#7. Extract_multi-evidence_request and https://wiki.de4a.eu/index.php/Intermediation_pattern_communication_diagram

²² Their follow-up by each pilot, along with other more specific recommendations is assessed in the next chapters based on the evidence provided in the final reports and considering the perspectives of different types of users and stakeholders (e.g. regarding Use, Value but also Learning for Adoption piloting principles).

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pilots. Such perspectives on sustainability of DE4A results and future pilot-related roadmaps are actually explored from the mentioned work package which has interacted with leaders of respective pilots in upcoming deliverable D6.3 “New Models for Shared Delivery of Common Services Roadmap”.

- ▶ **Identify and leverage opportunities in collaboration with the “Stakeholder dialogue, dissemination and communication” work package for dissemination of pilots’ results and findings:** especially through liaisons with other similar projects and general events in the eGovernment arena, as well as sector-specific conferences in the domain of each pilot where achieving impact towards targeted audiences may yield particularly important results.
- ▶ Improvement of the **logging system used on the different endpoints and the Connector** as a common component: a revised common syntax was agreed together with DE4A pilots from the “Common Component Design & Development” and with the “Semantic Interoperability Solutions” work packages and DE and DO partners were asked to implement it on their endpoints. The following data are now possible to obtain through improved logs and error messages definition between DE4A pilots:
 - Number of transactions per pattern used.
 - Number of transactions per combination with detail of between which countries the cross-border exchange takes place.
 - Number of errors per component / stage of cross-border flow and most frequent types of errors e.g. for interrupted procedures, it could be extracted from DE/DO logs the number of times evidence was not available yet.
 - Number of evidence exchanges rejected in Preview step can be extracted from DE/DO logs (also relevant for SDG OOTS statistics).
 - For cases of multi-evidence cross-border exchange, the logging system could potentially also be used to analyse information about the number of canonical evidences exchanged in one transaction, allowing the analysis of how many evidences were successfully transmitted and which ones.

Log analyses have not been extensively addressed by the pilots (except in SA Pilot for analysis of procedures’ durations) given the fact that the effort to do this starts to pay off as the number of transactions also becomes high enough to generate true statistical relevance, which is something that was not expected and did not happen in DE4A pilots. Another reason is that, given the overlap between cross-border piloting with real users and cross-border testing in Connectathons often involving MS infrastructure (Connectors, DE/DO endpoints, etc.) as well as Playground components, distinguishing for analysis between logs generated by tests and logs generated from real end-user activity required extra efforts (e.g. matching end-user testing times with logs recorded times) and this was deemed as less relevant in the case of DBA pilot, for example, compared to direct user feedback for qualitative metrics obtained from interviews.

All pilots have reflected in Section 3.3 of their Initial and Final Running Phase reports how **Technical Common Criteria** (Openness, Transparency, Technological Neutrality and Data Portability, User-centricity, Security and Privacy, Administrative Simplification, Effectiveness and Efficiency) have been addressed. Those findings are fact-based and clearly positive, and can be summarised as follows:

- ▶ Regarding **Openness and Transparency**, the availability of open source common components (GitHub, <https://github.com/de4a-eu>) and documentation as well as information on the status of connections and readiness for the pilots (in the DE4A Wiki, <https://wiki.de4a.eu> and <https://de4a.eu> website) allows to follow along the progress and study project details. Furthermore, other MS interested in DE4A results and how to set up solutions based on them can benefit from guidance on what are the steps that need to be followed: https://wiki.de4a.eu/index.php/Getting_started_guide
- ▶ Regarding **Reusability** pilots highlight the use of external building blocks/standards/infrastructures and frameworks like eIDAS, eDelivery and EBSI/ESSIF as well as internal building blocks (e.g.

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Connector, Authority Agent), also reusing existing data sources and in some cases eProcedure portals (pre-production versions in some cases) and national eIDs familiar to users; in DBA, one of the Member States aims to re-use developed software for the pilot, to improve data quality within the organisation. **Technological neutrality** comes from general reliance on technologies that are not vendor-specific and from the freedom to choose the AS4 gateway and standards and software in endpoints, which is also highlighted. Data Evaluators and Data Owners chose their own standards and software and developed an integration to the DE4A common components using the proposed APIs to the Connector and other common components. The use of canonical evidence models and the Information Exchange Model designed in DE4A contribute decisively to achieve **data portability**.

- ▶ For **User-centricity** Studying Abroad highlighted high appreciation by students of control given over evidence exchanged through features such as reauthentication and Preview at DP side (USI pattern) or the SSI features of VC pattern. DBA pilot highlighted how much and to a large degree, usability depends on standards applied in each portal as well as by eIDAS interfaces and users seem capable to cope with a certain level of challenges when switching between user interfaces. Accessibility can be improved when more languages are supported for texts presented to users (in this regard MOR functionality is helpful to provide customised user interfaces in the preferred language of users for Explicit Request and Preview steps). In DBA it was observed that users generally don't like to read the entire texts on the screen (texts like in the Explicit Request, although legally perfectly sound, are hardly ever read by users). While switching between user interfaces introduces some confusion, it does not seem to bother representatives too much.
- ▶ For **Security and Privacy**, findings refer to complexities regarding obtaining of certificates and configuration of firewalls within authorities' technical domains, where several policies and administrative procedures apply and can be very time-consuming and cause delays. Nonetheless, the authenticity, confidentiality and integrity of exchanged data is correctly ensured thanks to common infrastructure based on secure building blocks (eIDAS, eDelivery and TLS connections). In the case of VC pattern, the digital signing of Verifiable Credentials and the use of protocols like DIDComm guarantee the same properties. The pilots have followed measures to ensure data protection like (at organisational level) the signing of Memorandum of Understanding and supervision by Data Protection Officer. For privacy protection, a MoU and DPO were installed before and during the project. Also, recordings from pilot-runs were blurred so no personal or company data could leak to unauthorized actors. No incidents occurred during pilot runs. The Preview and Explicit Request are also highlighted on the technical level, and users have a high appreciation of privacy aspects, with no incidents happening in the running of the pilots.
- ▶ Finally, regarding **Administrative simplification, effectiveness and efficiency**, a massive reduction in effort required to process data (which is of higher quality and less prone to errors) is clearly appreciated by competent authorities and users (from weeks or days to very few minutes thanks to automation). The piloted procedures are seen as faster, simpler and secure to produce intended results for the stakeholders involved. Overall experience of users was seen to further improve in the second iteration (getting multiple evidence in just one request or with improved VC pattern flow and mobile app). Also, processing the data is easier because of higher data quality, resulting in less errors that need to be resolved. In some cases, introduction of working with the OOP TS also initiates process improvement within DE processes. In the case of DBA, a proper understanding of assurance levels and structures to define the representation relationship in mandates remain aspects that will need further efforts.

For the core subsequent sections of this deliverable, the respective pilot final reports are analysed based on results gathered through the monitoring activities carried out in the running of the respective use cases and cross-border evidence exchange combinations, oriented to the **end-user perception of usability and value**, and complemented by **inputs from pilot participating authorities** responsible for the integration of procedure portals, evidence sources and common infrastructure components. It must be noted here the fact that the eProcedures are generally repeated in low volumes by testing

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users during the pilot. However, the value of quantitative feedback should not be overestimated (also the feedback from authorities is limited to participating MS in each pilot) and pilots like DBA have addressed this by **increasing the focus on qualitative feedback**.

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3 Assessment of Studying Abroad Pilot Progress and Fulfilment of Pilot Goals and Mid-term Evaluation Recommendations

3.1 General considerations on pilot progress and results

The pilot launched its first cross-border combinations in February 2022 for UC#3 (VC pattern), followed by almost all envisaged combinations using USI pattern for UC#2 and UC#1 in April and until June, with the first iteration formally concluding in July 2022. For an overview of SA pilot definition, assessment of its setup with respect to the pre-defined targets, adherence to pilot principles and consistency of pilot goals with pilot definition and over-arching piloting objectives of DE4A and consistent implementation of bidirectional trail relating goals to success criteria and metrics, please see Section 3.1 of D4.13 Methodology and Mid-term Evaluation Report [24].

In parallel to running its first iteration, the pilot worked with the rest of the technical work packages to define in detail the design and **started testing in summer 2022 the updated common components, optimized USI and VC pattern flows, and new/updated canonical evidence models leading to an effective launch of the second iteration in October 2022 and running until March 2023**. This represents **in total 12 months of piloting with 3 MS²³**, although the duration is not the same for all combinations in the different use cases, which is also an expected piloting feature, as all pilots were expected to manage a phased and incremental launch of their cross-border services. The pilot also defined, agreed and applied several strategies and pragmatic approaches to mitigate and minimize, to the extent possible, the experienced delays, as explained in Section 2.2 of D4.3 [4] and D4.4 [26]. In some cases, these will be of interest for the MS teams that will be involved in the integration and testing phases of SDG OOTS, and which can, in some cases, face similar challenges.

The pilot demonstrated through real cross-border combinations, the **User-Supported Intermediation (USI) pattern** that is also used in MA Pilot (https://wiki.de4a.eu/index.php/User-supported_Intermediation_Pattern): it is now **the most similar pattern to the interaction pattern proposed for the SDGR OOTS** and it is **piloted in multiple scenarios (4 use cases between SA and MA pilots)** providing a high level of user control (as also found for VC pattern) by students over their credentials and high levels of satisfaction as well from public administration users for the high quality of data and achieved administrative simplification (see next Section 3.2 for more details). Especially **in the case of Studying Abroad, USI pattern has been demonstrated with 8 combinations between both iterations**. An improved USI flow with user redirection URL provided directly from the DP side and the support for the exchange of multiple evidence has also been piloted in the second iteration where additional learning and value has been documented, in addition to increased students' Use through improved user engagement plans exchanging where possible real user evidence data (Secondary and Higher Education Diplomas).

Regarding actual pilot usage and, as reported in Section 2.2 of D4.4 [26]), **some combinations were piloted with test eID credentials and/or test evidence** for testing cross-border exchanges due to technical/organisational limitations:

- ▶ test eIDs were used by 60% of Slovenian students due to the complexity of the registration process at the Slovenian Central Authentication System (an external pre-requisite) while 80% of Portuguese students and all Spanish users also used test eIDs avoiding general issues where

²³ Belgium withdrew from DE4A at the beginning of Y2 but impact on the pilot was mitigated through participation of additional partner from PT, INESC-ID, in UC#3 and later also as DO in UC#2.

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students don't have their eIDAS-based authentication means activated and/or don't remember the eID PIN.

- ▶ 80% of Portuguese students and 60% of Slovenian students in "Application to public higher education" Use Case used test data, whereas Spanish students used real academic data but anonymized and bound to the personal data of a test credential (except for disability and large family evidence where test evidence had to be used for piloting due to higher sensitivity and level of data protection in Spanish data sources).

The **impact of this regarding results and their interpretation is practically inexistent**, as real students were informed of the circumstances and were able to perform all steps in the procedures in order to answer the multiple questions in student feedback form to assess their satisfaction and experience when using DE4A solutions, although use of real eIDs would have allowed better assessment of record matching features.

The pilot provides in Section 3.1 of D4.4 [26]) an overview of all the goals and success criteria for assessing the satisfaction of public authorities and students as well as success criteria for fulfilment of the pilot technical goals, with a table measuring the extent to which targets for scale-type metrics have been below or on/over pre-defined target levels. This is based on responses verified with internal stakeholders and the students as pilot users. **Targets defined for metrics were all met for students, Data Evaluators, Data Owners and Member States except for one** related to success criterion D3 that contributes more to Learning dimension **which is almost met:**

- ▶ Metric D3.1 which is measuring if more than 50% of participating MS believe the cost and effort for setting up and deploying the AS4 gateway, the SMP and the DE4A Connector will eventually be outweighed by the benefits. Since only two of three piloting MS provided feedback and of these two only one estimated that the benefits will exceed the effort and cost of implementation, maintenance and training, the result was exactly 50%.

Regarding technical common criteria, Section 3.3 of D4.4 [26] reflects findings between both iterations and generally show a good level of satisfaction for all of them with adequate evidence and explanations given in each case. The aspects identified for improvement relate to inclusion and accessibility (clarity and simplicity of the procedures), see more details in next section, but it is to be noted that **when comparing results from both iterations overall satisfaction slightly increased over time** in the 5-point Likert scale (from 3.67 to 3.73, +1,6%). Further investigation with DEs and DOs has been carried out to detail a better degree of achieved administrative simplification in the same deliverable (with **savings thanks to the removal of manual processes for diploma validation of 20-30 minutes per student** depending on the MS).

3.2 Results and findings – Students' Perspective (Use and Value)

3.2.1 Pilot achieved interoperability and cross-border combinations for defined Use Cases

According to the results of achieved cross-border interoperability status (Section 2.3 of D4.4 [24]) it can be seen that the pilot was successful in that **it covered all three use cases, demonstrating interoperability for evidence exchange with 2 different interaction patterns for the 3 participating MS in 12 combinations that were all launched with real students as end-users.**

Real procedures adapted to DE4A common components APIs were provided by UJI DE of Spain (UC#1 in production) and MIZŠ DEs of Slovenia (UC#1 and UC#3 in preproduction) with simulated procedures being provided by Portugal INESC-ID (for UC#1 and UC#3) and by JSI from Slovenia for UC#2.

Data services (DO functionality) proved **successful integration with national infrastructures like the Spanish central data intermediation platform** that enabled evidence retrieval diplomas from UJI in XML and VC formats, a PT DO and Issuer implemented by AMA and INESC-ID integrated with Instituto Superior Técnico of Lisbon information system (Fenix), eVŠ preproduction system at the Ministry of Education, Science, and Sport of the Republic of Slovenia integrated through the Slovenian national

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OOP system Tray and the central Preview component (UC#1) and finally University of Maribor's Issuer instance (UC#3).

Student engagement has been highly successful in the second iteration doubling numbers, considering that students had to belong to one of the 3 academic institutions and have 1st level Bologna degree/secondary education diploma and that most of the combinations became ready for piloting in periods where students in some cases were harder to find²⁴ and were also known (invited) students (see other relevant details on user engagement in each MS in Section 4.2 of D4.4 [26]). Improvements in engagement strategy for the second iteration included that students from other departments of the participating universities who were not involved in any way with the project were this time also invited to participate in piloting. Furthermore, a longer period of piloting also contributed to the higher number of students. Of the total **104 students piloting**, 43% (45) were from Spain, 29% (30) from Slovenia, and 28% (29) from Portugal which shows a good distribution of students between the 3 countries. Details about all DEs and DOs with screenshots are provided in Subsections 2.1.2 and 2.1.3 of D4.4 [26].

The **first Use Case, based on the SDGR Annex II [22] procedure of 'Submitting an initial application for admission to public tertiary education institution'**, was designed for students to use national eIDs to access a foreign service and explicitly request the use of the DE4A technical system to have their secondary or higher education diploma evidence required by the service transferred electronically from a trusted source in their home country after previewing it at the source after successful record matching again based on eIDAS authentication and satisfying applicable provisions of the SDGR and the GDPR. For this use case, and with respect to the first iteration (that had fully launched 4 combinations), an additional combination was piloted (SI-MIZŠ DE – PT-INESC-ID DO) and another one was also fully launched (PT-INESC-ID DE – SI-MIZŠ DO) that was previously piloted in a more limited and supervised manner for a total of **6 combinations**. 38 users (37% of the total) piloted this use case (with a distribution between MS of 39.5% of Portuguese students, 34.2% Spanish and 26.2% Slovenian). In the case of Spanish DE, UJI, only enrolment in Master's Degree Studies was enabled, as regional governments are responsible for enrolment in Bachelor's Degree Studies in Spain. Regarding test and real credentials and evidence used:

- ▶ Slovenian students used real and test data (also in Diploma recognition Use Case), 60% authenticating with test eIDs²⁵ when piloting Spanish and Portuguese services (combinations ES-UJI – SI-MIZŠ and PT-INESC-ID – SI-MIZŠ),
- ▶ Portuguese students used test evidence for testing the combinations ES-UJI – PT-INESC-ID and SI-MIZŠ – PT-INESC-ID and 80% used test eIDs,
- ▶ Spanish students were using test credentials and anonymized real evidence when testing the services of Portugal and Slovenia (PT-INESC-ID – ES-SGAD, SI-MIZŠ – ES-SGAD).

The **second Use Case, based on the SDGR Annex II [22] procedure of 'Applying for a tertiary education study financing, such as study grants and loans from a public body or institution'** featured 2 combinations (SI-JSI – ES-SGAD, SI-JSI– PT-INESC-ID) and was designed to pilot the multi-evidence exchange functionality (by Spanish students) with items including the diploma for the 1st Bologna degree, large family evidence, and disability evidence with students selecting evidence(s) in Explicit Request step at the DE and previewing at the corresponding source one or more evidence, after a successful record matching. As a novelty in the second iteration, the DO of PT-INESC-ID was able to be used, as higher education diplomas were used by services in this and the previous use case (however,

²⁴ In such cases of piloting outside real application periods, universities (e.g. Spanish University Jaume I) required to exceptionally enable the application to some programmes and instructing the personnel to consider it a test situation despite being on a production service.

²⁵ Authentication at MIZŠ services proved cumbersome to pilot in a single session, with Slovenian pre-requisite of one-time enrolment at national authentication system involving 2 asynchronous steps with email sending step.

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Portuguese students only piloted single evidence requests as large family and disability evidence was not available in their country). For this Use Case, **a few PT students used real credential and real data** whereas Spanish ones used test credentials and a combination of real but anonymized academic data and test data for large family and disability evidence. **28 students** (27% of the total) piloted this use case (71.4% of students were Spanish and 28.6% were Portuguese).

The **third Use Case, based on the SDGR Annex II [22] procedure of ‘Requesting academic recognition of diplomas, certificates or other proof of studies or courses’** featured **4 combinations** (PT-INESC-ID – ES-SGAD, SI-MIZŠ – ES-SGAD, SI-MIZŠ – PT-INESC-ID and PT-INESC-ID – SI-UM). Leveraging the **DE4A Self-sovereign Identity supporting framework** implementing the **Verifiable Credentials exchange pattern** (see D5.8 [30]), students were able to obtain in their mobile wallets their diplomas in the form of Verifiable Credentials (attestations) from trusted data sources (universities where they previously studied or Ministries of Education) and were also able to present them as Verifiable Presentations to a competent authority in another MS to request their recognition. In the second iteration, all issuers and verifiers used updated respective Authority Agents (https://wiki.de4a.eu/index.php/DE4A_SSI_Authority_Agent, <https://github.com/de4a-eu/de4a-ssi-authority-agent-base>) and simplified the flow to reduce the number of student interactions with the services thanks to an also optimized Mobile User Agent wallet application (https://wiki.de4a.eu/index.php/DE4A_SSI_Edge_Agent, <https://github.com/de4a-eu/de4a-mobile-user-agent>).

In the second iteration previous limitations in some combinations (e.g. display errors or errors caused by changes in the piloting environment) were overcome. The only case where an endpoint was not ready is lack of resources in Slovenian MIZŠ authority to have Issuer ready for UC#3 which was solved by using the University of Maribor Issuer reference implementation.

Despite test credentials being used in some cases as explained above, the gathered data is still production-relevant: for example in the case of Spanish DO, test identities were bound to anonymised real data (academic data from real users but with all personal information erased and substituted by the info of the test identity) and the test evidence, which had also been used for Connectathons, allow to technically exchange evidence just the same as for real evidences, with no or minimal impact on user experience (students were informed of the circumstance so they expected to e.g. see test values in Preview step).

3.2.2 End-users’ Feedback and Use-related Metrics and Success Criteria Results

Regarding the **analysis of students’ feedback** (Criteria and metrics C.x) **on satisfaction with completed eProcedures** with a focus on 10 different aspects²⁶, the pilot has reflected accurately in the table and figures of Section 3.2.1.2 of D4.4 [26] the average of answers using 5-point Likert scales [19], divided between the 3 use cases (actually also including now answer for UC#3 piloting at Verifiers which was not considered in 1st iteration). Overall, **the most appreciated aspects** with values above 4 (“Satisfied”) are (between brackets, average values and increase/decrease when compared to 1st iteration values):

- ▶ **Duration of the procedures (4.26, +6.5%) with over 80% satisfied or very satisfied**
- ▶ **Control in managing own credentials (4.16, -1.2%) with over 80% satisfied or very satisfied and**
- ▶ **Required effort (4.02, +4.4%) with over 75% satisfied or very satisfied.**

Students were also satisfied or very satisfied with **security (almost 80%) and language aspects (almost 75%)**. The **least appreciated was the number of errors and interruptions (3.52)** which still yields a +8.3% better result with respect to the first iteration (users dissatisfied or very dissatisfied with this don’t reach 25% whereas in the first iteration they were over 30%): as reported by students, **errors are**

²⁶ Credentials, security, duration, communication, language, errors, simplicity, clarity, effort and overall appreciation.

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mainly related to the instability of the preproduction eIDAS environment, which is an external infrastructure to DE4A, the availability of enrolment calls at participating universities (both not under the control of the pilot), and connectivity issues between endpoints, common components, and national OOTS from time to time that prevented the use of cross-border services. **Clarity (3.62, +1.1%) and simplicity (3.61, -0.01%) of the procedures could still be improved**, as only 54% of the respondents were satisfied or very satisfied with them²⁷ but it is important to note that the complexity of procedures differs between Use Cases (SDGR “Life Events” in the domain of education) and where eIDAS authentication is inherently complex by itself. Communication and language aspects have slightly improved (+1.6% and +3.8 respectively) compared to the first iteration. In all cases for less positive answers they are closer to 4 (“Satisfied”) than to 3 (“Neutral”) with overall satisfaction at 3.73 (+1.6%).

In the second iteration, students appreciated Explicit Request step either positively (39.4%) or didn’t have specific feedback (54.8%) and similarly for Preview step (42.3% were fully informed of data being transferred and felt in control of the evidence and 54.8% didn’t provide feedback). The negative answers for both functionalities were finally between 6-13% (6 and 3 students out of 47 that provided an answer to this aspect) which is to be seen as a very good evolution as in the first iteration negative answers were between 25-29% (15 and 13 students out of 52).

Some interesting findings when comparing UC#1/UC#2 (USI pattern) with UC#3 (VC pattern) is that **satisfaction is somewhat higher with VC regarding experienced errors but for other aspects there is not clear difference between patterns** except that appreciation seems higher for Issuer of Verifiable Credentials in all aspects.

Students didn’t have significant complaints with errors and interruptions with Verifiable Credentials and the Mobile User Agent. Regarding internationalisation, over 70% of students were satisfied or very satisfied with the fact that services are provided in the language of the service provider and in English and less than 4% of students complained about incomplete translations to other languages or about language switches²⁸. Targets for **all C.x metrics are fulfilled** (as was also the case in the first iteration but with higher observed levels in some cases):

- ▶ for metric C1.1, 66% of students (+10% with respect to the previous iteration) were satisfied or very satisfied with the overall experience of the completed procedures in the three use cases
- ▶ for metric C1.2, 81% of the students were satisfied or very satisfied with the duration of the procedures (+4% with respect to the previous iteration)
- ▶ for metric C1.3, 80% of the students were satisfied or very satisfied with the security and privacy protection (-5% with respect to the previous iteration, which may be influenced by a service not using https which students didn’t notice or care about in the first iteration)
- ▶ for metric C1.4, 81% of the students were satisfied or very satisfied with the control they had when managing their education credentials (same as in previous iteration) with no significant difference between UC#1 (USI pattern) and UC#3 (VC pattern).

When it comes to log analysis, results for the **average and median duration of procedures from six DE services were analysed** making efforts to distinguish logs generated for testing in Connectathons from those generated by real users for a total of 154 log entries²⁹. Median values are more representative as they remove the impact of outlier values affecting average values:

²⁷ Students in the first iteration referred to having to use guidelines in order not to get lost although it is not known which parts of the procedure were less clear.

²⁸ The SDGR acknowledges issues with language barriers and makes some recommendations e.g. recitals 19 and 35 and some budget will be available for MS to do translations to English in OOTS implementation context.

²⁹ The number of logs is bigger than that of students as for ES and SI services (two) not only the service runs of the students who filled in the online questionnaire were considered, but also the logs including additional tests by pilot partners.

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Table 1: Duration of services (median) in SA Pilot

Use case	Service (n=logs considered)	Median (sec)
UC#1	ES-UJI (n=55)	44
	INESC-ID (n=8)	87
UC#2	SI-JSI (n=64)	65
UC#3	INESC-ID Issuer (n=7)	58
	INESC-ID Verifier (n=12)	60
	ES-SGAD (n=8)	61

Duration can be seen to vary between services due to different internal configuration of procedures and between use cases where also different exchange patterns were used (USI for UC#1 and UC#2 and VC for UC#3). Furthermore, for ES-UJI the values indicate only the time spent on the specific DE4A evidence retrieval part of the application (not the whole time spent on the procedure) whereas for ES-SGAD times exclude the eIDAS authentication and for INESC-ID the times exclude the initial eIDAS authentication at the portal. Except for INESC-ID, values tend to be around 60 seconds for pure DE4A interactions and since the number of logs is even higher than the number of real users, the results can be considered significant to show the fast and efficient exchange of student data that DE4A enables through direct evidence exchange between authorities (USI pattern) or the presentation of such evidence by students from mobile wallets (VC pattern).

Overall, **the pilot has clearly demonstrated the use of interoperable services based on Once-Only Principle in multiple (12) cross-border combinations between 3 MS and involving multiple competent authorities as DC and DP**, as well as MS infrastructure for authentication using eID of natural persons (eIDAS preproduction nodes) while **relying on semantic and common components from DE4A to realize 2 different evidence exchange patterns (USI and VC)**. It has also provided a good success story (Section 3.2.1.3 of D4.4 [26]) that focuses on the **multiple advantages experienced by students piloting the user-centric evidence exchange through VC pattern for Diplomas recognition (UC#3)**: including the use of mobile-first approach which is particularly adequate to younger users as early technology adopters and which enables them through user-friendly processes to acquire and manage in their wallets their digitised version of diplomas, available for them 24/7 and apt to be presented by them (full control) for different official processes with full guarantees on integrity and trustworthiness of such authentic data, saving a lot of time from only having to obtain the diplomas once only and re-use them multiple times, also with privacy-preserving features like selective disclosure.

3.2.3 Follow-up of Mid-term Evaluation Recommendations

Regarding Mid-term Evaluation recommendations (see Section 4.1.2 of D4.13 [24]) it can be seen that more real data was gathered and examples provided have also resulted in a better picture, specifically:

- i. SA pilot has followed faultlessly the first recommendation to reinforce **students' participation** with the **100% increase achieved during the second iteration** especially for Slovenian and Portuguese Higher Education Institutions: in particular, Spanish students increased from 26 to 45 (+73%), Slovenian students from 15 to 30 (+100%) and Portuguese students from 11 to 29 (+164%), so it can be seen that also effort has been greater to increase Slovenian and Portuguese users as recommended even if Spain still provides a relative majority of users.
- ii. The second recommendation was to **reinforce the number of students testing the Diplomas recognition Use Case (UC#3)** "given the increased relevance of this approach in the context of foreseeable and announced increased synergistic interplay between the OOTS of the SDGR

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and eIDAS European Digital Identity Framework”: this has also been followed passing from 16 to 38 students (+138%).

- iii. Regarding the recommendation to maximize the use of real data and real credentials as this could provide additional learning on important aspects like issues experienced for record (and identity) matching: while this has been the intent of the pilot, it has also been hampered (as already hinted in the recommendation itself) by the **limited number of students with eIDs having non-expired authentication certificates and remembering their PINs** as well as by **complex national registration procedures** (e.g. in Slovenia). Still, some 10 Slovenian students in UC#3 and a few more in UC#1 and 6 Portuguese students (around **20% of all testers**) used **real eIDs** and consequently the **effectiveness of record matching could not be fully evaluated**. For real data, it is considered that all Spanish users used such data (although anonymized and bound to the personal data of a test credential) which is 45 students to which 40% of Slovenian users can be added in UC#1 (less than 7 users) and 12 Slovenian users in UC#3. All Portuguese students except some in UC#2 and UC#3 used test data. This means that **around 60% of users used real data of some form** (accepting as real data the approach from Spain) which is a good result.
- iv. Recommendation to measure again satisfaction levels with same or similar aspects in order to have more solid grounds for conclusions has been followed: the aspects were maintained but for an enlarged user base of twice the number of students. The **online questionnaire for students was revised to obtain more detailed information on specific aspects**, e.g. parts of the procedures that are not clear or simple enough (also interviews with university administration staff were conducted) although it is not clear if this has served to understand better if different satisfaction levels relate to a different degree of complexity between procedures of different Use Cases; it is to be noted that students’ answers come from invited students who did not really want to go abroad or use a foreign e-service, so the pilot couldn’t assess the satisfaction of the students who want to go abroad or who actually used existing procedures in the past and can compare them with the DE4A procedures. However, some of the facts learnt seem to come from student feedback in free text elements of the questionnaire: such free text feedback was requested in particular for answers indicating negative levels of satisfaction and to describe experience with Explicit Request and Preview steps (e.g. did students understand under which conditions they are using the service, or how and from where the evidence will be retrieved and if they were fully informed what data will be transferred across the border and if they felt in control of the evidence transfer). Understandably, the pilot chose not to ask for free text feedback for positive answers as well, seeking balance in the length / complexity of the questionnaire in order to ensure users weren’t discouraged.
- v. Finally, **a more complete log analysis has been undertaken by collecting and analysing logs from 6 services** (compared to 2 services in the first iteration) but it has **focused on extracting average and median values for the duration of procedures** (rather than also identifying unsuccessful transactions and prevalent causes of errors). Probably this was not deemed cost-effective, given the generally high values of satisfaction obtained through the questionnaires and because errors in piloting environments (while occasional especially also due to the instability of certain pilot external infrastructures like eIDAS) were sought to be minimized by thorough testing in DE4A playground with test users of different nationalities for every cross-border combination. It was also acknowledged in the recommendation that error analysis would also entail additional complexity as most errors may be logged by Connectors rather than DE/DO endpoints which is the infrastructure more directly related to the majority of partners. The pilot also tracked as recommended the dates and times of real students testing to help identify as much as possible real usage from technical testing (although not completely). Advanced analyses like the effectiveness of record matching were not

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undertaken, given the fact that real eIDs could not be used in a generalised manner, for reasons explained in previous paragraphs. The pilot did manage to produce some statistics of usage like the number of piloting students per use case and nationality although this came more from questionnaire data analysis. In any case, the pilot seems to have done a good job with log analysis for the duration of procedures as reflected in Section 3.2.1.2 of D4.4 [26].

3.3 Results and findings – Public Administration Users’ Perspective

The Value of the Studying Abroad pilot can be best understood from the respective perspectives of the specific **benefits unleashed and verified both with real students as well as with staff of universities and Ministries of Education** in the context of cross-border piloting, related especially to **different kinds of administrative burden reductions and effort/time saving for both types of stakeholders** (enabled by DE4A OOTS for the Use Cases based on USI automated evidence exchange pattern and by DE4A Self-sovereign Identity Supporting Framework for the Use Case based on VC pattern). For the assessment of success criteria and related metrics, the focus in this section is on the feedback obtained from public administration users, especially staff of student offices at universities and civil servants from Slovenian MIZŠ, Portuguese AMA and Spanish SGAD in their roles of DEs and DOs, provided through interviews and questionnaires filled by such DEs, DOs and Member States teams responsible for common DE4A infrastructure components. Feedback collected was initially gathered during the first iteration, and was further enriched and complemented via interviews with student office officials and success stories in the second iteration.

Regarding the **assessment of benefits by participating MS** (2 of 3 participating MS contributed to this analysis), the **shorter duration of application processing (5) and effort and cost of maintenance (4.5) ranked highest** in terms of benefits compensating such costs, with effort and cost of training being also positive balance (4) and neutral value for the effort and cost of implementation (3). The latter value is seen to be impacted by one of the two Member States suffering delays due to internal security audits (which is arguably more related to the pilot nature of the DE4A project requiring additional audits, rather than relating to the actual pilot outcomes). For metric D3.1, which required more than 50% of respondents estimated that benefits would outweigh the costs of setting up common DE4A infrastructure, one MS confirmed such a positive balance while the other did not and therefore the metric is almost fulfilled. The significance of this result is very relative as more MS would have been necessary to extract conclusions, but it can be extended for similar metrics in other pilots (e.g. DBA pilot with 4 MS assessed cost and effort for setting up common infrastructure to be on par with the benefits which is a similar result). Analysis of costs borne by MS for deploying DE4A components (and related metric D3.2) is addressed in Section 3.4.1 below.

3.3.1 Data Evaluators / Verifiers results and findings

Data Evaluators and Verifiers (3 DEs for USI pattern of a total of 4 and 1 Verifier for VC pattern of a total of 2) provided feedback on the **quality of student data** (comprising availability of evidence in electronic and structured formats, and completeness, reliability, and meaningfulness of the available data) and on **effort required for processing students’ data obtained using DE4A solutions** (see Section 3.2.2.1 of D4.4 [26]): the values reported have not been modified with respect to the first iteration and are between 4 or 5 (high or very high) for quality of student data (all mentioned aspects) except availability in a structured format which is between neutral (VC Verifier) and closer to high (USI DEs) and 4 or higher for the amount of work or between 3 and 4 for less effort in processing student data (3.33 values are given for the interpretation of data and solving transcription / translation errors, missing data and exceptions by USI pattern DEs). While acknowledging new procedures benefits compared to baseline situation without DE4A, some issues mentioned relate to lack of officially

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translated content³⁰ and for processing effort that administrative burden reduction is only achieved when all data required by specific (enrolment) procedure is included in the evidence to avoid having to request scanned copies of certificated diplomas and validating them manually. When all data is available the reduction of time spent in validation procedures can be very significant, e.g. in Spain validations can take up to days due to volumes of emails and phone calls to applicants. DEs/Verifier valued as highest benefits trustworthiness of the data (5), shorter duration of application processing (between 4.33 and 5) and lower manual effort of processing and lower risk of errors (between 4 and 4.33) with lower communication costs being slightly less significant.

More interesting feedback was obtained from interviews e.g. in Portugal with director of academic services and the responsible for mobility and in Slovenia with representatives from all 4 universities in this MS. Starting from a baseline situation of complexity to understand and validate diplomas, DE4A facilitates automatic transfer/validation of such evidence making this process efficient and almost consuming no time. For institutions with thousands of students, the benefits are even higher considering a time reduction of on average 20 minutes per student in Portugal and 30 minutes in Slovenia (also 30 minutes was estimated as the average time saved in Spain by University Jaume I officials). Sometimes, in the current situation, it can take a week to receive from another MS information about the authenticity and validity of a diploma (if such confirmation is sent). It was also relevant to find that these stakeholders would welcome receiving, through solutions similar to DE4A, the whole Diploma Supplement (<https://europa.eu/europass/en/learn-europe/diploma-supplement>) and information on whether the foreign higher education institution is an accredited institution (something EBSI addresses for example through its Trusted Issuer Registry). This feedback was further underscored by a success story based on testimonials from University Jaume I student office describing the pre-existing, cumbersome and error-prone diploma validation process and how DE4A enables to save time to university officials (no email/phone checks), who can also handle received evidence with high degree of trust.

Regarding the metrics focused on DEs/Verifiers (not all provided feedback), metric A1.1 analysed % of DE answers appreciating the quality of the data and all respondents provided values above 4 (high) satisfying the established target in this regard (over 50%) of answers and this metric is fulfilled; metric A1.2 focused on the effort required to process student data using DE4A solution compared to baseline scenario where all respondents also answered positively with an average value of 3.78 for USI pattern and 4 for VC pattern and therefore this metric is also fulfilled. D.x and E.x metrics related to cost and effort balance to customize evidence portals and integrate with common components and to the balance of this with expected benefits are analysed in Section 3.4.1 as besides being related to Value for public administration users, they provide significant Learning for Adoption.

3.3.2 Data Owners / Issuers results and findings

Regarding Data Owners and Issuers (see Section 3.2.2.2 of D4.4 [26]), all of them provided feedback with an average value between **'high' or 'very high' for the appreciation of less effort required to process evidence requests** (implying that they were quite satisfied with the reduction in effort), where also estimated benefits peaked with values of 4.5 (VC pattern) and 5 (USI pattern) for benefits of lower manual effort of processing **and lower risk of errors and shorter duration of application processing** (values between 4.67 and 5).

Record matching effectiveness was seen as an important aspect by Data Owners to match degrees awarded to foreign students depending on the person identifier used and on the identifier presented by foreign user later when requesting the evidence, which may not match; resorting to attribute matching is currently not allowed in some instances due to lack of some key attributes so binding

³⁰ Provided English translations provide no benefit other than better comprehension for staff, but still official translation is still needed so that titles can be verified for the applied programme and some visual examination cannot be avoided to determine when degrees are valid to match application to a given programme.

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processes require further consideration to be well addressed. Regarding time saved by DOs, two success stories served to further uncover benefits: it was determined that **15 minutes can be saved per student in case of Slovenian student offices** by removing the need to complete request forms and in Spain the provision of multiple evidences from multiple sources uncovered the **need for standardization among different messaging structures**.

Regarding metrics, **B1.1 metric** focuses on **appreciation by DOs** with 75% of respondents confirming **less effort** (25% same effort), with an average value of 4.5 (between 'less' and 'considerably less' effort) and since the target was 50% of positive answers, this **metric is fulfilled**. Other D.x and E.x metrics related to cost and effort balance to customize data sources and integrate them with common components and to the balance of this with expected benefits are analysed in Section 3.4.1 as besides being related to Value for public administration users, they provide significant Learning for Adoption.

3.3.3 Follow-up of Mid-term Evaluation Recommendations

Regarding Mid-term Evaluation recommendations provided specifically to the pilot in relation to results collection and analysis from public administration users:

- i. Recommendation for **increased participation from DE/DO partners** (or MS) to respective questionnaires has been followed in part as some increase in respondents is noted between iterations (1 more MS, 1 more DO) and, more significantly, interviews have been conducted in all 3 MS with the relevant competent authorities that go beyond evaluation of authorities' beliefs, leading to valuable findings and opinions about their satisfaction with DE4A, its benefits and aspects to continue work in the future.
- ii. The pilot has been able to confirm "**how piloting with real students and real data for more time affects** (consolidates or changes) the results assessed regarding the quality of data and its processing" as assessed in the previous section with only slight differences in aspects appreciated by users which were well compared by the pilot between both iterations (at least one questionnaire, the online questionnaire for students, was also improved as explained above). The pilot assessed there was no need to modify or extend the previously established metrics.
- iii. The pilot has overall followed the recommendation to **obtain more details on the amount of work to process user data**, obtaining through interviews with incumbent stakeholders clear estimates of time saved for diploma validation processes per student in each MS and other valuable information on benefits for them.
- iv. Regarding efforts to **process evidence**, the recommendation has been followed to estimate the complexity and duration to obtain and confirm academic evidence with other foreign Member States in the currently existing situation (baseline) but extended findings on record matching at DOs have not been possible to fulfil due to on-going limitations in the use of real eIDs but with some useful considerations provided as explained above.
- v. For the **usefulness of DE4A components**, partners estimated the new versions of components didn't justify a need to re-assess them after the second iteration. Regarding sustainability considerations these are addressed in the next sections.
- vi. After actually checking with subcontractors/technical teams as recommended previously, it was found that appreciation in terms of understanding of technical documentation had increased with respect to the first iteration with available technical documentation in the public Wiki.
- vii. As recommended, the **relevance of technical exchanges** through dedicated instant communication channels (i.e. Slack) has been further acknowledged as in fact follow-up of multiple issues and exchange of technical information has intensified during the second iteration with the common components support team. As also recommended, technical details

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relevant to the configuration of end-to-end connectivity have also been published in DE4A Wiki and found very useful by partners to minimize certain errors and time spent solving them.

3.4 Results and findings – Learning for Adoption

The pilot has documented in table format several lessons learnt over both iterations, including suggestions relevant to adoption for each of them in Section 3.2.3 of D4.4 [26]. These cover different types of challenges and the pilot concentrated more in those aspects which can be of higher relevance for future adopters e.g. competent authorities integrating eProcedures or data services with SDG OOTS especially in the education domain. In this regard, the pilot documents the knowledge building process (phases, actors, sources) with clarity, also documenting interactions for this purpose that are not only project-internal but include interactions with external communities with convergent lines of work i.e. EBSI and SDG Work Package on “Data semantics, formats and quality”. It is first provided below the learning related results and metrics provided in the same section of the pilot’s final running phase report mentioned above.

3.4.1 Member States results and findings (efforts)

On the **estimation of efforts for the various tasks involved to customize endpoints** (See Tables 34 and 35 in Section 3.2.3.2 of D4.4 [26]) **and to integrate with common components**, these were provided by three DEs and two DOs for the USI pattern, two Issuers and Verifier for VC pattern, and two MS that deployed connectors, SMPs and configured certificates; this is one more issuer and one more MS compared to the first iteration. Estimations are not considering delays in the project and aspects like preparation of different environments (test, preproduction, production), obtaining production certificates, and additional security assessments required by IT departments of the pilot participants are excluded too focusing on real efforts relevant for future adopters (as all these could be too specific for DE4A). **Results show a total of 34 and 52 days of effort respectively for DEs and DOs for USI pattern while 8 days for Verifiers and 10 days Issuers for VC pattern are needed.** These results are used for **metrics D2.2, D1.2 and E1.2, E2.2, which are fulfilled** (as no target was defined).

Table 2: Average Costs Reported by MS Public Authorities in SA Pilot

DE4A component / MS Endpoint	Average Cost (Effort in Person-Days) to integrate (deploy/customize/configure)
DE4A Connector	7
SMP	6
Data Evaluator	34
Data Owner	52 (19 Iteration 1)

While the value for DO integration was previously only 19 days in the first iteration, it has greatly increased (to 52 days) based on the feedback from another MS but this could be due to particular issues at a national level and cannot become a definitive conclusion (namely that DO integration would be more costly than DE integration). The pilot warns that given small number of respondents, the different skills of the partners involved, and the differences in the partners’ environments, **it is difficult to compare the overall effort for DE and DO implementation and integration.**

Regarding metrics for DEs and DOs estimating if positive cost-benefit balance will result from integrating with the common components, with **all four DE/Verifier respondents confirming that benefits will exceed costs of customizing and integrating electronic procedure portals (average of 4.28 for USI and 4.33 for VC cases) so metrics D2.1 and E2.1 are fulfilled; all five DO respondents**

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confirm that benefits will outweigh costs for customizing and integrating data services (4.67 for USI and 4.63 for VC cases) so metrics D1.1 and E1.1 are fulfilled.

At MS level and for the effort required to deploy in general the OOTS central components provided by 2 MS, **it takes on average almost 6 days to set up an SMP and nearly 7 days to deploy a DE4A Connector** with an integrated phase4 AS4 gateway whereas **integration of an external gateway is seen to require between 15-20 person days** (due to complex and static configuration that depends greatly on other participants involved). This feeds into **metric D3.2** which didn't have a target and **is fulfilled**. **Time spent for endpoints adaptations and deployment and set-up of components in case of VC pattern seems substantially lower**, but that feedback originates from a small number of respondents (3), so it should be further confirmed in other projects (e.g. large-scale pilots in the context of EU Digital Identity Wallets).

Lastly, some observations can be made regarding the **assessment of the usefulness of DE4A patterns and components** (Solution Architecture, evidence exchange model, canonical data model, Connector, mocked DE and DO, central SMP, SSI agents, Kafka server for non-persisted errors) based on 6 answered questionnaires by partners involved in customization, implementation, deployment, or testing of DE, DO, and DE4A Connector (see Section 3.2.2.4 of D4.4 [26]). Results come from the first iteration and not all aspects were rated by every partner and results show generally high scores for the different components rated (7 were over 4 which means 'high' usefulness), the **highest values being for playground components, SMP, Connector and mobile user agent** (somewhat less but still positive appreciation was given to solution architectures and the Authority Agent). Technical teams seem fairly highly satisfied with the quality of support including over Slack by common components work package support team during integration and testing 4.5. There is somewhat less but still positive appreciation of the quality of technical documentation and testing methodology / Connectathons.

3.4.2 Lessons learnt from SA Pilot

Lessons learnt were built with different actors gaining experience in both pilot iterations and stem from users' feedback and interviews, internal discussions between service providers and governmental institutions, internal feedback from DEs, DOs and MS or external interactions with actors like those from EBSI. The lessons are presented organised according to project phases and knowledge provided to other parts of the project (analysis & design, customization integration and testing, lessons learnt for other project work packages) and cover a large number of learning topics (22) with suggestions for adoption based on the experienced challenges in a cross-border pilot of this complexity. This is in addition to the knowledge provided throughout the deliverable referred to the different types of pilot users and included in metrics tables or comparative results tables with corresponding analysis and interpretation.

Overall the **lessons learnt cover in a pragmatic way a significantly wide variety of topics of high relevance for SDG adopters in the education domain**: in-depth technical expertise required in both eIDAS and OOTS (eDelivery) domains, evidence content variability and canonical model schemes harmonization around Europass data model for higher education diplomas, the usefulness of simultaneous request for multiple evidence to potentially different DPs and common Preview, the need to consider national (jurisdictional) barriers that may arise in certain procedures, the importance for users of the clarity and simplicity of procedures or finding solutions for countries that have not yet notified eID schemes (which is very important to avoid negative impacts/discrimination on SDG users from those MS) to name a few.

Another important body of lessons refer to **those learnt to tackle DE4A's inherent high complexity of integrations and adaptations**, requiring collaboration between multiple technical teams during the critical phases of pilot customization, integration and testing. These range from organisational level with the importance of proper planning and securing of resources allocation with experienced coordinating teams addressing issues between participating agencies, to the strategic approach of

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deploying national central services (e.g. DE4A Connector with integrated AS4 Gateway) to scale up the integration of many DEs and DOs in each MS, the consideration of MS decision-making procedures with varying internal requirements (e.g. security and audits) leading to anticipation of varying paces for progress in MS developments and integrations and where the use of reference implementations of common components and common testing environment ('Playground' in DE4A) has proven extremely valuable providing extra confidence prior to moving into operational/production environments. Successful testing also relies on a phased approach with connectivity testing first, with channels for instant collaboration of MS technical experts and with the satisfaction of pre-requisites before cross-border testing of evidence exchange between endpoints ('Connectathons') that also include the need for coordinated exchange of test credentials and preparation of adequate test evidence sets.

The pilot explains (see Section 3.2.3.4 of D4.4 [26]) **lessons learnt in the process of participating in EBSI's Early Adopters Programme and the integration with that common blockchain infrastructure through ESSIF APIs**, explaining the scope of this integration and its importance, e.g. to increase trust through signed Verifiable Credentials (using EBSI-compliant DIDs) and validation by Verifiers of Verifiable Presentations and of their Issuers (retrieving information from EBSI distributed DID and Trusted Issuer Registries). Challenging aspects for implementation and integration are also well covered (e.g. changes in EBSI API endpoints and impact on DE4A SSI agents of switch to EBSI "pilot environment" at the end of 2022). Aspects that are on-going work at EBSI and are thus not yet available were also described, e.g. VC validation at Trusted Schema Registry not available during the second iteration, API-based registration of Issuers at the Trusted Issuer Registry, VC schema on-going standardisation activities (adoption by EBSI of Europass as data model schema combined with W3C data model for VCs) or the not implemented credentials revocation support on EBSI side. It is also explained aspects related to specific pragmatic choices by DE4A like the inclusion of the eIDAS Minimum Data Set attributed in VCs to facilitate verification of Diplomas (as belonging to the same person authenticating to Issuers and Verifiers) or local VC verification (as EBSI-supported verification was not available) or switch by EBSI to JWT-based Verifiable Presentations (not announced before second iteration started and where DE4A used JSON-LD).

While preparing for the second iteration, pilot partners had different **interactions with SDG Work Package on "Data semantics, formats and quality" providing highly appreciated feedback** covering various points of semantic portability for DEs to be able to present data to human agents in a meaningful, localised way (official translation of fields, normalised ranged values, etc.). Also, possibilities to provide more flexibility considering data availability were explored i.e. the possibility to define different incremental levels of "mandatoriness" using syntactically compatible variants of evidence e.g. including average grades, lists of courses, etc.

Aspects regarding the **need for clear, detailed documentation for developers, explanation of the inner workings of SDG OOTS components to public authorities and the use of visual tools** (video animations and presentations) to communicate OOP benefits to users were all highlighted too. The work during the project was fluid and interactive across WPs, but future integrators with varying technical background will need easily accessible and clear guidance. Setting up a Wiki like DE4A public Wiki is instrumental in making life easier for developers as required information could be accessed and updated very easily (the DE4A technical "[Getting started guide](#)" pages are mentioned as a good example of this).

3.4.3 Follow-up of Mid-term Evaluation Recommendations

Regarding Mid-term Evaluation recommendations for Learning:

- i. The pilot worked with limited results to increase internal rates of response to questionnaires in order to provide additional feedback on efforts and pain points when customizing national systems (one more DO contributed), deploying and integrating DE4A components (one more MS contributed) and overall the measurements did not change much in general (as analysed

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- in previous Subsection 3.2). It is however **noteworthy the interviews with Higher Education Domain officials from the 3 MS and learning resulting from this**. Therefore this recommendation is followed partially.
- ii. **Learning in specific areas like record matching has been limited**, impaired by certain set-ups at the national level and known challenges with the use of eID with students but the pilot partners really had the intention to increase the usage of real eIDs for gathering it. Nonetheless, it is seen that partners identified, discussed and provided some valuable feedback on record matching in the context of Higher Education.
 - iii. As commented previously the combination of updated students' questionnaires with more free text questions for negative feedback and the interviews with university officials have contributed as recommended to a better understanding of pilot results and to extend the lessons learnt with specific aspects relevant to benefits enabled by DE4A and future areas of improvement.
 - iv. The pilot has, as recommended, carried out a praiseworthy **effort to document and update well in DE4A public Wiki** (https://wiki.de4a.eu/index.php/Studying_Abroad_Pilot) technical and legal status, use case definition, the definition of participants and implementation in each use case, step-wise processes, etc. Links to pilot deliverables were also provided. Recommendation in this regard is well followed.
 - v. Following recommendations, **pilot learning knowledge is both well-structured and findable** with tables in Section 3.2.3 of D4.4 [26] **organising the lessons learnt by project phases and interactions (relevant for other projects in the domain of the SDG) and with multiple learning topics** in each table, providing for each lesson **suggestions for adoption** to the incumbent stakeholders. While the largest part of this body of lessons learnt was already built during the first iteration, it has been revised and updated considering project progress (e.g. improvement of evidence types or optimization of VC pattern interactions and consolidation of experience with EBSI Early Adopters Programme) and SDG landscape evolution (e.g. recommendation to implement Preview at Data Provider side is no longer needed as it has been adopted in the Implementing Regulation for the OOTS).
 - vi. Finally, the pilot has followed the recommendation to explain (Section 4.2 of D4.4) with examples for each of the countries how it has engaged with relevant stakeholders in an effort to disseminate more widely its results (e.g. **interactions with SDG semantic working group, in 2022 annual conferences of EUNIS -with paper registered in the proceedings- and EEMA or in 2023 with a national workshop in Slovenia with representatives from all universities and the DE4A final event**, <https://finalevent.de4a.eu/>).

It can be concluded that the SA Pilot has contributed to the expected DE4A project benefits by fulfilling its mission to validate internal outcomes in operational cross-border settings in two iterations and with effective scope extension with optimised functionalities, integrating new versions of common components and with successive endpoints adaptations: it has validated the project start architecture, the User-supported Intermediation and the Verifiable Credentials patterns, as well as the canonical model for higher education diplomas. The pilot has also validated the common components such as DE4A Connector with underlying evidence exchange infrastructure and the Self-Sovereign Identity supporting framework components integrated with EBSI infrastructure. All this materialises in the learning suitable for post-project adoptions that the pilot has generated.

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4 Assessment of Doing Business Abroad Pilot Progress and Fulfilment of Pilot Goals and Mid-term Evaluation Recommendations

4.1 General considerations on pilot progress and results

For an overview of the DBA pilot definition, assessment of its setup with respect to the pre-defined targets, adherence to pilot principles and consistency of pilot goals with pilot definition and overarching piloting objectives of DE4A and consistent implementation of bidirectional trail relating goals to success criteria and metrics, please see Section 3.2 of D4.13 Methodology and Mid-term Evaluation Report [24].

A general assessment of the pilot with focus on the four goals this pilot proposed to achieve, and the success criteria related to them, results in a positive outcome as the metrics on which such criteria are based have generally been fulfilled in terms of achieving defined targets with few exceptions that will be commented further below in this chapter. Pilots are a good exercise to solve “first-time” problems for future implementation of the SDG OOTS and DBA Pilot has been no exception: the pilot verified through the executed eProcedures leveraging company data and business events notifications, many of the expected benefits the SDG regulation intends to materialise through the cross-border Once-Only Technical System: **simpler eProcedures, shorter durations, immediate results, high quality of service and less effort for processing rank highest among the benefits that were observed.**

In this regard, the pilot has generated **multiple valuable insights in relation to the main objective of lowering barriers for companies starting and/or doing business across borders**: partners analysed and piloted solutions the most important challenges for the implementation of the SDGR in the business domain (like record matching, evidence definition and powers validation), and developed an international infrastructure for cross-border exchange of company evidence. This was achieved by **designing, deploying and integrating DE4A common components to business registers and service providers in the four piloting Member States (AT, NL, RO and SE)**, also enabling cross-border authentication on behalf of companies through pilot-specific eIDAS nodes supporting extensions ([SEMPER](#)) for validation of powers of representation. The **resulting piloting infrastructure was extensively tested and used throughout two iterations for real-life piloting with several companies, Data Owners and Data Evaluators**. From a business goals perspective, the **resulting piloted eProcedures have shown simplicity and speed, as well as lower cost for both companies and public authorities** acting as Data Evaluator and it is a **requirement to pursue a broad implementation to maximize cost-effectiveness** in terms of covering as many eProcedures as possible and serving larger user base.

The pilot has successfully piloted in the available combinations the **Intermediation (IM, https://wiki.de4a.eu/index.php/Intermediation_Pattern) and Subscription & Notification (S&N, https://wiki.de4a.eu/index.php/Subscription_and_Notification_Pattern) evidence exchange patterns**: the former is largely similar to the interaction described in TOOP project [16] and which was the starting point for the OOTS while the latter enables direct back-office exchanges to automatically propagate information (evidence) updates to other authorities. The second piloting phase has **validated the need for receiving notifications³¹ for previous subscriptions³² to changes in company data and company-related events in business registers** which is a functionality that existing systems like BRIS don't cover (BRIS does not cover all types of companies and not all public authorities have

³¹ See https://wiki.de4a.eu/index.php/Notification_pattern_communication_diagram

³² See https://wiki.de4a.eu/index.php/Subscription_pattern_communication_diagram

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access to it). The pilot finally did not pilot the Lookup pattern (designed to enable repetitive requests between DCs and DPs that already know each other up-front) indicating that “it technically is identical to the Intermediation pattern and added no learning value compared to UC1”.

The pilot also adopted several strategies during both iterations and has provided **suggestions for pragmatic approaches to mitigate and minimize to the extent possible the impact of delays with availability and integration of cross-border infrastructures** (which can be caused by different organisational and technical complexities), see Section 2.2 of D4.7 [5] and D4.8 [27]. In the second iteration examples of such strategies included agreement with the Common Components WP to include in the second iteration Connector component a so-called “compatibility layer”³³ as well as the use of (often existing) lightweight and standalone environments for testing without interference to other projects or systems migrations at DEs/DOs which was useful for piloting the second use case with S&N pattern. Such strategies and approaches can be of interest for the MS teams that will be involved in the testing phase of SDG OOTS, and that may face similar challenges in some cases considering the commonalities in cross-border integration of solutions developed at potentially different paces by heterogeneous teams.

The pilot has learned regarding **the Intermediation pattern** that, in the context of the Business domain, it **has proven usable for procedures where evidence exchanged does not contain personal data** and where record matching can be performed without additional control, through the user leveraging unique identifiers at European level (e.g. for companies as used in BRIS and possibly as well for vehicles used by EUCARIS). **It may serve to bridge existing sectoral exchange systems such as business registers networks and to realize back-office exchanges without (further or any) user interaction when the legal basis exists to skip the Explicit Request and Preview requirements.** IM pattern continued to be piloted in DBA by one more MS (AT) for the same use case of the first iteration (**full powers validation**) while other MS (NL, RO and SE) addressed extended use case of **fine-grained powers validation**.

For S&N the pilot learned that even while Data Owners sometimes have similar functionality available for national companies, the approach used in the pilot seems to be more advanced and detailed than these mechanisms, and the setup may therefore be used as an example to advance existing national functionality. **For Data Evaluators, subscribing to business events receiving notifications is considered to be useful and helps them provide their services adequately**, however the share of foreign companies registered with a public authority may be rather low, so the number of notifications is also expected to be small (furthermore, the added value of this mechanism is considered higher for public authorities that do not have access to BRIS, as BRIS already notifies changes in Limited-type companies). **For subscribing and notifying on company events / changes there needs to be a specified set of harmonised company event types.**

Last but not least, the type of cross-border piloting addressed in DE4A, which allows hands-on experience to be built in relation to interoperability barriers, has allowed to derive important lessons learnt for the wider SDG community: **required efforts for integration of eProcedure portals as evidence requestors and of data providers is heavily determined by the used local infrastructure** and hence it was observed that Member States establish their own velocities depending on their specific starting points and challenges faced to implement infrastructural, legal and procedural changes. **The pilot recommends applying a general step-by-step strategy for implementing the SDG infrastructure, gradually increasing complexity, with focus on feasibility and management of the implementation.** More details on other lessons learnt can be found in Section 4.4 below.

³³ This allowed the pilot DEs and DOs to integrate and use without changes in their interfaces the same common components for the Intermediation pattern.

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4.2 Results and findings – Company Perspective (Use and Value)

4.2.1 Pilot achieved interoperability and cross-border combinations for defined Use Cases

During the second iteration, the pilot scope was notably extended with a **second use case (“Doing business in another Member State”)** that also featured the new Subscription & Notification evidence exchange pattern while simultaneously **increasing numbers of Member State combinations and piloted functionality with Fine Grained Powers Validation** in the use case of “Starting a business in another Member State”. The second running phase also achieved a **five-fold increase in the number of cross-border combinations among the 4 MS: from 2 to 10 between both use cases** (of a maximum of 14 possible combinations for the second iteration). The pilot also successfully achieved a **near three-fold increase in the number of companies (final end-users) involved, from 6 companies in the first iteration to 17 companies** (also counting 4 companies in the pilot that was carried out with Germany).

13 company representatives directly involved in the first use case were interviewed to obtain in-depth understanding of their experiences and perspectives. Regarding Administrative Users, the **first use case incorporated an additional Data Evaluator (BVE from Sweden) and 2 new Data Owners (BRZ from AT and KvK from NL)**, while the second use case featured **3 Data Evaluators from AT, NL and SE that were also interviewed and 2 Data Owners (from RO and AT)**.

4.2.2 End-users’ Feedback and Use-related Metrics and Success Criteria Results

Regarding assessment of pilot **business goal B of reduction of manual work, lower transaction costs and improving enrolment speed for companies when using the Once Only Principle**, the **pilot has verified throughout both iterations such benefits to companies** (findings are more representative as well considering that the total number of involved companies -including the companies in the German/Dutch pilot- increased from 6 to 17 during the second iteration):

- ▶ **Difference of duration to enrol for starting business in another Member State goes from days or weeks in the baseline scenario without DE4A to minutes** (less than 2 minutes at best³⁴) thanks to OOTS and eIDAS/Powers Validation mechanisms³⁵: **this represents a reduction of several orders of magnitude for the time spent by end-users (company representatives) in business procedure activities, being the most appreciated benefit by company end-users** as it results in important savings for them of time and money spent for applying for a cross-border service for businesses. It is an **important pre-requisite** for achieving this enrolment speed that specific administrative requirements are met, namely that **electronic mandates must be correctly configured in Mandate Management Systems**; differences for registration of mandates do exist between Member States and can be not straightforward and cumbersome, however such processes concerning mandate management and validation are out of scope and something that cannot be changed by the DE4A project. The existence of pre-requisites to access the eProcedure such as mandate registration in national registers that could discourage the user to actually start to use the eProcedure, **while not being strictly part of the OOTS, it is a relevant finding towards SDG actual use**. This is also valid for the integration with eIDAS with screens where the user is redirected during the authentication prior to the eProcedure.
- ▶ **Online powers validation has been demonstrated to be not only necessary, but it can be quick and easy**, assuming administrative prerequisites are met in the mandate management system in the DP Member State. A relevant finding was that **representatives of SMEs did not feel more in control when Finer Grained Powers Validation was applied** (7 companies were specifically

³⁴ Number of minutes can vary for other procedures depending on i.e. number of electronic forms, existence of a payment step, among other factors.

³⁵ This is in fact achieved thanks to the semi-automated flows in DE4A’s OOTS chaining steps like authentication and proof of the authorisation, evidence collection and transportation, fast and error-free registration in forms, etc.

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interviewed about this mechanism) **as full powers is usually adequate for them**. However, **this feature is deemed to become likely quite relevant for larger companies** as they normally have the need to establish and use different powers for different purposes and **delegating responsibilities to different representatives** (while recommended by the Mid-term Evaluation, engaging of large companies became particularly challenging despite efforts made in events like EEMA Annual Conference or through embassies of pilot partners).

- ▶ **Immediateness, ease and speed are explicitly and highly appreciated by company representatives**, who were observed to focus on completing the eProcedure in as little time as possible, being impressed by the fact that **they don't have to collect and upload documents anymore, which saves them very valuable time and effort**. This extends to immediate results with Powers Validation, enabling representatives to avoid collecting and uploading documents about mandates and adds to the reported positive experiences.

Regarding an **overview of usage of the DE4A system**, participants considered the piloting in general **as a very positive experience and highlighted the ease of use and simplicity of the procedure** (first use case), with 100% of them (6 of them evaluated the entire process) **confirming very little effort required to carry out the enrolment procedure with the system (metric B1.1 target is fulfilled)**. Furthermore, the 4 interviews carried out to company representatives in the Dutch-German pilot have served to 'further substantiate findings on **positive perception with regards to ease of navigation in the portal, procedure efficiency and reliability**' which was one of the recommendations in the Mid-term Evaluation.

An additional relevant finding is that **users rarely studied or used consciously the Explicit Request and the Preview steps to understand what is offered to them, spending little time to read legally required information** (texts longer than 2 or 3 sentences, will not be read by most participants) as company representatives focus on finishing the procedure as fast as possible. Also, when having to manually choose the representation in structure for mandates, representatives tend to struggle as they are not used to use such structures on a daily basis. For **qualitative metric D3.1 a large majority of company representatives preferred to just be asked and shown the information for these steps only the very first time when enrolling to the procedure** (as research metric there was no pre-defined target).

This positive feedback extends to the satisfaction with more particular aspects like:

- ▶ **92% of 13 company representatives confirmed regarding adequacy (effectiveness and efficiency) of the method used for providing proof of being entitled to represent a company and the duration** to complete all aspects of the online procedure including reliability of powers validation method, **accessibility of method (language barriers), simplicity and robustness of the method**; results were averaging on appreciation of 'very adequate' so **metric B2.1 is fulfilled**.
 - A relevant finding relates to the online **authentication and authorisation (Powers Validation) steps, which must be as simple as possible, avoiding technical details/jargon** (i.e. 'assurance levels') in order not to confuse users.
- ▶ The **satisfaction the user expresses on several aspects the duration of the process** to apply for a service or registration considering average of all activities: collect and provide company data, collect and provide proof of authorisation, completing the forms in the eProcedure portal and dealing with Explicit Request and Preview steps. **83% of the 6 company representatives that evaluated the entire process confirmed, averaging on appreciation of 'very satisfied' (metric B3.1 is fulfilled)**. The extent to which the usability could be judged depended on the portal(s) in which representatives piloted in, given the fact that in simulated portals they sometimes had a reduced set of functionalities available compared to those that piloted in a production portal. **More positive responses were observed in portals having applied a simple implementation for authentication and authorization steps**.
- ▶ Users confirmed time and/or cost saving when completing application for service eProcedures (compared to the baseline scenario): **100% of companies evaluating the entire process confirmed, averaging on less time/effort (metrics B4.1 and B4.2 are fulfilled)**.

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Regarding **usability findings**, it was not surprising to find that **company representatives did not seem to understand fully the redirections and user interface switching implicit in eIDAS mechanisms between environments of destination (DE) and home (DP) Member States (with sometimes different languages in the corresponding user interfaces)**, but it is also true they weren't bothered as long as the process worked for them. It is worth noting for this that the complaints of non-optimal user experience with user redirection in eIDAS node interfaces for authentication, are well known for years and not under the scope of DE4A as eIDAS eID is an existing building block that is re-used. The new paradigm of EUDI wallets will surely change the game as well.

Regarding language barriers and communication aspects within eProcedures, company representatives are usually able to read English text, and some would consider text in their mother tongue to be an improvement of the already friendly eProcedure (MOR functionality in DE4A although not piloted in DBA could help in this regard). Mixing languages in eProcedure portals is to be avoided as observed by participants.

An aspect confirmed by few representatives, is their wish to have greater control and insight on the extent to which data will be used by the Data Evaluator and particularly over **the data source selection**: it was a pilot design decision to have the source is automatically selected as there is only one possible Data Provider per MS. Nonetheless, DE4A Information Desk supports this kind of Data Provider selection for the Intermediation pattern .

Although obtained feedback is only from a limited number of users (17 companies and 3 DEs/DOs for most metrics), via questionnaires and interviews, D4.7[5] explained the **challenges found in involving companies** and which are related to the fact that companies that wanted to start doing business across border exactly during the time when the pilot is running are few. In order to compensate for the limited number of pilot runs and users, a more qualitative approach has been followed in the second iteration based on in-depth interviews and a more focused analysis of metrics on respective main topics covered by each of them.

Overall, the pilot has demonstrated the use of interoperable services based on Once-Only Principle in ten cross-border combinations between 4 MS and involving competent authorities as DC and DP as well as MS infrastructure for authentication of company representatives (eIDAS piloting nodes, Full and Fine Grained Powers) while relying on semantic and common components from DE4A to realize IM and S&N evidence exchange patterns.

The intense effort involved from all pilot partners for achieving this has yielded **highly significant achievements in terms of benefits for companies' end-users verified through the fulfilment of all established metrics and success criteria**. This is further underscored by two **success stories** provided in the second iteration by the pilot from Dutch and Romanian entrepreneurs who expressed the wish for such solutions to be implemented across Europe under the SDG in order to lower existing barriers to cross-border procedures, making them as simple and short as experienced in the pilot.

4.2.3 Follow-up of Mid-term Evaluation Recommendations

The **pilot has also generally followed the specific recommendations** provided in the Mid-term Evaluation **for consolidation of Use and Value findings and results** as commented further above for the **further substantiation of company representatives** experience as well as for **providing a more detailed assessment about parts of procedures (or pre-requisites)** which may be less appreciated by the end-users; the latter was made possible by the pilot's correct choice to address such aspects in direct interviews in the context of a more qualitative-oriented approach in comparison to the first iteration, generating more in-depth understanding of actual experiences. The **pilot also followed recommendations to strengthen engagement plans with substantial increase in number of company representatives involved**, where increase in number of cross-border combinations and MS achieving them also helped even though **large companies were not targeted**. Recommendation to elicit more details from end-users of which steps were perceived as particularly easy and fast to do, compared to

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standard manual procedures can be considered to have been followed as well, as it was found through interviews different aspects when experiencing the authentication, authorisation, explicit request and preview steps, being the highest satisfaction with the duration of procedures perceived as very fast in particular for the central evidence exchange step. Finally, a recommendation that was implemented in part was that of logging to support error-tracking and which was confirmed to be very useful during testing but **logs did not seem to add additional findings regarding identification of unsuccessful transactions or prevalent causes of errors in actual piloting or issues with identity/record matching: the value of log analysis will become more relevant for higher volumes of transactions in production conditions** where different statistics such as number of transactions per pattern used and per cross-border combination, errors per component, number of evidences rejected in Preview functionality, etc. will become more valuable (chapter 3 of D3.7 Machine Learning Algorithms [29] describes in more detail such possibilities).

4.3 Results and findings – Administrative Users and MS Perspectives (Use and Value)

The feedback received from competent **public authorities (4 Data Evaluators and 3 Data Owners)** in their role of Administrative Users that need to deliver high-quality services shows **clear benefits with regards to the use of high-quality, authentic (validated) and well-structured (harmonized) data** and the **reduction of administrative time and cost burdens** for processing company registrations, which will become progressively higher as the implementation of fully online procedures in the context of the SDG for businesses becomes broader as well. Regarding the improvement of the quality company data by re-using data, **DE4A offers faster and easier data processing and avoids typing errors** compared with the situation when the information has to be introduced manually, **resulting in less processing overhead due to such errors for the Data Evaluators who also acknowledge the importance of receiving notifications related to company business events to maintain high quality of service delivery** (see below).

Regarding outcomes from other DE4A technical work packages including common components, Data Evaluator and Data Owner **public authorities in DBA pilot rank highest the Solution Architectures, the canonical data models, the information exchange model and the Playground components**. Other common components like the **Connector and central SMP are closer to High value as well** in their assessment. Both the **quality of support and communication channel (Slack)** provided by common components WP during the integration and testing and the contribution of testing methodology and Connectathons for testing with other MS to the successful launch of the pilots **were highly valued** (4.3 in a scale of 5).

4.3.1 Data Evaluators results and findings

DEs were confirmed to appreciate the online powers validation, being executed in the DP MS (as the DP MS knows best how to interpret legislation that is the foundation for mandates): the outcome of the validation is shared with the DE and allows the DE to simply accept the result and move forward with the eProcedure. **Direct digital evidence provision from authentic sources in harmonized fashion is also greatly beneficial** for Data Evaluators as **automation of the processing of data is facilitated with less errors** (manual validations with their associated burdens become unnecessary). Furthermore, the second iteration also confirmed that **Data Evaluators value positively the possibility to use the S&N pattern to be continuously informed through notifications about companies' situation and changes**, enabling them to adjust service delivery if needed based on this information (even if volume of notifications is not expected to be high as number of foreign companies is limited currently). These notifications on changes in companies are even more valuable for public authorities that:

a) do not have access to BRIS or

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b) work with any type of company (as BRIS only addresses Limited companies). These findings were addressed in qualitative metric D5.

All the mentioned benefits translate into offering fully online procedures featuring **optimized processes with estimated savings of up to hundreds of person hours per year per Data Evaluator** using OOTS and eIDAS/Powers Validation mechanisms and when extended to all relevant procedures offered in the respective portals, also justifying **positive cost-benefit balance for public administration users (cost effectiveness does depend on the number of procedures integrated with the new cross-border mechanisms)**. This finding relates to the recommendation in the Mid-term evaluation for assessing administrative simplification achieved together with new patterns and associated procedures in the second iteration,³⁶ and to effectively disseminate this to other stakeholders which was done in events like EEMA Annual Conference, the DE4A final event and by engaging in piloting with Germany.

An important feedback from some Data Evaluators was that, while acknowledging the process improvements and high value of benefits accrued, it is also a fact that **OOTS increases the technical complexity of solutions** supporting user-focused processes and highlighted the **importance for having a good organisation of maintenance and support in the context of the SDG to prevent or solve issues** e.g. in case of failing components.

It is also relevant to mention that DEs consider well-suited and beneficial for piloted eProcedures to use national eID for eIDAS authentication as users are familiar with it (this seems to assume wide availability of national eIDs notified through eIDAS Cooperation Network, which is not necessarily the case yet for all MS). In this regard, consideration of upcoming Digital Identity Wallets proposed in the context of revision of eIDAS regulation becomes relevant.

Data Evaluators also confirmed the **suitability and flexibility of the canonical evidence data model** (CompanyRegistration Evidence Type) in terms of coverage of the data (mandatory attributes) required by the eProcedures that the pilot used. It is important to highlight the work done with the Semantic Interoperability Solutions work package and between pilot partners to find a pragmatic balance between optional and mandatory attributes (i.e. when some attributes cannot be provided by some business registers or when some mandatory attributes that can be provided were included because some procedures need them in some countries). At the same time, **it can be expected that new and extended evidence types will be introduced for other eProcedures in the context of large-scale implementation of the SDG and which could contain non-structured, human readable data and information on representatives**, based both on the needs from additional eProcedures and the available evidence from authentic sources beyond business registers. **Record matching based on CompanyRegistrationID worked according to expectations in the pilot to prevent data doubling in databases of Data Evaluators** or to recognize previous registrations in the portals but not all eProcedures will need this feature as some are not designed for recurrent visits. **More advanced record matching that takes into account matching of (representing) natural person may be needed by some portals** (beyond the pilot). Qualitative metric D4.1 gathered DE feedback showing that matching on Legal Person generally sufficed for eProcedures where recurring customers were expected (on one occasion matching also on natural person identification would be necessary).

Considering fulfilment of relevant metrics (A.x, D.x and C2.1 for DEs and C1.1 for DOs), at the end of the second iteration and based on piloting both patterns and use cases results are overall positive or very positive with some isolated exceptions:

³⁶ Interviews in the second iteration confirmed that DEs were able to maintain adequate service provisioning but they didn't say anything specific on opportunities to simplify processes.

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- for **assessing reliability of company data** in electronic structured format as being more complete correct and meaningful 100% of DEs (3 participating in first use case) confirmed this as being on average considerably more reliable: metric A1.1 is fulfilled.
- for **effort required for company data processing** as being considerably less, 67% of the 3 DEs processing such data in first use case confirmed it as being on average less effort when compared to the baseline: metric A1.2 is fulfilled.
- for **estimated benefit of having company data** always up to date (second use case, metric A1.3), this was confirmed by 33% of the DEs to be high and two more (66%) indicated it was medium. Assessing this result more closely, the metric should have been marked as being green in Annex I of D4.8 [27] given the fact that the target admits more than 50% of respondents with medium appreciation. It was also confirmed that DEs expect high benefits per case where information is updated but the result is related to the fact they expect the volume of notifications to be rather low.
- for reliability of powers validation method, 67% of the DEs confirmed in average this being more reliable than the baseline: metric A2.1 is fulfilled.
- for **applicability of full and fine grained powers validation** methods to DE services 2 of the 3 DEs expressed it as being very adequate or sufficient, there was no target for this metric (D2.1) as this was classified as a type of research topic but given the majority of positive/non negative feedbacks and the assessment in Annex II of D4.8 that “For the piloted eProcedures, the powers validation mechanism (more than) sufficed”, it can be considered to be fulfilled.
- for **effort in verifying powers of company representative** as being less than in the baseline, 33% (1 DE) indicated they expected much less effort after implementing the piloted solution while 2 DEs expect to have same effort as in current solutions (metric A2.2 is not fulfilled). This is not problematic because the piloted solution does not take more effort than the current solution, while (according to the interviews) the DEs appreciate the fact that the DP MS performs the validation and knows best how to do it. This indicates better results against the same amount of effort (or less, if looking at the MS that stated so).
- for **cost-benefit assessment**, 100% of DEs (4 respondents) estimated that benefits³⁷ will exceed cost, especially when implementing the solution for multiple procedures as expected for full-fledged OOTS deployments and as explained above: metric C2.1 is fulfilled. However, the assessment of this by DOs (3 respondents) shows that they expect benefits to be on par or below cost but not to (vastly) exceed them which was the target so metric C1.1 is not fulfilled. However, DOs indicated that implementing assessed functionality will be mandatory for them, so benefits are not the most important factor for them (and cost was also found to be less depending on availability of existing APIs for sharing data).
- for **appreciation of company evidence data model**, 66% of DEs confirmed (3 DEs piloting the first use case) it as being adequate. There was no target as this was classified as a type of research topic but the metric (D1.1) can be considered to be fulfilled.

As a general point, the experience of the pilot with validated structured data, the value of the eIDAS/Powers Validation and the integration of OOTS, can be seen to point to the future development and interest in adoption by administrative users and MS of such robust technical and organizational solutions in the area of cross-border interoperability of services for business and eID management for the benefit of multiple stakeholders. This is further stressed attending to provided **success stories**, which **explain how (i) it is feasible as demonstrated by Germany who (was not even a partner but participated as an observer) to implement DE4A solutions (OOTS infrastructure, eIDAS with Powers Validation) and to integrate business portals and execute a pilot in less than 6 months** by benefitting from good organization and from available documentation and support from the project and (ii) **S&N**

³⁷ Less manual effort, lower communication cost, lower risk for error, shorter duration of processing and more complete, consistent, trustworthy and up-to-data data

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functionality is considered valuable and a step for providing fully online services of a high standard that will make it more attractive for foreign companies to do business in their country.

4.3.2 Data Owners results and findings

For **Data Owners** with data services already available (**3 in the first use case and 2 in the second use case**), the **support to both use cases was not found to have major (positive or negative) impacts on them and this seems to relate to the fact that no user interactions need to be supported on their side** with Intermediation pattern and **also because they require comparative less effort to adapt services besides** processing evidence requests, translating data to the appropriate structures (canonicalization) required for the cross-border evidence exchange and handling errors. When multiple business registers may be involved requests may require distributed querying or user may be offered choice of the source to be used. **While added value and benefits are seen to be greater for DEs, cross-border demand of (harmonized and/or domestic) evidence thanks to the SDG OOTS can reasonably be considered to lead to higher consumption of DO services**, with less manual work for processing requests, handling errors and offering guarantees of data quality, integrity and provenance for cross-border data exchanges, in compliance with applicable regulatory frameworks. The pilot noted that the **added value in this case is not internal to the DOs but is created for other parties and to fulfil legal requirements.**

DOs valued between adequate and perfectly adequate the ease to transform their evidences to canonical format (4.5 in a 1-5 scale).

With the second use case it was found with Data Owners that, at national level, sometimes similar functionality exists for notifications but the piloted S&N pattern as a collaboration between DOs and DEs was also found to be more advanced and a good basis to make progress over existing solutions. Furthermore, Data Owners in that context were able to use APIs from the first use case to verify existence of companies when subscription to notifications about them were made.

DBA pilot emphasizes that **online validation of electronic mandates (powers) is an important pre-requisite for EU-wide implementation of the SDG Annex II procedures for businesses** and this functionality was also found to be fast and reliable by pilot participating authorities; Fine Grained Powers Validation piloted in the second iteration was also seen to enable better access to company representatives even when lacking full powers of representation. Data Evaluators also realised how this will lead to re-design and improvement of certain process steps in current eProcedures. **Member States should more widely notify company representation and legal person attributes in the context of eIDAS and in their production systems.** It is also considered that **extended approaches could be required** for cases (that were out of the scope of the pilot) **when multiple representatives/board members have to confirm cross-border eProcedures.**

The pilot continued to wisely apply pragmatic approaches to piloting in the second iteration such as leveraging of certain DE4A Connector features to ensure backwards compatibility without changes to DE/DO integration with respect to the first iteration or the piloting of the “Doing business in another MS” (second use case) using simulated eProcedures in a light-weight fashion with simulated notifications (for each MS combination, at least 1 successful subscription and notification were executed). **Positive experience with automated company updates with this use case resulted in some Data Evaluators confirming intention to use piloting results for future developments to improve data quality.**

4.3.3 Follow-up of Mid-term Evaluation Recommendations

When considering the Mid-term evaluation recommendations and in addition to the recommendation mentioned above about assessing and disseminating administrative simplification achieved with the piloted patterns and use cases, the **recommendation to leverage even more the use of Slack, Connectathons and Wiki pages to boost information exchanges and consolidate technical learning**

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between pilot partners and for other external stakeholders has been well followed as can be seen for example with the **extended online documentation from DBA pilot in DE4A Wiki (https://wiki.de4a.eu/index.php/Doing_Business_Aboard_Pilot) and information in the pilot-specific micro-site (<https://www.de4a.eu/studyingabroadpilot>)**. One recommendation for which details couldn't be found in the final running phase report was to discuss with DE partners how many procedures in participating MS could potentially be required to be offered across borders following SDGR obligations in order to confirm that it will be multiple procedures that will contribute to increase benefits of DE4A-related solutions, but it can be safely understood that it will not be very few. In this regard, the pilot found that DC MS authorities (e.g. in The Netherlands) start with initial assessments now and part of that is the **assessment of procedures that fall under the SDG. For piloting, such an assessment was not done as DEs only focused on the one procedure that was planned for piloting. Now that the full SDG implementation has started, broader assessments take place.**

At the end of the second iteration the pilot can also be considered to have followed the recommendation to explain through its detailed reporting and success stories how it is contributing to the benefits DE4A generates for different communities such as the Once-Only and SDG community and to the domain specific stakeholders that will offer to business procedures and data services similar to those piloted in real-life conditions by DBA (involved MS have also continued to provide feedback to SDG OOTS sub-groups and to DG DIGIT on topics like electronic mandates and record matching).

4.4 Results and findings – Learning for Adoption

Regarding the lessons learnt for future uptake of the piloted solutions and knowledge gained with them, these were assembled, consolidated and documented using different channels including offline (emails and questionnaires), online meetings notes and, more importantly and in a joint effort with other DE4A work packages, in the public DE4A Wiki, also sharing it externally in dissemination events (EEMA Annual Conference, DE4A Final Event) and through a joint pilot between NL and Germany.

The pilot actually learned between iterations that that **quantitative evaluation is less useful when limited number of DEs, DOs and companies participate as the results may be less meaningful, recommending instead to focus more on qualitative feedback through interviews and observations to maximize learning benefits** as they did for the final round of piloting and results gathering / analyses.

Lessons learnt in this pilot with regards to technical (analysis, design) and organizational (planning and management) activities executed prior and during the pilot are highly interesting but were covered in Section 4.2.4 of D4.13 [24] and are thus not repeated here as **focus in this final evaluation is more on lessons learnt in the actual implementation and running phases of the pilot and the recommendations for sustainability.**

4.4.1 Member States results and findings (efforts)

For metrics C3.1 and C4.1 which were answered by MS teams responsible to set up the OOTS and eIDAS specific infrastructure for the pilot, 66% confirms that benefits if online powers validation exceed costs (metric C3.1 is fulfilled) whereas all 4 MS found that the **effort, cost and time of setting up the pilot specific eIDAS node and Connector was on par (doable) with expectations** (that were never explicitly stated) **which is positive (even if the target was to have more than half of the MS find the cost to be less than expected so metric C4.1 is nominally not fulfilled)**. This is **not necessarily a bad result as it was not known before the pilot was implemented how much effort deploying such core common components would take and also many 'first-time' problems needed to be tackled (Germany for example benefitted from this learning curve)**. It was also seen by MS that available piloting environments could be well used to deploy the Connector and **all DEs confirmed for similar metric C2.1 that benefits exceed cost**. It can also be seen in valuation of common components (table

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8 of D4.8 [27]) the **Connector has been assessed by DEs and DOs with High values for ease of integration and potential to include in sustainability plans, with a close overall assessment close to High.**

The **cost to integrate the Connector** actually varied between 100 and 450 manhours (depending on the infrastructure at each MS) with an **average of 250 manhours (31 person-days) which is comparatively less than DE/DO adaptations or effort to integrate eIDAS/Powers Validation solutions.** In this regard, **costs in manhours to customize and integrate DE portals average to around 700h or 88 person-days (with important variations depending on the type of portal) while average effort to customize and integrate DO data services is 500h (63 person-days).** Effort to integrate Mandate Management Systems with eIDAS nodes was on average 350 hours (44 person-days) while the combined cost to set up the specific eIDAS piloting node was at most 1250 manhours (156 person-days).

Table 3: Average Costs Reported by MS Public Authorities in DBA Pilot

DE4A component / MS Endpoint	Average Cost (Effort in Person-Days) to integrate (deploy/customize/configure)
DE4A Connector	31
Data Evaluator	88
Data Owner	63
Mandate Management System	44
eIDAS Piloting Node	156

The overall learning has been that **while preparing the infrastructure has shown a significant amount of challenges, the OOTS “can be considered fully implementable without any major or unexpected technical difficulties with several tests and the real-life pilot confirming that the solution works and does what it is supposed to do:** facilitate the cross-border request and exchange of evidence for business procedures mentioned in the SDGR (Annex II) [22] and supporting subscription to business events and sending notifications is proven possible and valuable (especially for Data Evaluators and public authorities not having access to BRIS)”. A significant example is **that core SDG functionalities such as Explicit Request and Preview based on a generic design were integrated with no problems and found to be simple and low-cost to implement. Attention to legal texts from end-users could be improved** with provided recommendation by DE4A legal work package on making screens even more lightweight (following a layered approach), as well as by raising awareness on the privacy protection these mechanisms offer as foreseen in the Regulation.

4.4.2 Lessons learnt from DBA Pilot

Lessons learnt from challenges encountered and pragmatic approaches applied for implementing and testing DE4A OOTS (also including recruitment and interaction with users and authorities)

The pilot found how **integrating production systems (especially when using same local common components) was more challenging** (obviously) than working with simulated environments: occasionally this led to decision to work in isolated environments, in order to reduce/prevent interaction with (and dependency of) other systems and projects.

The **pilot recommends that a coordination team is established in each MS, and it should be tasked with keeping activities prioritized and making sure heterogeneous issues (legal, technical, organisational) are resolved in a timely manner.** A multi-month phase for establishing alignment, responsibilities, financial means, etc. among organizations involved seems necessary as well.

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Pilot **implementation was delayed by numerous discussions (within Member States and between Member States) on alignment with the SDG OOTS** that was being addressed in parallel by the SDG Coordination Group. Although this approach (to minimize dependency on ongoing lengthy discussions at SDG level) had been deliberately chosen and agreed upon at the start of the DE4A project to enable real piloting and provide input to SDG, in practice discussions were raised over and over again and caused **prioritization challenges for the pilot activities of partners**.

The **speed of development was found to be different between pilot participants and this had impact on the readiness for cross-border testing**: the lesson learned here was to **allow for flexible planning and phased rollouts, also with clear readiness for parties to participate in interoperability testing sessions** (e.g. setup and test national eIDAS infrastructure thoroughly prior to OOTS testing).

Successful interoperability testing required tests credentials shared between participants and critical settings configured correctly in the systems: use of DE4A **wiki to exchange configuration details revealed as highly useful for Connectathons and piloting**. The **EC should coordinate the exchange of test credentials to enable proper interoperability, avoiding complex bilateral exchanges**. Furthermore, processes that may depend on external parties like the obtention process of certificates for eDelivery, should be considered in the planning as it was a time-consuming procedure. As already seen in eIDAS, the **management of certificates is a very complex and critical aspect to ensure the availability of services and interoperability between the systems involved: the EC and MS should consider how this process could be simplified and kept running smoothly to guarantee OOTS connectivity** e.g. in case of updates of certificates or even changes of root CAs/sub-CAs.

The pilot also recommends **that efforts to explain the working of OOTS components (as well as designs and specifications) to all authorities involved** are undertaken to ensure a common comprehensive understanding of such design details prior to testing phases.

Similarly, **investment in proper and clear documentation or a team of technical experts providing support to MS (similar to what has been done on small scale in DE4A) is also advised** to solve doubts on ways to deploy and configure common components, for example. In this regard, and within the DE4A project, knowledge was effectively transferred from Solution Architecture to Pilots Work Package and Common Components Work Package in order to have a comprehensive common documentation and understanding of all the design details prior to the implementation phase.

Starting recruitment of participants for piloting with a long anticipation and with effort to keep them involved is an important finding as getting actual commitment from users takes a long time.

Open channels of direct messages (i.e. Slack) have found to be a good means to have developers of different MS / WPs collaborate. This is a valuable lesson learned towards the future integration of the OOTS as many different technical teams will also be involved (even within each Member State).

Lessons learnt regarding pilot learning for sustainable impact and new governance models

A major recommendation is to **set up “a proper and clear structure for maintenance and support for the infrastructure” in order to ensure sustainability of the SDG OOTS**: this includes **operating an adequate organisation to prevent errors, maintain components and certificates and provide support to issues that arise**. Perceived lack of awareness of cross-border authentication concepts among different stakeholders such as levels of assurance and about representation with electronic mandates can represent a possible bigger problem for wide adoption: **eProcedure portals in the business domain need to be equipped to support with simplicity the necessary mechanisms (i.e. eIDAS extensions for mandates or powers of representation** or approaches for this in upcoming EUDI wallets), allowing company representatives authentication and associated checks. Furthermore, there is **need for harmonizing mandates** which is challenging considering heterogeneous legal landscapes between MS and diversity of approaches for electronic Mandate Management Systems (when available).

Regarding fine-grained powers validation, the pilot recommends MS to agree on a harmonised set of services starting from Annex II of the SDGR [22] (this could be addressed in a first instance from eIDAS side). Related to this, a need of harmonization of mandate models in the Member States is

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noticed: there is still a long way to achieve it given the **substantial differences in powers and mandates definition and use across Europe and differences in national legislation**. This belongs to a long-standing process of discussion with implications beyond the SDGR and more in the domain of eIDAS revision of the European Digital Identity Framework.

In line with general findings of DE4A Semantic Solutions work package, the pilot advises to work with canonical evidence types for exchange of information, allowing for some information to be exchanged that a DE might not need. As well, there is **need for specifying a set of harmonised company event types for subscribing and notifying on company events / changes**, where DBA pilot Solution Architecture is a first example (https://wiki.de4a.eu/index.php/DBA_2nd_iteration_Solution_Architecture).

In order to maximize impact when **communicating OOP implementation benefits** to different stakeholders, which might be interpreted as abstract by users / companies that might benefit from it and where large parts of the solution are "complexity under the hood" **visual tools like animations and videos should be used, creating a good storyline and wireframes that illustrate the flows**.

4.4.3 Follow-up of Mid-term Evaluation Recommendations

Finally, regarding lessons learning recommendations from the Mid-term Evaluation, the **pilot has followed the recommendation to focus (as explained above) on the learning aspects relevant for sustainability of the pilot** (including new aspects covered in the second iteration) and has collaborated with the "Sustainable impact and new governance models" work package. **Learning has also covered recommendations related to important aspects in the domain of the pilot related to harmonization of powers information and the challenges involved for a wider adoption of representation mechanisms**, based on the pilot experience. The pilot has extensively documented findings in the pilot's Wiki pages as described before, including its conclusions (https://wiki.de4a.eu/index.php/DBA_main_conclusions) and pilot between the Netherlands and Germany (https://wiki.de4a.eu/index.php/Germany_and_The_Netherlands). In this regard, this evaluation finds that **the pilot also structured its knowledge to make it easy to manage and be studied by all interested stakeholders**.

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5 Assessment of Moving Abroad Pilot Progress and Fulfilment of Pilot Goals and Mid-term Evaluation Recommendations

5.1 General considerations on pilot progress and results

The Moving Abroad (MA) pilot of the DE4A project, implements **fully online electronic procedures for moving and living abroad realizing across borders the principles of “Once Only” and “Digital-by-default” between Luxembourg, Portugal, Slovenia and Spain**, aiming to demonstrate tangible benefits for citizens and administrative users. It has defined and implemented **two use cases related to the SDG Annex II Life Events of “Registering a change of address” (UC#1, that also addressed deregistration of old domicile for one combination) and “Requesting civil status certificates” (UC#2 with focus on birth and marriage certificates)**. The pilot has been integrating, configuring and testing updated common building blocks and components before the launch of the procedures in the pilot’s final phase, where they have been validated gathering experience and lessons learnt from running the pilot in realistic environments. For a more detailed overview of the MA pilot definition, assessment of its setup with respect to the pre-defined targets, adherence to pilot principles and consistency of pilot goals with pilot definition and over-arching piloting objectives of DE4A and consistent implementation of bidirectional trail relating goals to success criteria and metrics, please see Section 3.3 of D4.13 Methodology and Mid-term Evaluation Report [24]. **Together with SA Pilot, MA Pilot has piloted extensively the User Supported Intermediation (USI) pattern (https://wiki.de4a.eu/index.php/User-supported_Intermediation_Pattern)³⁸**, highly relevant for EU MS as **it matches the evidence exchange pattern that has also been chosen to implement the SDG OOTS** in the corresponding Implementing Regulation[31], while demonstrating **advanced features like dynamic location of DPs** (through SMP and IAL) that could be relevant for future evolution of that system.

The final **outcomes in MA Pilot have been impacted by long-lasting issues** that already became apparent in the first part of the planned piloting phases with **changes in pilot partners’ composition** (see section 2.3) and with **dependence of cross-border combinations** on only one MS with DC role at that stage (Luxembourg) where delays in integrating the DE portal in that MS with common components resulted in only testing in Connectathons and in that no combinations could be launched for real users piloting at that stage; thus no citizen end-user feedback could be gathered and analysed initially (as explained in D4.11 Initial Running Phase report [6]) and Mid-term Evaluation could only be performed only in a limited manner over partial results provided from internal stakeholders feedback (3 MS). Fortunately, this changed in the final phase of piloting (see below) but still the pilot had to cope with a critically required Portuguese partner leaving the project in M30, which determined that **Use Case on Pensions and labour status could not finally be implemented³⁹** (only Spain remained available), and **Romania finally confirmed that their DE portal would not be integrated with DE4A OOTS on time for piloting due to lack of internal resources and prioritisation issues**, which also had a significant impact in **reduction of number of possible combinations with other MS**.

The pilot adopted **different strategies to mitigate and minimize to the extent possible both scope reconfigurations and experienced delays** (see Section 2.2 of D4.11 [6]), which exemplify pragmatic approaches, which in some cases may be of interest for the MS teams that will be involved in the

³⁸ Except in the sub-scenario of Domicile deregistration where an automatic ‘push’ mechanism internally supported on modified Lookup pattern was implemented.

³⁹ The initially involved partners in the use case, including Sweden that also left the use case, modelled with support from Semantic Interoperability Solutions work package and after exchanges with EESSI canonical evidence types that could be useful in the future.

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testing phase of SDG OOTS, when facing in some cases comparable challenges: relevant examples include **maximizing re-use of existing national components, mocking of steps to cope with different paces and availability of integrations using as well Playground components to also ensure step-by-step validation of integrations, incremental addition of functionality starting from an MVP concept**, etc. These strategies have continued to be applied in the final piloting phase where for example **Spain has made available a DE portal** to address the risk of on-going delays with Luxembourg's integration of MyGuichet pre-production portal, **making combinations possible first with Slovenia for multi-evidence exchange in the second use case (piloted with 20 testers from Slovenia) and then adding capacity to make cross-border requests of domicile evidence for the Change of Address (first use case, single evidence) piloted with 8 testers from Portugal**.

Progress in MA pilot can be seen both in the launching of these piloted combinations and additional cross-border combinations achieved and verified at testing (Playground) environment level⁴⁰ involving 4 MS (all those active in the final phase of piloting except Romania as explained above). The Playground combinations that were fully functioning for cross-border evidence exchange at the time of writing this report include one with Luxembourg as DE and Spain as DO, another with Spain as DE and Slovenia as DO both for domicile registration in UC#1⁴¹ and deregistration sub-scenario between Luxembourg and Portugal. This has allowed to generate **results reported in D4.12 [28] that now cover pilot running phase perspectives from both end-users (citizen) and administrative users from 4 MS across Use, Value and Learning for Adoption dimensions**, with assessment of metrics and success criteria fulfilment.

A more complete functional scope was achieved with multi-evidence exchange (supported as well from Explicit Request and Preview steps at DE and DO respectively) **and deregistration advanced scenarios, as well as MOR integration for Preview functionality in Spain**. Significant efforts were devoted between Luxembourg and Portugal for defining, integrating and implementing **deregistration** given the intrinsic interest of this sub-scenario **as an original instance of informed proactive citizen service** and the intention confirmed by both MS to offer this in production level in a near-term horizon after the end of the project. Spain and Romania also worked intensely together and with the Semantic Interoperability Solutions in order to pilot MOR component in the Change of Address Use Case, integrated for Preview with Spanish DO and with Romanian DE for Explicit Request, but the final unavailability of the latter due to lack of internal resources prevented to assess this feature as originally planned in the pilot.

5.2 Results and findings – Citizens' Perspective (Use and Value)

5.2.1 Pilot achieved interoperability and cross-border combinations for defined Use Cases

During the last phase of DE4A piloting (October 2022-April 2023) MA Pilot achieved the launch of two combinations involving Spain as DE and Portugal and Slovenia as DOs for both UC#1 (Change of Address) and UC#2 (Request for Civil Status Certificates) supporting in the latter case exchange of multi-evidence of different types (Birth and Marriage certificates). Regarding Use dimension, these **combinations were piloted with some 28 real users recruited by Slovenian and Portuguese pilot partners (MPA and AMA) in a proportion of approximately 70% of Slovenian testers and 30% of Portuguese testers**. Given it was ensured that these users were not involved in DE4A activities, it is fair to rely on the judgement that they were not biased with pre-existing knowledge about the pilot and its context (Once-Only and SDG). **This corresponds to a best effort approach, as other citizens'**

⁴⁰ For the latter cross-border combinations that were proved to function in Playground environment, the time spent for complex trouble shooting of errors determined there was no time left to organize piloting with external real users but their technical value to proof cross-border evidence exchange in different use cases remains high.

⁴¹ 3 more combinations with LU as DE with the other 3 MS were nearly functioning and one more with LU as DO with ES as DE for domicile registration.

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recruitment channels did not yield positive results (e.g. through LinkedIn, MS embassies or Active and Healthy Aging community which had ceased to exist) and other relevant limitations existed such as no external access for foreign MS testers to pre-production MyGuichet portal in Luxembourg.

Users could only be secured for piloting respectively in Slovenia in February 2023 and April 2023 in Portugal, so this can also be seen as a factor explaining the relatively low figures for cross-border users in this pilot as effective recruitment has been confirmed to be a time-consuming process, added to the intrinsic factors traditionally challenging high numbers of users in cross-border pilots. The **potential lack of statistical relevance can be seen to be compensated to some extent by the freshness of responses of users** (even if forming a limited universe) **exposed for the first time to pioneering solutions in the context of cross-border Once-Only implementations⁴², and can hold relevance to gain through their perceptions valuable understandings on their appreciation of multiple aspects** captured through online questionnaires, further complemented with additional feedback obtained through interviews in a few cases (5 with Slovenian users).

Test evidence (comprising the mandatory XML canonical evidence and where available multilingual forms in PDF) was used for the three evidence types (Domicile for registration and deregistration including in the latter case optional email attribute used by Portugal, Birth and Marriage) but which was **equivalent to real evidence and was thus fully acceptable to assess user experience**.

In general, partners/MS were not ready to pilot using real procedures prior to the SDG OOTS provisions coming into effect (this will happen at the end of 2023). In this regard, **Spain set up a simulated but otherwise realistic portal based on the “Citizen Folder” concept available for Spanish citizens** where they can Preview relevant information (in this case the evidence received from the DO country) and **Luxembourg integrated with DE4A OOTS a pre-production instance of their MyGuichet portal, technically equivalent to the production portal for all its features** such as eID-based authentication (integrated with eIDAS pre-production network), Explicit Request, interrupted procedure functionality, etc.

A very positive fact is that **Slovenian users used real eIDs to authenticate to DE portal in Spain and then to DO service in their own country⁴³**, something that DE4A made possible (as in SA pilot) by using eIDAS pre-production network (Slovenian eID is only in pre-notified status and thus not accepted in eIDAS production network).

5.2.2 End-users’ Feedback and Use-related Metrics and Success Criteria Results

Regarding Value dimension for citizens, the pilot has analysed obtained feedback in section 3.2.1.2 of D4.12 [28], resulting in multiple findings on appreciation by real end-users about 10 aspects about the piloted procedures using USI pattern.

- ▶ **The most appreciated aspects (users very satisfied and satisfied) are**
 - Overall User Experience, Language (75%)
 - Clarity of the procedure and Communication (74%)
 - Simplicity of the procedure (71%)
 - Effort to effectively complete all elements of the procedure (70% appreciated)
 - Overall duration of the procedure (67%)
 - Perceived security and protection of privacy, control when moving data (60%)
- ▶ **Less appreciated was number of errors and interruptions (15% dissatisfied and 30% neutral) but still positive** as 55% were still satisfied or very satisfied. Some bugs and errors were generally quickly fixed and only on some occasions users had to retry to complete procedures.

⁴² Which are actually in MA pilot close to the proposed evidence exchange approaches in the Implementing Regulation setting out technical and operational specification for SDG OOTS [31].

⁴³ Portuguese end-users used both their real eIDs and test eIDs.

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Regarding **procedure duration**, this was measured based on logs from ES DE in both use cases as can be seen in table below from Section 3.2.1 of D4.12 [28]:

Table 4: Duration of services in MA Pilot

Use case	Service	DO	Average (sec)	Median (sec)
UC#1	ES DE - PT DO (Domicile Registration) (n=8)	PT	121	101
UC#2	ES DE - SI DO (Multi-evidence) (n=20)	SI	116	136

Times average to around 2 minutes and are including eIDAS authentication (this could account for higher values compared to SA pilot for the same evidence exchange pattern) and are excluding an outlier user which took 13 minutes probably due to some distraction.

For 7 of the Slovenian users, average duration was around 5 minutes (287 seconds of average and a median of 222 seconds). It is deduced that Slovenian users comparably took longer for UC#2 than PT users for UC#1 due to national differences e.g. when authenticating to different DOs and also because multi-evidence exchange is more complex.

The citizens' perspective covered in this subsection corresponds to pilot Goal B ("Simplified procedures and reduced manual work, lower transaction costs and improving enrolment speed for the moving Citizens" and Success Criteria B1 ("The user acknowledges the procedure for applying for a service to be effective and efficient") and B2 ("The user acknowledges the duration of completing the online eProcedure activities to apply for a service as acceptable"), with one corresponding quantitative metric for each (B1.1 and B1.2):

- ▶ **Metric B1.1 focuses on the effort to effectively complete all elements of the procedure and also to the overall user experience and it is fulfilled with the 70% of satisfied and very satisfied users** (as the target was to have 50% of respondents indicate satisfaction or high satisfaction with effort devoted to complete the procedure). The metric can also relate well with overall user satisfaction which is also above target with 75% being satisfied or very satisfied.
- ▶ **Metric B1.2 measures satisfaction the user expresses on several aspects of the duration of the process to apply for a service or registration with target above 50% and is also fulfilled as 74% of the respondents were satisfied or very satisfied with the duration of the procedures.**

Feedback obtained from users through free text boxes in the online questionnaire and complementary interviews provides additional valuable insights such as:

- ▶ Users are not always clear regarding which parts of the process are executed in which MS: this is an already known issue in cross-border settings with eIDAS authentication involving redirections between service provider and identity provider countries and is further made more complex within USI pattern as citizens first interact with DE portal for a given electronic procedure explicitly requesting to retrieve evidence using OOTS, they are subsequently redirected to a DO service where they need to provide again their eID credentials and optionally other data for record matching and then after previewing evidence and consenting its transfer are redirected back to the DE portal. **Some users expressed wish for clearer information about redirections as there are many steps and points/portals involved across the whole procedure.**
 - **In some cases, this complexity can affect perception of transparency** and some users seemed to get also confused about where data is located and who (which civil servants) can see it or if there is chance for evidence to be leaked (features like data encryption and integrity ensured by eDelivery building block are not obvious and would require explicit explanation at least in the Explicit Request step). Nonetheless, there is in any case a partial

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understanding of the conditions of the cross-border service and from where evidence is to be retrieved.

- ▶ **Language appreciation in terms of language selection flexibility was very high but users experienced some issues e.g. depending on locale language selection settings** in their browsers and chances exist of having more than one language involved in different parts of the process given the number of systems involved from different MS. **MOR component can further facilitate interpretation of evidences with translation of attribute labels and also enhance UX experience for selection of DOs according to administrative and territorial organisation of such services in each MS.**
- ▶ **Users appreciated positively the clarity of Preview functionality at the source** (with room in some cases to improve presentation of the data) as it enables them to confirm their desire to have evidence transferred to the requesting procedure service in another MS **also finding the Explicit Request clearly understandable and straightforward.**
- ▶ Last, but not least, **a number of users' comments confirmed their feeling of being in control of the evidence transfer and satisfied with perceived security and data protection.**

While not piloted with actual real users as LU portal was not enabled for it, D4.12 explains well the detailed design and in particular the **benefits for citizens of the deregistration sub-scenario, which, in the absence of a solution such as the one devised for DE4A implies very high burdens in terms of effort and time spent with significant paperwork and manual overhead to manage required evidence:** citizens have to perform successive steps with public administration in the country of destination (often through embassies / consulates) to register a new address, wait for this to be confirmed and then inform public administration of the country of origin of the new address to proceed to deregistration of the old one. **DE4A's approach enables citizens to interact fully online for registering the new address and allows to automatically trigger the deregistration of the old domicile with the destination country proactively pushing the new address evidence to the country of origin of the citizen** (after confirmation of the address change by the citizen who receives a code in their email address), all of which has clear advantages in terms of simpler, more secure and highly convenient integrated public service delivery to citizens across borders.

5.2.3 Follow-up of Mid-term Evaluation Recommendations

Regarding pilot follow-up of recommendations related to Use, **achieved user engagement shows a partial consideration of suggestion to reinforce end-user engagement strategy leveraging experience from other pilots** for reasons explained above (especially the late availability of combinations). The pilot has only **had limited possibilities to assess extended scope functionalities with the end-users (e.g. deregistration could not be tested with real end-users from PT due to portal access limitations in LU, integration of MOR component being only achieved finally in Spain).** MA Pilot has followed the recommendation to assess the satisfaction levels of the end-users with different aspects of the cross-border flows like duration or issues with different parts of such flows as explained above. Duration (average and median values) of procedures shows at least limited follow-up of recommendation to use log information although there is no evidence of other kinds of detailed log analysis (same as for the other two pilots).

5.3 Results and findings – Public Administrations Perspective (Use and Value)

Regarding perspective from involved public administrations, **the pilot has gathered feedback from the 2 Data Evaluators (in ES, LU), 4 Data Owners (in ES, LU, PT, SI) and other MS teams involved responsible for common components deployment and configuration,** covering several quantitative and qualitative metrics and research questions. These are related to pilot goals A, C and D and their corresponding success criteria (some of which like C.x.2 related to costs and efforts are analysed in next subsection on Learning for Adoption).

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5.3.1 Data Evaluators results and findings

Specifically considering **Data Evaluators feedback** on their Use of DE4A OOTS and the Value generated for them, confirm appreciation of benefits such as:

- ▶ Having access to **validated data available from authoritative and trustworthy data sources in electronic and harmonized / structured and easy to process format** as this **saves them time while minimizing evidence processing errors**. As in the case of DBA pilot this could save thousands of hours per year and DE depending on the number of procedures being integrated with the SDG OOTS, which is a relevant factor to maximize cost-effectiveness of the adoption of the proposed building blocks.
- ▶ **Reliable and fast authentication using eIDAS and evidence exchange using OOTS**. Use of **multi-evidence** in a single request can add some time to overall duration but still **saves much time when compared to having to request evidences one by one running separate requests**.
- ▶ **Canonical evidence models were found to fit direct evidence requirements** from Data Evaluators although it was also found a **complex exercise to find the balance between mandatory and optional attributes** in such complex certificates like birth and marriage (similarly for pensions, labour and unemployment information) and this will be a much larger challenge when addressed across all EU MS considering many different electronic procedures and data services. However, the pilot benefited from work done for defining **Multilingual Forms in the context of the Public Documents Regulation EC 2016/1191**, considering changes when adapting models from such PDF evidence when moving to fully electronic format (XML).
- ▶ Some aspects like **delegation scenarios between natural persons for procedures involving evidence of multiple family members or legal custodians** of minors, elderly or people with disabilities **are inherently complex and could not be addressed by MA pilot** but deserve further research given the relevance in the context of procedures for citizens moving abroad.

Data Evaluators assessed multiple aspects related to their appreciation of the quality of Moving Abroad data received from DOs using the defined canonical models and USI evidence exchange implemented solution (availability of data in electronic and structured format, completeness, correctness, reliability and meaningfulness of available data). Given that ratings from both DEs are between High and Very High averaging on 4.7 in 1-5 scale, **metric A1.1 that focuses on data reliability as average of all mentioned perspectives is fulfilled** (target was that 50% of respondents found data more reliable using DE4A).

Metric A1.2 relates to cost-benefit assessment with target of 50% of respondents appreciating effort of processing Moving Abroad data as (considerably) less effort than without DE4A and **is fulfilled as an average of 4.5 in 1-5 scale (benefits considerable exceed cost and effort) was confirmed by both DE** for aspects like: lower manual effort of processing (5), lower risk or errors (5), lower communication costs (4), shorter duration of application (to a service) processing (4), more complete, valuable consistent and correct data (4) and trustworthiness of the data (5).

Metric A1.3 measures estimated benefit for DEs of Moving Abroad data that is always up to date with (considerably) less effort to resolve exceptions, interpret data, manually change data, etc. and **is fulfilled** as target was for 50% of respondents confirming medium or considerably high benefit: both DEs confirmed with maximum value (5) considerably less effort and benefit regarding amount of work, interpretation of data and solving errors for the processing of citizen data.

Metric C2.1 is related to success criterion C2 (“DE believes the **cost and effort for integrating to the DE4A Connector will eventually be outweighed by the benefits**”) and **is fulfilled** as target was for 50% of respondents to confirm benefits to (vastly) exceed the cost and effort to integrate with the OOP TS (more details on actual costs in next subsection) and values converge to 4.5 (common answers with metric A1.2 above).

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The assessed metrics and overall successful satisfaction of A1 success criterion (“DE recognizes the moving data is of higher quality, more reliable and easier to process when using the OOP TS to retrieve Moving Abroad data from the DO”), show that **the pilot has done a significant effort to achieve Pilot Goal A (“Improve the quality of personal/Moving evidence data within the service fulfilments process by re-using data from authentic sources, thereby reducing manual work and lowering processing costs”)**. Contribution in terms of benefits perceived from DE4A OOTS exceeding the costs involved, is also confirmed towards achieving **Pilot Goal C (“Evaluation of OOP-components supporting the cross-border information flow”)**.

In addition, 2 research questions (with no associated targets) were also addressed, regarding whether the **Explicit Request and Preview requirements as specified in the SDGR proved suitable for the Moving Abroad electronic procedures (D2)** and whether **mechanisms for record matching were proven adequate and effective for the procedures (D3)**. DEs confirmed that **integrating the Explicit Request based on a generic design caused no problems** and the functionality is very focused, simple and low-cost to implement. Regarding **record matching**, specific requirements for registration of users and authentication of recurrent users apply for each DE, and **reliance on eIDAS personal identity attributes formally attested by EU MS authorities in (notified) eIDs is definitely helpful for DEs**.

5.3.2 Data Owners results and findings

Four DOs contributed assessment of benefits based on their participation in combinations piloted with real users (Slovenia and Portugal) and in Playground combinations (Spain and Luxembourg).

With respect to cost-benefit assessment, with values provided for 4 aspects (lower manual effort of processing, lower communication costs, lower risk of errors, and shorter duration of request processing), **DOs provided an average of 4.75 in a 1-5 scale, meaning benefits considerable exceed cost and effort. This satisfies metric C1.1** that has a target of more than 50% of respondents estimating mentioned benefits (considerably) exceed the invested cost and effort and **is fulfilled**.

DOs also answered **two research questions** corresponding to two metrics:

- ▶ **Metric D2.1 on appreciation of implementing Preview** in various procedures and where it was found that implementing the Preview (following generic wireframes that were provided in collaboration with “Common Component Design & Development” WP) was achieved without problems (however effort for this in Slovenia was reported as costing significantly more than by other MS).
- ▶ **Metric D3.1 refers to appreciation by DOs on mechanisms for record matching and DOs appreciate positively record matching at Evidence Provider side** enabled by USI pattern and **no specific issues were highlighted** for this aspect (also less than 20% of users reported errors in general when piloting).

This contributes positively to **Pilot Goal D “Evaluate whether the solutions designed to the MA specific challenges have proven adequate in piloting the MA eProcedures”**.

To end this subsection it is important to mention that pilot Value is further underscored with **two success stories coming from MS representatives**:

- ▶ Success story from **Spain** highlighting the **benefits of Multilingual Ontology Repository** developed to simplify and accelerate the Explicit Request functionality (including its dialogues with users and with the central components of the system) and enabling language selection for the Preview functionality supporting multilingual labels for evidence attributes.
- ▶ Success story from **Luxembourg** of how **DE4A is a success for MS as essential preparation** (pilot implementation) **of many core elements and solutions needed for SDG OOTS** that launches in December 2023, allowing MS to gain hugely in maturity for this milestone and in understanding of the many issues involved. Being an MS-driven project it is of key importance how an **MS in MA Pilot highlights the way in which the pilot and the project allowed MS to provide essential and**

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valuable input in context of dozens of discussions in SDG Coordination Group, SDG Committee and numerous Working Groups, in particular highlighting the fact that **SDG OOTS essentially uses USI pattern piloted in MA pilot (and SA pilot)**, deemed as “the most appropriate pattern in our opinion to fit the requirements and needs defined in Article 14 of the SDGR” as “it allows, to the highest extent, for the reuse as is of the national solutions used for authentication (e.g. eIDAS nodes) and the other national solutions (e.g. preview space), achieves hence the highest level of interoperability and efficiency and makes identity matching as easy as possible”.

5.3.3 Follow-up of Mid-term Evaluation Recommendations

Mid-term evaluation recommendations were followed at least in part in the sense that **preliminary findings of usefulness of DE4A components and solutions have received further validation in the running phase of the pilot also collecting feedback from more MS (4) and where all competent authorities (DEs, DOs, MS authorities in charge of common components), have provided feedback to assess on a quantitative and qualitative manner respectively the efforts and the pain points (different types of challenges and barriers) for customizing existing systems and for deploying and integrating components from the project.** The feedback has covered as well and as recommended new versions of the Connector, national SMPs and further adaptations in DEs, DOs required for new USI implementation, multievidence management, updated evidence types, etc.

5.4 Results and findings – Learning for Adoption

MA Pilot documents several lessons learnt (including suggestions relevant for adoption for each of them) both for activities during the analysis and design phase, those related to the customization, integration and testing phase and those learnt from semantic, technical and organizational/legal activities: they are documented in table format in Section 3.2.3 of D4.12 [28]). Covering different types of challenges, the pilot has concentrated more in the **aspects with highest relevance for facilitating adoption by similar stakeholders in SDG OOTS context, beyond the project** (e.g. competent authorities integrating eProcedures in Moving Abroad domain or data services like civil and population registers). While a major part of body of lessons learnt comes from the first phase of DE4A piloting where several issues and delays had to be addressed in terms of solving complex technical, semantic and organisational challenges, **the pilot has further revised, extended and consolidated the lessons based on additional experience gained in the running phase of the pilot.** It is noteworthy that, while some lessons are specific to MA pilot, others match those in other pilots which is not surprising considering commonly faced challenges and approaches to overcome them in many cases.

5.4.1 Member States results and findings (efforts)

Regarding cost-benefit assessment, **the 4 MS assessed benefits in a 1-5 scale in terms of: effort and cost of implementation (4), effort and cost of implementation (4), effort and cost of training (4) and shorter duration of application processing (5), averaging on a value of 4.25 which satisfies metric C3.1** that had as target that over 50% of respondents estimated the benefits to exceed or vastly exceed the cost and effort.

On the **estimation of efforts for the various tasks involved to customize endpoints and to integrate with common components** (see comparative table in section 3.2.3 of D4.12 [28]) **the 4 MS provided estimates** of such efforts to implement USI pattern which included deploying, configuring and integrating DE4A common components (Connector, SMP), integrating endpoints with eIDAS preproduction node and with DE4A Connector, implementing Explicit Request at DEs and Preview at DOs, transforming to canonical evidence at DOs and from canonical evidence at DEs and doing UI internationalisation. The adding up of individual efforts allows the 4 participating MS to indicate **overall effort to have ready DEs and DOs respectively using DE4A common technical and semantic building blocks for cross-border exchange.** The overall effort for DE and DO also include the

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configuration once real testing was performed and final adjustments needed to be implemented and non-technical activities (management overhead) are also included.

In several cases actual efforts measured exceed those originally planned as those were based on rough estimations made at an earlier stage of the project without knowing the **impact that organisational issues (e.g. availability of experts and complexity of issues to be addressed by multiple different teams)** at that time and **the extent of actual technical changes really needed over existing systems**. In the case of Spain, several planned efforts do match actual efforts, considering its expertise in its role as leader of “Common component design & development” work package and taking advantage of similar work done for SA Pilot. **Generally for MS, Connector integration took more effort than planned due to configuration issues**. Spain implemented Preview splitting implementation due information being slightly different for canonical and PDF evidence.

Table 5: Average Costs Reported by MS Public Authorities in MA Pilot

DE4A component / MS Endpoint	Average Cost (Effort in Person-Days) to integrate (deploy / customize / configure)
DE4A Connector	16 (5.5 to 25)
SMP	8 (2 to 15)
Data Evaluator	36 (31.5 to 40)
Data Owner	54 (34.5 to 93)

Comparison of the obtained effort values in person-days shows differences between MS for each of the mentioned effort items: for example **widest variation is seen in implementation of Preview functionality** ranging from 3 person days to 30 which may be caused by the re-use of pre-existing or centralised Preview modules (e.g. in Luxembourg or Portugal) or **in case of common components variation is high for SMP deployment and set-up (2-15 person days) and for DE4A Connector (5,5 to 25 person days) which seems to depend on the direct expertise of the MS** e.g. Spain less effort for Connector given its high technical knowledge as leader of development of this component and Luxembourg less effort for SMP as technical expert developing this component integrated it in that MS.

On the other hand, **effort values tend to be similar for Implementation of Explicit Request (2-4 person-days), for transformation to canonical format in DOs (4-5 person days) and similarly to use received canonical evidences at the DEs. UI internationalisation also costed 3-4 person days.**

The **overall DE effort which varies between 31.5 and 40 person days** has been used to assess fulfilment of **Metric C2.2** which **had no pre-defined target**, but which is **longer than originally planned, due to the different technical / organisational challenges that had to be addressed for real deployment integration and testing.**

The **overall DO effort varies between 34.5 and 93 person days** has been used to assess fulfilment of **Metric C1.2** where the value of **93 days in Slovenia stands out with most of the variation seen for cost of implementing Preview functionality** as commented above.

Other MS not in DE4A are expected to benefit from these estimates as well as from those of SA Pilot in order to have an idea of magnitude of effort to integrate Evidence Requestor and Evidence Provider endpoints inasmuch USI pattern is similar to the approach in the technical specifications of the SDG OOTS but also considering that there are differences in the common components and APIs in that system which may also have significant impact.

Regarding views on usefulness of common components and fundamental DE4A outcomes (Solution Architecture, Information Exchange Model, Canonical Data Models, Connector, Mocked DO and DE,

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Central SMP and Kafka Server), D4.12 offers no updates in this regard, so readers are referred to D4.11 [6] for this.

5.4.2 Lessons learnt from MA Pilot

As already explained in D4.13 [24], lessons learnt cover a significantly wide variety of topics: from in-depth expertise required in eIDAS and OOTS, to focus on most frequently used scenarios and core research questions with strict scoping (e.g. 2 MS) and pragmatic choice-making, to bundle GDPR consent within SDGR Explicit Request function, to consider up-front essential requirements like authentication of citizens from MS that have non-notified eIDs (2 MS in the pilot), to be aware as well the complexities of alignment with sectoral initiatives like EESSI⁴⁴ and ESSPASS, to use mechanisms like wireframes for user interaction design to help user experience in terms of consistency and understandability.

Important lessons learnt also relate significantly in the case of MA pilot to USI pattern, which is de facto taken up as the evidence exchange pattern in OOTS Implementing Regulation can be considered to be almost equivalent to DE4A's USI pattern. **The pilot advises to use this pattern in the context of evidence exchange for online procedures and data services holding citizens data (SDG Moving Life Event), considering a number of important MS requirements and guarantees that are satisfied thanks to user interactions at DP side including reduced errors in record matching, increased user control and transparency of the process having Preview at DP side.** Furthermore, **the experience of building on multilingual forms from the previously existing Public Documents Regulation (EU) 2016/1191-** in order to leverage existing solutions that are beneficial in cross-border contexts, **combined with the flexibility of DE4A's Information Exchange Model** to exchange structured evidence (canonical) as well as original evidence and the multilingual forms, has proven a good approach to be considered by future adopters in the domain of citizen-oriented public services.

It is relevant to highlight that, while preparing for the running phase, pilot partners had different interactions with SDG Work Package on "Data semantics, formats and quality", in particular for **integrating MOR component** and for **small updates to canonical evidence types** (e.g. branching of Domicile evidence with a variant for deregistration including email optional attribute), generating **additional knowledge that is relevant to be considered by more MS in the SDG context both for linked/proactive procedures and translation and improvement of UX experience.** In-depth and lengthy discussions were also seen as very important to get a good mutual understanding about semantic concepts with nuanced meanings and applications depending on varying cultural and legal aspects across MS.

For implementation and integration phase **lessons learnt are provided considering pilot experience with long-lasting difficulties within some MS that related to expert resource availability and complexity of adequate and coordinated organisation of tasks** between multiple teams within the MS highlighting the **importance of strong internal coordination and commitment /prioritisation for needed technical activities and with good explanation of design details to implementation teams involved and easy to access, clear and detailed documentation through mechanisms like the Wiki** that enable it to be also easily updated. **Immediate and easy communication** using tools like **Slack** was also key for swift technical collaboration between MS teams and can even be used internally within MS too. **Early addressing of complexities for trust infrastructure is important**, including **lifecycle of certificates for eDelivery components, security audits** that may be complex and lengthy or **test credentials/test evidence exchange**, which can be complex administratively and time-consuming. **Careful consideration of impact in existing systems (DE/DO)** for integration in cross-border

⁴⁴ At the beginning of 2022, the pilot had various interactions, together with the "Semantic interoperability solutions" work package with experts from EESSI in order to gain good understanding of the common data model, code lists used, and messages employed for business use cases and messages exchanges across borders. Such interactions served to further assess potential synergies considering future synergies between SDG and sectoral systems like EESSI.

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infrastructure such as SDG OOTS **may require strategies like use of isolated project environments in the testing phase**. MA Pilot also confirmed usefulness of approaches like **phased testing and launching of services to cope with varying speeds of development between MS** or the use of **Playground environment to ensure step-by-step technical progress and compliance with pre-established technical specifications**, including API definitions. **Dependency on stable authentication infrastructure (eIDAS) also was confirmed as being extremely important**.

Given some users feedback related to need to understand better cross-border flows, lesson learnt to **explain OOP through animations and videos** seems particularly important while lessons on the technical side recommend for example considering **advanced identity linking mechanisms in the future, to address the problem of lack of persistence of some unique identifiers in eIDs**.

Regarding governance and sustainable impact, lessons learnt span from the need to **establish minimum level of common agreed security measures, to the early sharing of plans and approaches with adjustments to cope with different levels of progress in deployments** (e.g. network ports opening), **simplification and harmonisation of these deployments and facilitation of quicker decision-making at MS** based e.g. on exchange clear cost and effort estimates. MA pilot proposes to agree on one domain (Digital Government Transformation) model, not only for the SDGR services but also all services reusing the canonical evidences.

5.4.3 Follow-up of Mid-term Evaluation Recommendations

Finally, regarding recommendations for learning provided to the pilot in the Mid-term Evaluation, **the pilot followed the recommendation to update questionnaires with free text to capture more details from end-users and also conducted some interviews with them**. Wiki was updated to reflect aspects of the final scope for use cases although Wiki-based documentation is less extensive than the other two pilots. **Certain areas were indicated as interesting to preserve knowledge** as lessons learnt from internal discussions including identity and record matching, experience with non-notified eIDs for authentication, non-piloted scenarios of representation between natural persons or the canonical models also designed for the not piloted use case of pensions and labour information. This **recommendation can be seen to be followed with varying degrees as there wasn't time to progress much with natural persons representation, for example, but the mentioned canonical models on pensions, unemployment and means of living are well preserved** in DE4A GitHub (https://github.com/de4a-eu/moving_abroad). Possibly additional lessons learnt related to actual running phase could have been generated and organised but the technical complexity in getting the majority of combinations also left little time for this.

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6 Conclusions

The Final Evaluation has been performed over the three DE4A pilots according to the proposed methodology for this phase of the project, thoroughly assessing a rich set of piloting results and findings consolidated in Final Running Phase Reports from the pilots to provide an objective assessment⁴⁵ on the extent to which the three pilots have progressed over time to fulfil their respective business and technical goals and deliver a practical, multi-faceted, cross-border realisation of tangible benefits for DE4A stakeholders validating project outcomes in real life settings. These were provided as well from the respective perspectives of different pilot users (students, company representatives and citizens as end-user and Public Administration users in charge of providing fully online cross-border services to them aligned with a selection of SDGR Annex II Life Events). All these results and findings relate to piloting principles of Use, Value and Lessons Learnt for Adoption.

Pre-defined qualitative and quantitative KPIs (metrics) satisfaction has been verified considering established targets for them, enabling to assess a highly positive fulfilment of the different Success Criteria defined for each of the technical and business goals that the pilots were set to reach, also contributing to overall goals of DE4A project. With very few documented and analysed exceptions the agreed metrics targets have been met and this, together with additional evidence from the pilots' extensive reflection on findings and feedback from internal and external stakeholders, allows to conclude that pilot goals have been achieved in a highly satisfactory manner, considering as well the realized outcomes in relation to the complete planned scopes agreed for each pilot in terms of functionality, components, patterns and solutions from DE4A validated by real end-users and in realistic environments and conditions, with data protection compliance. In the case of MA pilot it needs to be acknowledged that it has particularly suffered throughout its lifetime from changes in partners composition and roles as well as from internal organisational issues in some MS (availability of technical resources, prioritisation of other national projects) which resulted in delays (no launch of combinations in the first piloting phase) and less combinations than planned available for pilot in the final phase of the project. In any case, all three pilots demonstrated impressive progress in terms of maturing initial MVPs to more full-fledged implementations that were validated with real users: from multi-evidence support in USI pattern and updated /additional canonical evidence types (SA and MA pilots) to highly optimized flows in VC pattern (SA pattern), new S&N pattern supported on definition of ontology for business events and fine-grained powers validation (both in DBA), very significant increase of end-users in SA and DBA pilots, proactive/linked procedures and Multi-lingual Ontology Repository for improved user experience with Explicit Request and Preview (MA Pilot), etc.

Overall, recommendations provided in the Mid-term Evaluation for improvement of piloting activities during the last phase of the project towards maximization of pilots' results and impact related to principles of Use, Value created for pilot stakeholders (benefits) and especially Learning for Adoption, have been well considered and followed with some exceptions (e.g. to extract more detailed feedback from logs): this can be accounted for considering need for time and/or effort trade-offs which can be understandable from a pilot management decisions perspective, and which are compensated on the other hand through a more qualitative-based approach. In this regard, it can be confirmed that the pilots have pursued, especially in the second part of the project, real efforts to generate a large and rich set of results focused on facilitating adoption by many different stakeholders across the EU. In this regard pilots provided (non-comprehensive list):

⁴⁵ An objective basis was used to assess how well pilots accomplished their mission and attained their respective over-arching technical and business goals considering the bi-directional trail relating metrics to the satisfaction of Success Criteria, as well as pilot addressing of commonly defined cross-cutting Technical Criteria (Related to ISO/IEC 9126, EIF Interoperability and DE4A principles).

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- ▶ Highly positive assessments (by the respective MS competent authorities and other pilot partners responsible for their integration for the pilots) both of usefulness of DE4A common components (Connector, SMP/IAL, Wallet and Authority Agent, Playground components, Information Exchange Model, Multilingual Ontology Repository) and of the expected benefits vs incurred costs in the setting up of DE4A's OOTS, with detailed effort estimations that reveal some relevant variations between MS and pilots as velocity for integration and configuration highly depends on pre-existing starting points and available expertise and resources. This is of direct relevance for teams in other MS not participating in DE4A and success stories about positive MS experience on DE4A's OOTS integration have been provided by DBA and MA pilots;
- ▶ Tangible benefits found by the Data Evaluators and Data Owners regarding the delivery of high quality cross-border public services (e.g. electronic procedures, evidence provision), the fitness and quality of trustworthy automatically exchanged data and the highly significant administrative burden reductions to process evidence / evidence requests and with less errors;
- ▶ Highly positive appreciation of internal technical support and documentation made available to the pilots from Common Component Design & Development and Semantic Interoperability Solutions work packages, enabling swift collaboration between developers, especially through approaches like DE4A common testing environment (Playground) and Connectathons, that provided needed confidence in the implementation of solutions prior to piloting;
- ▶ Real end-users' satisfaction expressed through online questionnaires and in-depth interviews, analysed for multidimensional (ten) aspects to extract the most and least valued aspects for their piloting experience with the different evidence exchange patterns, also studying all involved steps (cross-border authentication, Explicit Request and selection of evidence source, redirections to/from data services with record matching and Preview, etc.). SA and DBA pilots also consolidated Use and Value findings in success stories from students and company representatives showing very high satisfaction with duration of the procedures and control over own data;
- ▶ Measuring duration of complete flows piloted by the real users in each pilot (providing average and median values obtained from logs in the case of SA and MA pilots), confirming short durations of only a few minutes (typically 2-5 minutes depending on the procedure, pattern used and number of evidence items exchanged) thanks to the administrative simplification and automation inherent to OOTS approach;
- ▶ Lessons learnt and corresponding suggestions to the EC, MS and other stakeholders to facilitate adoption based on pragmatic experience gained in overcoming or mitigating encountered cross-border challenges for implementation and operation of cross-border public services relying on eIDAS, OOTS and other frameworks (EBSI/ESSIF, BRIS, EESSI, EUDI Wallets...) to realize Once-Only benefits in the context of the SDG. These lessons and suggestions have been extended and enriched with the experience of recruitment and interaction with different types of users and stakeholders in the pilots' execution and through intense interaction with other work packages contributing to technical, semantic and legal needs of the pilots. In particular all three pilots offer recommendations relevant for other MS explaining how to cope with inherent complexity of OOTS and the different paces of implementation and integration with multiple teams involved with different expertise and with issues of scarce specialised resources and changes in priorities during project lifetime. They also highlight some key recommendations towards sustainability and success of the SDG OOTS based on DE4A experience e.g. key role of proper and clear support and maintenance structure with a responsible organisation that helps prevent errors, maintains components and certificates and assists when issues arise.

DE4A pilots are thus seen to have truly realised their expected roles becoming the point of convergence for results integration and validation for the whole project: serving the purpose of demonstrating the extent to which DE4A technical and semantic outcomes, architectural models and patterns, building blocks and interoperability enablers are successful when put to test for their intended use, under realistic conditions, with direct involvement of real users and with the support of

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eGovernment authorities delivering pilot operational environments and support to them. In this regard, pilots have provided invaluable hands-on knowledge to DE4A and SDG-involved MS, to the EC and to many stakeholders regarding practical solutions to address interoperability challenges at all levels (technical, semantic, organisational and legal) including complex aspects for which they have been at the core from requirement to integration and real-life testing: from elicitation approach for (complex) canonical evidence definition, to cross-border authentication (even for non-notified eIDs in pilots) and authorisation also based on (full and fine-grained) powers validation achieved extending eIDAS infrastructure with pilot-specific nodes in DBA, effective record matching at DOs, improved and secure eDelivery framework with dynamic discovery and with open source Connector to save cost and effort in MS (also improving interoperability by supporting multiple patterns in a single application and making easy scalability to connect large numbers of DEs and DOs), or establishment of a self-sovereign identity supporting framework successfully integrated with cutting-edge blockchain EU infrastructure (EBSI Early Adopters programme) and innovative technologies (mobile wallets and agents), anticipating for MS fully user-centric evidence exchange and foreseen synergies between the SDG and upcoming eIDAS EUDI Wallets ecosystem, to name a few.

The pilots' common ambition has been that the knowledge and hands-on experience, delivered through different channels (project deliverables, public Wiki, dissemination events, papers, etc.), serve the community of Once-Only practitioners at European Commission and Member States levels in the context of the Single Digital Gateway and its OOTS. They are also relevant for longer-term initiatives in the context of inclusive, trustworthy, value-based digital transformation in the public sector, strengthening Europe's digital sovereignty and interoperability.

It can be reasonably concluded as well that DE4A pilots have made important contributions towards DE4A overall sustainability as a MS-driven Large-Scale Pilot at various levels:

-On a general level by generating value for the SDG activities in particular regarding preparation for the SDG OOTS implementation (deep understanding of the requirements and the needed technical options and contributions): MS have reflected in testimonials how "the piloting and the many discussions and preparatory work done in this context allowed us and the other participants to gain hugely in maturity and in understanding of the issues involved" (see Luxembourg success story in Section 3.2.4 of D4.12 [28]). In turn, this allowed these MS to provide a structured and informed discourse delivering essential and valuable input to several instances of the SDG process (SDG Coordination Group, Committee, specialized sub-groups...) with clear and positive results, which can be seen to be reflected in particular in the specifications for the SDG OOTS of the recent Implementing Act [31] where a solution for evidence exchange fundamentally analogous to the USI pattern is defined. Also pilot partners contributed during the project with their advice to a wide range of topics to OOTS architecture and semantic working groups.

-On a sectorial level, generating value and tangible impact by making fundamental contributions to aspects: for the experience with Verifiable Credentials can be highlighted (EBSI registries, agents for competent authorities and wallets for students) aligned with Europass-EDCI data models for student-centric evidence provision (SA Pilot); the cross-border authentication and powers validation infrastructure usable for legal persons representation that effectively lowers barriers for companies to start or do business in a different MS, as well as mechanisms to be informed of company events and/or keep company data automatically updated through subscription to notifications about changes in business registers (DBA pilot); the proactive citizen services with automated back office deregistration procedure linked to a previously confirmed address change (MA Pilot).

It seems fair to also state that the highest value observed is that DE4A piloting has helped the 8 participating MS (also Germany who joined as Observer for an additional pilot with The Netherlands) to gain invaluable, direct, hands-on experience confronting multiple practical challenges at all levels of interoperability (technical, semantic, organisational and legal), before implementing the production solutions for the SDG OOTS, where pilots also allowed to see what solutions work to overcome them.

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The challenge was even higher compared to previous experiences in the domain of OOP given the will to make DE4A's multi-pattern architecture (four patterns including innovative technology in VC pattern now closely related to the EUDI Wallets / eIDAS revised Regulation) a reality for realistic piloting across the 3 pilots, with 7 different use cases and over 200 real users testing 25 cross-border combinations in the context of the types of online electronic procedures and data services. None of this would have been possible without the close interaction with other DE4A work packages, namely "Inventory of current eGovernment landscape", "Architecture Vision and Framework", "Semantic Interoperability Solutions", "Common Component Design & Development", "Sustainable impact and new governance models", "Legal and ethical compliance and consensus building" and "Stakeholder dialogue, dissemination and communication".

In conclusion, high degree of progress has been verified not only in terms of increased users and cross-border combinations, but with value for stakeholders confirmed through multiple "success stories", through advanced technical functionality (like exchange of multiple evidences at once, streamlined user experience in USI with multilingual support and simplified steps in VC pattern and, more importantly, with the consolidation of lessons learnt and advice provided for the most significant types of challenges to achieve cross-border interoperability that MS will need to face in similar projects like the SDG OOTS implementation. More importantly, pilots are assessed to have met very well their respective technical and business goals based on the objective evidence of the qualitative and quantitative metrics and success criteria that have been fulfilled not only for their respective sectorial domains but having decisively contributed with wider significance and impact to DE4A's over-arching mission: to push forward and to generate for MS and other stakeholders the necessary experience to address short, medium and longer term challenges in the contexts of Once-Only, Single Digital Gateway and effective and integrated cross-border public service delivery to citizens and businesses in the context of public services modernisation across the EU.

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