D5.2

Transdisciplinary Evaluation Framework

Project number:	959072
Project acronym:	mGov4EU
Project title:	Mobile Cross-Border Government Services for Europe
Start date of the project:	1st January 2021
Duration:	36 months
Programme / Topic:	H2020-SC6-GOVERNANCE-2020, Governance for the future

Deliverable type:	Report
Deliverable reference number:	DT-GOVERNANCE-05-959072 / D5.2 / V2.0
Work package contributing to the deliverable:	WP5
Due date:	December 2021 – M12
Actual submission date:	30th May 2022

Responsible organisation:	DUK
Editor:	Thomas Lampoltshammer
Dissemination level:	PU
Revision:	V2.0

Abstract:	This document presents the initial draft of the transdisciplinary evaluation framework, which is going to be employed to evaluate the pilots conducted in the mGov4EU project in terms of their design and implementation phase. The deliverable starts out with a description of the overall goal of and the alignment with other activities around the pilot evaluation within mGov4EU. It then continues to present the workflow structure of the Task 5.1, outlining the logical embedding of the evaluation framework within the piloting. After this, the methodology of the inherent literature review concerning existing transdisciplinary evaluation approaches is presented, followed by the results of the review. These results are then presented along the currently available pilot descriptions to outline, the reasoning behind the selected indicators for evaluating the pilots.
Keywords:	mGov4EU, transdisciplinarity, pilots, evaluation framework.

The project mGov4EU has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 959072.

Editor

Thomas Lampoltshammer (DUK)

Contributors

Gregor Eibl (DUK)

Lucy Temple (DUK)

Rachelle Sellung (Fraunhofer)

Bogdan Romanov (UTARTU)

Carsten Schmid (UTARTU)

Executive Summary

mGov4EU advances the practical use of inclusive mobile Government services in Europe. The vision of mGov4EU is to enable secure and user-friendly mobile cross-border services by identifying, developing, arranging, integrating, and testing the required technical building blocks. Building blocks produced in mGov4EU are evaluated during the project using several pilots and can later be used to leverage arbitrary mobile Government services. To achieve its goals, mGov4EU focuses on two areas. On the one hand, the project addresses electronic identification in cross-border scenarios. In this regard, mGov4EU builds on previous work related to the eIDAS Regulation and the eID interoperability framework defined therein. On the other hand, mGov4EU has a strong focus on secure cross-border data exchange in mobile application scenarios. There, mGov4EU builds on the results of previous activities related to the SDGR. mGov4EU will carry out research to advance those areas to mobile use and combine it to enable mobile cross-border service and applications that rely both on secure and reliable user authentication and the secure and convenient exchange of user-related data.

In mGov4EU, the pilots play a crucial role to test and validate the developed technical building blocks. Hence, a framework is required that provides the general guidelines and direction of how to evaluate the pilots' design and implementation. To provide an integrative perspective on the pilots' development and their evaluation, a transdisciplinary approach has been chosen, which does not only include the perspective of the scientific partners, but also the perspective of the technical and piloting partners. By doing so, the evaluation framework does not only provide essential information on how to evaluate and design the pilots, but also about important aspects concerning the cooperation of partners, their exchange, and knowledge integration throughout the project. To cover these perspectives, a three-fold approach was chosen, which included the alignment of all involved partners to a joint mission view, the screening of literature concerning transdisciplinary projects and their inherent properties (e.g., indicators, dimensions, challenges), as well as pilot-specific indicator development workshops to ensure fitting results and cooperation on eye-level with the piloting partners. While the design and development of the pilots' specifications are not finished yet, D5.1. provides the initial version of the framework, which will be adapted and updated where required to match the final pilots in M20.

The following table shows the relation between D5.2 and other tasks, work packages and deliverables:

Contributing tasks of this WP	WP5: T5.1
Input from other tasks/WPs	WP1: T1.1, T1.3 WP2: T2.1 WP5: T5.3, T5.4
Output to other tasks/WPs	WP2: T2.6, T2.7 WP5: T5.3, T5.4
Output to other deliverables	WP2: D2.8 WP5: D5.5, D5.7

Table of Contents

List of Figures

List of Tables

List of Abbreviations

Abbreviation	Meaning
AdES	Advanced Electronic Signature
DoA	Description of Action
eIDAS	electronic IDentification, Authentication, and trust Services
eID	electronic IDentity
SDG	Single Digital Gateway

Chapter 1 Introduction

This deliverable addresses the development of the transdisciplinary evaluation framework as outlined as one of the core targets in Task 5.1. Along with its description in the DoA, this deliverable covers the necessary steps, processes, and methods to derive the required evaluation framework. In order to recognise the developments in the overall mGov4EU project structure, Task 5.1 and thus Deliverable D5.2 are well-aligned with the other tasks and activities. This starts with the recognition of functional requirements of building blocks and the pilots in general, as covered in WP1. In addition, requirements stated by the key stakeholders, identified in WP2 – T2.1, are also covered. Furthermore, the currently ongoing Task 2.6 concerning pilot applications plays an important role in the development of the transdisciplinary evaluation framework.

As the final set of pilot specifications will only be available later on in the project (D2.7 "mGov4EU Pilot Specification and Architecture" due in M20), this deliverable offers a first, initial set of indicators for evaluating the pilots. This initial set will be further developed and updated, wherever required by the final pilot definitions. As this might also impact the evaluation process in general, the process has been split into two parts. The first part covers the evaluation of the design phase of the pilots, resulting in the D5.5 "Pilot Evaluation Report – V1" due in M25. The second part covers the implementation and execution of the pilots, resulting in D5.7 "Pilot Evaluation Report – V2" due in M36. By splitting the evaluation into these two phases, we are not only able to focus on the crucial sub-parts of the pilots, i.e., the design and the implementation, but also tackle potential future racing conditions between the tasks, the pilots, and the associated evaluations (see Figure 1).

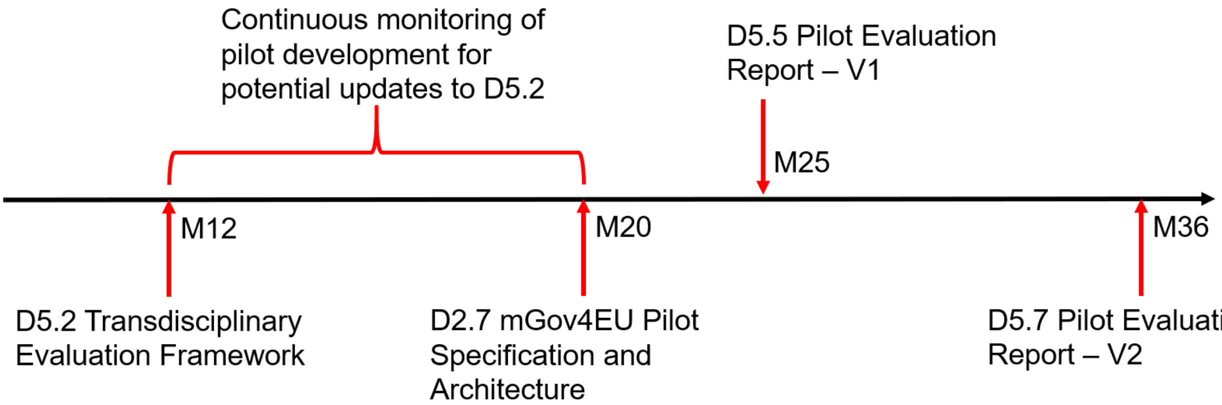

Figure 1: Timeline for activities in T5.1

Besides the evaluation of transdisciplinarity aspects in the design and implementation phase of the pilots, it was decided to separate the second stream of evaluation into its dedicated task, i.e., T5.2 "Security Evaluation" and associated deliverable D5.6 "Security Analysis of mGov4EU Pilots". This task focuses on the identification of barriers in terms of security issues and threats concerning technical aspects of the mGov4EU project. Security evaluations conducted in this task are two-fold. First, interfaces, apps, and services designed in WP2 are analysed systematically to identify potential security risks and to derive adequate countermeasures for these building blocks already on the architectural level. Second, a security-analysis framework is developed and applied to the pilot use cases defined and implemented in WP4 to identify the pilots' specific security-related risks and to provide them with risk-mitigating countermeasures. As the implementation, execution, and adjustment of the pilots are running until the end of the project, the associated deliverable D5.6 "Security Analysis of mGov4EU Pilots" is also due – same as D5.7 – in M36.

Chapter 2 Transdisciplinary Evaluation Framework

2.1 Workflow of Designing the Framework

In the following, we are going to describe the design of the underlying process, which finally led to the development of the current framework draft. The design and development process run over a period of one year (M01-M12) and included several steps, covering both literature, as well as partner involvement from both groups, i.e., pilot leaders and other partners. **Fehler! Verweisquelle konnte nicht gefunden werden.** Figure 2 depicts the different steps taken

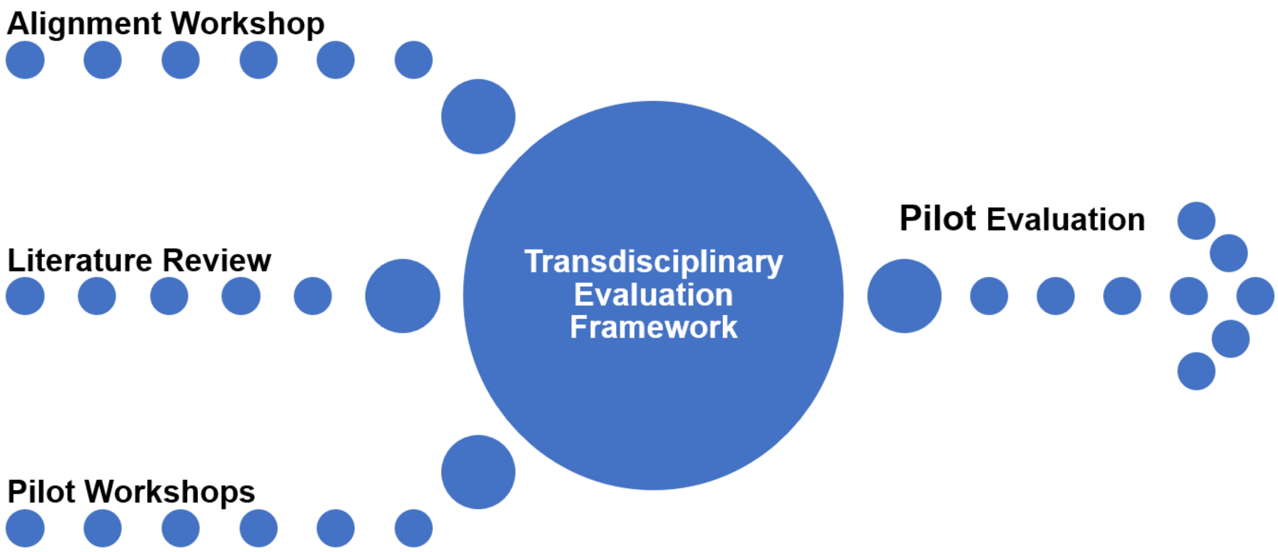

Figure 2: Three main phases for design and development of the evaluation framework

during the design and development process.

2.1.1 Alignment Workshop

As a first step, we started with an alignment workshop with all partners involved in Task 5.1 on the 5th of February 2021. Besides the scientific partners, this also included Scytl to represent a piloting leader and to have them sanity-check our discussions and plans from a piloting point of view. The workshop was held online, and we used a Mural[1] board as means of interaction and documentation of our thought process (see Figure 3). In this workshop, the partners reflected upon the given tasks according to the DoA, and how they are dependent on each other. We then continued to group them by theme and overall activities to achieve a better picture of what to do, by when and by whom. Along with this discussion, we also identified internal roles that partners would keep in mind when acting or interacting within WP5 but also concerning other ongoing tasks and work packages such as WP1 and WP2 at that time. Afterward, we jointly orientated the grouped activities along the project timeline, also considering the foreseen evaluation phases, represented by the according deliverables, i.e., D5.5 and D5.7. This helped us to identify potential racing conditions with other pilot activities (see Chapter 1), and also to draft realistic expectations of the degree of stability the initial evaluation framework can achieve, taking into consideration the ongoing processes of pilot definitions, architecture development, and associated building block development.

[1] https://www.mural.co/

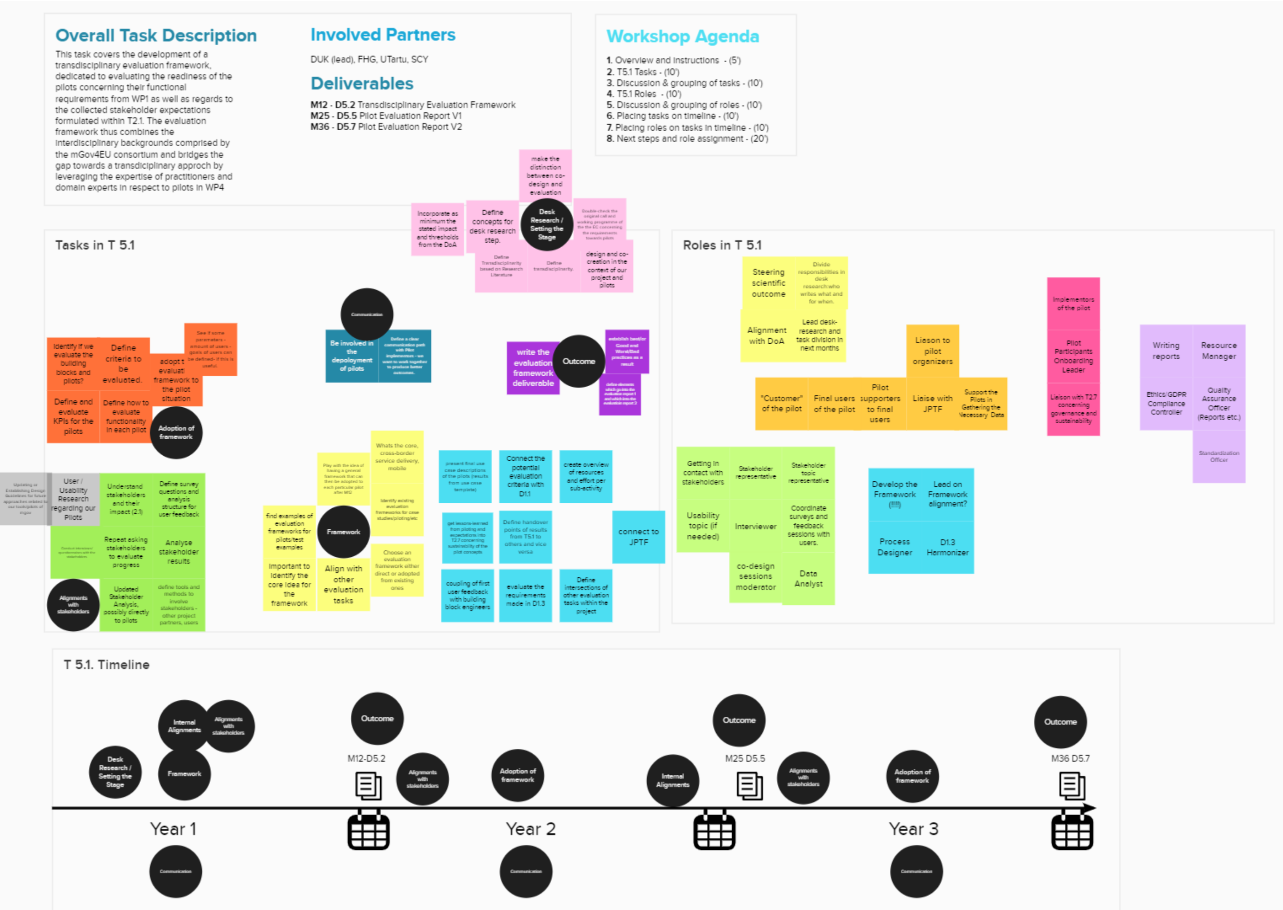

Figure 3: Mural board reflecting the discussion process within the T5.1 alignment workshop (for illustration purposes only)

After the initial alignment was completed and the project partner agreed upon a timeline for the upcoming work, the next phase of the design and development for the transdisciplinary evaluation framework was started, i.e., the screening of literature to reflect the state-of-the-art in the domain of transdisciplinarity in the upcoming draft of the framework itself.

2.1.2 Literature Review

In order to be able to design our transdisciplinary evaluation framework, a thorough literature search was conducted, seeking the most recent and relevant academic publications on transdisciplinary evaluations. Due to transdisciplinarity being an interdisciplinary field of study, the search for the publications was conducted in two of the largest peer-reviewed literature databases: Scopus and Web of Science. The search string that was used to conduct the search was

TITLE-ABS-KEY ((transdisciplin AND (framework OR model) AND (evaluation OR benchmark* OR assessment))).*

This way publications that focused on transdisciplinary frameworks or evaluations could be found. The search resulted in 806 results in Scopus and 631 in Web of Science. These were further filtered to those papers available in English, reducing the starting amount to 776 and 605 respectively, summing up to 1381. After duplicates were removed, the search revealed 1006 papers. To be able to narrow down the number of publications by filtering those that were deemed unsuitable for the topic at hand, two researchers conducted a deep review of the title and abstract of the list of publications, removing publications for the following criteria:

1) Duplicates that had not been detected before;

2) Publications that were too specific: focus on the field of medicine, veterinary, ecology;

3) Not a publication on transdisciplinary evaluation;

4) Lack of indicators or relative sources of information for the goal of this desk research.

The sample was narrowed down to 185 publications, and finally, a conjoint discussion with three researchers discussing those articles that were slightly unclear if they should be included in the analysis or not brought the final sample down to 75. Out of these 73 were available for download and were further reviewed and explored in their entirety.

In order to be able to move forward with the analysis, MAXQDA[2] was selected as the software for coding the literature. An inductive approach was selected as the best option for this research, where a coding schema was defined after a sample of the literature was reviewed. First, three researchers reviewed and coded the same five papers that were deemed highly relevant when screening the databases. Next, a workshop was set up to discuss the individually found codes and subcodes for segments to understand transdisciplinarity at its core and how to evaluate it. A final set of codes and subcodes were defined upon, alongside guiding principles on how to select a specific code for a segment. The rest of the papers were divided equally into the three partner organizations participating in the design of the evaluation framework. A total of 1375 segments were extracted in the texts and the categories in which they were coded are the following:

- Characteristics of transdisciplinarity
- Frameworks
- Dimensions
    - Purpose
    - Timing
    - Scope
    - Actors
    - Impact
    - Mix/Granularity
- Indicators
- Challenges of transdisciplinary evaluation

2.1.3 Pilot Workshops

Once the literature review was completed by the involved scientific partners, i.e., UTARTU and FHG, we then transitioned into the development of pilot-specific indicators via direct involvement of all pilot leaders, i.e., Scytl, ECSEC, and go.eIDAS. This was done via three pilot workshops. The first workshop was held during the consortium meeting in Graz at the end of October 2021. The second and third workshop were held in November 2021 respectively. Each of the pilots was handled by a dedicated person of DUK, as well as an associated scientific partner, i.e., UTARTU for the i-Voting Pilot, FHG for the Mobile Signature Pilot, and DUK for the Smart Mobility Pilot. For each of the pilots, the pilot leaders were guided through four distinct phases. An overview of the process can be seen in the example Mural board in Figure 4.

[2] https://www.maxqda.de/

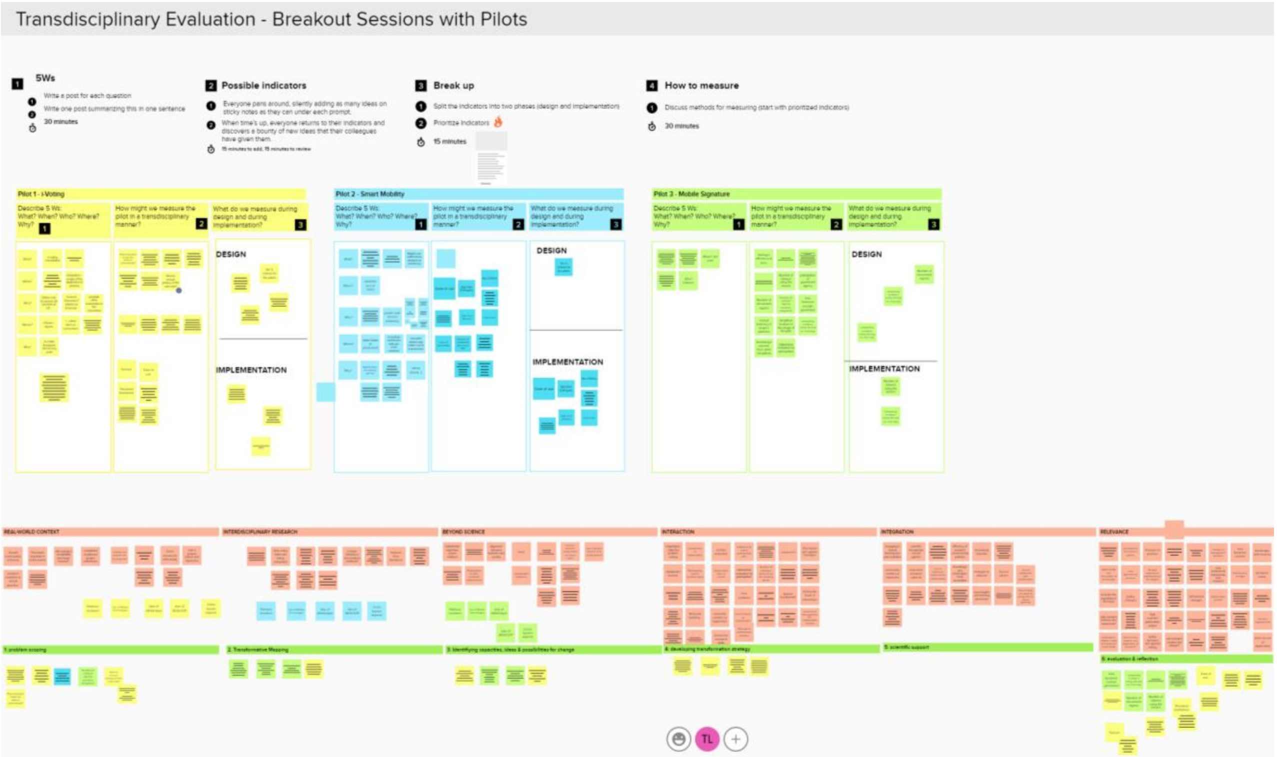

Figure 4: Example of the initial working session with the pilots (for illustration purposes only)

In the 1st phase, the pilot leaders were asked to answer the "5 Ws" [1] in order to provide the scientific partners with a current state of the pilot definitions. These questions refer to: i) what are the pilots about; ii) why are the pilots necessary iii) when and iv) where are they going to happen; and v) who is going to be involved and targeted respectively. In the subsequent 2nd phase, the pilot leaders were asked to elaborate on potential, pilot-specific indicators. In addition, they were provided input from the literature review in terms of possible, more generic indicators. Here, we also supported the pilots in the discussion around the definition of transdisciplinarity and how to interpret this concept in the context of the mGov4EU project. We then moved to the 3rd phase, we then asked the pilots to separate the jointly developed indicators into two categories, i.e., related to the design process of the pilots, and the implementation itself. In case of a high number of indicators, we also requested the pilot leaders to prioritise the indicators. In the 4th and final step, we asked them to reflect with us on how to measure each indicator, where information for the assessment and analysis could be found, if the indicator could be a generic one independent of one pilot and if the group agrees on considering the indicator.

2.2 Surveying the State-of-the-Art Literature

In the following section, we are summarizing core aspects of transdisciplinarity that were identified during the literature review process. These aspects do cover the terminology of transdisciplinarity as such, an overview of existing transdisciplinary frameworks, dimensions to consider when designing transdisciplinary projects, generic indicators for transdisciplinarity assessment, as well as challenges for transdisciplinary approaches.

2.2.1 Characteristics of Transdisciplinarity

By analysing the literature, different definitions of transdisciplinary research could be found. Therefore, authors often refer to existing definitions and then develop their definitions to relate to them. We have tried to highlight the main pillars of transdisciplinary research. In that sense, transdisciplinary research is embedded in a real-world problem context, is tackled in an interdisciplinary way, extending beyond science stakeholders, is done together in an interactive joint engagement, making sure that the knowledge of everyone is integrated and transferred to enhance the relevance for the active stakeholder, but also the society as the recipient (see Figure 5). All six pillars (i.e., real-world context, interdisciplinary research, beyond science, interaction, integration, and relevance) will be explored further in the following subsections.

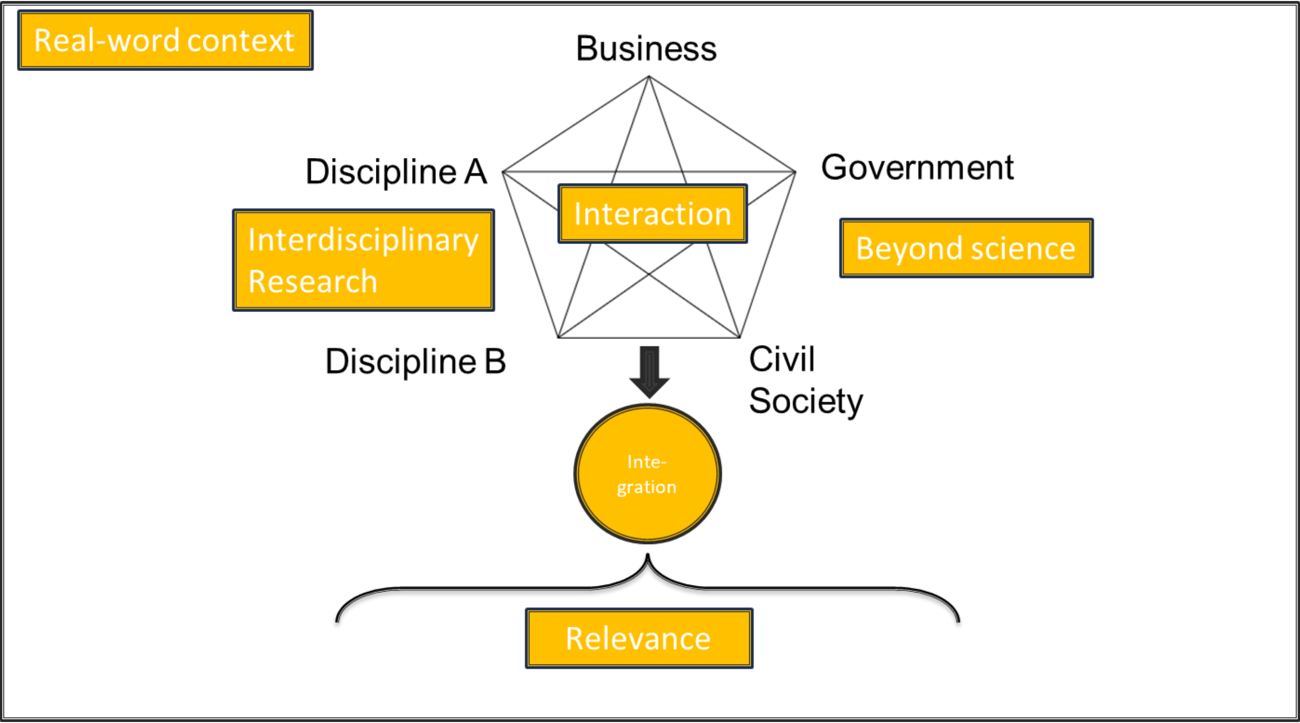

Figure 5: Six pillars of transdisciplinary research

Real-world context

At the beginning of transdisciplinary research, there is a **problem of everyday life** that has to be solved [2]. For practitioners, it is of particular importance that the solution of an everyday life problem is addressed. These everyday life problems are examined to shape real processes. In addition, legal frameworks and possible actions have to be considered in their context [2]. In other words, transdisciplinary research focuses on solving **real and complex problems** and questions aiming at creating knowledge that is solution-oriented to societally relevant problems [3], [4]. Also, other authors [5] consider this **problem – and solution approach** essential for transdisciplinary research. Its knowledge emerges from a **particular context of an application** by addressing societally relevant problems as drivers for posing scientific research questions [6].

Interdisciplinary research

Transdisciplinary research includes interdisciplinary research, where transdisciplinary is the broader term of both concepts. The main purpose of transdisciplinary research is to search for solutions to a matter or a complex problem that cannot be solved with knowledge and techniques from a single discipline [3]. In other terms, it frees itself of its specialized or disciplinary boundaries, defining and solving its problems **independently of disciplines**. This is not to dismiss specialized and disciplinary knowledge, but to ensure that problems are not seen in a one-dimensional way, i.e., from a solely specialized or disciplinary perspective [6]. Interdisciplinary research includes considering the **context** of multiple disciplines and their intrinsic **knowledge** gathered in the same environment through disciplinary transcendence and transgression [3], adding **perspectives** from different disciplines [4]. This requires researchers of different disciplines **to work jointly** [2] and to **collaborate** [7].

Beyond science

One important aspect of transdisciplinary research is its **bridging** function between **science and practice,** transcending the boundaries between scientific disciplines and societal actors [5], [6]. The involvement of various **non-academic stakeholders** is an essential characteristic of transdisciplinary research projects [2], which can span from business, government to civil society, or from industry to societal entities, seeking for application of the research results [3]. Beforehand **societal problems have to be related to scientific problems** [8] so that researchers can work jointly with practical experts [2] on an equal basis [4] involving scientific and non-scientific sources or practices [9]. This alignment of partners' needs and desires, makes the process **relevant to all parties** [10], contributes to both **societal and scientific progress**, accounts for the **diversity of perspectives** [6], and can create a **culture of accountability** [3].

Interaction

As already mentioned, very different actors from different disciplines and beyond the scientific field work together in a transdisciplinary project. In many definitions and descriptions of transdisciplinary research, this interaction is emphasized and referred to in different ways. The term **co-production** is considered a core concept of transdisciplinary research, representing the importance of **interaction** between the stakeholders [3]. Others emphasise the notion of research **collaboration** [4], [6], or the **cooperation** of different algorithms and approaches [9]. The goal is to **connect skills and knowledge** through **teamwork** and collaborative networks [3], **cooperative learning and problem solving** [9], **active participation** of all stakeholders [2], and **engaged participants** in processes of reflection, deliberation, and negotiation [7].

Integration

Given the purpose of the above-described interaction, terms such as integration, synthesis, or transition are mentioned. Transdisciplinary research seeks to overcome the fragmented view of science and hyper-specialization **through dialogue and integration of knowledge** [3]. **Integration** is the cognitive operation of establishing a new, previously non-existent connection between the distinct epistemic, socio–organizational, and communicative entities that make up the given problem context [6]. Thus, it produces new knowledge by integrating these different scientific and extra-scientific findings [8], which others refer to as **synthesis** of the individual findings [4]. While the term integration implies the integration of disparate entities into a new entity, others emphasise the term **transition,** which refers to the successful solutions or applications to a distinct application domain [9].

Relevance

The promises of transdisciplinary research can be distinguished between **benefits for project members (internal)** and **benefits for external stakeholders (external)**. Within the project boundaries, the most fruitful engagements will occur in environments and partnerships that provide **mutually beneficial and relevant learning opportunities** for both users and researchers [10]. Mutual learnings should be facilitated in successful transdisciplinary projects [4]. Other internal effects besides shared learning include **mutual accountability, ownership, and leadership** among project participants [7]**.** Outside the project boundaries, transdisciplinary research **contributes to both societal and scientific progress** [6], [8], which is guaranteed by the broad stakeholder engagement beyond science, mentioned above. In turn, other authors emphasize the practical benefits to society, e.g. by initiating public health programs, generating land-use plans, developing environmental policies, and excluding some of the standard academic outputs such as peer-reviewed publications or academic [7] or stress the need to secure the promised societal benefits [4].

Overall, transdisciplinary research aims to provide a **fundamental understanding** [2] to generate **knowledge that is solution-oriented, socially robust, and is transferable** to both scientific and societal practice [6].

2.2.2 Transdisciplinary Frameworks

The field of transdisciplinarity is complex, as it focusses often on real-world, wicked problems, includes a high number of heterogenous stakeholders, and also demands for the acknowledgment of sector-specific requirements, cultures, knowledge, and expertise. It is therefore not surprising that the scientific discussion concerning the standardisation of such transdisciplinary projects is also quite diverse. According to [11], the discussion of frameworks in transdisciplinarity can be organised around three different perspectives:

- the setup of transdisciplinary projects,

- the experience of researchers concerning transdisciplinary projects, and
- the evaluation of transdisciplinary projects.

Considering the area of setting up transdisciplinary projects, there do exist approaches that try to present ideal archetypes of such projects, including the strong focus of mutual learning. Examples for such attempts can be found in [12]–[14], as well as [15]. Overall, most works agree upon the main phases being problem framing and team building, co-creation, and knowledge building, as well as knowledge integration. This implies that the results are useful to both parties, the scientist, as well as the practitioners (see Figure 6Figure 6 That being said, if all these phases are always implemented and in consequence can achieve constantly the desired impact is still debated within the literature [11], [16].

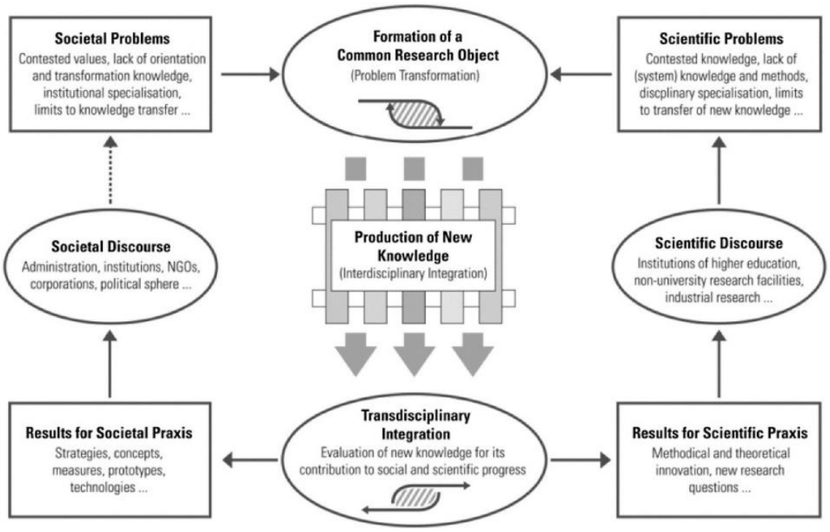

Figure 6: Joint benefits for science and practice through transdisciplinarity [17]

In the second area, i.e., the reflection of real-world experiences of researchers of transdisciplinary projects, there do exist reports of finished projects (see [11], [18]), yet often these reports do focus strongly on the scientific perspective, seldomly on the co-leader of practice, and are lacking the same coverage of generalised frameworks as present in the area of setting up projects [11].

In the third and last area, i.e., the evaluation of transdisciplinary projects, has seen ongoing discussion of how to approach this challenging task [8]. Several evaluation frameworks and sets of indicators have been presented to measure the societal impact of transdisciplinary projects (e.g., [19]–[21]), yet there is still no unique way of how to include the different views of all stakeholders, i.e., research and practice, into the evaluation of a transdisciplinary project (see [11], [16], [21]). Thus, a custom approach, based on the particularities of the project, needs to be co-developed by the stakeholders, considering the particularities of the desired impact, i.e., in the case of mGov4EU, the three pilots.

2.2.3 Dimensions

Transdisciplinary projects can be evaluated in several dimensions. In the following, we are summarizing the six major dimensions that were identified during the literature review process.

Purpose

Concerning the overall purpose of the evaluation, it has been a suggestion to differentiate into the following categories **accountability, strategy, broader purposes like learning and marketing, or multiple purposes** [22]. In addition, it was suggested to sort several criteria along with the following four principles: **relevance, credibility, legitimacy, and effectiveness** [23].

Timing

Another possible dimension is the timing according to the nature of evaluation objects, which can be separated into **ex-ante, ongoing, ex-post, ex-ante + ex-post, or interactive** [24]. In terms of general evaluation phases, often authors refer to classical ex-ante and ex-post evaluations [5]. In

[25], the author separates the areas of analysis into **premise, content, and process**. Premises are reflections on the underlying assumptions and perspectives, contents are reflections on what was constructed or planned, and processes are reflections on how it was implemented and evaluated. It has also been observed that already before the formal commencement, lengthy discussions and intensive negotiations could occur [26]. As an example, [27] discusses a project that profited from a procedure, where different expectations and demands of stakeholders and scientists regarding the results of the research have been made aware and discussed right from the beginning. In regard to intervals of evaluation, there exist suggestions to conduct further surveys in regular intervals like six months intervals adapting the questions to the status of the project [28]. This is also in line with [29], where it is noted that some of the activities are expected to occur in a loop and through multiple iterations or being taken in a circular approach.

Scope

Here, assessments could be categorized into a single assessment of an **individual object** of analysis or performing a **networking assessment**, studying the interaction between joined groups or institutions [3]. Assessments can also span **products, entire projects, or programs** [8]. One possible distinction is what happens internally within a project and what happens externally primarily in the organizations of the stakeholders, but also within society [30]. Transdisciplinary scientific collaboration can be evaluated at different scales ranging from proximal/micro to distal/macro levels of analysis [31].

Actors

During the evaluation, different actors can be identified. For example, the researchers conducting a study can also be the evaluators or different persons who take over this role [19]. Another possibility to form an evaluation could be a coaching model, facilitating self-reflection about what members are supposed to be doing and how well they are doing it in comparison to a jury model [32]. One differentiation is how interdisciplinary teams integrate disparate bodies of knowledge in 4 types: **common group learning, modelling, negotiation among experts, and integration by a leader** [5].

Impact

Considering the impact of a particular project or action, different types of affects can be achieved. Societal impacts of research projects range from **direct impacts** (e.g., knowledge generation) to **long-term community impacts** (e.g., community well-being) [19]. Another possibility can be found when following the principles of citizen science. The evaluation of engagement can be considered in three dimensions: (i) **scientific impact; (ii) participant learning and empowerment; and (iii) impact on society at large** [33].

Mixed

This category contains dimensions that can be seen from multiple perspectives at the same time. Considering the term "evaluation", it can be described as "the systematic collection of information about the activities, characteristics, and outcomes of projects" that aims to assess the achievement of the objectives, the efficiency, effectiveness, impact, and sustainability of a plan [18]. The formative evaluation of the engagement process and its impacts, including demonstration of the success of both process and outcomes is essential [23]. In this context, activities can be seen as actions conducted by the project, leading to output generated by the project. They steer outcomes, which are changes in knowledge, attitudes, skills, and relationships, manifested as changes in behaviour. These changes, which are changes resulting wholly or in part from a chain of events to which the project has contributed, finally create impact [24]. When this setup should be assessed, in general, one possible categorization of an evaluation framework is comprised of: **(1) individual abilities; (2) collaboration; (3) content; and (4) output and outcomes** [3]. Other categorical classifications focus on **object analysis specifications, physical and financial inputs, and outputs** [3]. When it comes to assessing performance, the following three factors might be considered: **output performance, process performance, and career opportunities** (e.g., scientific career development via publications or acting as PI)**.** Output performance relates to the quality of results and relevance to practice, process performance describes the quality of the cooperation and career opportunities to scientific reputation indicators [4].

2.2.4 Indicators

The following section is an overview of the indicators for transdisciplinary projects and evaluations found in the literature. Indicators help aggregate information, allowing for the analysis of complex issues and adding value to thus help decision-makers make a suitable decision [2]. The evaluation of scientific projects is usually shaped by expert perspectives, analysis of outputs, bibliographic bibliometric outputs, and quantitative and qualitative indicators of cooperation, all these are insufficient to measure the quality of a transdisciplinary project [4]. Moreover, transdisciplinarity-specific indicators such as mutual learning, or cooperation between science and practice are important, but also need other indicators such as the quality of project performance and the completion of planned milestones and activities [4]. The most available literature on the evaluation of transdisciplinary projects focuses on criteria to evaluate the process, "competence of the project partners, adequacy of the problem formulation, flexibility of the project management, legitimacy, and fairness" [19].

Some transdisciplinary indicators include whether a project or research is or was socially relevant if the focus was on solutions if it will be sustainable in time, rigorous, and scientifically robust [25]. Evaluators, especially internal evaluators should attempt to question and analyse their actions and thoughts on how things are being done [6].

Chapter 5 Annex shows the list of relevant indicators, and criteria found in the literature, these include questions that should be answered by evaluators and members of transdisciplinary projects and some examples of indicators included in transdisciplinary projects and their evaluations presented in the analysed literature.

Several authors raised the issue of the importance of joint development of indicators by the researchers and stakeholders involved [6], [25]. To present a series of relevant indicators for the evaluation of the mGov4EU project and pilots, several workshops both hybrid (online and offline simultaneously) and online were conducted. The goal of these workshops was to involve and receive input and feedback from the partners and developers involved in the pilots, to design and co-produce relevant and suitable indicators for the pilots, a key part of the overall project. More details on the methodology of the workshops may be found in Section 2.1.3. The transdisciplinary evaluation framework presented in this deliverable will include not only indicators discussed and agreed on in the workshops but also some of the key indicators found in the literature that are applicable and appear to be useful to evaluate the mGov4EU developments.

2.2.5 Challenges

The analysis of the literature on transdisciplinary evaluation raised a series of potential challenges. These challenges vary from aspects that must be taken into consideration when conducting a transdisciplinary process, such as privacy and ethical considerations [34], to barriers that must be overcome due to the transdisciplinary nature of a project or evaluation. In this section an overview of these challenges will be presented, ranging from considerations regarding the evaluators, the timing and size of projects and the effect this may have, the involvement of stakeholders, not only at the ideal point in time but also the importance of actually representing stakeholders faithfully. Moreover, the competences needed in order to develop transdisciplinary processes, and the problems that might arise from working with a variety of disciplines, ranging from the lack of a clear glossary of terms to specific guidelines [35], [36].

The initial barriers of transdisciplinary research lie in the differences between the organizational and institutional variances of the disciplines [35]. Many times, transdisciplinary research has to face the division between science and practice [37], each process needs to adapt to a specific context, the needs of both scientists and non-academic parties, and reach the desired outcomes taking into account the limited amount of money and time [38]. Selecting the appropriate methods for collaboration, knowledge integration, and evaluation is important to accommodate each particular project's context [39]. Often a broader conceptual framework is needed as traditional bibliometrics for evaluation are insufficient for transdisciplinary projects [25], [26]. Defining a conceptual evaluation framework may involve not only searching through existing literature but consulting with experts, practitioners, and experienced stakeholders in a variety of fields [29]. This analysis of all parts is crucial to avoid a project or evaluation being viewed as a collection of disjointed pieces [26]. Addressing the range of criteria needed to evaluate a transdisciplinary project requires understanding the importance and value of identifying these aspects and working to create opportunities and learnings from each particular challenge.

One of the key challenges mentioned throughout the literature is time. Particularly, the authors stated that the consequences, contributions, and long-term effects of transdisciplinary projects may not be taken into consideration, and a long time frame may be required to evaluate the outcomes of an initiative [25], [40]. The reason for this is that some outcomes may emerge gradually and are not visible immediately [25], results can take years to materialize and impacts are sometimes hard to trace back to a particular project [31], [41]. Moreover, projects that are evaluated immediately may be skewed by the impressions of the recent activities in the project and the actual effects from the outputs require more time before they can be evaluated [19]. It is also difficult to capture the long-term contributions of activities that extend through several months or years [42]. Some of the impacts may be temporary or long-lasting: an immediate evaluation may show the temporary results and impacts, but not necessarily the long-lasting effects [25].

Time is not only related to the timing and precise moment of the evaluation of a project, but also throughout the project development. A long-term commitment of partners may pose a challenge, and time may also put pressure on the financial constraints of projects or programmes [43]. Finally, the need to allocate sufficient time and money to define the objectives, even before the activities begin is key to providing the basis for a successful transdisciplinary endeavour [38].

A recurrent challenge presented throughout the literature was the need for adequate competences and capacities within transdisciplinary projects. The changes implemented in transdisciplinary projects can be technological, attitudinal, and cultural and require professionals and stakeholders to develop specific competences [44]. Some of these competences include the need for clear communication and facilitation of knowledge [35]. Interdisciplinary coordination capabilities are crucial for project success, yet it is not always available, personnel and managers need to adapt to the project circumstances and learn to collaborate within academia but also with non-academic stakeholders [45].

On that note, the involvement of stakeholders is a key characteristic of transdisciplinary developments. Nevertheless, this participation of stakeholders from different areas raises a series of challenges for these projects. Firstly, in some projects the drive to involve stakeholders is unclear, and the lack of awareness leads to expectations not being met [46]. Moreover, it is an even greater challenge to get the appropriate stakeholders on board for a project, despite conducting a rigorous stakeholder analysis, the understanding of power relations and dynamics is not always straightforward and may require proper incentives to promote participation [7], [38]. One project only had participants, coordinators, and project leaders participate in the evaluation: one question remains, are these involved stakeholders the correct ones to assess the project objectively, or should other stakeholders be involved in the assessment process [47]. This is closely related to the fact that ties and relationships to some stakeholders may develop smoothly, while others may take longer or more work [38].

Also, the involvement of non-academic actors requires a joint understanding of the research, focusing not only on the scientific aspects but also on societal issues [3], [38]. Recurringly, the authors mentioned that stakeholders' opinions remain unconsidered, stakeholders need to feel heard, represented and somehow trust researchers to take into consideration their input [4], [23], [44], [48]. Therefore, a key challenge for transdisciplinary projects is to shift the focus from basic research to the co-production of knowledge involving a variety of stakeholders, by including and taking into account their views, input, and opinion [33]. Transdisciplinary projects usually take place in complex contexts, allowing for a diverse group of stakeholders, with varying views on the project at hand, but not all possible stakeholders are available or can take part in the process [38], [39]. It is important for project leaders to facilitate the collaboration process, and consider stakeholder knowledge and expertise [49].

Finally, transdisciplinary projects might be easier to implement in smaller projects, and when shifting to larger projects the management of stakeholders, among other barriers, becomes too hard a task [35]. It is important for project managers, to not allow the co-production of knowledge to continue to reproduce society's existing power imbalances, but to select an array of stakeholders representing even the smaller, less powerful groups in society [37].

A few challenges found in the literature were associated with the people evaluating transdisciplinary research projects: the evaluators. Evaluators may sometimes be external, sometimes internal, and close to the project, and sometimes a mixture of both. When evaluators are external, they may thrive on the distance they have from the project, but at the same time lack the comprehension of how the internal dynamics developed, and what may be the ideal criteria to assess a project process [39]. The complexity of transdisciplinary projects requires evaluators to go beyond traditional reference systems for evaluating projects [2]. When evaluators are internal, or part of the project, it is important for them to consciously review their actions, and reflect on how things have been done [25]. As mentioned previously, time represents a challenge, as it might affect stakeholder memory of past activities [39]. Evaluators have a complex task, especially when there exists a lack of high-quality data to evaluate a project [39]. Guidelines for evaluation and peer-review have to take into consideration the different disciplinary standards [32], furthermore, it is not an easy task to find reviewers with cross-disciplinary experience [23].

A key characteristic of transdisciplinary projects is the inclusion of a variety of disciplines working together, many disciplines, professions, and fields are usually involved [21]. This enriching process implies a series of challenges associated with it. Firstly, multiple stakeholders may have different views, priorities, and goals for a project [50], it is important to create a balance of these perspectives and generate a coherent whole [32]. The initiatives must be tailored to somehow address the main priorities and goals of the disciplines [50], mainly since changes and results extend through multiple domains [42]. The researchers from different disciplines working together might have trouble not only getting along but also implementing mixed research methods [51], there is a need for mediations and an understanding of potentially conflicting values and expectations [34]. Transdisciplinarity is a growing field, but there is no common glossary of accepted definitions, terminology, or common shared framework [35], [36], [40], it is hard to participate in a discipline with particular terminology that one does not understand [48].

Not addressing the articulation of these disciplines and actors may lead to those involved being disappointed [46]. Taking into consideration and understanding the challenges associated with the transdisciplinary process and evaluation, may help implementors design processes according to their needs, building upon their strengths and finding ways to mitigate the challenges.

2.3 Pilot-specific Indicators

2.3.1 Smart Mobility Pilot

This pilot is dedicated to demonstrating the overall applicability of the mGov4EU architecture and its inherent building blocks in mobile use-case scenarios. In the concrete case, we are focussing on state-subsidised mobility services, which require the customer (citizen) to provide proper identification. The pilot is conceptually placed in an existing mobile solution, i.e., where a citizen can use their German eID "Personalausweis" as a means of identification and interact with the system by making use of an NFC interface. The existing mobility application is referred to as FiftyFifty Taxi App[3] and allows local citizens within a certain age range to use the taxi service with subsidised prices, after confirming age and place of residence via eID. However, currently, the system works only with the German eID. Hence, this hinders citizens from the other Member States to make use of the service in the same convenient way as their German counterparts, although being eligible in general. The mGov4EU Smart Mobility Pilot is going to enhance the system in the way that foreign eIDs become usable within the described mobility service scenario. Figure 7 shows the adapted

[3] https://play.google.com/store/apps/details?id=de.ecsec.FiftyFifty&pcampaignid=MKT-Other-global-all-co-prtnr-py-PartBadge-Mar2515-1

mobility solution concept, while Figure 8 shows the current architectural overview, including the enhancements provided by the mGov4EU project.

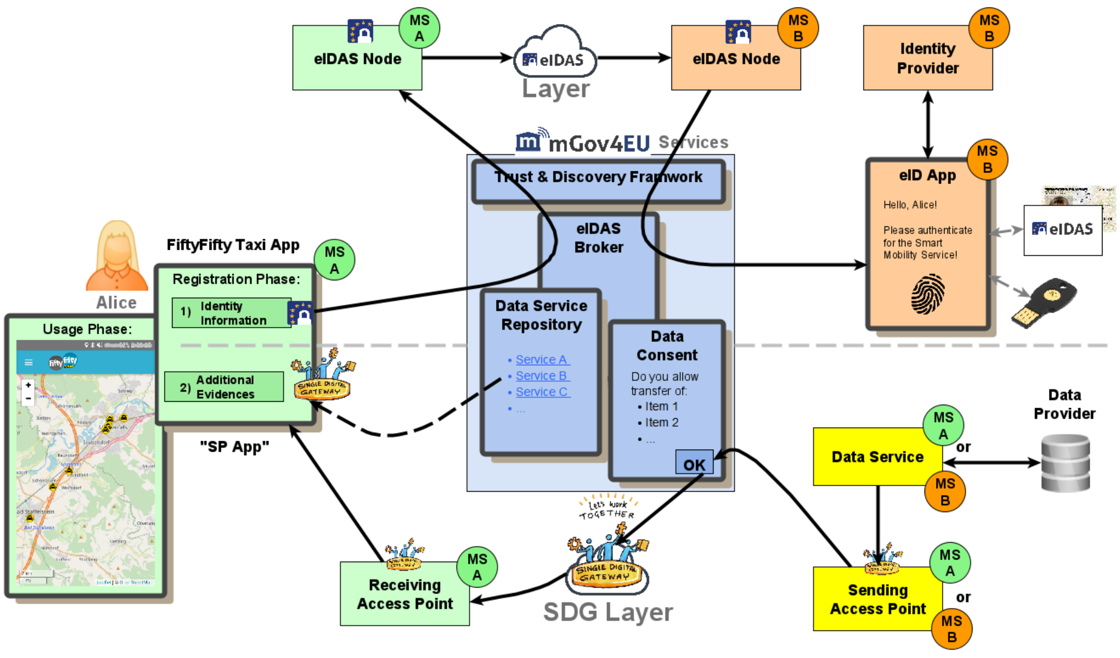

Figure 7: Overview of the Smart Mobility Pilot

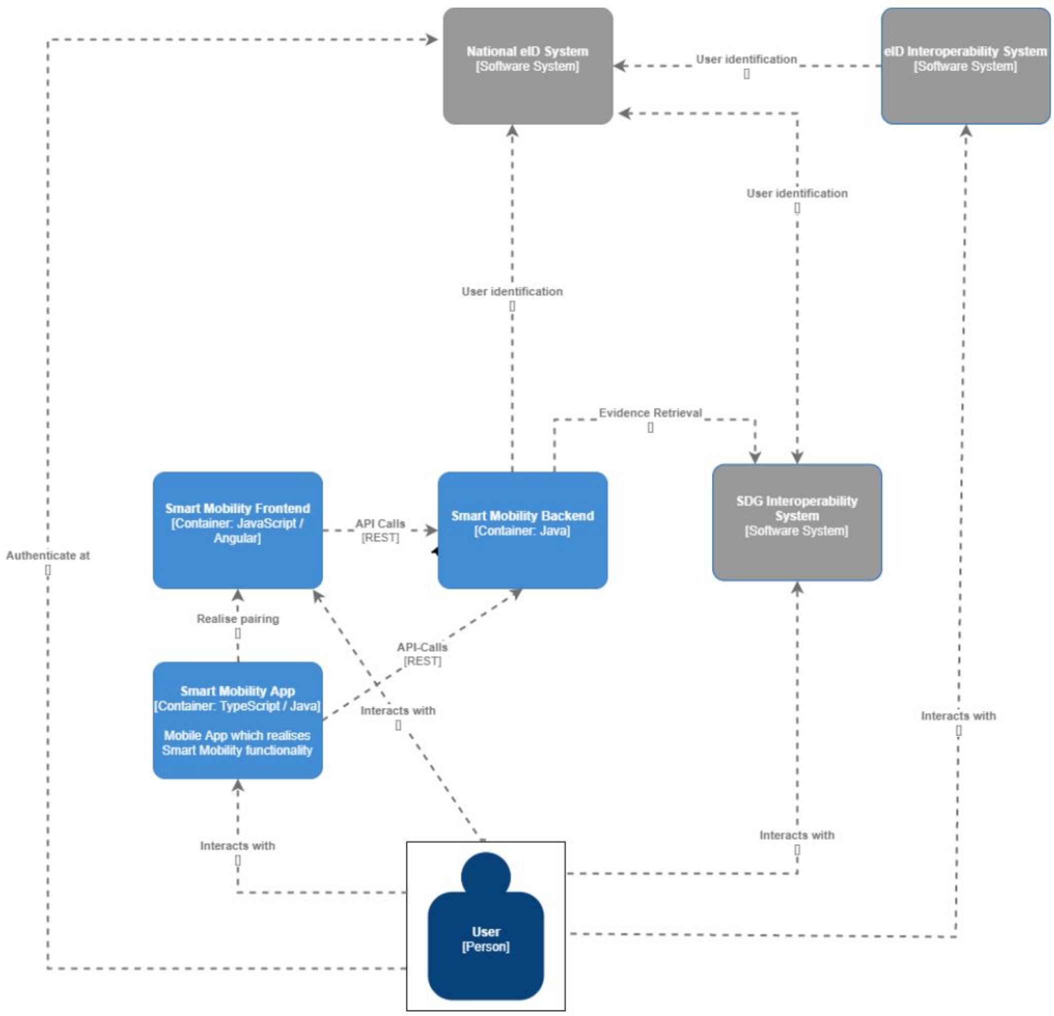

Figure 8: High-Level Architecture of the Smart Mobility Pilot

The mGov4EU Smart Mobility Pilot will thus make use of eIDAS compliant eIDs for mobile applications, following a mobile-first approach. Based on the respective eID, a set of credentials can be derived, which are then used for authentication. From a cross-border perspective, the pilot incorporates selected notified eID schemes, enabling foreign eIDs to be used within the pilot.

Table 1 lists the name of accepted indicators together with their source of origin and a longer description. This is an overview of the indicators that will be used to measure and evaluate the Smart Mobility Pilot.

Indicator	**Source /Nature**	**Description**	**Success Metric**
Ease of Use (Customer) - eID sub-process	interview/survey/focus group **Technical**	Likert scale rating the ease of use of the application.	On a 7point Likert scale (7=max ease of use, 1= min. ease of you) the average user feedback should be 4 or above.
Technical ease of Integration of e-ID (openID Connect, SAML)	interview/survey/focus group of design partners **Technical**	How difficult is it to integrate a new member state into the system? (Description of obstacles)	Number of obstacles solved vs number of obstacles identified (at least 60%)
Degree of freedom concerning the license	Interview/comparison with framework **Theoretical**	Use software licensing frameworks - Designers have to state their licenses	The license is given for all software systems, which are being used. At least 50% of all licenses are open access.
Openness	System / **Technical**	number of foreign eIDs that are integrated for testing	At least 2 foreign eIDs are integrated for testing.
Registration time	mobility application System / **Technical**	the time it takes to register using a foreign eID	It will on average take under 1 minute to register using a foreign eID.
Mutual Learning of Project Partners	Survey or Interview of Project Partners/ **Theoretical**	Degree of mutual learning between project partners and qualitative results on concrete learnings	On a 7-point Likert scale (7=max mutual learning) the average user input should be 5 or above.

Indicator	Source /Nature	Description	Success Metric
Knowledge Transfer from other disciplines	Survey or Interview of Project Partners/ **Theoretical**	Degree of mutual learning between project partners and qualitative results on concrete transfers	See above Mutual learning processes take place between science and practice
Success rate	System / **Technical**	Number of failed transactions or transactions that could not be finished in comparison of total numbers	Failed transactions are less than 1% of all transactions.
Time efficiency	System / **Technical**	Time or steps needed for registration in comparison to existing systems	At least 50% faster/sleaker registration in comparison to manual registration.

Table 1: Initial set of indicators for evaluating the smart mobility pilot

2.3.2 *Mobile Signature Pilot*

The Mobile Signature Pilot aims to provide a user-friendly way to create advanced and qualified electronic mobile signatures according to the eIDAS regulation. It will support the user-controlled provisioning of documents and the creations of signatures. This pilot aspires to optimize the use of advanced signatures with existing workflows. In addition, the pilot will demonstrate how it will simplify workflows by improving the ease of use of using European mobile signatures without the need for signature cards.

The mobile signature pilot will demonstrate the use case “international contract signing procedures”. It will showcase how the procedure can be done with multiple signatories and eIDs from different EU member states and cross-border data exchange processes with a mobile solution (see Figure 9).

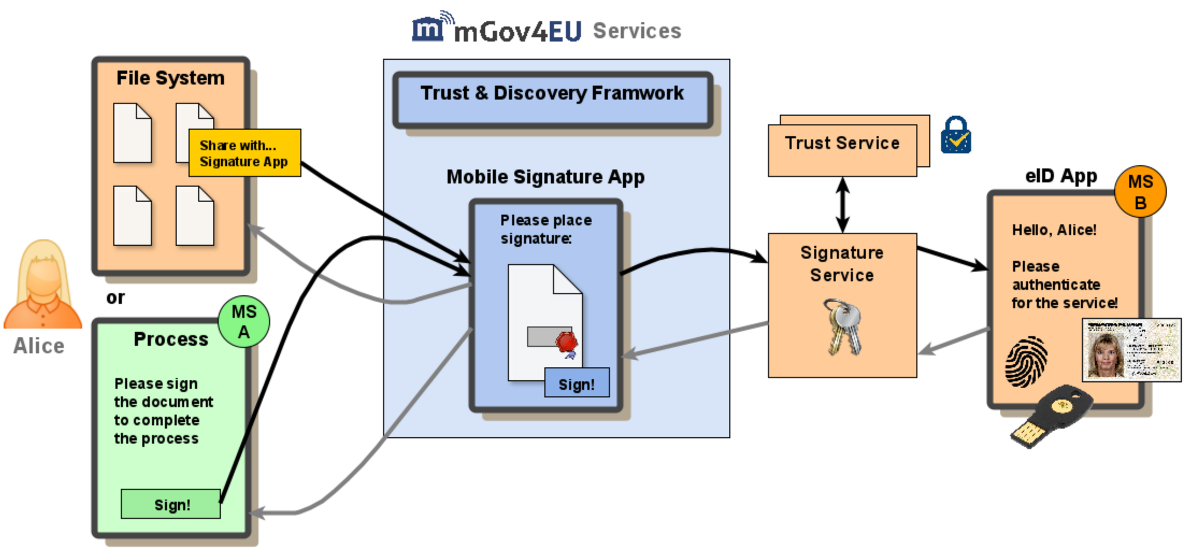

Figure 9: Overview of the Mobile Signature Pilot

The pilot will be using mobile technologies with the mobile signature. It will be using the eIDAS layer in two ways. First, it will use the capabilities of the system for advanced and qualified signatures. Second, it will ensure that the e-signatures are based on the eIDAS regulations. The pilot will be supporting the SDG principles by allowing the user to have control over what data is shared when signing a document, however, it will not be using the SDG layer explicitly. Regarding the cross-border aspect, it will demonstrate how various eIDs from different member states can sign the consortium agreements.

From a technical point of view, the mobile signature pilot will be using two main building blocks. The eID Interoperability system and the eSignature Interoperability System. The eID Interoperability system currently plans to have the ability to use an extended eIDAS framework with mobile devices for eIDAS based mobile cross-border authentication. In addition, it may be possible to authenticate through a digital wallet, where the user has control over their eID attributes.

The eSignature Interoperability System has four planned features at this point in time. First, it will be able to create AdES signatures. Second, it will be able to create an authorization of a seal signature with contact-less cards. For example, with the German eID. Third, it could create the authorization of a seal signature with a derived credential from a contact-based eID card (e.g., the Estonian eID, Belgium eID). Fourth, it will allow the dispatching of signature generation of different sub-systems depending on the home country of the user (see Figure 10).

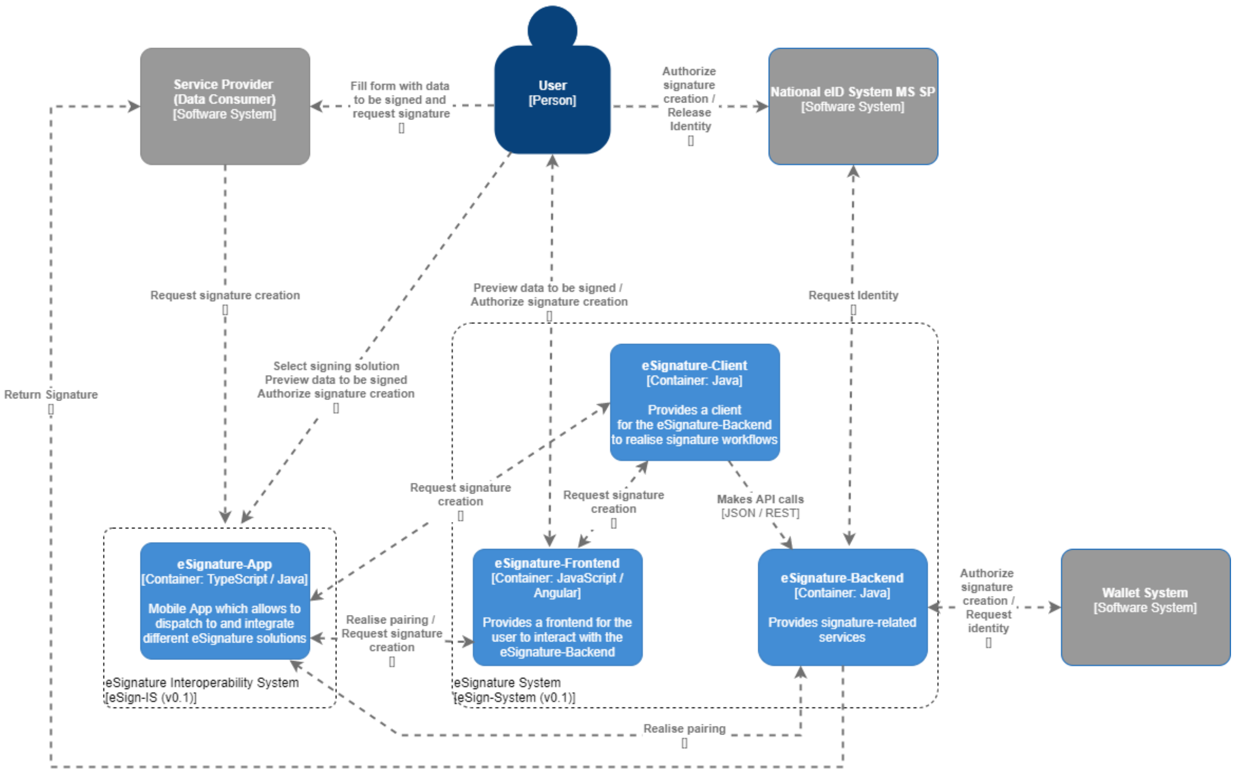

Figure 10: High-Level Architecture of the Mobile Signature Pilot

Table 2 lists the name of accepted indicators together with their source of origin and a longer description. This is an overview of the indicators that will be used to measure and evaluate the Mobile Signature Pilot.

Indicator	**Source /Nature**	**Description**	**Success Metric**
Time Efficiency for	Different versions	Compares different approaches to minimizing interactions and to avoid	Measure how many contexts switches you have in the process. Maximum 1 context

Indicator	**Source /Nature**	**Description**	**Success Metric**
Users	**Theoretical**	context switches for the user	switch foreseen.
Disciplines involved in the Design of the Pilot	Interviews/ **Theoretical**	Number of disciplines included in existing taxonomies	At least three disciplines from “X” taxonomy. (eg. Austrian discipline taxonomy)
Number of National Signing Solutions Integrated	Interviews/ **Theoretical**	Number of different member states that can potentially use the pilot	A minimum of 2 national signing solutions integrated. At least 2 foreign eIDs are integrated for testing.
Number of Connected Signature Solutions	Interviews/ **Theoretical**	Number of existing signature solutions that can be integrated into the solution	A minimum of 2 connected signing solutions integrated.
Mutual Learning of Project Partners	Survey or Interview of Project Partners/ **Theoretical**	Degree of mutual learning between project partners and qualitative results on learning outcomes	On a 7-point Likert scale (7=max mutual learning) the average user input should be 5 or above.
Stakeholder motivation for participation	Survey or Interview with stakeholder board/ **Theoretical**	Degree of stakeholder motivation of stakeholders and qualitative results on concrete motivational examples	Extract expectations, points from interviews WP2, then confirm these with advisory board members via interviews and then compare how many of these were actually covered by the developed pilot (e.g., 3 out of 12)
User Base	System / **Technical**	Number of national and cross-border users	At least 10 users were involved from at least 2 different member states.

Indicator	Source /Nature	Description	Success Metric
User Adoption	System / **Technical**	Cases signed per user	Each user signed on average at least 2 cases.
Number of signatures	System / **Technical**	Number of created signatures within a certain timespan	In the test system at least 100 signatures were created during the pilot phase.
Success rate	System / **Technical**	Number of successful transactions or transactions that could be finished in comparison of total numbers	Failed transactions are less than 1% of all transactions.
Time efficiency	System / **Technical**	Time or steps needed for registration in comparison to existing signature systems	At least 10% faster/sleaker registration in comparison to an alternative system based on video-identification.

Table 2: Initial set of indicators for evaluating the mobile signature pilot

2.3.3 I-voting Pilot

Despite the recurring rise of populism and similar democratic deficits, modern democracies still heavily rely on the rotation of officials and cabinets, which is realized with regular elections. 2016 and 2017 cyberattacks and attempts to “hijack” US elections reemphasized the necessity to ensure the security and privacy of the electoral process in the Digital Era. This usually implies the confidentiality of voters’ personal data and the integrity of the casted votes.

However, these principles are cued a bit later within the electoral process, the initial stage is authentication. This authentication stage might be simultaneously the most vulnerable for attacks and manipulations especially in the context of online voting due to third-party applications, violation of the un-coercibility principle, and identity theft.

Nevertheless, the situation is not as dire as it is described, there is a solution embedded into the i-voting pilot use case, which will not only help to overcome the above-mentioned hazards and challenges but also it could make EU-level elections more seamless and convenient for the electorate. The solution, offered by the mGov4EU project, is based on electronic national identifiers for authentication (eID) that were recognized by the corresponding governments within the eIDAS interoperability framework and has a premise, consideration that a person might have several eIDs. To simplify the procedures, for the i-voting pilot a self-registration of voters is foreseen. The databases used by different administrations in the Member States are primarily designed for specific cases or services. The register’s underlying structure is often set up before generic rules for exchanging eIDs, such as in the eIDAS regulation, are established. This causes a gap of attributes that allows an automated exchange of information and mapping of identities. This gap - as a generic issue - was identified by the EC, the SDGR-Coordination Group and the mGov4EU project (D1.1). Hence, the first step is to provide a unique mapping between a person (e.g., a voter) and their identifiers, which could be obtained from various EU MSs. The second step is then to incorporate the mapping into a solution (e.g., a web-based application) that can be used by the platform for i-voting. As the issue was already identified in the context of the amendment of the eIDAS regulation it is expected that a general solution will be provided as part of the new eIDAS regulation and can be reused for the mGov4EU project. This architecture would provide additional safeguards for personal data privacy and ballot secrecy since it will be based on already tested and proven systems.

Complementary subtasks will be the gathering of voter authorizations, issued by one or more entities that will have the function to authorize voters to vote for a given election. These voter authorizations will be obtained by requesting the voter's consent to access them using the SDG-Layer. Another possible, optional, subtask is the signature of the vote using the signature services provided by the project. Finally, the last aspect is that since the pilot has far-reaching goals, information about the electorate's overall perception of the interface and/or voting process would benefit the establishment of the final product.

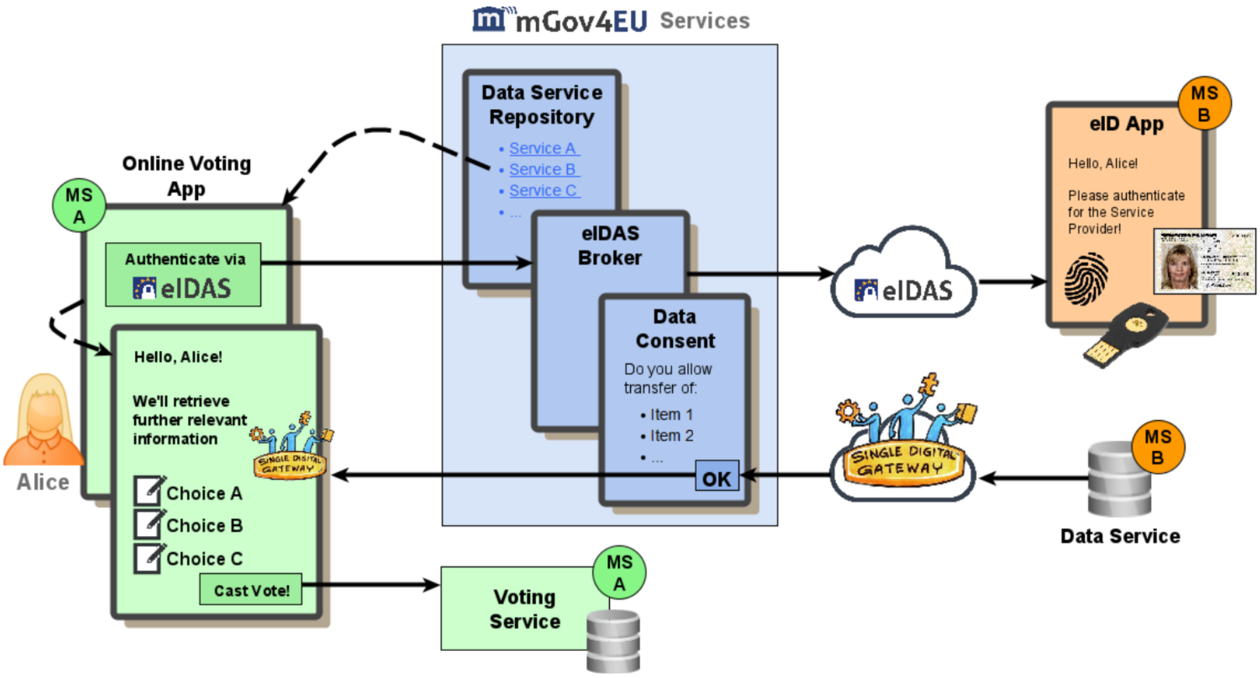

Figure 11: Overview of the I-Voting Pilot

The i-voting pilot will enable voters to cast votes and to verify that they are cast as intended, i.e., that the content of the vote cast is really the one introduced by the voter in the voting device. As depicted in Figure 12, the cast of votes and validation of votes will make use of the eIDAS identification mechanism. Also, the cast of votes will make use of the SDG interoperability system to retrieve voter authorizations and, as an optional task in the project, it might use the eSignature system to sign the vote to be cast.

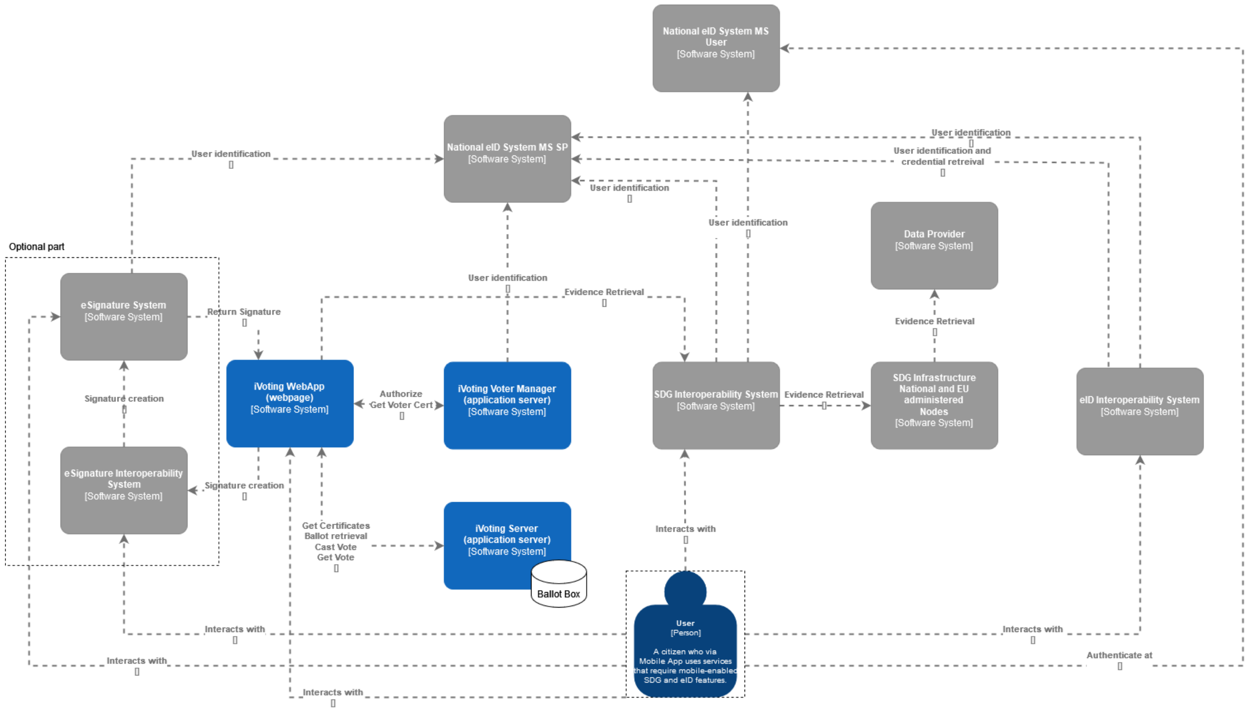

Figure 12: High-Level Architecture of the i-Voting Pilot

Both objectives will be reached with the help of i-voting pilots. These pilots are crucial to the project's overall success for two main reasons. Firstly, it is a *litmus paper* -- it will support or falsify our initial theoretical assumption about the feasibility of the person-eID mapping; if the pilot is not successful within the walls of the University of Tartu, then it should be reconsidered and updated. Secondly, the pilot and universities constitute the electoral circumstances, which are almost identical to real-life electoral politics, but on a smaller scale and thus with fewer aftermaths and stakes. Here, if the pilot proves its consistency and sustainability, it can be replicated on a bigger scale.

Table 3 lists the name of accepted indicators together with their source of origin and a longer description. This is an overview of the indicators that will be used to measure and evaluate the i-Voting Pilot.

Indicator	**Source/Nature**	**Description**	**Success Metric**
How many steps/descriptions of the process	the i-voting system, identity provider system/ **Theoretical**	The indicator is a conceptual assessment tool since it is based on the preparatory theoretical framework and the design prepared by the identity provider.	At least 10% faster/sleaker usage in comparison to a yet to be defined alternative system.

Indicator	**Source/Nature**	**Description**	**Success Metric**
How long is the whole voting process? (authentication, vote casting, ballot procurement, etc.)	i-voting system/ **Technical**	This indicator might help to assess the speed of response of the web-based voting application. The measurements can be done with the authentication and vote casting data. Moreover, this data could be combined and analysed with user satisfaction, thus allowing us to conduct the basic statistical test, e.g., a correlation between the duration of the voting procedure and user satisfaction might shed light if there is an association of any sort.	It will on average take under 1 minute to cast your vote in the system and complete the process.
Authentication success rate	i-voting system /e-id system/ **Technical**	Authentication attempts are calculated by the i-voting system and presented as several attempts to sign in with eID. Hence, the authentication success rate is a derivative, which divides the number of successful authentications by the overall attempts.	Failed authentications are less than 1% of all authentications.
How long does it take to cast a vote after pushing the cast button?	i-voting system/**Technical**	On the technical level, this is the time passed since the voter pushes the cast button until a voting receipt is obtained. During this time the final encrypted vote is created, sent to the voting server, received by the server, and acknowledged with the receipt.	It will on average take under 10s from submission to registration.
How to ensure the privacy of the casting vote?	the architecture/ **Technical & Theoretical**	At this stage of pilot development, we cannot elaborate on the technical privacy aspect. For that, we need to consult with security evaluation algorithms.	*This can be taken from the security evaluation framework and the actual sec. evaluation*
How many voters complete the process?	i-voting system/**Technical**	This should be not only the number of authenticated voters or the votes cast. The golden mean is to count voters who went through all the stages mentioned in the respective indicator.	Retention rate (voters completing the process vs. voters using the system vs. retention rate) >80%

Indicator	Source/Nature	Description	Success Metric
Frequency of use of SDG – frequency curve / cross-border SDG use	i-voting system/ **Technical & Theoretical**	Can be retrieved from the service provider app. Time and logs, to compute the frequency. See how much it lasts, how many are possible.	Frequency (requests per minute)
Usage of SDG attributes	i-voting system	Which attributes are used for the i-voting pilot for what purpose	Voter authorizations. They are used to authorize a voter to vote in a certain election
How did you integrate the different stakeholder viewpoints?	piloting partner/architecture and building block partners/ **Theoretical**	Even though the size of the consortium is impressive and partners are coming from different fields and areas, we do not strive to isolate mGov4EU from stakeholders' opinions and critiques.	Quantification in the number of interviews conducted (before and/or after piloting) and the background of the interviewees
How representative is the electorate?	users/ **Technical & Theoretical**	The open-call nature of sample formation is biased towards the exclusion of some electorate cohorts. Nevertheless, we are still eager to assess the degree of representativeness of the voters on the basis of age, gender, nationality, etc. This indicator might not affect the pilots in other universities since it is not the number one priority, yet it will be considered after the pilots for the final product.	Collection of demographics of participants to showcase diversity
User satisfaction	Users, i-voting system/ **Technical & Theoretical**	This indicator can be realized as a pop-up window appearing after the vote is cast. The window will have a short survey with a Likert scale, assessing the components of the voting process. How did the latency impact the user experience? This question could be incorporated in the same pop-up	On a 7point Likert scale (7=max satisfaction, 1= min. satisfaction (dissatisfaction)) the average user feedback should be 5 or above.

Indicator	Source/Nature	Description	Success Metric
		short survey. What kind of connectivity does the user have? The last criterion, which is related to the survey, might be a multiple-choice question with types of connectivity: cellular internet, domestic or public WiFi, etc.	

Table 3: Initial set of indicators for evaluating the i-voting pilot

Chapter 3 Summary and Conclusion

The objective of this deliverable, based on its definition in the DoA, was the documentation of the developed evaluation framework, including methods, processes, and tools necessary to conduct the iterative pilot evaluations. We thus started to describe the methodological approach chosen to develop the first draft of the evaluation framework. For doing this, we presented the three distinct steps, i.e., alignment, literature review, and pilot workshops, which led to the derived set of indicators. Each step was described in detail and how it contributes to the overall activities in T5.1 towards the creation of D5.2. We then presented the condensed findings from the literature concerning the overall concept of transdisciplinarity and its role within the pilot evaluation of mGov4EU. This was then followed by a description of the current status quo of the pilot definitions, as well as an overview of so far identified pilot-specific indicators. It should be noted again at this point, that the development of the pilot definitions is still ongoing, thus, the development of this initial evaluation framework works against a moving target to some degree. The partners involved in the evaluation will thus closely monitor the further development during the second project year and will adapt and modify the framework where necessary to reflect the demands of the pilots in terms of evaluation accordingly.

The quantified metrics defined per pilot in this deliverable are providing the basis for the upcoming two evaluation rounds in T5.1, i.e. D5.5 and D5.7 in M25 and M36 respectively. They will not only show the level of success for each pilot in the general scope of the project, but also concerning each individual focus point of the selected piloting area. They thus complement the results from the security evaluation, as well as the legal and ethical evaluation in WP5. In addition, the lessons-learned from the evaluation(s) will serve as a solid basis to describe the necessary processes to further enhance existing results and accelerate areas with future potenial in the sustainability and governance plan of the project, handled in T2.7 and documented in D2.8 respectively.

Chapter 4 Bibliography

[1] A. C. T. Klock, I. Gasparini, and M. S. Pimenta, ‘5W2H Framework: a guide to design, develop and evaluate the user-centered gamification’, in *Proceedings of the 15th Brazilian Symposium on Human Factors in Computing Systems*, 2016, pp. 1–10.

[2] A. Heilmann and S. Reinhold, ‘Evaluation of a Transdisciplinary Research Project for a Sustainable Development’, in *Handbook of Theory and Practice of Sustainable Development in Higher Education*, W. Leal Filho, C. Skanavis, A. do Paço, J. Rogers, O. Kuznetsova, and P. Castro, Eds. Cham: Springer International Publishing, 2017, pp. 201–214. doi: 10.1007/978-3-319-47889-0_15.

[3] T. M. de Oliveira, L. Amaral, and R. C. dos S. Pacheco, ‘Multi/inter/transdisciplinary assessment: A systemic framework proposal to evaluate graduate courses and research teams’, *Res. Eval.*, vol. 28, no. 1, pp. 23–36, Jan. 2019, doi: 10.1093/reseval/rvy013.

[4] J. Zscheischler, S. Rogga, and A. Lange, ‘The success of transdisciplinary research for sustainable land use: individual perceptions and assessments’, *Sustain. Sci.*, vol. 13, no. 4, pp. 1061–1074, Jul. 2018, doi: 10.1007/s11625-018-0556-3.

[5] S. Hoffmann, C. Pohl, and J. G. Hering, ‘Methods and procedures of transdisciplinary knowledge integration: empirical insights from four thematic synthesis processes’, *Ecol. Soc.*, vol. 22, no. 1, p. art27, 2017, doi: 10.5751/ES-08955-220127.

[6] S. Hoffmann, C. Pohl, and J. G. Hering, ‘Exploring transdisciplinary integration within a large research program: Empirical lessons from four thematic synthesis processes’, *Res. Policy*, vol. 46, no. 3, pp. 678–692, Apr. 2017, doi: 10.1016/j.respol.2017.01.004.

[7] A. Wiek, S. Talwar, M. O’Shea, and J. Robinson, ‘Toward a methodological scheme for capturing societal effects of participatory sustainability research’, *Res. Eval.*, vol. 23, no. 2, pp. 117–132, Apr. 2014, doi: 10.1093/reseval/rvt031.

[8] T. Jahn and F. Keil, ‘An actor-specific guideline for quality assurance in transdisciplinary research’, *Futures*, vol. 65, pp. 195–208, Jan. 2015, doi: 10.1016/j.futures.2014.10.015.

[9] E. Pyshkin, ‘Designing Human-Centric Applications: Transdisciplinary Connections with Examples’, in *2017 3rd IEEE International Conference on Cybernetics (CYBCONF)*, Exeter, United Kingdom, Jun. 2017, pp. 1–6. doi: 10.1109/CYBConf.2017.7985774.

[10] F. R. Eanes, J. M. Silbernagel, D. A. Hart, P. Robinson, and M. Axler, ‘Participatory mobile- and web-based tools for eliciting landscape knowledge and perspectives: introducing and evaluating the Wisconsin geotools project’, *J. Coast. Conserv.*, vol. 22, no. 2, pp. 399–416, Apr. 2018, doi: 10.1007/s11852-017-0589-2.

[11] C. R. Binder, I. Absenger-Helmli, and T. Schilling, ‘The reality of transdisciplinarity: a framework-based self-reflection from science and practice leaders’, *Sustain. Sci.*, vol. 10, no. 4, pp. 545–562, 2015.

[12] R. W. Scholz, D. J. Lang, A. Wiek, A. I. Walter, and M. Stauffacher, ‘Transdisciplinary case studies as a means of sustainability learning: Historical framework and theory’, *Int. J. Sustain. High. Educ.*, 2006.

[13] D. J. Lang *et al.*, ‘Transdisciplinary research in sustainability science: practice, principles, and challenges’, *Sustain. Sci.*, vol. 7, no. 1, pp. 25–43, 2012.

[14] A. L. Carew and F. Wickson, ‘The TD wheel: a heuristic to shape, support and evaluate transdisciplinary research’, *Futures*, vol. 42, no. 10, pp. 1146–1155, 2010.

[15] T. Bruhn, J. Herberg, G. Molinengo, D. Oppold, D. Stasiak, and P. Nanz, ‘Grounded Action Design. A Model of Scientific Support for Processes to Address Complex Challenges. A Concept Developed by the Research Project Co-creation and Contemporary Policy Advice’, 2019.

[16] J. Zscheischler, S. Rogga, and T. Weith, ‘Experiences with transdisciplinary research: sustainable land management third year status conference’, *Syst. Res. Behav. Sci.*, vol. 31, no. 6, pp. 751–756, 2014.

[17] O. Renn, ‘Transdisciplinarity: Synthesis towards a modular approach’, *Futures*, vol. 130, p. 102744, 2021.

[18] S. Serrao-Neumann *et al.*, ‘One human settlement: A transdisciplinary approach to climate change adaptation research’, *Futures*, vol. 65, pp. 97–109, 2015.

[19] A. I. Walter, S. Helgenberger, A. Wiek, and R. W. Scholz, ‘Measuring societal effects of transdisciplinary research projects: Design and application of an evaluation method’, *Eval. Program Plann.*, vol. 30, no. 4, pp. 325–338, Nov. 2007, doi: 10.1016/j.evalprogplan.2007.08.002.

[20] B. Wolf, T. Lindenthal, M. Szerencsits, J. B. Holbrook, and J. Heß, ‘Evaluating research beyond scientific impacthow to include criteria for productive interactions and impact on practice and society’, *GAIA-Ecol. Perspect. Sci. Soc.*, vol. 22, no. 2, pp. 104–114, 2013.

[21] J. T. Klein, ‘Evaluation of Interdisciplinary and Transdisciplinary Research’, *Am. J. Prev. Med.*, vol. 35, no. 2, pp. S116–S123, Aug. 2008, doi: 10.1016/j.amepre.2008.05.010.

[22] J. Ormiston, ‘Blending practice worlds: Impact assessment as a transdisciplinary practice’, *Bus. Ethics Eur. Rev.*, vol. 28, no. 4, pp. 423–440, Oct. 2019, doi: 10.1111/beer.12230.

[23] B. M. Belcher, K. E. Rasmussen, M. R. Kemshaw, and D. A. Zornes, ‘Defining and assessing research quality in a transdisciplinary context’, *Res. Eval.*, vol. 25, no. 1, pp. 1–17, Jan. 2016, doi: 10.1093/reseval/rvv025.

[24] L. G. Pinto and P. Ochôa, ‘Information science’s contributions towards emerging open evaluation practices’, *Perform. Meas. Metr.*, 2018.

[25] E. Piggot-Irvine and D. Zornes, ‘Developing a Framework for Research Evaluation in Complex Contexts Such as Action Research’, *SAGE Open*, vol. 6, no. 3, p. 215824401666380, Jul. 2016, doi: 10.1177/2158244016663800.

[26] M. Pregernig, ‘Transdisciplinarity viewed from afar: Science-policy assessments as forums for the creation of transdisciplinary knowledge’, *Sci. Public Policy*, vol. 33, no. 6, pp. 445–455, 2006.

[27] P. Scherhaufer, ‘Better research through more participation? The future of integrated climate change assessments’, *Futures*, vol. 125, p. 102661, 2021.

[28] G. W. Harper, L. C. Neubauer, A. K. Bangi, and V. T. Francisco, ‘Transdisciplinary research and evaluation for community health initiatives’, *Health Promot. Pract.*, vol. 9, no. 4, pp. 328–337, 2008.

[29] A. Zabaniotou, O. Boukamel, and A. Tsirogianni, ‘Network assessment: Design of a framework and indicators for monitoring and self-assessment of a customized gender equality plan in the Mediterranean Engineering Education context’, *Eval. Program Plann.*, vol. 87, p. 101932, Aug. 2021, doi: 10.1016/j.evalprogplan.2021.101932.

[30] B. M. Belcher, L. F. Ramirez, R. Davel, and R. Claus, *Retraction: A response to Hansson and Polk (2018)“Assessing the impact of transdisciplinary research: The usefulness of relevance, credibility, and legitimacy for understanding the link between process and impact”*. Oxford University Press, 2019.

[31] D. Stokols *et al.*, ‘Evaluating transdisciplinary science’, *Nicotine Tob. Res.*, vol. 5, no. Suppl_1, pp. S21–S39, 2003.

[32] J. T. Klein, ‘Afterword: the emergent literature on interdisciplinary and transdisciplinary research evaluation’, *Res. Eval.*, vol. 15, no. 1, pp. 75–80, 2006.

[33] A. Kliskey *et al.*, 'Thinking big and thinking small: A conceptual framework for best practices in community and stakeholder engagement in food, energy, and water systems', *Sustainability*, vol. 13, no. 4, p. 2160, 2021.

[34] M. Hitziger *et al.*, 'EVOLvINC: EValuating knOwLedge INtegration Capacity in multistakeholder governance', *Ecol. Soc.*, vol. 24, no. 2, p. art36, 2019, doi: 10.5751/ES-10935-240236.

[35] R. Axelsson *et al.*, 'The Challenge of Transdisciplinary Research: A Case Study of Learning by Evaluation for Sustainable Transport Infrastructures', *Sustainability*, vol. 12, no. 17, p. 6995, Aug. 2020, doi: 10.3390/su12176995.

[36] P. Chillakanti, S. Ekwaro-Osire, and A. Ertas, 'Evaluation of Technology Platforms for Use in Transdisciplinary Research', *Educ. Sci.*, vol. 11, no. 1, p. 23, Jan. 2021, doi: 10.3390/educsci11010023.

[37] J. M. Holzer *et al.*, 'Evaluating transdisciplinary science to open research-implementation spaces in European social-ecological systems', *Biol. Conserv.*, vol. 238, p. 108228, Oct. 2019, doi: 10.1016/j.biocon.2019.108228.

[38] L. Woltersdorf, P. Lang, and P. Döll, 'How to set up a transdisciplinary research project in Central Asia: description and evaluation', *Sustain. Sci.*, vol. 14, no. 3, pp. 697–711, May 2019, doi: 10.1007/s11625-018-0625-7.

[39] L. Verwoerd, P. Klaassen, S. C. van Veen, R. De Wildt-Liesveld, and B. J. Regeer, 'Combining the roles of evaluator and facilitator: Assessing societal impacts of transdisciplinary research while building capacities to improve its quality', *Environ. Sci. Policy*, vol. 103, pp. 32–40, Jan. 2020, doi: 10.1016/j.envsci.2019.10.011.

[40] R. Schulte and A. Heilmann, 'Presentation and Discussion of an Evaluation Model for Transdisciplinary Research Projects', *Eur. J. Sustain. Dev.*, vol. 8, no. 3, p. 1, Oct. 2019, doi: 10.14207/ejsd.2019.v8n3p1.

[41] M. T. Gómez-Villarino and L. Ruiz-Garcia, 'Adaptive design model for the integration of urban agriculture in the sustainable development of cities. A case study in northern Spain', *Sustain. Cities Soc.*, vol. 65, p. 102595, Feb. 2021, doi: 10.1016/j.scs.2020.102595.

[42] S. Williams and J. Robinson, 'Measuring sustainability: An evaluation framework for sustainability transition experiments', *Environ. Sci. Policy*, vol. 103, pp. 58–66, Jan. 2020, doi: 10.1016/j.envsci.2019.10.012.

[43] M. Trimble and R. Plummer, 'Participatory evaluation for adaptive co-management of social–ecological systems: a transdisciplinary research approach', *Sustain. Sci.*, vol. 14, no. 4, pp. 1091–1103, Jul. 2019, doi: 10.1007/s11625-018-0602-1.

[44] L. Gaspar Pinto and P. Ochôa, 'Information science's contributions towards emerging open evaluation practices', *Perform. Meas. Metr.*, vol. 20, no. 1, pp. 2–16, Feb. 2019, doi: 10.1108/PMM-05-2018-0015.

[45] B. König, K. Diehl, K. Tscherning, and K. Helming, 'A framework for structuring interdisciplinary research management', *Res. Policy*, vol. 42, no. 1, pp. 261–272, Feb. 2013, doi: 10.1016/j.respol.2012.05.006.

[46] L. Schmidt, T. Falk, M. Siegmund-Schultze, and J. H. Spangenberg, 'The Objectives of Stakeholder Involvement in Transdisciplinary Research. A Conceptual Framework for a Reflective and Reflexive Practise', *Ecol. Econ.*, vol. 176, p. 106751, Oct. 2020, doi: 10.1016/j.ecolecon.2020.106751.

[47] S. Hansson and M. Polk, 'Assessing the impact of transdisciplinary research: The usefulness of relevance, credibility, and legitimacy for understanding the link between process and impact', *Res. Eval.*, vol. 27, no. 2, pp. 132–144, Apr. 2018, doi: 10.1093/reseval/rvy004.

[48] S. D. Hohl, S. Knerr, and B. Thompson, 'A framework for coordination center responsibilities and performance in a multi-site, transdisciplinary public health research initiative', *Res. Eval.*, vol. 28, no. 3, pp. 279–289, Jul. 2019, doi: 10.1093/reseval/rvz012.

[49] I. Kalinauskaite, R. Brankaert, Y. Lu, T. Bekker, A. Brombacher, and S. Vos, ‘Facing Societal Challenges in Living Labs: Towards a Conceptual Framework to Facilitate Transdisciplinary Collaborations’, *Sustainability*, vol. 13, no. 2, p. 614, Jan. 2021, doi: 10.3390/su13020614.

[50] D. Stokols, S. Misra, R. P. Moser, K. L. Hall, and B. K. Taylor, ‘The Ecology of Team Science’, *Am. J. Prev. Med.*, vol. 35, no. 2, pp. S96–S115, Aug. 2008, doi: 10.1016/j.amepre.2008.05.003.

[51] E. A. Moallemi *et al.*, ‘Evaluating Participatory Modeling Methods for Co-creating Pathways to Sustainability’, *Earths Future*, vol. 9, no. 3, Mar. 2021, doi: 10.1029/2020EF001843.

Chapter 5 Annex

Transdisciplinarity Phase	Indicators from Literature
Real-world context	Should meet policy interests
	Research manifest in actual practice
	Perceived importance of the events
	How likely would you be to use the application outside the context of the project?
	Was a project sustainable and future focused?
	Completion of planned project milestones
	A follow up project can be acquired
	Dissemination of project results
	Used resources effectively
	Was a project robust and rigorous
	Popularity of the project in the corresponding expert community
	The project develops implementable solutions for practice
Interdisciplinary research	Do members work or are involved in activities related to diversified fields?
	How many fields are being integrated?
	Are the journals or other ways of dissemination of production classified in diverse fields?
	Diversity in workshops (nationality-gender-scientific expertise)
	How many articles or other scientific predoc's have diverse co-authorship?
	Do the products combine knowledge from different fields?
	Do members have diversity in their academic degrees?
	Is there diversity in the research methods?
	Variability of goals - epistemological or methodologic forms, product development, pragmatic problem solving
	Impacts from literature
	Are articles cited or cite diverse fields (cross-disciplinary citations)
Beyond Science	Stakeholder capacities, power relations
	Representation of all relevant opinions and perspectives
	Is the project supported by relevant expert opinion/knowledge
	Participation of extra-academic professionals
	Alignment between business and society
	Trust
	Collaborative readiness
	Should meet stakeholder preferences/interests
	Interaction between academia, productive sector and society
	Representatives from all important stakeholder groups are involved
	Science-practice cooperation on equal basis
	Was a project diverse and deliberative?
	Variability of criteria in indicators - experimental rigor, feedback to multiple fields, enhances research capability

	creation of new structures for multi-sector collaboration
Interaction	Negotiation, collective problem solving
	Distribution of ideas
	Collaboration between partners
	Productive interactions (e.g., direct communications, financial interactions)
	Affective effects, sense of relief/reassurance, sense of community belonging, building trust
	Network effect - new relationships, strengthened existing relationships
	Network building
	Leadership and coaching - shared decision making, consensus building
	Participatory events (number, type)
	Coordination of stakeholders
	Conflict reduction
	Stakeholder roles in events
	Iterative work to ensure collaborative inputs, transparency, and mobility of participants
	Networks created or expanded
	Enhanced research
	Fulfilment of critical participatory roles
	Interaction of social and cognitive factors in collaboration-managing tensions, negotiating among stakeholders
	Number of initiatives fostered by the working group
	Response rate for questionnaires
	New contacts
	Stakeholder motivation for participation
	Engagement of stakeholders
	Mapping out and resolving disagreement and conflict
	Level of involvement of stakeholders
	Discussion and opinion formation
	Consideration and processing of stakeholder input
	Adequate level of interaction
	Assess impact of collaboration
	Diversity of participatory activities
	Development of new collaborations
	Empowerment and technological ownership
	Assess trust and respect in the collaboration context
Integration	Engaging in mutual learning and joint activities
	Community created or expanded
	Mutual learning processes take place between science and practice
	Leveraging integration-strategies that promote communication and consensus
	Scientific knowledge can be gained
	Improved research capacity
	Changes in knowledge, understandings and skills
	Integrative participation of all authors in the construction of production

	new or improved professional relationships
	social consequences such as social dynamics, size of social network
	Efficiency of research conducted by partners
	Knowledge and information more accessible
	Distribution of knowledge (production and distribution of new ideas)
	Knowledge transfer
	Changes in attitude
	New insights and learning processes
	Trust in others - increase?
	Cognitive effects, new knowledge and enhanced capacities, transdisciplinary competence
	Acquired knowledge individual or collective knowledge transfer
	Assess satisfaction with collaboration
	Results from sub-projects merge into an overall synthesis
Relevance	Development of implementable solution for practice
	Applicability and translation of knowledge
	Increase the popularity of the issue
	Was a project reflexive and responsive
	Publications, citations, reads and shares on social media
	Perceptions of involved parties
	New agreements reached
	Policy changes
	Number of citations-patents-licenses-revenue generated
	What are the impacts and application of research?
	Changes in practice
	Positive experience participating in the project
	Is scientific production bringing solutions to complex real problems?
	High scientific publication output
	Policy decisions and agenda setting
	Actual use of technological outputs
	Was a project socially relevant and solutions oriented?
	Effectiveness and impact - inclusion of unpredictable long-term impacts
	Enhanced communication skills
	Was a project creative and elegant?
	Public goods/products produced
	New scientific methods and theories developed
	Behavioural changes
	Understandability / ease of communication
	Shift in organizational expectation
	Changes to management practices
	New institutional frameworks from research
	Policies/laws passed
	Project results are generalizable and transferable to other contexts
	Outputs-usable products, final reports, presentations, joint action plans

	New business models
	Infrastructure changes
	New knowledge and information incorporated in policy, strategy and plans
	Understanding of others (community identification, reflection and learning)
	Landscape shift (norms)
	Decisions made
	Changes in organizational culture
	Solutions implemented
	Ease of use of application