Promoting and Incentivising Federated, Trusted, and Fair Sharing and Trading of Interoperable Data ASsets

D5.2
Demonstrator's Activities Evaluation Results-First Report

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Abstract	This deliverable reports on the evaluation of the alpha version of the PISTIS platform, in accordance with the evaluation framework set out in D5.1. and provides direction for the next phase of the project.

Executive Summary

This deliverable marks the first use of the Evaluation Framework as set out in D5.1.

The deliverable reports on the technical evaluation of all that was available when the Alpha version of the PISTIS platform was released at M21.

It also checked that all the preparation work had been carried out at the demonstration sites, in order to smoothly proceed to the next phase of the project.

The Evaluation Framework also emphasised “evaluation as a management tool” and in this capacity, we revisited our “Theory of Change” for PISTIS and incorporated insights into how the project should evolve in the final year.

The technical testing showed that the Alpha Release of the platform served well its purpose of introducing the concept of PISTIS to the demonstrators and for letting them provide early feedback, while the overall potential of the platform as recorded by the demonstrators has been ranked as relatively high, as the majority of the features that were delivered fully were very well perceived.

A firm basis has been laid for moving forward for deploying and evaluating the Beta and Final versions.

Table of Contents

List of Figures

List of Tables

Terms and Abbreviations

ABAC	Attribute-based access control
AI	Artificial Intelligence
AIA	Athens International Airport
AODB	Airport Operations Database
AOBT	Actual off-block Time
API	Application programming interface
BIEO	Business, Innovation and Exploitation Objectives
BPMN	Business Process Model Notation
BR	Business requirements
CIM	Common information model
D	Deliverable
DAC	Discretionary access control
DER	Distributed energy resources
DIH	Digital Innovation Hub
DLT	Distributed Ledger Technology
DoA	Description of Action
DPIA	Data protection impact assessment
DSO	Distribution service operator
EaaS	Energy as a service
EOSDIS	Earth Observing System Data and Information System
ESG	Environmental, Social and Governance
EU	European Union
GDPR	General Data Protection Regulation
GIS	Geographic information system
GSE	Ground support equipment
IDSA	International Data Spaces Association
IEC	International Electrotechnical Commission
ISO	International Organisation for Standardisation
KPI	Key performance indicator
MCT	Model Contractual Terms
ML	Machine learning
MO	Market operator
MOOC	Massive Open Online Courses
MoSCoW	M - Must have, S - Should have, C - Could have, W - Won't have.
MVP	Maximum/Minimum Value Product
NASA	National Aeronautics and Space Administration
NFT	Non-fungible token
NIS	Network and Information Systems
NWP	Numerical weather prediction
OASA	Athens Public Transportation System
ODRL	Open Digital Rights Language
OEI	Other Ethics Issues

PoA	Proof of authority
PoW	Proof of work
PRM	Passengers with disabilities and reduced mobility
PV	Photo-voltaic
P2P	Peer-to-Peer
RTO	Research and Technology Organisation
SATA	Syndicate of taxi drivers of Attica
SCC	Standard Contractual Clauses
SLA	Service level agreement
SME	Small and Medium Sized Enterprises
STO	Scientific and Technical Objectives
TAM	Technology Acceptance Model
ToC	Theory of Change
TOBT	Target off-block time
TRL	Technology readiness level
WP	Work Package

1 INTRODUCTION

The Vision for the PISTIS project is to provide a reference federated data sharing/trading and monetisation platform for secure, trusted and controlled exchange and usage of proprietary data assets and data-driven intelligence based on open APIs and standardised components of known initiatives (IDSA[1], Gaia-X[2], etc.), that can be used jointly or autonomously enabling existing data space users to complement their existing services with the new methods arising from PISTIS and not forcing them to be abandoned.

It has two core parts, which are:

- the PISTIS Data Space Factory, which is deployed "locally" over each data space, and which holds all the Data, and;
- the PISTIS FAIR Data Trading & Value Exchange Monetisation Platform, which coordinates the Interaction between the Data Space Factories and oversees all data trading transactions and contracts.

The key participants involved are the data owners, data providers (and data subjects) identified as the data-supply side on the one hand, and the data consumers and data users (data-demand side) on the other hand.

We need to demonstrate that we have enabled richer and more robust insights, improved operations, whilst addressing concrete business problems and generating new business opportunities, through secure, seamless, and trustful data sharing among different stakeholders at a global scale.

[1] Home - International Data Spaces
[2] Home - Gaia-X: A Federated Secure Data Infrastructure

1.1 "WHAT IS INCLUDED IN PISTIS AND WHAT ISN'T."

Figure 1. below clarifies the scope of the PISTIS project indicating the boundaries of our work.

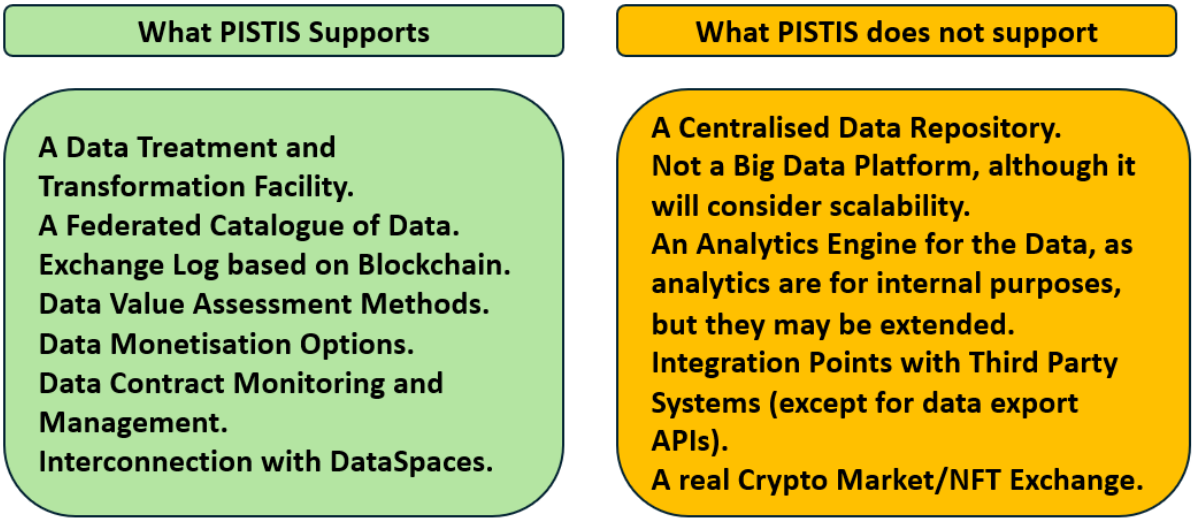


Figure 1: What PISTIS supports and doesn't support

1.2 THE INNOVATIVE ELEMENTS OF PISTIS

PISTIS involves four axes of innovation, illustrated in Figure 2. below.

The Four PISTIS Axes of Innovation

Federated Data Management, Interoperability & Governance which includes:

- Data Collection, Curation, Security and Control
- Syntactic, Semantic, Metadata Interoperability
- Data observability
- Data source certification mechanisms

Federated, Secure Data Sharing which includes:

- Secure peer-to-peer (encrypted/unencrypted) data transfer
- Data usage monitoring/tracking
- Multi-party contracts
- Contract Compliance/Enforcement

Data Valuation and Monetisation which includes:

- articulating and recommending data value,
- identifying data generation cost
- Identifying probable income and market dimensions

Data Sharing Skills Cultivation which includes:

- Training material to educate stakeholders around data sharing
- Empowerment to understand needs and identify gaps
- MOOCs

Figure 2: The Four PISTIS Axes of Innovation: Overview of work planned in WP5

The work package covers how we will demonstrate and evaluate the results of the project.

"D5.1 Demonstrators Evaluation Plan and Preparation Activities Report"[3] was the first of the intrinsically linked deliverables of "WP5: Multi-Layer Demonstrators Setup, Operation and Business Value Exploration".

It outlines the plan for assessing the impact of PISTIS in the demonstrators from a business, technical and legal perspective, and for reporting on preparation activities.

It set out to describe how we will evaluate both the pilots and the project as a whole. It provided the "Documentation of the evaluation framework and validation methodology, the definition of the various practices for recording feedback from the demonstration activities and included a set of test-cases to be executed by the demonstrator partners."

The work carried out in producing that deliverable brought to a conclusion the first phase in the work package, in which we set out how we will carry out the demonstrations and how we will evaluate them. This deliverable subsequently reflects work carried out in the second phase embracing the use of this framework to evaluate the alpha version of the platform.

This will be followed by the third phase which entails the production of the final evaluation at M40, with the resulting delivery of "D5.3.-Demonstrators' Activities Evaluation Results - Second Report".

This deliverable will also set out some of the planning for this forthcoming period, as the project matures.

1.3 Work underpinning this Deliverable.

The Task 5.1 – Verification and Validation Framework Definition and Baseline Impact Assessment provided the basic grounding for carrying out the evaluation exercises described later in this document. We created specific validation scenarios, associating them to sub-groups of Key Performance Indicators (KPIs) to properly address the specific circumstances of each pilot case, whilst also retaining a uniform evaluation of the project results.

The Evaluation Framework also focused on defining additional quantified KPIs (technical, economic, environmental, social, business) to enable the holistic assessment of the project impact per demonstrator hub. Appropriate instruments for the uniform collection of evaluation data during pilot executions. These included online questionnaires, data collection forms, impact check-lists, etc. These additional KPIs will be finalised and documented prior to the release of the Beta platform.

These piloting activities are concentrated in three "Demonstration Hubs" and these cover:

- Mobility and Urban Planning Ecosystem Experimentation
- Energy Ecosystem Experimentation
- Automotive Ecosystem

[3] https://www.pistis-project.eu/wp-content/uploads/2025/04/D5.1-Demonstrators-Evaluation-Plan.pdf

In addition to these core demonstrators, we also have three “Cross-Demonstrator Data Spaces Instances Deployment and Experimentation” covering Open Data, Weather Data and a space for experimentation to be used by the Living Labs.

The plan for demonstrating and evaluating PISTIS set out in D5.1 leant upon “T5.2 - Demonstrators Use Cases Detailing and Execution Planning.”

We created a detailed list of the available data assets at each demonstrator for the realisation of the project’s piloting activities. This complemented the data requirements identified in the initial work for the landscaping that was delivered by T1.2. Description of these data assets were refined to enable a better understanding of how they will be handled and managed during the experimentation at each data ecosystem, assisting the data modelling process.

We also performed a gap analysis at the project’s demonstrator sites to define additional activities (such as consent collection, deployment of internal infrastructure, connections sensors, compatibility with specific APIs, resolution of network communication issues) which are necessary in order to facilitate the realisation of the project’s demonstrators.

Together the two tasks formed a solid basis for the demonstration implementation, operation and evaluation, contributing in the following way:

- They elaborated the Verification and Validation Framework for the project.
- Provided a general guideline to monitor and align the demonstrators’ phases within the evaluation framework.
- Guided the planning and coordination of the Demonstrators’ Set-up.
- Prepared for and set-up the Demonstrators’ Implementation.
- Prepared for evaluating the demonstrators and estimating their impact.
- Prepared for the Technical Verification and Validation.
- Prepared for the Business Validation.

The deliverable is an output from T5.7 – Demonstrators Continuous Evaluation, Impact Assessment and Lessons Learned.

1.4 AIM OF THE DELIVERABLE

This deliverable seeks to:

- Ascertain the readiness of the demonstrations to utilise the PISTIS platform, following the release of the Alpha version, which is a key moment in the project.
- To assess the degree to which the elements developed by PISTIS can be successfully introduced to the different data spaces.
- To effectively evaluate PISTIS in real-life settings, supporting real-life business scenarios and within D5.1’s all-inclusive framework for verifying, validating, and evaluating the project’s outcomes.
- To steer and guide improvements for the release of the Beta version, whilst looking for early “Lessons Learned”.
- And to plan the necessary activities to be carried out in the later stages of the project.

Within the project, and specifically for WP5, this deliverable performs a role of knitting together all the elements of the project. It takes a holistic view and looks not simply to ensuring that the technical work is implemented successfully, but that in turn contributes to the needs of other Work Packages, including dissemination, exploitation and legal aspects.

1.5 Overview of the PISTIS Evaluation Process

As described in detail in D5.1, the evaluation is underpinned by the "Evaluative Thinking" process. An evaluation that reflects evaluative thinking is the systematic process of telling the PISTIS "story" by:

- Identifying assumptions about why we think the project will work and be a success starting from the Description of Action (DoA).
- Determining what change we expect to see during and after we implement what we have set out to do in the DoA.
- Collecting and analysing data to help us understand what happened during the project.
- Communicating, interpreting and reflecting on the results.
- Using these results and lessons learned to help make informed decisions to be able to plan for a successful exploitation after the project finishes and to make any minor adjustments to our work as a result of the interaction with the PISTIS Theory of Change, included as Annex 3.

In short, "Evaluation is an objective process of understanding how a project or other intervention was implemented, what effects it had, for whom, how and why"[4]

At each release, a different set of features/functionalities will be made available.

The Alpha version offered basic functionalities (as described in the final MVP set out in D1.3[5] and in deliverables D3.1[6] and D4.1.[7]). This includes Data Sources Connection and Closed Group Data Collection. The Alpha version was planned to be evaluated mainly by a small, closed group of users, usually employees of the demonstrator who have also taken part in setting up the PISTIS platform at the premises of the demonstrator, i.e. with good knowledge of the goals of the project and both the technical details (such as the connection of the data sources) and the business details (such as the goals that each demonstrator aspires to achieve via the adoption of the PISTIS platform).

The Beta version will offer full functionality, with non-critical features being at an early experimental level of maturity. In this phase there will be an Extension of Data Owners base and operational readiness testing and covers the early operation.

[4] HM TREASURY, The Magenta Book, assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/220542/magenta_book_combined.pdf

[5] https://www.pistis-project.eu/wp-content/uploads/2025/04/D1.3-PISTIS-Technical-Requirements-and-MVP-v2.pdf

[6] D 3.1 - Data Valuation, Sharing and Trading Framework - PISTIS

[7] D 4.1 - PISTIS Reference Architecture and API Documentation - PISTIS

Version 0.5 will fix all major defects identified after the evaluation of Alpha and Beta versions and shall offer full functionality plus mature, experimental-to-functional level of non-critical features.

It is stressed that the evaluation of the system and of the scenarios is being carried out within WP5, whilst the technical testing is being carried out in WP4, which is:

- Constructing the reference architecture and producing detailed specifications of the integrated PISTIS platform,
- Describing thoroughly the interfaces and designing the APIs of all the different components/ bundles/ services that will be integrated.
- Documenting an integration plan which will guide the integration and DevOps efforts (code maintenance, continuous integration, software evaluation) and will integrate the various components of the main service bundles of the reference architecture, at the PISTIS platform level and at the on-premises PISTIS factory instances.
- Assessing and validating the correct functioning of the PISTIS platform implementation as a whole and making sure corrective actions are taken upon any defects encountered.

The testing effort in WP5 has started with pilot planning and preparation activities, well before the Alpha version was available. The development of the connectors and necessary customisations at each demonstrator followed, so that every demonstrator was ready to connect to the Alpha version of the platform on its release. Prior to the availability of the alpha version, the main technical interaction between the development team and the demonstrators was in ensuring that their viewpoint remained in focus and so that the demonstrators could plan what technical developments and interfaces, software etc. were to be required for them to be able to integrate with the PISTIS platform.

1.6 PISTIS EVALUATION FRAMEWORK

The PISTIS evaluation framework can be described as having six interdependent and iterative steps:

- Engagement of the stakeholders- those persons involved in or affected by the project and primary users of the evaluation.
- Drawing from the project plan in the DoA, a description of its needs, expected effects, activities, resources, stages, context, etc.
- Focussing the evaluation design on relation to purpose, users, uses, questions, methods, agreements.
- Gathering credible evidence- indicators, sources, quality, quantity, etc.
- Justifying conclusions/analysis/synthesis, interpretation, judgment, recommendations.
- Ensure further use and share lessons learned.

In the early work of WP5 we have:

- Defined a high-level logic model for the project.
- Defined the “audience” of stakeholders and started to interact with them.

- Identified the objectives of the evaluation and the research questions to be answered.
- Defined the monitoring framework and considered what data is required to answer the evaluation's research questions, whilst identifying data sources.
- Defined the design of the demonstration hubs operation.
- Defined the key components of the measurement framework: the outputs, the outcomes, indicators, measures of change, data sources and the frequency and methods for collection.

This has provided the basis for evaluating the success of the project as it moves into the real deployment stage, following the more minimal evaluation of the simpler alpha version, which is reported in this deliverable.

To this end, the iterative approach adopted engaged the project's demonstrators in the assessment and feedback loop from the very early development stages. The demonstrator partners and their support technology partners are engaged with the intermediate platform releases, starting with the alpha version, to constantly evaluate and test their functionalities, while feedback will be provided to the development teams to update, parameterise and improve the corresponding services.

For this purpose, the three different demonstrator hubs have been planned with the aim of validating the PISTIS outcomes in a multi and cross-domain setting and guarantee their applicability for use in different, existing or emerging data spaces. As such, during the validation and demonstration activities, all the different features will be tested and benchmarked, and the corresponding KPIs will be measured to verify the achievement of the objectives set. A start has been made with the task of testing the alpha version and reporting this, but much will need to wait until later versions. This later work marks the commencement of Phase III: Verifying, Validating and Demonstrating PISTIS which commences a couple of months after the delivery of D5.2 with the release of the Beta Bundles at M30.

During the validation and demonstration activities, all the different features will be tested as they become available and the corresponding KPIs will be measured to verify the achievement of the objectives, both in terms of functional completeness, as well as in terms of users' satisfaction and experience.

The evaluation framework is studied extensively as it will lead to valuable observations and conclusions about the viability and the sustainability of the PISTIS platform. All partners participating in WP5 will collaborate in the review of test cases that will take place during the execution of the demonstrators. These test cases have been designed based on the business cases, use cases and requirements identified in the previous WPs of the project.

The demonstrators fulfil three distinct functions in the evaluation process.

- Firstly, they need to be sure that what is being tested is suitable for their own interests and processes in their day-to-day activities:
- Secondly, they need to help to evaluate the overall platform for the wider benefit of the project and:
- Thirdly, they have been set a requirement through T5.7 which states the demonstrators "will also propose improvement actions, interventions and measures

to be applied for successfully paving the exploitation path of the project" and that "Evaluation will also pay special attention to assessing the cost-efficiency and viability of new business models developed by the project in WP7."

1.7 PREPAREDNESS AND STATUS OF THE DEMONSTRATION SITES

The PISTIS Demonstration and Evaluation Plan needed to take into account the following stages which the demonstration sites needed to be suitably prepared for, in order to ensure a successful demonstration and evaluation process.

These included in relation to **planning the roll-out of the demonstrators**:

- Performing an analysis in the pilot sites for defining available data assets and relevant interfaces for integration.
- Creating an accurate baseline to be used as a reference for the verification of the impact.
- Utilising the PISTIS verification & validation framework set out in D5.1 and applying it in the context of the different demonstrators.
- Coordinating and realising the demonstration/ validation of the PISTIS platform in the project's demonstrators.

All the identified preparatory activities required from the demonstrators, set out in Table 1. below, have been carried out.

Planned Preparatory Actions to enable the deployment of the PISTIS Platform.
A detailed list of the available data assets at each demonstrator for the realisation of the project's pilot activities.
Refining the landscaping of the data assets involved in the project's demonstrators and their characteristics
Reviewing relevant IPR policies at each data-ecosystem.
Designing Demonstrator-specific use cases based on the end-to-end usage scenarios and data trading lifecycle design identified in T1.2.
A detailed execution plan will be provided with the demonstration activities, including processes, needed inputs and expected outputs.
Perform a gap analysis at the project's demonstrators to define additional activities.
Define Consent Collection procedures where required.
Define deployment of internal infrastructure.
Define connections and sensors.
Cover compatibility with specific APIs.
Resolve any network communication issues.

Table 1: Preparatory work carried out by the demonstrators.

1.8 DOCUMENT STRUCTURE

Following this introduction to the PISTIS project and its evaluation process, the Legal and Ethical aspects which underpin the project, and which the demonstrators need to fulfil, are considered.

Following on from this, each of the three demonstration hubs report their results in Chapters 3, 4 and 5. These are followed by Chapter 6 which matches the use-case data treatment requirements with the wider scope of all the functionalities which need to be tested. (Appendix 1 outlines the actions established for each of the eleven use-cases.)

Chapter 7. looks at the limited expected progress towards the final expected impact which is achievable at the alpha stage and how the expected impact can be enhanced and measured.

Chapter 8. sets out the plans for communicating and interacting with stakeholders in the final stages of the project and what is to be achieved by this activity.

Then the technical testing and evaluation results coming from WP4 are reported in Chapter 9, with the TAM questionnaire used being included as Appendix 2.

Chapter 10 looks at progress in meeting the non-functional requirements and the evolution of the PISTIS product, with Chapter 11 covering the Business, Innovation and Exploitation Objectives.

Chapter 12 outlines the next steps in the project which were already planned, whilst Chapter 13 covers the additional new activities proposed and how they might be evaluated, once a mature platform is available.

Chapter 14 returns to the use of the PISTIS Theory of Change, which is reproduced as Appendix 3, at the evaluation stage. Finally, Chapter 15 summarises the evaluation process for the alpha version, as well as summarising the progress which has been made so far.

2 LEGAL AND ETHICAL CONSIDERATIONS FOR DEMONSTRATOR HUBS

This chapter sets out the legal and ethical considerations for the demonstration hubs. The aim is to guide the technical partner responsible for the operation of the PISTIS platform, as well as the demonstrators, in implementing the project use cases in compliance with the legal requirements and ethical principles that have been identified in the previous project deliverables of D1.1 — PISTIS Operation Principles and Context Detailing[8] and D9.1 - OEI - Requirement No. 1. [9]

In PISTIS, legal and ethical compliance has the utmost importance as it has been recognised as the main facilitator and enabler of trust in data spaces. However, creating and maintaining trust requires the operators and the users of data space to take into account various ethical and legal considerations to ensure responsible and lawful use of data and to create a level of comfort and trust among data space users. In that regard, PISTIS follows the guidance of the EU lawmakers considering that the significance of trust in data sharing has been consistently

[8] D 1.1 - PISTIS Operation Principles and Context Detailing - PISTIS

[9] PISTIS D9.1 OEI - Requirement No. 1 v1.0.docx

and repeatedly noted in the recitals of Data Act[10], AI Act[11], Data Governance Act[12] and Digital Services Act[13].

Furthermore, PISTIS considers also that integrating artificial intelligence technology into data space introduces additional challenges to creating trust among the users due to the complexities of AI systems.

Considering that PISTIS aims to enable data sharing among a multitude of sectoral sub-data spaces within its urban planning and mobility, energy, and automotive hubs, the legal and ethical considerations focus on EU cross-sectoral or horizontally applicable EU digital legislation, such as the Data Act, AI Act, GDPR[14], Data Governance Act, Digital Services Act, or NIS 2 Directive[15], that lays out principles and guidelines that apply to all sectors.

This approach will enable PISTIS not only to create a baseline for the validation of project outcomes but also to produce and test best practice for cross-sectoral data spaces and consequently contribute to the development of common European data spaces.

In the preparations for the testing of the Alpha version, the demonstrators have taken into account all the legal and ethical considerations during the planning process. All these issues which are relevant for the alpha testing phase of the project have been taken into account.

These are set out in Table 2 and Table 3 below. All the necessary actions have been taken in collaboration with the demonstrator's internal compliance teams, particularly in the thematic areas which are covered within these considerations.

This approach supports the development of PISTIS solutions in compliance with EU laws.

2.1 Ethical Considerations for PISTIS Demonstration Hubs

Consideration	Definition	Alpha stage situation
Use Case Definition	It is essential to have clear descriptions of use cases including any technologies, datasets, data processing activities they may involve and their purpose(s). This will give the partners a better understanding of the nature, scope, context and purpose of the activities and help them determine any potential regulatory requirements, challenges or boundaries.	The guidance set out in Chapter 3.4 of D9.1 – OEI - Requirement No.1. has been followed by all demonstrators. The use cases and their requirements were made clear in D1.2 [16] and its iteration of D1.3 reporting on T1.5 - PISTIS User Stories, Technical Requirements and MVP Design.
Privacy and Data Protection	The rights to privacy and protection of personal data are the fundamental rights and therefore they need to be safeguarded by the users and orchestrator of PISTIS digital ecosystem. Therefore, prior to	All demonstrators are fully aware of their legal responsibilities in relation to personal data and will remain vigilant regarding the use of personal data throughout the

[10] Regulation - EU - 2023/2854 - EN - EUR-Lex
[11] Regulation - EU - 2024/1689 - EN - EUR-Lex
[12] Regulation - 2022/868 - EN - EUR-Lex
[13] Regulation - 2022/2065 - EN - DSA - EUR-Lex
[14] Regulation - 2016/679 - EN - gdpr - EUR-Lex
[15] Directive - 2022/2555 - EN - EUR-Lex
[16] D 1.2 - PISTIS Technical Requirements and MVP - PISTIS

Consideration	Definition	Alpha stage situation
	making a dataset available in PISTIS platform, it is important for the data holder to check whether such dataset contains personal data. In such case, the personal data needs to be appropriately processed by all the relevant parties, including the data holder, data recipients and other third parties such as provider of data sharing platform and ancillary services in compliance with law.	demonstrations. Where identified, the personal data will be appropriately processed by all the relevant parties, in full compliance with the applicable rules. In the alpha testing no personal data was involved, but this will not be the case with the final PISTIS product.
Risk Assessment and Security	Risk assessment is a critical ethical consideration when managing a data sharing ecosystem as it involves identifying, analysing, and mitigating potential risks associated with data handling. This process is essential for ensuring responsible and ethical data and AI practices. Identifying and assessing risks enables the users and providers of PISTIS services to implement appropriate security measures to prevent protect PISTIS data sharing ecosystem from unauthorised access, breaches and cyberattacks. Regular risk assessment is important to update security measures to address evolving cybersecurity threats.	Risk assessments have been carried out by all demonstrators and these are reported in the tables below. As new risks are identified, appropriate security measures will be put in place. Following the internal validation phase for the alpha version, the regular risk assessments will become more important as the breadth of PISTIS widens and more threats become apparent.
Transparency	It is important to be transparent about how data is processed and how AI-based services function. Information on data processing activities and AI-supported operations should be made available and communicated in a clear and plain language by the operators of data spaces to the users and other relevant stakeholders.	The issue of transparency was treated as an important aspect within the user-needs/user interfaces evaluation process and will continue to be paramount for the Beta and Final versions. At this stage AI-based services and AI-supported operations may be introduced.
User Control and Traceability	Data space should preserve data holder's control over the data they generate and share within its legal boundaries. The availability of traceability mechanisms could be a measure consolidating such control.	The Alpha version is evaluated in a cloud infrastructure controlled by an infrastructure administrator from the PISTIS technical team. For every participating data holder is prepared an own copy of the data holder's PISTIS infrastructure and software with individual credentials to access it. All data transactions are recorded in the PISTIS ledger and can be traced.
Accountability	Accountability in the context of PISTIS means the state of being responsible or answerable for data transactions and the provision of ancillary services in PISTIS platform and for their potential impacts. This acknowledgement of responsibility for	This ethical aspect has been acknowledged and will be more in focus once the beta version is available and contracting and monetisation aspects of the project evolve.

Consideration	Definition	Alpha stage situation
	actions, decisions, and assets is the fundamental step for creation of trust. Identity and access management in a data space may play an important role for ensuring accountability.	
Fairness and Openness	It is essential to create and ensure a competitive, fair and equal playing field in the context of exchanging commercially sensitive data. This requires fair treatment of the users of PISTIS and avoid discrimination toward certain groups in data sharing and in the governance of PISTIS ecosystem. In addition, participation in the PISTIS ecosystem remains open to all organisations to ensure openness.	The structure of the PISTIS project enables full and fair involvement of the widest range of stakeholders possible. Full access will be granted to external stakeholders as the project matures, with a factory dedicated to their use and controlled by the Living Labs established to bring about this wide and open access to PISTIS.
Data Accuracy	The accuracy of the data made available in PISTIS is essential to prevent misinformation and potential harm. To maintain the accuracy, PISTIS project aims to develop and implement certain mechanisms that can correct inaccuracies and update outdated datasets.	The Alpha version PISTIS enables data holders to describe the data, its semantics and structure using the PISTIS data model. The tool for assessing the data quality will be evaluated as part of the beta version. A key aspect of the principle of data accuracy is the data subject's ability to correct inaccuracies in their data and has been considered under the Alpha version and this principle will be considered further when reviewing the data quality assessment tool under the Beta version.

Table 2: Ethical Considerations for PISTIS Demonstration Hubs

2.2 Legal Considerations for PISTIS Demonstration Hubs

Table 3 below sets out the Legal Considerations and the current status at the alpha evaluation stage of the project.

Consideration	Definition	Alpha stage situation
Compliance with EU Digital Legislation	The EU Digital Legislation, particularly, the Data Governance Act, Digital Services Act, Data Act, AI Act, NIS 2 Directive regulate the digital infrastructures and data intermediation services that will be provided by PISTIS and thus the orchestrators, service providers and the users are required to comply with a number of conditions and requirements set therein, including adopting procedures to prevent fraudulent or abusive practices, unauthorised access, etc.	Hub leaders have confirmed that all their use-cases are in compliance with EU Digital Legislation.

Consideration	Definition	Alpha stage situation
Compliance with Data Protection and Privacy Laws	Any processing operations on datasets containing personal data should be carried out in compliance with relevant data protection and e-privacy regulations such as GDPR, e-Privacy Directive or other national data protection and e-privacy laws. Particularly, such processing operations should have at least one applicable legal ground stipulated in the relevant legislation. Furthermore, before using the PISTIS solution for processing personal data, it is always recommended for the users and the operators to carry out a Data Protection Impact Assessment to assess potential risks and to adopt necessary technical and organisational measures including data processing agreements, privacy policies etc.	Whilst no personal data was used in the alpha version it is likely that the basic demonstration activity planned, may be augmented with personal data. Whilst personal data may be utilised in the final versions of PISTIS, it should be pointed out that this will be an enhancement to the basic Beta offering as personal data sharing falls outside the scope of the project. However, expertise from the DataVaults project which specialised in personal data is available and the issue can be considered in more detail when required.
Data Sharing Agreements	Data sharing agreements to be used in PISTIS should have fair, proportionate, and non-discriminatory terms and conditions, outlining the permissible ways in which data can be used, shared, and processed by the recipient and provide legal certainty to the users.	This consideration has been acknowledged and will be examined in more detail in the Beta version.
Terms and Conditions	The providers of PISTIS platform and of the relevant services should define and inform the users about the rules of a data space as well as the terms and conditions of the offered services. It is essential to notify the users, impose in a clear, plain, intelligible, user-friendly and unambiguous language, of their responsibilities and liabilities in relation to data transaction which they become party of, and of any conditions, restrictions, and/or limitations that the operator may impose.	This consideration has been acknowledged and will be examined in more detail in the Beta version.
Protection of Intellectual Property Rights	Having necessary measures in place to protect intellectual property rights related to data including copyrights and *sui generis* rights is crucial to create trust in data sharing ecosystems	This consideration has been acknowledged and will be examined in more detail in the Beta version.
Access Control and Authentication	Access control measures to restrict access to a data space and authenticate users to prevent unauthorized access need to be implemented.	The measures taken to restrict access and to authenticate users are set out in D4.2 which describes the service.

Table 3: Legal Considerations for PISTIS demonstration hubs.

Building on these legal and ethical considerations, the evaluation of PISTIS solutions will be carried out with the aim to promote the operationalisation of the ethics-by-design-and-by-default approach, supporting the project compliance with the ethical principles constituting

the core of the EU digital legislation and policies, and elaborating lessons learnt for the PISTIS operations in real-life environments.

2.3 REGULATORY, LEGAL AND ETHICAL ASPECTS[17]

Objective	Description	Means of Verification.	Comments at Alpha stage.
Regulatory and Legal Aspects			
R.1. Data intermediation services and other additional services are provided in compliance with EU legislation.	D1.1 identifies a list of legal requirements in EU digital legislation, particularly in Open Data Directive, Data Act, Data Governance Act, that are relevant to the PISTIS services including data intermediation services. A checklist (Table 5 below) is intended to be used by the technical partners responsible for development of PISTIS solutions and the demonstrator partners as reference for the identification of and compliance with the relevant legal requirements.	The partners' input to checklist will be used for assessment.	Given that these services are still in development phase and thus the legal requirements cannot yet be applied to any practical outcomes, it is recommended that the relevant partners remain aware of these requirements and proactively consider them during the development of PISTIS digital ecosystem.
R.2 The governance of the PISTIS platform is designed and carried out in compliance with the principles adopted in Digital Services Act and E-Commerce Directive.	Pursuant to the findings of D1.1, the PISTIS platform is likely to be considered as online platform as defined in Digital Services Act and therefore it is important to comply with the certain principles adopted in Digital Services Act such as transparency, non-discrimination, etc. A checklist (Table 5) is intended to be used by the technical partners responsible for governance of data space and the demonstrator partners as reference for the identification of the relevant legal requirements and obligations.	The partners' input to checklist will be used for assessment.	Given the alpha version is for internal evaluation, the comment for objective R.1 above applies.
R.3. PISTIS demonstrators are aware of and are compliant with	Although, the end-users of PISTIS will be businesses and not individuals, the datasets which will be made available by the business end-user may still contain personal data and	The partners' input to checklist will be used for assessment.	The demonstrators are aware of and are compliant with all relevant data protection laws. It is

[17] Relevant Impact KPI is "Improved Trust Security and Privacy Guarantees of Data Sharing"

Objective	Description	Means of Verification.	Comments at Alpha stage.
relevant data protection laws.	thus exchange, upload, transfer of such dataset will constitute processing of personal data pursuant to GDPR. In that regard, any processing of such dataset in PISTIS should comply with the data protection requirements under GDPR which are explained in D1.1. A checklist (Table 5) is intended to be used by the technical partners responsible for governance of data space and the demonstrator partners as reference for the compliance with the relevant legal requirements and conditions set forth in D1.1.		anticipated that more attention and action will be required to ensure compliance with the relevant rules with the development of the Beta version.
R.4. Conditions of use and practical arrangements of data sharing should be fair, reasonable and non-discriminatory and provide legal certainty to the users of PISTIS.	To create consistency between data access rights and further stimulate business-to-business, PISTIS ensure fair, reasonable, non-discriminatory, and transparent terms and conditions of data sharing.	Data Sharing Contract templates to be used by the Demonstrators will be reviewed.	It is anticipated that the data sharing agreement to be used by the demonstrators in PISTIS once the Beta version is available will contain fair, reasonable and non-discriminatory terms.
R.5. There are measures in place to ensure that PISTIS activities do not infringe intellectual property rights over the datasets.	The intellectual property rights that could be established on datasets in EU jurisdiction have been identified in D7.1 – PISTIS Exploitation, Business Model and Market Entry Plan – Report 1.	PISTIS terms of services and the Data Sharing Contract templates to be used by the Demonstrators will be reviewed.	For the Beta version, the demonstrators will put in place measures to ensure that there is no infringement of intellectual property rights over the datasets handled.
R.6. The AI systems in PISTIS have been designed and developed in accordance with the ethical principles for trustworthy AI	The ethical principles are explained as part of AI Ethics in PISTIS in D8.2 – Data Management Plan [18] . PISTIS adheres to these principles in the development of AI systems to be used as part of PISTIS solution.	The descriptions of PISTIS AI systems provided in the technical deliverables	This objective is not directly relevant for the alpha version but all the ethical principles already identified and which the

[18] D 8.2 - Data Management Plan - PISTIS

Objective	Description	Means of Verification.	Comments at Alpha stage.
systems set by the Commission and in compliance with the requirements in the AI Act.	As explained in D1.1, the classification of the AI systems to be utilised in PISTIS needs to be done in order to assess which legal requirements in the AI Act will become applicable to PISITS systems.	will be reviewed for the assessment.	demonstrators are aware of, will be considered and the relevant activities will be in compliance with the AI Act.
Ethical Aspects			
E.1. The guiding ethical principles set in D9.1 have been duly considered when developing and implementing the use cases	In D9.1, five ethical principles are determined as the core of PISTIS Data and AI Risk Assessment Framework, and the demonstrators are expected to consider these ethical principles when designing and developing their use cases.	The partners' input to checklist will be used for assessment.	All the principles established in D9.1 have been adhered to in developing the use cases.
E.2. PISTIS has utilised effective privacy preserving measures to protect rights to privacy and protection of personal data.	PISTIS utilises components for data security and privacy preservation services in data sharing ecosystem explained in the technical deliverables.	The descriptions of PISTIS Data, Security, Trust and Privacy Preservation services provided in the technical deliverables will be reviewed for the assessment.	For the Beta version, all privacy preserving measures will be reviewed to ensure their compliance with the applicable rules.
E.4. PISTIS provides the demonstrators with a Data and AI Risk Assessment Framework.	D9.1 Chapter 3 provides a comprehensive framework to assess potential risk associated with processing of personal data, use of blockchain technology and AI systems in the demonstrations.	The demonstrators are expected to utilise the PISTIS risk assessment framework when conducting their risk assessment.	The demonstrators have indicated that they understand fully the challenges outlined in the Framework and are well prepared to meet them.
E.3. PISTIS has a clearly defined legal and ethical framework.	D1.1 Chapter 4 and D9.1 outline the legal and ethical framework for PISTIS.	The partners' input to checklist will be used for assessment.	The Legal and Ethical Framework established for PISTIS remains in place. The relevant

Objective	Description	Means of Verification.	Comments at Alpha stage.
			legal developments will be monitored and the framework will be updated accordingly.

Table 4: Legal and Ethical Aspects

2.4 CHECKLISTS FOR LEGAL AND ETHICAL ACCOUNTABILITY

These checklists refer to and are based on Deliverable D5.1. They are *indicative* in nature and should be read and applied as such. They are qualitative, not binary; in other words, whilst they indicate some topics and areas to be considered as part of a compliance exercise, an *onging* and *complex* approach is required to ensure accountability.

Hence the user of the checklist should mostly consider if it has reached the appropriate level of measures *before, during* and *after* a pilot, for the particular use case and related context, on a case by case basis.

Given the limited nature of an alpha delivery, only some of these will be relevant and the full exercise will be undertaken at the Beta version stage.

Indicative Checklist for Legal and Ethical Accountability

Requirement	Alpha	Final
Platform Governance		
Terms and conditions of PISTIS platform are clear and transparent ensuring fair and non-discriminatory access to its services.	Beta	
Terms and conditions of PISTIS platform provide the end-users with clear information on any restrictions that they impose in relation to the use of their service.	Beta	
Terms and conditions of PISTIS platform include information on policies and tools used for the purpose of content moderation, including algorithmic decision-making and the rules of procedure of their internal complaint handling system.[19]	Beta	
There are measures in place to tackle and prevent illegal activities and unauthorised/misuse of PISTIS services, including against PISTIS itself.	Yes	
Identity management and access control mechanisms are in place	Yes	
Provision of Data Intermediation Services		
Technical standards, formats and specifications used in PISTIS support interoperability across different sectors and with other data spaces.	Yes	
There are measures to ensure an appropriate level of security for the storage, processing and transmission of the datasets.	Yes	

[19] For the alpha version, the project is primarily concerned with the technical functionalities. A policy or system required by the said requirement is rather administrative or organisational and can be easily implemented at any stage of the project and as a consequence attention has not been paid to it at this technical development stage.

Requirement	Alpha	Final
There are measures in place to ensure a high level of security for the storage and transmission of the datasets containing competitively sensitive information.	Yes	
Technical standards and specifications implemented support interoperability across different sectors.	Yes	
There are measures in place to inform data holders/owners without delay, in the event of an unauthorised transfer, access or use of their datasets.	Yes	
A log record of data transactions is kept.	Yes	
Privacy and Protection of Personal Data		
There are measures in place to support data minimisation but it is the responsibility of the data provider to decide which data should be offered.	Yes	
There are measures in place to check data accuracy. Data Quality assessment tools are partially implemented, but it will be evaluated starting from Beta.	Partially	
There are measures in place to consolidate data security.	Yes	
Information relating to the processing of personal data will be easily accessible and easy to understand by the data subjects. We plan to include a GDPR conformance functionality in the Beta version to advise the Data Providers and we already provide a data anonymisation tool, but we don't provide any other information on the topic in the alpha version.	Beta	
Data protection by design and by default approach has been duly considered.	Yes	
There need to be tools for the data holders to comply data subject rights. We plan to include a GDPR conformance functionality in the Beta version to advise the Data Providers and we already provide a data anonymisation tool.	Yes, in Beta	
There are measures in place to govern transfer of personal data to outside of EU. The GDPR conformance checker tool will advise the data providers on that.	Beta	
There are organisational and technical measures in place to ensure an appropriate level of security of personal data (including designating a data protection officer, adopting access authentication and authorisation policies, encryption, anonymisation, network infrastructure security systems, etc.)	Yes	
The terms of data sharing agreements used between the end-user are fair, reasonable, and non-discriminatory ensuring a level playing field.	Yes	
Risks associated with processing of personal data in PISTIS is thoroughly assessed. (Including conducting a Data Protection Impact Assessment).	Yes	
Compliance of AI Systems		
Any processing operations on datasets containing personal data are carried out in compliance with relevant data protection and e-privacy regulations. In the project, yes, but the tool itself is just a generic AI tool built from existing components. It doesn't provide any specific treatment/governance for personal data.	Beta	
Risk classification of PISTIS AI Systems is made in accordance with the AI Act. it is the responsibility of the ML model developers (if any), to self-assess if their models are compliant with the AI Act or any other relevant legislation.	Beta	

Requirement	Alpha	Final
The AI Act compliance checker can be found at: https://artificialintelligenceact.eu/assessment/eu-ai-act-compliance-checker/.		
Ethics		
Ethics by Design	Yes	
Accountability	Yes	
Clear allocation of responsibilities and liabilities	Yes	
Transparency	Yes	
Fairness	Yes	
Privacy	Yes	
Assessment of risks and Safety	Yes	
User friendly user interface	Yes	

Table 5: Checklist for Legal and Ethical Accountability

The partners' input will be taken into account as part of the project verification and validation framework for the assessment of legal and ethical aspects of the project results as the Beta phase of the project is entered.

Feedback was gathered from each of the use-cases and fed into the three hub leaders to report back on the situation at designated times.

All the risks identified and listed in this chapter have been scrutinised and as would have been expected from the internal alpha version evaluation process, any which were applicable for this phase of the project have been satisfactorily assessed with no remedial action required.

At AIA, the leader of Hub 1 (Mobility and Urban Planning Ecosystem), a robust governance framework has been established to address the diverse legal and ethical considerations across its five use cases. Since Hub 1 involves multiple stakeholders handling sensitive transportation data, AIA's Legal Department and Data Protection Office have been actively involved throughout the alpha testing phase, ensuring compliance with GDPR and other relevant regulations. The nature of the data sharing varies significantly across use cases - from operational flight information requiring minimal anonymisation to passenger flow data necessitating comprehensive privacy protection measures.

For each data exchange scenario, Data Protection Impact Assessments have been conducted in collaboration with AIA's IT Security team. This systematic approach has allowed the identification of potential risks early in the process and implement appropriate technical and organisational measures.

Cuerva is the leader of the Energy Hub and the main data provider within it. As a DSO, the company's focus is on the development and maintenance of the distribution network, which means that the data required for the development of the various use cases is primarily technical in nature (infrastructure-related).

Therefore, anonymisation is minimal in most cases. When dealing with customer personal data, it is already anonymised internally, and this anonymisation and traceability will be further enhanced through the use of the PISTIS platform.

In addition to this, Cuerva has a dedicated team of data and IT professionals who are focused on improving data quality, management, and utilisation.

At VIF, the leader of the Automotive Hub, an internal legal department oversees the legal aspects of digital applications developed in EU projects such as PISTIS. They are supported by IT department colleagues specialising in data protection and information security, both generally and specifically for EU projects like PISTIS. As part of the risk assessment, discussions with these teams provided valuable input, contributing to the assessment process and the completion of the table.

There will be vigilance as the Beta version becomes available to ensure all the new risks, which may emerge as the platform matures, have all been satisfactorily identified and assessed.

3 DEMONSTRATION HUB #1 - MOBILITY AND URBAN PLANNING ECOSYSTEM

This and the following chapters 4 and 5 cover the Alpha version evaluation of the three demonstrators. Appendix 1 includes a summary of all the actions which were carried out, at a use-case level, for each hub. At this stage of the project, the assessments of progress are only at the individual hub level. D5.3 will look at the aggregated and comparative assessments.

Demonstrator Hub #1 focuses on facilitating data trading and sharing amongst stakeholders in aviation, public transport, and public administration, who are key actors in a value chain that can be built around mobility and urban planning data, augmented with data from the "support hubs" and elsewhere. The demonstrator includes AIA (Athens International Airport), GOLDAIR (Ground Handling Service Provider), OASA (Athens Public Transportation System, including bus and metro lines) and DAEM (City of Athens IT company), that act as data consumers and/or providers depending on the use case.

The measurement of the actual impacts will be provided in deliverable D5.3 and the process for evaluating this progress is set out in Chapter 1 of this document.

This demonstrator has five use cases.

- Use Case #1.1. Baggage Handling Management.
- Use Case #1.2: Transfer Passenger Management.
- Use Case #1.3: Aircraft Turnaround process.
- Use Case #1.4: Public Transportation Planning Support.
- Use Case #1.5: Insights for city commercial businesses.

All five use-cases share the same approach to handling data and the current situation is captured in Table 6 below. The table indicates the stages of data-handling engaged with during this initial alpha phase of PISTIS.

Actions of Buyers of Data carried out in Alpha version testing for all five use-cases.					
	UC1	**UC2**	**UC3**	**UC4**	**UC5**
Data Exploration					
Data Navigation/Querying					

	UC1	UC2	UC3	UC4	UC5
Data Matchmaking Services					
Data Contract Preparation					
Contract Drafting					
Contract Notification					
Data Acquisition					
Data Transfer					
Data Decryption					
Actions of the Data Spaces owners- the sellers of data					
Data Ingestion, Transformation and Treatment.					
Data Check-In: the collection of data from the PISTIS system through various options (e.g., APIs, Pub/Sub, etc.).					
Data Enrichment: the cleaning of data from errors and/or inconsistencies and the matching of ingested data to a common model for interoperability purposes.					
Analytics/Insights Engine: the application of some ready-made analytics on the data, to extract some information.					
Data Lineage Tracking: the application of tracking tags on the data for allowing tracking of the subsequent actions.					
GDPR Checker: the evaluation of whether the data contains GDPR relevant information and the suggestion to strip (if wanted) such information from the dataset (or to change it if needed) prior to exchanging it with other stakeholders.					
Data Anonymisation: Application of anonymisation techniques.					
Data Quality Assessment: The assessment of the data for extracting indexes that can describe the quality in different dimensions.					
Data Storage: The storage already treated data back to the original data storage facilities, keeping “pointers” at the PISTIS facility.					
Data Publication Preparation.					
Access Policies Definition: Mechanisms for the application of policies for the access level on stored data of PISTIS system.					
Data and Metadata Publication: The publishing of metadata of the treated datasets in the federated PISTIS repositories for the allowing their querying and the publication of a small set of Data online to be displayed to interested stakeholders.					
Other actions of Data Spaces owners					
Transactions Monitoring (in case transactions are available).					
Auditing of Transactions: An interface where a user can have a log of his transactions.					
Auditing of On/Off Platform Usage: An interface where the user can witness how the data he has traded is used.					

Table 6: Covering all five Use-cases in Greek Hub.[20]

[20] Green colour – evaluated functionalities; yellow colour – functionalities to be implemented in the next versions and to be evaluated later

3.1 USE CASE #1.1. BAGGAGE HANDLING MANAGEMENT.

Ground handlers receive baggage-related timestamps from the airport that enable proper baggage management and make it possible for the early identification of irregularities in the baggage delivery process to the passengers. Post-operation analysis of such data is very important to investigate further incidents or non-optimal performance of the baggage delivery process.

3.1.1 Ambition **of use-case**

To **improve operational performance** of baggage handling, reduce irregularities in the process and predict the probability of flights delays due to baggage handling. Efficient baggage handling reduces the risk of delays and coordination between the airport and ground handling would help mitigate operational anomalies.

3.1.2 Target Audience Descriptions

The actors in UC1.1 are the Greek cluster partners of PISTIS, namely AIA and Goldair that collaborate for the preparation and implementation of the Hub 1 demonstrator. The actors can be identified as data owners (AIA) and seekers (Goldair), and they are divided as internal (the PISTIS partners) and external - from other stakeholders, bodies and organisations such as other Ground Handling Companies operating in Athens Airport or state authorities.

3.1.3 Summary of status after Alpha testing phase

During the Alpha testing phase, AIA and Goldair successfully collaborated to test the core functionalities of the PISTIS platform for baggage handling management data exchange. The testing focused on establishing the data pipeline between AIA as the data owner and Goldair as the data seeker. Sample baggage-related timestamp datasets were prepared in CSV format and uploaded to the PISTIS Data Factory, where they were processed and made available through the marketplace.

The testing validated the platform's ability to handle baggage handling data securely while maintaining data sovereignty. Both organisations verified that the platform could ingest, process, and deliver the relevant baggage management data needed to identify potential irregularities in the baggage delivery process. The data workflow execution was completed successfully, demonstrating the platform's core functionality for data exchange in this specific use case.

While the basic data marketplace scenario was validated, advanced features like data enrichment, quality assessment, and monetisation were not implemented in the Alpha version, as expected. The testing provided valuable insights for future iterations, particularly regarding the integration of real-time baggage data feeds that would be required for operational use. The foundation has been laid for more complex testing in the Beta phase, where these advanced functionalities will be incorporated.

3.1.4 Data Landscape for Baggage Handling management

Data Type	Data Provider	Internal/ External	Data Consumer	Data Format	Data Accessed	Comments
Historic Traffic Data	OAG	External	AIA, GOLDAIR	CSV file		Sample data files were successfully tested
Arriving/Transfer/Departing timestamps	AIA, GOLDAIR	Internal	AIA, GOLDAIR	.txt/.csv		
Minimum Connecting Times for Transfer Bags	GOLDAIR	Internal	AIA	.xlsx		
Flight Schedule and day of operation updates (Delays, Scheduled/ Estimated/ Actual Flight Timings)	AIA, GOLDAIR	Internal	AIA, GOLDAIR	.xml		
Force majeure and operational irregularities	AIA	Internal	AIA, GOLDAIR	.txt		
Weather data (adverse weather conditions)	UBIMET	Internal	AIA, GOLDAIR	.csv, GeoTIFF		
Public Transport Scheduling data (staff arrival issues)	OASA	Internal	AIA	GTFS data, .txt, .csv		

Table 7: Data Landscape: Baggage Handling Management

3.2 USE CASE #1.2: TRANSFER PASSENGER MANAGEMENT.

The impact of delayed transfer passengers who transit at the Athens International Airport (AIA) is being investigated. Information on the number of passengers' transfers at AIA and on the delay of arriving flights is useful for departing flights which are waiting for transfer passengers, to calculate the impact of such delay on their schedules.

Sharing information on scheduled and actual transfer passengers between airlines, ground handlers and the airport is also able to help the optimal allocation of aircraft stands to specific flights to minimise passengers' connection times between arriving and departing aircrafts.

3.2.1 Ambition of use-case

The goal for this use case is to optimise allocation of aircraft stands for specific flights and minimise passengers' connection times.

3.2.2 Target Audience Descriptions

The actors in UC1.2 are the Greek cluster partners of PISTIS, namely AIA and Goldair that collaborate for the preparation and implementation of the Hub 1 demonstrators. The actors can be identified as data owners (AIA) and data seekers (Goldair), and they are divided as internal (the PISTIS partners) and external from other stakeholders, bodies and organisations such as other Ground Handling Companies operating in Athens Airport or the state authorities

3.2.3 Summary of status after Alpha testing phase

For the Transfer Passenger Management use case, the Alpha testing focused on establishing the data exchange pathway between AIA (providing data on passenger transfers and flight delays) and Goldair (receiving and utilising this data). Sample datasets with anonymised passenger transfer information and flight delay data were successfully uploaded to the PISTIS platform, processed, and retrieved by the data seeker.

The testing validated the platform's ability to handle passenger-related data with appropriate privacy measures while ensuring that the core information needed for stand allocation optimisation remained intact. Both stakeholders were able to complete the end-to-end data sharing workflow through the Alpha version of the marketplace, demonstrating the feasibility of this data exchange for future operational use.

The testing also highlighted areas for improvement in subsequent versions, particularly regarding data format standardisation and the need for near-real-time data processing capabilities that would be essential for operational decision-making about aircraft stand allocation. These insights will inform the development of more advanced functionalities in the Beta version, where additional features like data quality assessment and usage analytics will enhance the value proposition for this use case.

3.2.4 Data Landscape: Transfer Passengers Management

Data Type	Data Provider	Internal/ External	Data Consumer	Data Format	Data Accessed	Comments
Flight status	OAG	Internal	AIA	API		
Handler processes data stamps	GOLDAIR	Internal	AIA, GOLDAIR	.xml		
Arrival/Transfer/Departing Bag Number	AIA	Internal	AIA, GOLDAIR	.txt/.csv		
Transfer passenger numbers and destinations	GOLDAIR	Internal	AIA, GOLDAIR	.xml		Sample Data files were successfully tested
PTM Messages	GOLDAIR	Internal	AIA	.txt/.ftp		
Transfer Baggage information	GOLDAIR, AIA	Internal	AIA			
Type of connections	AIA	Internal	AIA, GOLDAIR	txt/.csv		
PRM Passengers	AIA	Internal	AIA, GOLDAIR	.xml		
Minimum Connecting Times	AIA	Internal	AIA, GOLDAIR	.xlsx		
Flight Schedule and day of operation updates	GOLDAIR, AIA	Internal	AIA	.xml		
Force majeure and operational irregularities	AIA	Internal	AIA, GOLDAIR	.txt		
Weather data	UBIMET	Internal	AIA	.csv, GeoTIFF		

Table 8: Data Landscape: Transfer Passengers Management

3.3 USE CASE #1.3: AIRCRAFT TURNAROUND PROCESS.

Information about the Target Off Block Time (TOBT) and the turnaround times for the aircraft's servicing and the underlying processes, such as catering, fuelling, cleaning etc. is very important for it to be exchanged between the involved stakeholders. Additionally, information on the aircraft turnaround process enables us to estimate whether the daily schedule will be performed as planned. It is very important for the airport to know as soon as possible any issues regarding the turnaround of the aircraft and to exchange real-time information with the handlers and airlines regarding issues or incidents in a secure manner. The sooner the airport or handler become aware of any irregularities, the shorter the reaction time for mitigation measures will be, thus minimising impact.

3.3.1 Ambition of use-case

The **ambition** for this use-case is to Optimise processes to achieve an increasingly efficient turnaround process and avoid delays compared to target off-block time.

3.3.2 Target Audience Descriptions

The actors in UC1.3 are the Greek cluster partners of PISTIS, namely AIA and Goldair that collaborate for the preparation and implementation of the Hub #1 demonstrator. The actors can be identified as data owners (AIA) and seekers (Goldair), and they are divided as internal (the PISTIS partners) and external- those from other stakeholders, bodies and organisations such as other Ground Handling Companies operating in Athens Airport or State authorities.

3.3.3 Summary of status after Alpha testing phase

The Alpha testing for the Aircraft Turnaround process use case successfully demonstrated the basic capabilities of the PISTIS platform for exchanging turnaround-related data between AIA and Goldair. Test datasets containing Target Off Block Time information and timestamps of various aircraft servicing processes (catering, fuelling, cleaning, etc.) were prepared and processed through the platform's data exchange workflow.

Both organisations were able to verify the platform's ability to ingest, process, and deliver this operational data securely, while maintaining its usefulness for turnaround process optimisation. The testing confirmed that the core data marketplace functionality works as designed, enabling the sharing of critical turnaround process information that would help identify potential delays early in the process.

The Alpha testing identified the need for enhanced notification capabilities and more sophisticated data processing features in future versions, which would be crucial for real-time operational response to turnaround irregularities. These requirements have been documented for implementation in the Beta version. Additionally, the testing established a baseline for understanding how this data sharing could be expanded to include other stakeholders in the aircraft turnaround process, setting the stage for more comprehensive testing in the next phase of the project.

3.3.4 Data Landscape: Aircraft turnaround process

Data Type	Data Provider	Internal/ External	Data Consumer	Data Format	Data Accessed	Comments
Flight schedules	GOLDAIR	Internal	AIA, GOLDAIR	.xml		
Flight Delay data	GOLDAIR	Internal	AIA, GOLDAIR	.xml		
Aircraft Stand allocation data	GOLDAIR	Internal	AIA, GOLDAIR	.xml		
Aircraft Stand usage	AIA	Internal	AIA, GOLDAIR	.xml		Sample data files were successfully tested
Load factor data	GOLDAIR	Internal	AIA, GOLDAIR	.xml		
Type of Aircraft	OAG	Internal	AIA	API		
Ground times (major EU hubs)	OAG	Internal	AIA, GOLDAIR	API		
Weather	UBIMET	Internal	AIA, GOLDAIR	.csv, GeoTIFF		
Passengers' numbers	GOLDAIR	Internal	AIA, GOLDAIR	.XML		
Force majeure and operational irregularities	AIA	Internal	AIA, GOLDAIR	.txt		

Table 9: Data Landscape: Aircraft turnaround process

3.4 USE CASE #1.4: PUBLIC TRANSPORTATION PLANNING SUPPORT.

Data exchange between the airport and the municipality can help improve the overall planning of public transport, allowing the development of services that are able to predict the accuracy of the load within the day to improve route scheduling, deployment of vehicles and the efficient utilisation of its fleet, thus offering to commuters better services and lowering operational costs.

The outputs of the analysis will be valuable to parties such as the airport and the city, for the latter to be able to improve their own offer and services towards the commuters, or to relevant third parties (e.g., duty-free shops, local city businesses, etc.). This can be achieved by combining data for incoming passenger traffic to the airport from public transport (e.g., bus occupancy), data from the airport service handlers (e.g., expected queuing, check-in counters availability, security checkpoint staffing), and information such as airport routing, flight, and weather information, etc.

3.4.1 Ambition of use-case

The **aim** of this use case is to design a better service for passengers from and to the airport and the optimisation of the public transport service for the airport.

On top of that, the use case will try to set up a process to enable the live data sharing on road traffic conditions (kerbside), between AIA and OASA. This is to facilitate the OASA driver to make an informed decision on the route to follow so as not to get stuck in traffic and be delayed. The existing data coming from the access control system at the kerbside needs to be further processed so as to provide a meaningful piece of information that is worth sharing.

3.4.2 Target Audience Descriptions

Athens Urban Transport Organisation (OASA), Athens International Airport (AIA) and the City of Athens (DAEM) are the core actors involved in Use Case 1.4. In the public transportation planning support process, OASA acts both as a data seeker and a data owner. As data seeker, OASA will utilise the input data provided by the other actors with the aim of refining its services, whereas as data owner, the organisation will trade back data to the rest of the actors in order for the latter to improve their own services and offerings. The same applies to AIA who acts as a data owner, mainly feeding the PISTIS platform with the relevant data to be utilised by OASA and as a data seeker receiving data from the Public Transport Authority. DAEM in Use Case 1.4 mainly acts as a data seeker, whereas UBIMET acts as a data owner with its weather data.

3.4.3 Summary of status after Alpha testing phase

Data plays an important role in successful public transport planning, directly impacting passenger satisfaction and operational efficiency. The PISTIS Data Factory facilitates seamless data exchange among stakeholders, enabling advanced analysis and predictive insights. This empowers public transport operators to optimise service planning, enhance user experience, and allocate resources more effectively to meet passenger demand.

As part of the alpha testing phase, OASA evaluated the core functionalities of the PISTIS Data Factory. The process involved ingesting and managing data samples through the following steps:

- Job Configurator: Datasets were uploaded by specifying the file name and description.
- Workflow Execution: The upload progress was monitored in real-time.
- Data Transformation: Datasets were processed using the Transformation Catalogue and Data Transformation tools.

Once published, datasets became available in "MyData", where their properties, such as pricing, availability and download limits could be configured. Additionally, the Marketplace was tested to explore available datasets and simulate purchasing functionalities.

During testing, a few technical issues, such as data formatting inconsistencies, minor delays in workflow execution and error displays in the Marketplace, were identified and solved, proving valuable feedback for further improvements and ensuring a smoother user experience in the next releases.

In its full implementation, the PISTIS platform will provide comprehensive datasets for analysis via an interactive dashboard, ultimately refining public transport planning and decision-making processes.

3.4.4 Data Landscape: Public Transportation Planning

Data Type	Data Provider	Internal/ External	Data Consumer	Data Format	Data Accessed	Comments
Public transport schedules (Bus/ Metro)	OASA	Internal	AIA, DAEM	GTFS data		
Card and ticket validation data	OASA	Internal	AIA, DAEM	.txt data files		
Transport Demand (Origin-Destination matrices)	OASA	Internal	AIA, DAEM	.xls, .csv		Data will be available for specific periods in 2023 & 2024.
Geolocation dataset on all bus routes and bus arrivals/ departures (currently available for 2023 & 2024)	OASA	Internal	AIA, DAEM	.csv data files		
Historic data (e.g. flight schedules, gate/terminal usage)	AIA	Internal	OASA	IATA standards, excel, text, API		
Airport modal share	AIA	Internal	OASA, DAEM	IATA standards, excel, text, API		
Weather	UBIMET	Internal	OASA, AIA, DAEM	.csv, GeoTIFF		
Inbound/outbound passengers per hour	AIA	Internal	OASA, DAEM	Open file format		
Transport modal split	OASA, AIA	Internal	AIA, OASA, DAEM	.xls data files		These data will not be uploaded, they will be used as parameters in the dashboard.
No. of Buses dedicated to the Airport routes	OASA	Internal	AIA, DAEM	.xls data files		As above.
Capacity of Buses servicing routes to/ from the Airport	OASA	Internal	AIA, DAEM	.xls data files		Data currently sparse.
Bus Occupancy data for routes servicing the airport	OASA	Internal	AIA, DAEM	.xls data files		Data currently sparse.

Table 10: Data Landscape: Public Transportation Planning

3.5 USE CASE #1.5: INSIGHTS FOR CITY COMMERCIAL BUSINESSES.

Added value services will be offered across specific areas of interest in the city of Athens based on the analysis and prediction of the load expected within the city, informing local businesses on how people are expected to move within the commercial zones of the city. The intention is to improve local entrepreneurship and boost businesses turnover, and to deliver services that can improve the mobility experience of the citizens and visitors of the city, which will lead to an optimisation of mobility services in specific areas (e.g. dynamic PT timetables, less queuing at touristic sites) and could help the Public Transport Operator to adapt, in the longer term, its routes and timetables with respect to touristic/heavy load destinations.

3.5.1 Ambition of use-case

The intention is to enable data exchange between the airport, the public transport agencies and the city to offer better services to citizens, to improve local entrepreneurship in Athens according to expected loads in specific areas and to leverage the mobility as well as the touristic experience of the city according to foreseen mobility flows.

3.5.2 Target Audience Descriptions

The actors in UC1.5 are the Greek cluster partners of PISTIS, namely AIA, OAG and DAEM that collaborate for the preparation and implementation of the Hub 1 Demonstrator. The actors can be identified as data owners and seekers, and they are divided as internal (the PISTIS partners) and external from other stakeholders, bodies and organisations.

3.5.3 Summary of status after Alpha testing phase

The Alpha version testing for the Hub was finalised at M28. The relevant guidance was shared with the Hub 1 partners in terms of links, accounts, credentials, steps to take, etc. The evaluation of the testing included a first demo testing of AIA and followed by the rest of the partners proceeding with their processes. DAEM tested the relevant factory (daem.pistis-market.eu). An account and the json file was shared prior to the testing.

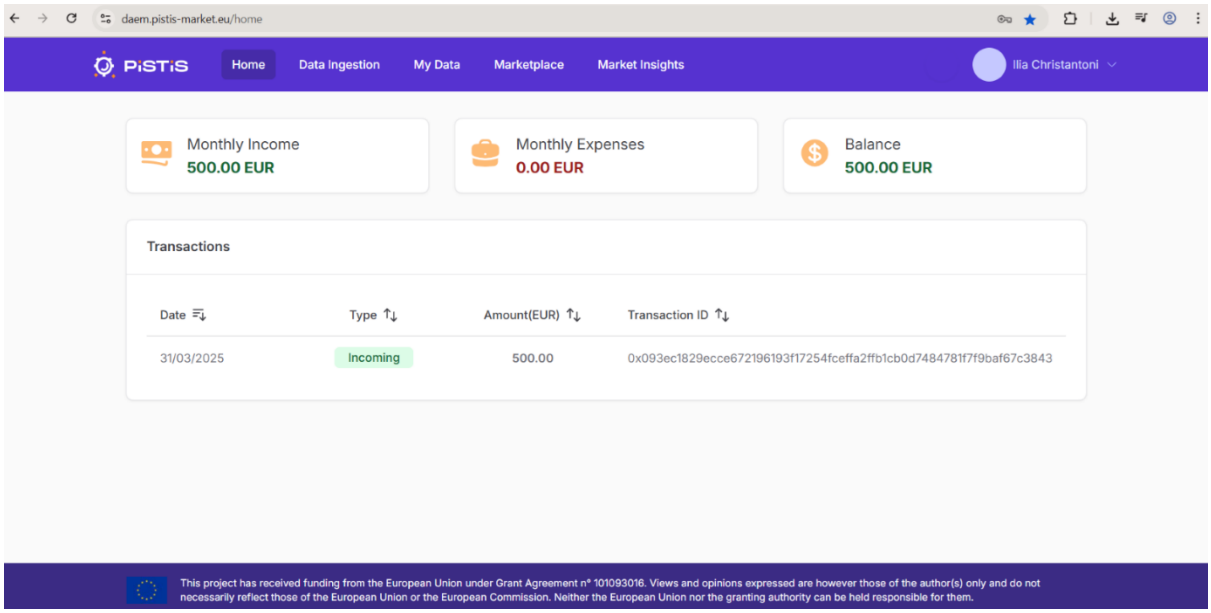


Figure 3: Data Factory daem.pistis-market.eu

A sample dataset was used from the registry of businesses in Athens converted to a compatible format of UTF-8 encoding.

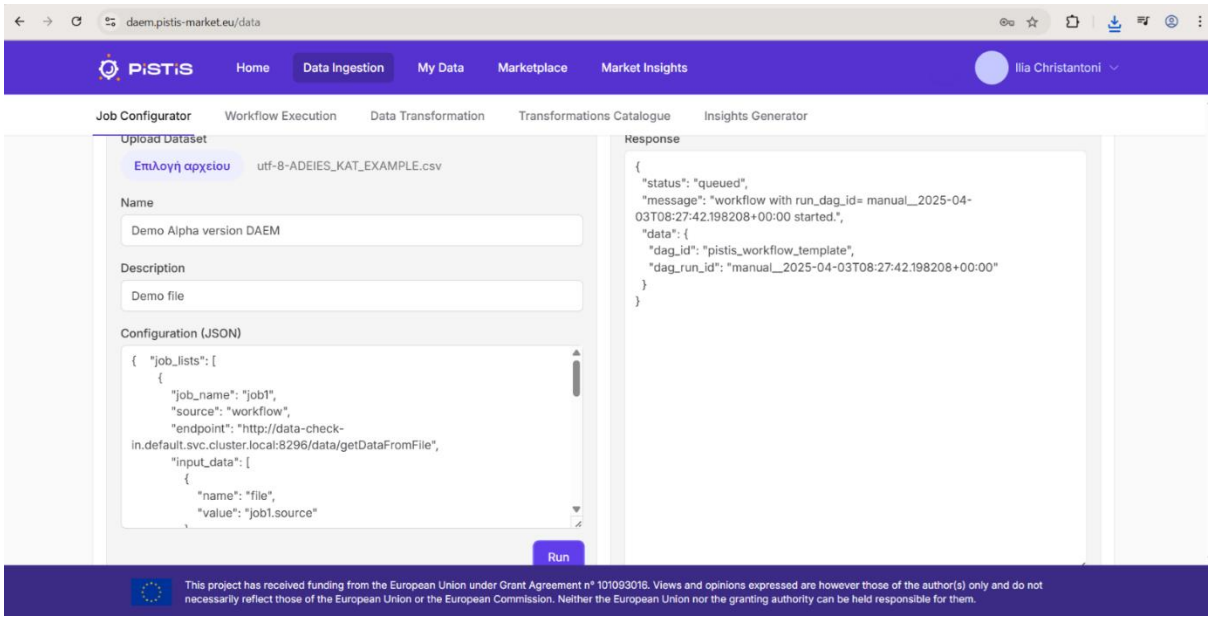


Figure 4: Sample file upload and response

Initially the sample was uploaded and the json file was copied. The response was sent back from the PISTIS platform. Then the testing involved the whole workflow of the Alpha testing, namely the Job Configuration, Workflow execution and Publish of the datasets in the marketplace.

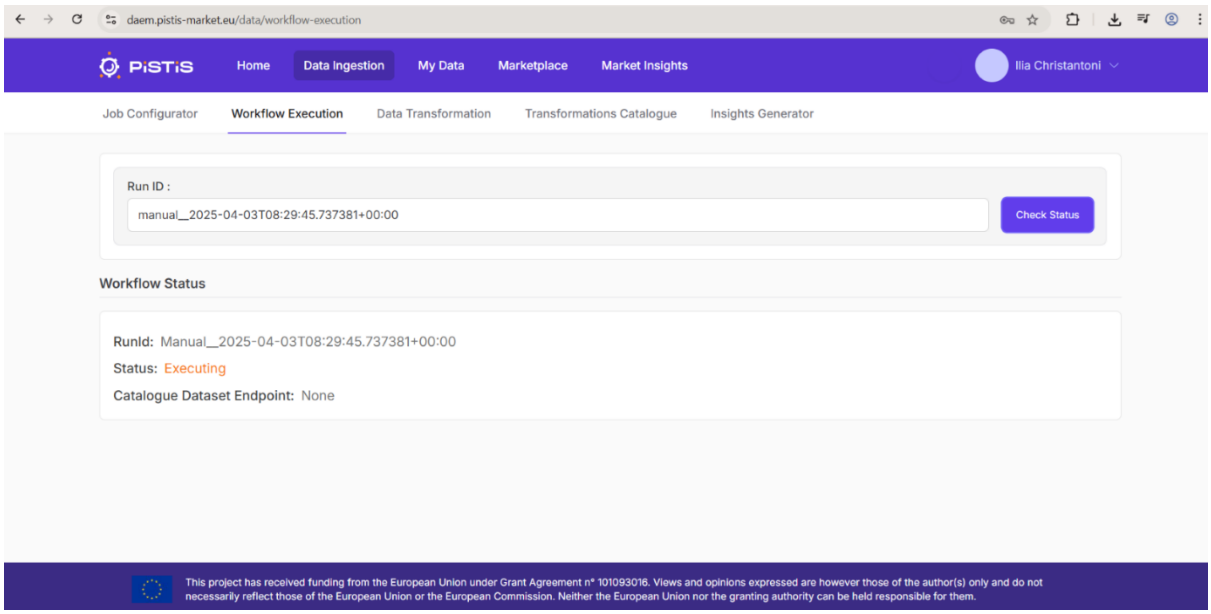


Figure 5: Workflow execution

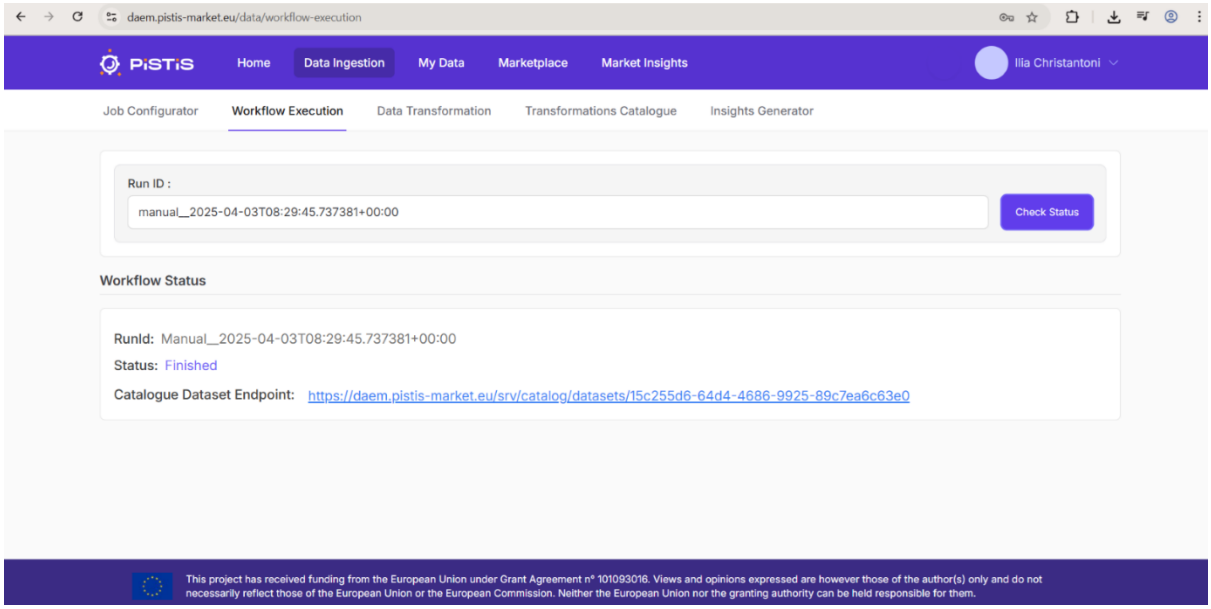


Figure 6: Finished workflow in data ingestion

Sample files were both uploaded and downloaded satisfactorily with an ease-of-use. The final steps of the workflow of Data enrichment and quality assessment are not implemented in the Alpha version.

In summary, the testing resulted in a simple interface, process and usable marketplace. Finally, a TAM questionnaire was completed.

3.5.4 Data Landscape: Insights for City Commercial Businesses

Data Type	Data Provider	Internal/ External	Data Consumer	Data Format	Data Accessed	Comments
Mobility/touristic/business registry.	AIA, OASA	Internal	DAEM	O-D matrices in .xls format for OASA Mobility data.		
Number of expected visitors.	AIA	Internal	DAEM	xls/csv		Data will be available for specific periods in 2023 & 2024.
Destination of visitors.	AIA	Internal	DAEM	xls/csv		
Business registry GIS info on location, district, address, floor, postal codes, areas codes.	DAEM	Internal	DAEM	xls/csv		
Business registry - Type of business and admin changes.	DAEM	Internal	DAEM	xls/csv		
Municipality of Athens GIS data – Athens roads, coding	Municipality of Athens	Internal	DAEM	xls/csv		
Municipality of Athens GIS data – Athens areas names, coding, municipal district	Municipality of Athens	Internal	DAEM	xls/csv		
Municipality of Athens GIS data – municipal districts	Municipality of Athens	Internal	DAEM	xls/csv		
Departure and arrival bag data.	AIA	Internal	DAEM	xls/csv		
Public transport data on buses- timetables, passengers, routes.	OASA	Internal	DAEM	xls/csv		
Weather and environmental data and forecasts.	UBIMET	Internal	DAEM	zip		
Public transport data for metro, tram, railways.	Ellinico Metro, Hellenic	External	DAEM	This information is not		This is an indicative external

Data Type	Data Provider	Internal/ External	Data Consumer	Data Format	Data Accessed	Comments
	Railways Organisation			available yet.		data set that will be retrieved in the next version
Data for taxi fleets, load of passenger, destination/departure points.	Taxi associations & companies	External	DAEM	As above.		As above.
Data on touristic flows, points of interest, locations for accommodation.	Region of Attica, Ministry of Tourism, neighbouring municipalities	External	DAEM	As above.		As above.
Number of visitors, analytics on visits (seasonal, hours of peak visits, demographics of visitors etc) from touristic, cultural and archaeological bodies.	Museums, National Garden of Athens, Athens Culture Net, Acropolis Museum	External	DAEM	As above.		As above.

Table 11: Data Landscape: Insights for City Commercial Businesses

4 DEMONSTRATION HUB #2 - ENERGY

The Energy Demonstrator hub will focus on ensuring the resilient operation of the distribution grid through the utilisation of the flexible capacity that can be offered by local prosumers and triggered by the aggregator (as the main actor involved in flexibility transactions and representing aggregated clusters of prosumers in energy markets), thus providing a real environment for validating the operational benefits of data sharing.

Three use cases share the same approach to handling data, and the current situation is summarised in Table 12 below. The table outlines the data-handling stages involved during this initial alpha phase of PISTIS.

The fourth use case, which is more closely related to data monetisation, will build on the added value that PISTIS has provided to the previous three. It will be complemented with real data on the costs of grid digitalisation, with the ultimate goal of offering a realistic estimation of the cost of generating a data package.

The measurement of the actual impacts will be provided in deliverable D5.3 and the process for evaluating this progress is set out in Chapter 18 of D5.1.

Actions carried out in Alpha version testing for all four use-cases.

	UC1	UC2	UC3	UC4
Data Exploration				
Data Navigation/Querying				
Data Matchmaking Services				
Data Contract Preparation				
Contract Drafting				
Contract Notification				
Data Acquisition				
Data Transfer				
Data Decryption				
Data Ingestion, Transformation and Treatment.				
Data Check-In: the collection of data from the PISTIS system through various options (e.g., APIs, Pub/Sub, etc.).				
Data Enrichment: the cleaning of data from errors and/or inconsistencies and the matching of ingested data to a common model for interoperability purposes.				
Analytics/Insights Engine: the application of some ready-made analytics on the data, to extract some information.				
Data Lineage Tracking: the application of tracking tags on the data for allowing tracking of the subsequent actions.				
GDPR Checker: the evaluation of whether the data contains GDPR relevant information and the suggestion to strip (if wanted) such information from the dataset (or to change it if needed) prior to exchanging it with other stakeholders.				
Data Anonymisation: Application of anonymisation techniques.				

	UC1	UC2	UC3	UC4
Data Quality Assessment: The assessment of the data for extracting indexes that can describe the quality in different dimensions.				
Data Storage: The storage already treated data back to the original data storage facilities, keeping "pointers" at the PISTIS facility.				
Data Publication Preparation.				
Access Policies Definition: Mechanisms for the application of policies for the access level on stored data of PISTIS system.				
Data and Metadata Publication: The publishing of metadata of the treated datasets in the federated PISTIS repositories for the allowing their querying and the publication of a small set of Data online to be displayed to interested stakeholders.				
Transactions Monitoring (in case transactions are available).				
Auditing of Transactions: An interface where a user can have a log of his transactions.				
Auditing of On/Off Platform Usage: An interface where the user can witness how the data he has traded is used.				

Table 12: Covering all four Use Cases[21]

4.1 USE CASE #2.1: INCREASE THE HOSTING CAPACITY OF THE GRID.

The demo case focuses on the effective resolution of distribution grid congestions, through innovative flexibility-based grid management mechanisms. Smart metering data provided by local prosumers, together with distributed generation data (photo-voltaic, PV) and SCADA (Supervisory control and data acquisition) information from the Distribution Service Operator (DSO) will be jointly analysed to extract accurate demand and generation forecasts (in the short and mid-term). Also to estimate anticipated events in the distribution grid thanks to the digital twins. The required flexibility to effectively address them will be procured by the Aggregator.

4.1.1 Ambition of use-case

The **aim** of this case study is to Increase the hosting capacity of the grid by accommodating DERs smoothly, whilst also negotiating new short-term flexibility products.

Thanks to the short-term flexibility market, one-off events due to grid overload can be avoided by making the flexible elements work, so that during the rest of the time it is possible to accommodate more distributed generation in the grid, thanks to controllability.

4.1.2 Target Audience Description

In this Use Case, the participating actors include all those from the Energy Hub, where Omie is the MO (Market Operator) and provides a local flexibility market platform, with Cuerva as the DSO, and Bamboo as the aggregator. In the case of Cartif, it will act as the developer providing the technology that in a real-world setting would be part of the DSO. Additionally, Cartif will also serve as an independent flexibility service provider, a role to which the

[21] Green colour – evaluated functionalities; yellow colour – functionalities to be implemented in the next versions and to be evaluated later

aggregator turns to create the flexibility offering. UBIMET will provide meteorological data to Cartif for the generation of consumption, generation, and network event prediction data.

4.1.3 Summary of status after Alpha testing phase

Following the tests carried out with the PISTIS platform, using datasets already available and currently being used in the parallel development of the use cases, it has been demonstrated that the platform's integration can streamline certain processes, such as data anonymisation and the handling of specific issues, while adding significant value through data enrichment.
In addition, the ability to "offer" these datasets for usage or exchange simplifies their control and traceability within the development process, where maintaining a structured development backlog is essential.
Once Use Case 1 was fully developed alongside the platform, it was also demonstrated that it can be fully integrated into the short-term flexibility market workflow, verifying data communications and maintaining a comprehensive log. This serves as an example not only for Use Case 1, but also for Use Case 2, which focuses on the long-term flexibility market.
In the image below, the green highlights indicate where the platform integrates within the market flow diagram.

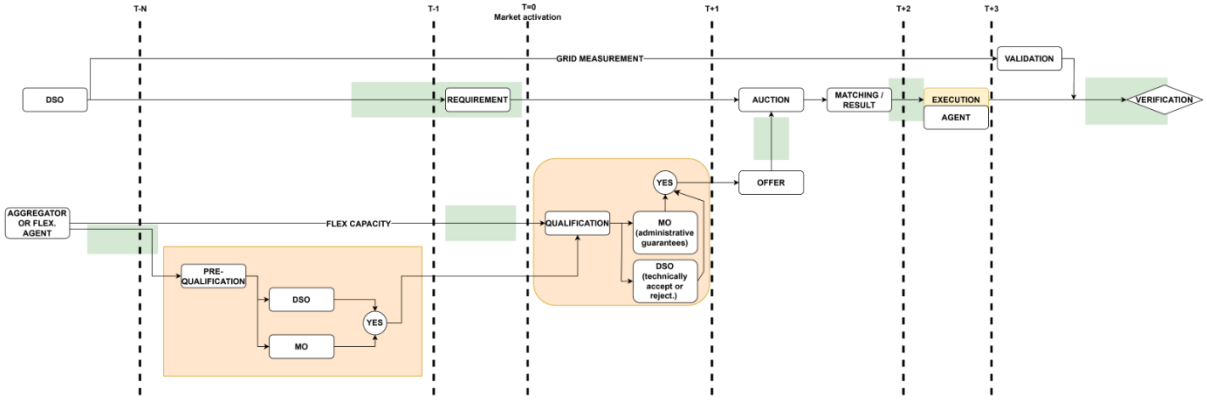


Figure 7: Long-term flexibility market

After conducting tests with various datasets related to Use Cases 1, 2, and 3, a TAM (Technology Acceptance Model) questionnaire was completed to gather feedback on key aspects of the platform, including its usability, interface, and areas for improvement.
In general, the platform was perceived as user-friendly and intuitive, with the expectation that it will not only add value to the data itself but also to the processes derived from the market trial, supporting more efficient and structured workflows.

4.1.4 Data Landscape: Increasing the hosting capacity of the grid.

Data Type	Data Provider	Internal/ External	Data Consumer	Data Format	Data Accessed	Comments
Grid Topology	CUERVA	Internal	CARTIF	CSV, Static data		
DERs Location	CUERVA	Internal	CARTIF, OMIE	CSV Static data, form		
DERs Generation	CUERVA	Internal	BAMBOO	CSV Time series		
Grid Events (historical)	CUERVA	Internal	CARTIF	CSV Static data		
User Consumption (historical)	CUERVA	Internal	CARTIF	CSV Time series		
Flexibility Aggregated Data	BAMBOO	Internal	OMIE, CARTIF	CSV Time series		It depends on previous analyses based on accessible data.
Bids	BAMBOO	Internal	OMIE, CARTIF	CSV Static Data		As above
Hosting Capacity Analytical Results	CARTIF	Internal	CUERVA	CSV Static Data		As above
Topology of the network, measurement of energy use by customers, future actions on the network and the economic value that this entails.	CUERVA	Internal	BAMBOO, CARTIF	CSV Static data		
Unit power, unit location, unit schedule, unit bids (hour contract, quantity and price)	BAMBOO, CUERVA	Internal	OMIE	CSV Static data		As above
Requirement (quantity, limit price, hour contract)	CUERVA	Internal	OMIE	CSV Static data		As above
Data generated by the grid (voltage, current, power, switches position, etc.), Data generated by the users (energy consumption)	CUERVA	Internal	BAMBOO, CARTIF	CSV Time series		
Weather data, energy forecasting data for PV.	UBIMET	Internal	BAMBOO, CUERVA	API, CSV, time series		
Electrical consumption and generation.	CUERVA	Internal	BAMBOO, CARTIF	CSV Time series		

Table 13: Data Landscape: Increasing the hosting capacity of the grid.

4.2 USE CASE #2.2: INVESTMENT DEFERRAL.

This Use Case focuses on investment reduction thanks to the available data and the flexibility of the system. The most benefited actor is the DSO that can plan the grid operation, including the use of flexibility agents, and create a long-term local flexibility market. In this case, the market is planned to create commitments with the DSO for the following months or years, thus effectively providing a new management tool for the DSO. These data are interchanged over time thanks to the platform, being thus registered, and if it is necessary, apply tradability or penalties in the validation process.

4.2.1 Ambition of use-case

The **goal** for this use-case is to focus on studying the impact of utilising data and flexibility in grid development, as an alternative to traditional approaches that address issues like overvoltage and congestions. There is the need to facilitate the exchange of valuable information and resources, leading to more efficient grid management and cost savings in the energy sector.

4.2.2 Target Audience Descriptions

The interaction with the platform and all the processes in the flexibility market are the same as stated above in the use-case #2.1 Hosting Capacity of the Grid. Similarly, the data to be shared are the same and the only difference is the period of the events, and the flexibility offers.

4.2.3 Summary of status after Alpha testing phase

In the case of Use Case 2, both the data inputs and the overall structure of the use case mirror those of Use Case 1. The key difference lies in the time horizon: while Use Case 1 focuses on the operation of a short-term flexibility market, Use Case 2 explores the dynamics of a long-term flexibility market, which introduces different requirements and perspectives, particularly in terms of forecasting, planning, and investment decision-making.

As both use cases are still under development, it is expected that the specific differences will become clearer once each is fully implemented. For now, the testing of the PISTIS platform for Use Case 2 has been performed using the same datasets as in Use Case 1, as they are technically valid for both applications.

This shared structure has allowed the team to validate core functionalities of the platform — such as data uploading, processing, anonymisation, and interaction with services — while also identifying potential adjustments that may be needed once the long-term market-specific data becomes available.

The ability to reuse and adapt data pipelines between use cases highlights the flexibility and scalability of the platform, reinforcing its role as a central enabler in future market-oriented data ecosystems.

4.2.4 Data Landscape: Investment deferral

Data Type	Data Provider	Internal/ External	Data Consumer	Data Format	Data Accessed	Comments
Grid Topology	CUERVA	Internal	CARTIF	CSV files, Static data		
Grid Investment	CUERVA	Internal	CARTIF	CSV files, Covering the planned actions for the coming years.		
Grid Events (historical)	CUERVA	Internal	CARTIF	CSV, Static data		
User Consumption (historical)	CUERVA	Internal	CARTIF	CSV, Time series		
DERs Generation	CUERVA	Internal	BAMBOO	CSV, Time series		
Flexibility Aggregated Data	BAMBOO	Internal	OMIE, CARTIF	CSV, Static data		It depends on previous analyses based on accessible data.
Result of problem solved thanks to flexibility	CARTIF	Internal	CUERVA	CSV, Static data		As above
Topology of the network, measurement of energy use by customers, future actions on the network and the economic value that this entails.	CUERVA	Internal	BAMBOO, CARTIF	CSV, Static data		
Unit power, unit location, unit schedule, unit bids (hour contract, quantity and price)	BAMBOO, CUERVA	Internal	OMIE	CSV, Static data		As above
Requirement (quantity, limit price, hour contract)	CUERVA	Internal	OMIE	CSV, Static data		As above
Data generated by the grid (voltage, current, power, switches position, etc.), Data generated by the users (energy consumption)	CUERVA	Internal	BAMBOO, CARTIF	CSV. Time series		
Weather data, energy forecasting data for PV.	UBIMET	Internal		API, Time series		As above
Electrical consumption, electrical generation.	CUERVA	Internal	BAMBOO, CARTIF	CSV, Time series		

Table 12: Data Landscape: Investment deferral

4.3 USE CASE #2.3: P2P TRADING BETWEEN USERS OR ENERGY COMMUNITIES.

Currently, in view of the promotion of self-consumption, shared self- consumption and the growing number of new energy communities, users are increasingly wishing to be aware of the origin of the energy purchased from the grid and the destination of the energy fed into the grid. At present this information is unknown, beyond the guarantees of origin offered by some traders. Peer-to-Peer (P2P) trading is proposed to allow the user to choose which grid user to sell to or buy from, thus enabling the creation of these peer-to-peer exchanges and, therefore, empowering the users to know exactly what they are consuming and where it comes from.

This could be enabled by new platforms operated by the MO, where different resources trade energy in local level. In this case, the DSO is not seeking to solve a problem with the supply quality, but it cannot allow events to occur due to exchanges between users that could lead to unexpected situations. Therefore, the distributor's role is to act as a controller of these exchanges for prior validation before technical dispatch.

4.3.1 Ambition of use-case

The **aim** is to create peer-to-peer exchanges with a new platform operated by the MO, to facilitate free negotiation among energy resources and assets (that is -without any DSO call).

It is also interesting for the DSO to study how P2P affects not only the grid, but also short and long-term flexibility markets, and the need to intervene in P2P to ensure the quality of supply.

4.3.2 Target Audience Descriptions

In this use case, the primary roles are covered by the Market Operator and the Aggregator, using the short-term market platform as a free market platform. In this scenario, end-users could place energy demand and supply on the platform outside of the time periods when the DSO requires flexibility for specific moments. However, it is essential to consider how these P2P exchanges affect the grid and whether they generate new flexibility requirements.

4.3.3 Summary of status after Alpha testing phase

In the case of Use Case 3, the same user consumption and network data previously used in Use Cases 1 and 2 have been employed for testing purposes. While the objective of Use Case 3 differs—focusing on a different dimension of data usage within the energy system—the underlying datasets remain relevant and applicable due to their foundational role in representing real operational conditions.

This approach has allowed for the reuse of validated data pipelines, streamlining the integration with the PISTIS platform and enabling consistent testing of core functionalities such as data upload, processing, and enrichment. The use of familiar datasets also facilitated the assessment of the platform’s performance in a comparable context, making it easier to identify usability improvements, validate system responses, and ensure interoperability across different use cases.

Although Use Case 3 introduces its own specific analysis and goals, leveraging the same datasets has proven effective for the initial validation phase, and sets a solid baseline for future expansion with more targeted or domain-specific data inputs. This further demonstrates the flexibility and adaptability of the PISTIS platform to support a variety of energy-related data use cases.

4.3.4 Data Landscape: P2P Trading Users or Energy Communities

Data Type	Data Provider	Internal/ External	Data Consumer	Data Format	Data Accessed	Comments
Any kind of data collected by or from stakeholders.	CUERVA	Internal	EURECAT	CSV, Static Data		It depends on previous analyses based on accessible data.
Grid Topology	CUERVA	Internal	CARTIF	CSV,Static data		
User Consumption (historical)	CUERVA	Internal	CARTIF	CSV, Time series		
DERs Generation	CUERVA	Internal	BAMBOO	CSV, Time series		
Flexibility Aggregated Data	BAMBOO	Internal	OMIE, CARTIF	CSV,Static data		As above
Topology of the network.	CUERVA	Internal	BAMBOO, CARTIF	CSV, Static data		
Measurement of energy use by customers.	CUERVA	Internal	BAMBOO, CARTIF	CSV, Time series		
Unit power, unit location, unit schedule, unit bids (hour contract, quantity and price).	BAMBOO, CUERVA	Internal	OMIE	CSV, Static data		As above
Data generated by the users (energy consumption).	CUERVA	Internal	BAMBOO, CARTIF	CSV, Time series		
Weather data, energy forecasting data for PV.	UBIMET	External	CARTIF	API, Time series		As above
Electrical consumption, electrical generation.	CUERVA	Internal	BAMBOO, CARTIF	CSV, Time series		

Table 13: Data Landscape: P2P Trading between Users or Energy Communities

4.4 USE CASE #2.4: MONETISATION OF ENERGY EXCHANGE DATA

This Use Case will explore the possibility to monetise the data, which is owned by the different actors participating in the energy exchange over the grid, to third parties for different uses, such as energy as a service (EaaS). The potential consumers are aggregators, installers, energy service companies, retailers, consultancy or advisory companies, private research groups and universities, EV charging companies and software companies. They would be able to optimise their existing services and develop new ones thanks to the additional information obtained through use of the data.

4.4.1 Ambition of use-case

The **Goal** for this case study is to define the process of data valorisation to target potential consumers of energy assets, who may use them for Energy as a Service (EaaS) including aggregators, installers, energy service companies, retailers, consultancy firms, research groups, universities, EV charging companies, and software companies.

4.4.2 Target Audience Descriptions

In this scenario, every member of the Energy Hub acts as both a data owner and a data seeker, collaboratively exploring potential external entities that might be interested in acquiring the data produced.

4.4.3 Summary of status after Alpha testing phase

In the case of Use Case 4, the platform has not yet been tested with datasets specifically tailored to this use case, as its main focus lies in the valorisation of data, rather than in operational processes or technical simulations like the previous use cases. However, the initial testing phase using the shared datasets from Use Cases 1–3 has proven highly valuable in assessing how the platform handles data ingestion, processing, enrichment, and traceability.
Although no direct monetisation scenarios have been tested yet, the experience so far has provided a clear overview of the technical and economic value that PISTIS can add to raw datasets. Features such as data cataloguing, metadata generation, quality control, and usage tracking demonstrate how the platform can support the creation of standardised, reusable, and traceable data products — all of which are essential building blocks for the future development of data-driven business models.
This early evaluation has not only improved our understanding of the platform's potential in the context of data monetisation, but has also helped to establish the conceptual and technical foundations for the implementation of Use Case 4. Going forward, these insights will support the definition of relevant datasets, the identification of value creation mechanisms, and the design of data-sharing frameworks aligned with market and regulatory needs.

4.4.4 Data Landscape: Monetisation of Data owned by the different Actors to Third Parties

Data Type	Data Provider	Internal/ External	Data Consumer	Data Format	Data Accessed	Comments
Digitalisation Costs.	CUERVA	Internal	CUERVA, BAMBOO, CARTIF	CSV, Static data		Further investigation needed.
Grid O&M operation.	CUERVA	Internal	CUERVA, BAMBOO, CARTIF	CSV, Static data		
Data Infrastructure Costs.	CUERVA	Internal	CUERVA, BAMBOO, CARTIF	CSV, Static data		
Future actions on the network and the economic value that this entails.	CUERVA	Internal	CUERVA, BAMBOO, CARTIF	CSV, Static data		
Data generated by the grid (voltage, current, power, switches position, etc.), Data generated by the users (energy consumption).	CUERVA	Internal	CUERVA, BAMBOO, CARTIF	CSV, Time series		
Weather data, energy forecasting data for PV.	UBIMET	Internal	CUERVA, BAMBOO, CARTIF	API		Depends on the grid area.
Electrical consumption, electrical generation.	CUERVA	Internal	CUERVA, BAMBOO, CARTIF	CSV, Time series		

Table 14: Data Landscape: Monetisation of Data to Third Parties

5 DEMONSTRATION HUB #3 - AUTOMOTIVE

The Demonstrator Hub #3 focuses on facilitating data sharing amongst stakeholders in the mobility and transport system.

The automotive demonstrator hub will support environmentally friendly, safe, and efficient mobility and transport. Specifically, the mobility hub will use various data sources, e.g. connected vehicle data from car manufacturers (via CARUSO, data provider operating a data marketplace), vehicle trip data (via VIF, Europe's largest RTO for virtual vehicle technology), weather data (via UBIMET), map data (OpenStreetMap), and air quality data (open government data) to focus on traffic quality assessment in urban areas and driving style and driving risk assessment.

The two use cases in this Hub will use the data and provide concrete data-driven services to individual drivers (driver warning and coaching), businesses (corporate mobility management for green driving), and public administrations (urban emission modelling, risk hotspot analysis).

The measurement of the actual impacts will be provided in deliverable D5.3 and the process for evaluating this progress was set out in Chapter 18 of D5.1 and referred to in the first chapter of this document.

Given that the Use Case #1 Traffic Quality Assessment builds upon Use Case #2 Driving Style and Risk Assessment, it is logical in this document to present that use case first.

Actions carried out in Alpha version testing for both use-cases.

	UC1	UC2
Data Exploration		
Data Navigation/Querying		
Data Matchmaking Services		
Data Contract Preparation		
Contract Drafting		
Contract Notification		
Data Acquisition		
Data Transfer		
Data Decryption		
Data Ingestion, Transformation and Treatment.		

	UC1	UC2
Data Check-In: the collection of data from the PISTIS system through various options (e.g., APIs, Pub/Sub, etc.).		
Data Enrichment: the cleaning of data from errors and/or inconsistencies and the matching of ingested data to a common model for interoperability purposes.		
Analytics/Insights Engine: the application of some ready-made analytics on the data, to extract some information.	Only insights Generator[22]	
Data Lineage Tracking: the application of tracking tags on the data for allowing tracking of the subsequent actions.		
GDPR Checker: the evaluation of whether the data contains GDPR relevant information and the suggestion to strip (if wanted) such information from the dataset (or to change it if needed) prior to exchanging it with other stakeholders.		
Data Anonymisation: Application of anonymisation techniques.		
Data Quality Assessment: The assessment of the data for extracting indexes that can describe the quality in different dimensions.		
Data Storage: The storage already treated data back to the original data storage facilities, keeping “pointers” at the PISTIS facility.		
Data Publication Preparation.		
Access Policies Definition: Mechanisms for the application of policies for the access level on stored data of PISTIS system.		
Data and Metadata Publication: The publishing of metadata of the treated datasets in the federated PISTIS repositories for the allowing their querying and the publication of a small set of Data online to be displayed to interested stakeholders.		
Transactions Monitoring (in case transactions are available).		
Auditing of Transactions: An interface where a user can have a log of his transactions.		
Auditing of On/Off Platform Usage: An interface where the user can witness how the data he has traded is used.		

Table 15: Covering Use-cases in Automotive Hub.[23]

[22] The Insight generator is available. It generates a report, which can be seen as part of the data check-in process. Additionally, there is a ready stand-alone Analytics Engine, but it is not included in our Alpha evaluation.

[23] Green colour – evaluated functionalities; yellow colour – functionalities to be implemented in the next versions and to be evaluated later

5.1 USE CASE 3.2: DRIVING STYLE & RISK ASSESSMENT.

The assessment of driving style and driving risk by using multiple data sources is a major topic for safe driving research and applications. This is a comprehensive safety technology designed to analyse various factors related to driving behaviour, environmental conditions, and potential hazards on the road. The ultimate goal is to provide timely warnings to drivers, helping them proactively navigate potential risks and enhance overall road safety.

A driving risk can be computed by analysing data from connected vehicles (such as location, speed, or driving direction), data about past accident hotspots, data indicating individual driving behaviour (such as harsh braking, acceleration, speed or driver distraction), and data indicating weather conditions and changes, to name a few examples. Thereby, driving-risk relevant events extracted from various data sources form the input for a driving risk assessment pipeline. Drivers may undergo categorisation based on their distinctive driving behaviours, encompassing safety-related events like speeding, braking, use of assistance systems, or reckless driving, all derived from the vehicle's sensor data. To enhance the precision of the driving risk evaluation, the severity of driving events is carefully weighed by incorporating contextual data. Factors such as weather conditions, road topography, locations of harsh driving, or accident hotspot data are integrated to provide a more nuanced understanding.

In the subsequent phase, this rich dataset may become a cornerstone for personalised driver coaching. Leveraging gamification strategies, drivers are incentivised through point systems or rankings, fostering a sense of competition. This encourages the adoption of environmentally friendly and safe driving practices. By employing these engaging techniques, the driving experience transforms into a dynamic platform for continuous improvement, benefitting both individual drivers and the broader community.

In a nutshell this use case revolves around analysing shared data to identify safety-related events. Tailored to individual driving contexts, the system issues driver warnings, promoting safer driving practices. For transportation managers, a comprehensive overview of the entire data landscape is presented through an interactive dashboard, providing a holistic perspective on driver-risk relevant events.

5.1.1 Ambition of use-case

The **goals** are to create a data-driven driving risk prediction and warning system for (1) vehicle drivers that enhances driver awareness, reduces risky behaviours, and improves overall driving and road safety, integrating different data sources from different data providers. The knowledge of risky locations in the road network may also be of interest to (2) transportation managers who may want to establish risk mitigation mechanisms and are therefore provided with an interactive dashboard.

Therefore, the use case aims to

- Establish data trading partnerships or agreements with data providers (e.g., for vehicle and weather data) to ensure a continuous supply of current and historical data.

- Obtain data from relevant sources to develop algorithms and models for a more accurate and useful inference of driving risk and the development of respective driver warning and assistance systems.
- And to have access to large-scale car data alongside current and historic weather data, for a more scalable solution adaptable to a broader application context.

5.1.2 Target Audience Descriptions

VIF can provide access to data containing the location of past acceleration, braking and curve driving events including metadata such as location, time, driving speed and speed change, derived from data containing past road trips. CARUSO can provide access to vehicle data (personalised data) if the driver/owner of the vehicle has agreed to the use of this data for a specific service. CARUSO also has access to anonymous/synthetic vehicle data. UBIMET can provide access to current weather data as well as to historical weather data. VIF is seeking access to vehicle data (provided by CARUSO) as well as to current and historical weather data (provided by UBIMET).

5.1.3 Summary of status after Alpha testing phase

Data sharing is at the core of the automotive hub, which integrates weather, hazard, and vehicle data to provide driver risk warnings, emissions modelling, and visualization. By leveraging the PISTIS Data Factory on a cloud platform, testing was streamlined, enhancing both user experience and convenience by eliminating the need for local deployment by partners.

During the demonstration phase, partners rigorously tested the PISTIS Alpha version, ingesting diverse datasets—including vehicle data and traffic risk events—while transforming, enriching, and anonymising data, all via CSV files. For example, VIF shared risk-related event data, which TRAFFICON acquired and integrated into their dashboard. Beyond technical testing, hub partners established data-sharing agreements, facilitated multiple transactions, and monitored logs for cost and revenue tracking.

While minor UI issues were identified and can be easily resolved, the alpha version demonstrates strong potential for both data sharing and monetisation. We eagerly anticipate evaluating the next iteration.

In Use Case 2, TRAFFICON leveraged CARUSO Car Data to estimate motorised vehicle emissions, enhance or develop emission models, and visualise the results on a dashboard. The dashboard also integrated data from virtual weather stations and local driving hazards.

5.1.4 Data Landscape: Driving Style and Risk Assessment.

Data Type	Data Provider	Internal/ External	Data Consumer	Data Format	Data Accessed	Comments
Past trip data (anonymised trips).	VIF	Internal	CARUSO, VIF	CSV		Not planned to be shared via PISTIS
Data about location of brake events.	VIF	Internal	CARUSO, VIF	CSV		
Data about location of acceleration events.	VIF	Internal	CARUSO, VIF	CSV		
Data about the location of curve events.	VIF	Internal	CARUSO, VIF	CSV		
Data about the location of driver warnings.	VIF	Internal	CARUSO, VIF	CSV		
Vehicle trip data.	CARUSO	Internal	CARUSO, VIF	CSV		
Driving style data.	VIF	Internal	VIF, TRAFFICON	API		API-calls via PISTIS are not planned for alpha version
Weather Data (historical).	UBIMET	Internal	VIF	API		API-calls via PISTIS are not planned for alpha version
Weather Data (live).	UBIMET	Internal	VIF	API		API-calls via PISTIS are not planned for alpha version
Anonymised Connected Car Data.	CARUSO	Internal	VIF	API		API-calls via PISTIS are not planned for alpha version
Personalized Connected Car Data.	CARUSO	Internal	VIF	API		API-calls via PISTIS are not planned for alpha version

Table 16: Data Landscape: Driving Style and Risk Assessment.

5.2 USE CASE 3.1: TRAFFIC QUALITY ASSESSMENT.

Driving patterns of vehicles will be analysed in their temporal, spatial and situational context using vehicle sensor data (connected car data via CARUSO). From this data, specific information is calculated, e.g. acceleration, speed, and fuel consumption patterns along a specific route at certain times and their correlation with weather and air quality. These insights are used as input parameters for urban analytics applications facilitating planning processes, such as emission models or the hot-spot detection of stop-and-go patterns. This generated information is also used for incentivising green driving styles and mobility decisions (such as reducing the share of motorised individual transport in the modal split of a commute) and optimising potentials for greener transport in the context of mobility management. Novel urban analytics components will be prototyped, including input parameters for emission models and traffic quality parameters, as well as mobility management services and mechanisms for companies to promote more sustainable driving styles.

5.2.1 Ambition of Use-case

The **goal** of this use-case is the development of two demonstrators: **urban analytics** and **corporate mobility management**. This will entail the exploration of new datasets, including previously unknown sources, and establish mechanisms for selecting only the right sources that are truly relevant and available on a stable basis.

a) Urban analytics

This will involve urban car traffic quality assessment with combination of geospatial time series data to generate an emission model. The combination of floating car data and detector data to estimate traffic volume, with acceleration patterns and locations of individual vehicles provided by CARUSO, allows the generation of an in-depth model of estimated air pollution levels for various road segments.

Subsequently, road segments with significant pollution levels are identified and clustered based on both temporal and spatial factors. This clustering not only enables a clear visual representation of pollution hotspots but also allows for detailed statistical analysis, offering deeper insights into the dynamics of traffic congestion and its environmental impact.

This results in an improved model of the environmental impact of road traffic on the surrounding environment, facilitating the implementation of targeted traffic planning measures in order to strategically minimise the burdens to the cities and communities.

b) Corporate mobility management

This will entail a dashboard integrating real-time data on weather conditions and emission levels across selectable locations. It actively encourages eco-friendly and healthy commuting by recommending sustainable transport options like bicycles or public transport. The recommendations consider user-specific factors such as the starting point and destination of journeys, but also generalisable factors such as current environmental conditions like temperature (provided by UBIMET), precipitation (provided by UBIMET), risk-zones (provided by VIF) and air quality (using the data generated in the urban analytics use case).

Recommendations are based on textual hints, called nudges, that encourage the user to make an environmentally conscious choice of transport.

5.2.2 Target Audience Descriptions

TRAFFICON has access to vehicle data, floating car data and public transport data. These data sources are already in use and available. Additional road networks based on OpenStreetMap data are used as reference point to combine the data and use as a standardised reference. CARUSO can provide access to vehicle data used to characterise emissions based on vehicle type, speed engine RPM and other factors. UBIMET can provide access to current weather data. VIF can provide risk events for further use by Trafficon. Trafficon seeks data from UBIMET, VIF and CARUSO via the PISTIS Platform. In addition, external data described above is imported in other means.

5.2.3 Summary of status after Alpha testing phase

In Use Case 1, VIF developed service-based systems using APIs, including dashboards and a mobile application, that leverage a specific geographic location key (GSK-geospatial key) to query driving risk-related events in the vicinity. These systems analyse events within geographic areas or along the vehicle's driving direction and corridor, correlate them with weather conditions, and issue warnings based on the actual driving speed.

5.2.4 Data Landscape: Traffic Quality Assessment

Data Type	Data Provider	Internal/ External	Data Consumer	Data Format	Data Accessed	Comments
Vehicle sensor data	CARUSO	Internal	TRAF	API		
Vehicle data	CARUSO	Internal	TRAF	API		API-calls via PISTIS are not planned for alpha version.
Fuel/Emission data	CARUSO	Internal	TRAF	API		API-calls via PISTIS are not planned for alpha version.
Weather Data (live)	UBIMET	Internal	TRAF	API		API-calls via PISTIS are not planned for alpha version.
Public Transport Data	TRAF	External	TRAF	OSM-CSV		Not planned to be shared via PISTIS
Floating Car Data (FCD)	TRAF	External	TRAF	JSON		Not planned to be shared via PISTIS
Road Graph Integration OSM	TRAF	External	TRAF	OSM-CSV		Not planned to be shared via PISTIS
Risk Events	VIF	Internal	TRAF	CSV & API		
Emission Model	TRAF	Internal	TRAF	CSV		

Table 17: Data Landscape: Traffic Quality Assessment

6 MATCHING THE HUB DATA TREATMENT REQUIREMENTS WITH THE CORE FUNCTIONALITY NEEDS.

The basis for evaluating progress in gathering together the required data in order to achieve all the goals for PISTIS, in running the demonstrations and for implementing the use-cases, can be found in Tables 7 to 19 above. These initial tables set out the data requirements for each use-case, whilst the later WP5 deliverables will now monitor the satisfactory access to the identified data requirements set in these tables covering the core hubs.

The table below sets out the usage of the core PISTIS functionalities per use-case, to ensure that there is a wide spread of their usage by the individual use-cases, so as to provide enough activity for these functionalities to be evaluated.

Core PISTIS Functionality	**Mobility & Urban Planning**					**Energy Hub**				**Auto-motive**	
	UC.1.	**2.**	**3.**	**4.**	**5.**	**1.**	**2.**	**3.**	**4.**	**1.**	**2.**
Data Ingestion tools and connectors											
Data Enrichment											
Data Transformation											
Analytics/Insight engine for data quality analysis											
Data Lineage tracking											
GDPR Checker (Not available until BETA Version)											
Data Anonymisation											
Data Quality Assessment[24]											
Data Storage											
Data Trading Contract Drafting											
Contract Notification											
Contract Execution											
Data Transaction Monitoring											
Data Navigation/ Querying											

[24] Only for Metadata at this stage. Data Quality will be evaluated starting from the Beta version

Core PISTIS Functionality	Mobility & Urban Planning					Energy Hub				Auto-motive	
Data matchmaking services[25]											
Internal to Pistis Data Acquisitions											

Table 18: Use Case deployment of core PISTIS functionalities

7 IMPACTS

In addition to the overall impacts expected from the project as a whole, individual hubs have their own KPIs, ranging from lowering baggage handling times to lowering investment costs in the energy sector, through to improving driver warning systems, but these cannot be utilised until the project matures and these will be referred to in the final evaluation carried out for D5.3.

It is noted that at the current stage, the three demonstrators have worked with the Alpha version of the PISTIS platform, which is offered as a mix of working prototypes and mock-ups, with the main purpose of this stage being that of debugging and allowing the demonstrators to get acquainted with the overall system, conducting small, close group experiments, and working on customisation and data preparation aspects as identified in their plans.

As such, none of our identified KPIs are to be measured yet, as those are grounded on the actual operation of the platform and these will only be able to be measured following the release of the Beta and of the v0.5 version of the PISTIS platform.

Table 21 below outlines these KPIs which we were set in the DoA and which will be focussing on as the project evolves and the impacts become measurable.

Demonstrator Hub #1
Reduction of Baggage Delivery SLA violations.
Reduction of delays (average delay time) per flight caused by Transfer Passengers or baggage.
Improvement on accuracy and time horizon of predictions of TOBT vs AOBT.
Improved prediction of loads for public transport to/from the Airport.
Reduction in bus trips with a very low load.
Increase of perceived QoS in routes to/from the airport.
Increase of turnover of local businesses due to insights on anticipated load.
Demonstrator Hub #2
Increase in the Hosting Capacity of the LV Grid;
Participation of 40 DER in the LFM (from 0 participating today)
Reduction in investment deferral in new grid reinforcements.
Demonstrator Hub #3
Number of events in the solution that are used to compute a driver warning.
Accuracy of risk models for driver warning.

[25] This functionality will be evaluated starting from the Beta version

Access to further relevant data sources via PISTIS.
Interchangeability of data sources per domain access.
Usefulness of driver warning solution.
Emission values per road segments.
Access to further relevant data sources via PISTIS.
Improve Analytic Capabilities.
Larger datasets at disposal for AI model training (timeseries data)
Project level
Increasing Data Interoperability
Improved Data Autonomy
Improved Data Discoverability & Acquisition
Improved Data Quality
Increased Lineage Tracking of Data
Improved Data Valuation
Added Value Generation from Data
Improved Trust Security and Privacy Guarantees of Data Sharing
Cultivation of New Skills
Lowering access barrier for SMEs to the usage of advanced data management operations
Diffusion of new knowledge on secure and responsible data management and trading
Contribution to standardisation groups covering data operations, sharing and cybersecurity
Contribution to open-source initiatives

Table 19: Demonstration Hub KPIs

Similarly, it is too early to refer to the overall PISTIS Impact KPIs as set out in Table 29 in D5.1.

Further, section 8.2 below refers to considering the impact of the PISTIS communication activities and their influence on the work of WP5. These are in addition to the targets for generally ensuring that the dissemination targets are reached and which are reported in WP6 and these are the other impacts which contribute to the more holistic perspective for PISTIS.

7.1 ADDITIONAL KPIS

In addition to the initial KPIs listed in Table 19 above, the Evaluation Framework will also focus on defining additional quantified KPIs (technical, economic, environmental, social, political, business) to enable the holistic assessment of the project impact per demonstrator hub, such as contributing towards the European Green Deal Strategy and the EU's commitment to global climate action for the Energy Hub.

Chapter 12 Next planned Steps, covers the proposed activity following the evaluation of the alpha version as this provides a watershed moment in the project in which greater emphasis is also placed on the holistic approach to the project. Section 12.2 "Planning WP5 activities for the next phase of the project" highlights the logic in the process of selection of the additional KPIs.

7.2 General Impacts at the Hub level

Hub 1	Hub 2	Hub 3
A reduction in baggage delivery Service level.	Increase in hosting capacity of grid.	Improved driving risk inference (based on additional data sources through PISTIS).
Agreement violations.	Integrate flexibility markets into Spanish energy system.	Improved driving style detection.
A reduction of flight delays.	Understanding technical requirements for this.	Greater availability of datasets to improve AI model training (for risk prediction and driving style detection).
Improved accuracy of load predictions.	Integration of communication requirements for industry.	Reduction of data being transferred from vehicle to data centre.
Improved capacity handling for public transport.	Capacity for swift adaptation for when flexibility markets are regulated and operational.	Greater objectivity in driving behaviour and driver risk assessment
Greater satisfaction with bus services provided to the airport.	Understanding the impact of flexibility on the grid.	Refinement of a research prototype assessment in its usefulness for drivers risk mitigation
Improvements to local businesses.	Opportunities for data owners to receive financial compensation	Refinement of a research prototype assessment in its usefulness for risk mitigation for transportation managers.
Improvement in Data Management and Sharing	Opening up new opportunities for monetisation.	Opportunities for data owners to receive financial compensation
Operational Efficiency through enhanced decision-making through better data utilisation.	Enabling the valuation of data assets and price estimations.	Opening up new opportunities for monetisation.
Passenger Experience improved through insights gained.	Increased value of driving risk prediction solutions based on the availability of additional data sources.	Enabling the valuation of data assets and price estimations.
Improved Transport Planning optimising services.	Significant contribution to the EU Road Safety: Towards Vision Zero programme.	Increased value of driving risk prediction solutions based on the availability of additional data sources.

Hub 1	Hub 2	Hub 3
Schedule Alignment between public transport and flight operations.	Provides the capacity to offer a highly valuable and indispensable product in the future.	Significant contribution to the EU Road Safety: Towards Vision Zero programme.
Smart City Initiatives enhancing municipal service delivery.	Greater understanding of requirements and adaptability for the best possible performance.	
Better urban planning and infrastructure development.	Availability and use of the guidelines for participation.	
Advancing the IT infrastructure for the City of Athens.	Exemplar to facilitate future deployment of the technology in other contexts.	
Data Value Enhancement: leading to new business opportunities.	The Use Case 2.3 (P2P trading) represents a step further. For the Market Operator, it means Leverage for existing platforms to adapt them to a free market among network users.	
Provision of Industry Insights for stakeholders.	Opening up new business models and services for the aggregator.	
Enhanced decision-making with shared weather data.	Data Value Enhancement: leading to new business opportunities.	
Weather-related operational disruptions reduced.	Enabling companies to access data to adapt to market and electrical system requirements. The ability to access and effectively utilise data can provide competitive advantages and inform decision-making.	
Increased efficiency in ground handling operations		
Better service to airline customers and passengers enhanced		
Cost Reductions through access to real-time and comprehensive data		

Table 20: Impacts at the hub level.

7.3 ANALYTICS CAPACITY

In terms of being prepared to fully experience the potential of PISTIS and realise the planned impacts, all the demonstrators/use-cases have confirmed their competence and capability to access and carry out analytics, whilst all use-cases have engaged with the early iterations of the PISTIS Analytics/Insights Engine, which is the application of some ready-made analytics on the data, to extract some information.

In the Greek demonstration Hub, both organisations (OASA, AIA) possess the ability to effectively leverage data analytics methods to derive meaningful insights and implement those in the decision-making process in order to drive business value. If needed ICCS will assist in data analysis and data modelling, given its expertise in intelligent transport systems.

The Energy Hub will utilise a specific Data Analytic for economic investment data and the Analytics/Insights Engine (the tool and scripts for data quality analysis). In the case of the grid data, Cuerva will provide CARTIF with all the information needed in order to define the grid and all the historical consumption and generation data, with this CARTIF will create the forecasting of consumption and generation to detect the events on the grid. For this, combining with other data sources may be necessary (climate data). Further, the Energy Hub will utilise a specific Data Analytic for economic investment data and the Analytics/Insights Engine (the tool and scripts for data quality analysis).

The companies in the Automotive Hub possess strong capabilities in data analytics. VIF has a dedicated automotive data science group, Trafficon specializes in mobility data analytics, and as a car data provider, CARUSO brings extensive expertise in data analytics.

8 COMMUNICATION /INTERACTION WITH STAKEHOLDERS

8.1 COMMUNICATION WITH STAKEHOLDERS

In addition to the "Dissemination Work Package" having its own KPIs which are reported in WP6 deliverables[26], D5.1 emphasised the importance of having good interaction within the Demonstration Planning and Evaluation Framework. Stakeholder interaction was a key activity covered and this was set out in Chapters 6 and 16 of D5.1. This complements the core work of WP6, taking the perspective from that of the demonstrators.

As a consequence, we need to monitor the involvement with external stakeholders throughout the project in order to ensure that we meet the requirements which we have set out. The following questions were raised.

[26] D 6.1 - Dissemination, Communication, Liaison, Training and Living Lab Plan - PISTIS and D 6.2 - Dissemination Activities Report, Training Material and MOOC - First Report - PISTIS

Communication with stakeholders: Questions raised	Response	Comment
Have we identified the stakeholder's roles in evaluation planning, implementation, interpretation of results and decision-making about the next steps?	YES	Stakeholders have been categorised in basic types of "potential adopter, data provider, data seeker, common scope content, common audience" etc. These are then directly linked to the roles described in the evaluation process and implementation
Has the list of stakeholders been reviewed to ensure all appropriate stakeholders are included?	YES	The online engagement tracker is constantly revised by all partners and includes companies from the real market, affiliated projects, key associations and others. Feedback has also been taken into account from workshops and common events which also provided valuable ideas for extended stakeholder group inclusion.
Have we created a plan for stakeholder involvement and a communication strategy?	YES	The main focus has been upon planning the demonstrator Living Labs and the plan will be revised as we approach the deployment of the Beta version of the platform
Have areas been identified for stakeholder input?	YES	Two key approaches have been adopted, through online surveys with questions covering issues such as privacy of data, compensation schemes and future intentions of stakeholders, and second by also starting to identify entities that could become first movers-adopters or providers/seekers of data as depicted in the WP5 Living Lab-Stakeholder Engagement plan.
Have stakeholders been brought together as needed?	YES	But the main coming together is in the later stages when there is something more tangible to show and to focus interest on potential adoption as well as help in providing feedback etc.
Have key stakeholders been targeted for regular participation.	Ongoing	The PISTIS engagement activities through the demonstration process has identified many key stakeholders to engage with through discussions, workshops, events, webinars, and through face-to-face meetings.
Have we involved stakeholders in the evaluation process?	Premature	Some minor input has materialised, but the main interaction with the targeted stakeholders in terms of their understanding of PISTIS and hence their capacity to help the

Communication with stakeholders: Questions raised	Response	Comment
		evaluation process is still to commence. Their input into the evaluation process and improving the PISTIS offering will become more significant at a later stage.

Table 21: Communication with stakeholders

8.2 IMPACT ON COMMUNICATION ACTIVITIES KPIS

The demonstrators have significant roles to play in contributing to the Communication Impact KPIs of WP6, whilst also contributing to WP5 KPIs. But these will only be covered in D5.3 as the project matures. Amongst these KPIs, the following stand out and indicate where effort is required from the demonstrator's perspective:

- Cultivation of New Skills.
- Lowering access barriers for SMEs to the usage of advanced data management operations.
- Contribution to standardisation groups dealing with, data operations, sharing and cybersecurity.
- Contribution to opensource Initiatives by demonstrators.

8.3 EXTERNAL STAKEHOLDER ENGAGEMENT PLAN FOR NEXT PHASE OF PROJECT

The key focus for maintaining and improving the Stakeholder Engagement Plans for the core demonstration hubs, building up to the Beta release, will be to augment the core lists of identified stakeholders at the demonstration site level, whose active participation will have the potential to make the demonstration activities a greater success.

This enlarged set of demonstration level stakeholders will have two functions:

- To provide valuable additional input into the evaluation process, including that of the business cases and,
- To attract those new stakeholders who will continually interact with the project right through to the final version of the platform enhancing the work of the core demonstrators and who would have the potential to become the first new deployers of the platform.

8.4 ROLE FOR THE DEMONSTRATOR-LED LIVING LABS

With the release of the Beta platform, there will be an extensive programme of Living Labs, led by the demonstrators and complementing those which are the focus for WP6. These will provide a strong focus for crucial activity in bringing the identified stakeholders into the PISTIS community in a real and interactive way.

For example, a preliminary list of stakeholders was identified for the airport operations within the Greek Hub at the outset of the project.

These included:

- Other Ground Handling companies operating in Athens Airport such as Swissport Handling, Skyserv Handling etc. Air Traffic Control, Aircraft Operators Network Operations.
- State authorities that may have an interest in baggage data including the Customs authorities, the Police and the Hellenic Civil Aviation Authority (HCAA).
- Aircraft Operators operating in Athens Airport or any state authorities that may have an interest for the turnaround process of flights.

Similarly, for the mobility and commercial use-cases in the city of Athens, these stakeholders already identified included:

- Hellenic Trains, which runs the Suburban Railway Line in greater Athens Area connecting Athens International Airport with the port of Piraeus.
- Ellinico Metro that operates the metro and tram lines.
- The Municipality of Athens.
- Weather and environmental bodies e.g. Meteo, the Hellenic National Meteorological Service etc.
- Private taxi companies and SATA (Syndicate of taxi drivers of Attica).
- Region of Attica, the Ministry of Tourism and the Ministry of Infrastructure and Transport.
- Municipalities neighbouring to Athens or in the wider area of Attica with business and touristic interest e.g. the municipalities of Elefsina, Tavros-Moschato, Piraeus, Glyfada etc.
- Touristic, cultural and archaeological bodies such as museums, the National Garden of Athens, Athens Culture Net, the Acropolis Museum etc.
- Local business associations and unions of shops and professionals operating in the Athens area.
- HATTA (Hellenic Association of Tourist and Travel Agencies),
- HHF (Hellenic Hoteliers Federation),
- POESE (Hellenic Union of Restaurants and similar food businesses),
- Athens Museums and Cultural Institutions Network,
- Local SME organisations

The other Hubs have similar lists of stakeholders targeted for early interactions.

We are attempting to create eco-systems wherein real value can be discovered, not just for the existing members, but for those being introduced to it and the requirements of these new participants will also be taken into account, bringing benefits all round. This will act as a

catalyst for further real deployments of the PISTIS platform. And the Living Labs will provide a focus for this interactivity.

We will be able to make adjustments to the benefit of the existing use-case scenarios based on real-world insights from the demonstrators and the internal risk assessment, augmented by further insights from the Living Lab participants. The iterative development process ensures continuous improvement of the scenarios. As new information or challenges emerge, the scenarios are adapted accordingly, maintaining their relevance and effectiveness.

In common with the general Living Labs spearheading the work of WP6, the specific demonstrator-led Living Labs will also contribute to reviewing and consolidating the project scenarios.

We return to this topic in Chapters 12 and 13 in planning the activities in the later, more mature, stages of the project.

9 TECHNICAL TESTING AND EVALUATION

9.1 PROCESS FOLLOWED TO DEFINE THE TECHNICAL REQUIREMENTS WHICH NEED TO BE FULFILLED

The principal scope of deliverable D1.3 of the project was to define the minimum set of technical requirements for PISTIS (under the notion of a set of user stories that would drive the formation of the MVP of the platform) that would meet the business needs and expectations of the end-users and would be implemented in the subsequent WPs of the project.

A methodology, derived from agile product development, was adopted following the stakeholder's identification and the provision of detailed descriptions of their interactions and functionalities required of the PISTIS framework from their individual perspectives, using the tool of user stories. Using common understanding between end-users and developers, a list of technical requirements was identified based on the analysis of these user stories. These requirements have been evaluated and prioritised based on the end-users needs and on the feasibility of their technical implementation. This resulted in the definition of the PISTIS MVP, which has subsequently been revisited to ensure it remains valid.

From the perspective of the actors-systems, the PISTIS platform was defined as the main system that will be interacting with the users. Further, the actors-systems includes some of the functional modules of the PISTIS Platform that are widely known to the users or are providing crucial operations, such as the Data Factory, Identity Access Management and Marketplace.

Based on D1.3, a list of fifteen user stories was selected to be elaborated on, based on the high-level business requirements identified in D1.1. For the depiction of each user story, a combination of natural language and formal definition were used. The work was conducted with the close collaboration of both end-users and technology providers.

Each user story includes:

a) The description of “Who, What, and Why” user stories template, defining the actors, the description and the benefits,

b) The formalism of the story using the Business Process Model Notation (BPMN) defining the interactions between users and systems, and

c) The list of technical and operational challenges and issues that must be taken into consideration in the design and implementation phase.

This thorough definition of user stories allowed the identification of seventy-six technical requirements for the PISTIS framework. These technical requirements are specific for expressing the added value and benefits provided by PISTIS and do not include classical information systems technical requirements, such as accessibility and standard security measures.

Finally, both end-users and technology providers have prioritised the technical requirements using the MoSCoW method.

9.2 THE TECHNICAL TESTING PROCESS

This technical testing work was carried out within WP4. As part of Task 4.5 - the Technical Verification and Integration Testing, execution of tests are being performed on a regular basis, synchronised with release schedules and the progress of this testing process will be monitored here. All the software development activities are being followed, and a software verification and testing framework is being employed and used on all outputs.

The components of the Alpha version of the platform have been covered by functional and integration tests. To keep the quality of the User Interface component, manual test scenarios were created based on the input received from the previous WP2 and WP3 work and have been executed both during the deployment of components phase, as well as during the integration of those into the overall PISTIS platform. Essentially Task 4.5 - Platform Software Validation and Verification will recap all the tests of the different components of the PISTIS Platform and verify if the outcomes of the tests are within the accepted limits. The detail of this will all be reported in D4.3 and D4.4, but we include an overview of this below.

9.3 RESULTS FROM TECHNICAL TESTING

The development of the PISTIS platform represented a significant undertaking, focused on delivering a robust, reliable, and functional solution. Central to achieving these goals was the implementation of the testing strategy, executed continuously throughout the development lifecycle. This strategy ensured testing from the initial stages of component design through to the deployment and evaluation of the Alpha version.

The PISTiS approach encompassed various testing levels, involved collaborative efforts across teams, and focused on systematically identifying and resolving issues to guarantee the platform's integrity.

9.3.1 Component-Level Testing for Alpha- Release Components

Recognising that the overall stability of the platform depends heavily on the reliability of its constituent parts, dedicated testing efforts were applied to each component as it was designed and built. Crucially, these initial tests were primarily executed by the developers responsible for creating the specific component. This approach leveraged their intimate understanding of the component's architecture, intended functionality, and potential weaknesses. Developers employed a range of techniques, including functional testing to ensure the component performed its specified tasks correctly in isolation.

This early-stage testing proved invaluable for catching bugs at their source, preventing them from propagating into later, more complex stages of development. While this phase identified the highest volume of bugs, these issues were often localised and could be resolved relatively quickly and efficiently by the developers themselves.

9.3.2 Flow-Level Testing

Before undertaking the task of full system integration, the consortium grouped related user stories into logical workflows (see deliverable D4.2) that represented the three main functional flows of the platform. This intermediate step allowed us to test these critical end-to-end processes within distinct segments of the application. Testing at the flow level involved simulating user interactions within these defined pathways, ensuring that data moved correctly between related components and that the collective functionality achieved the desired business outcomes for that specific flow.

This phase was essential for verifying that the combined logic of multiple components within a primary workflow operated as expected, prior to introducing the complexities of integrating the alpha version platform components. By isolating and validating these main flows, the consortium confirmed the correct implementation of core business rules and user experiences before proceeding to full integration, significantly reducing the risk of encountering major functional roadblocks later. During this stage, bugs were identified that had to do with the interactions of components that exchange information in the separate flows.

9.3.3 Integration and End-to-End Testing

The integration phase, where individual components and pre-tested flows were brought together to form the cohesive PISTIS platform, necessitated a dedicated and collaborative testing effort. Integration testing was planned and executed by the technical teams comprising both the integration specialists, responsible for the overall system architecture and component assembly, and the original developers of the components being integrated. This collaborative structure was vital, combining broad system knowledge with deep component-specific expertise.

This phase was critical for uncovering issues that manifest when components interact, such as data mismatches, messaging and timing problems, or unexpected conflicts. As anticipated, the number of bugs identified during integration testing was lower than during component-level testing. However, the issues uncovered here were often more complex and critical, potentially impacting significant portions of the platform's functionality. The joint effort of

integration teams and developers facilitated efficient diagnosis and resolution of these crucial interoperability bugs.

Following the integration of all components and the deployment of the PISTIS platform's alpha version, the final phase of testing involved comprehensive end-to-end validation, which had to be performed on a “clean” installation of the integrated PISTIS platform. As the notion of a Data Factory revolves around having a software infrastructure deployed on a computing infrastructure owned by an organisation (for enabling data privacy, sovereignty and serve the federated approach of PISTIS), automated deployment recipes were designed to serve this cause. As such, the final tests were performed over these new deployments, and the end-to-end tests simulated complete user scenarios, tracing workflows from the initial user interaction through all necessary system layers and components to the final output or result.

Furthermore, the demonstrators were also engaged in these tests, in the initial days of their “evaluation” period. This holistic approach aimed to validate the entire system functioning as a single entity in a deployed environment closely resembling real-world conditions. During this stage, a small number of bugs has been identified, with great severity however, which were all resolved timely to allow demonstrators to continue. These issues had to do mostly with environmental variables that have not been accordingly optimised to support dynamic input to update them during the deployment process.

Throughout all these distinct testing phases – component, flow, and integration – a continuous cycle of testing, bug identification, tracking, and resolution was maintained. We utilised GitHub as our bug tracking systems to log, prioritise, and manage defects discovered at every level.

All significant bugs identified during these phases, particularly those uncovered during integration testing, have been addressed and resolved in order to allow demonstrators to have the first round of testing their data exchange operations over the PISTIS platform. Furthermore, this testing process allowed us to identify specific scenarios and edge cases that the current Alpha version does not fully support. These "unsupported cases" have been documented and analysed and are not considered critical defects preventing core functionality. However, they represent areas for refinement and expansion during the beta version of the platform.

9.4 Technical Acceptance of the Evolving Solution

As the core of the technical evaluation of the developed product is happening under WP4, in this section we are going to cover the technical acceptance of the developed solution from the perspective of the demonstrators, based on qualitative, high-level evaluation.

For measuring the quality of the system from a user’s perspective (e.g. non-software performance level evaluation) PISTIS makes use of the ISO 25010 Quality in Use Model[27], which describes the perception of the quality of the system from a user’s perspective.

[27] https://www.iso.org/obp/ui/#iso:std:iso-iec:25010:ed-1:v1:en

The different characteristics and sub-characteristics of this model are derived from testing or observing the results of real or simulated use of the system and in the PISTIS case these are the results of the different demonstration rounds that are executed within WP5, starting with the testing of the Alpha version.

The Quality in Use Model assesses software quality (from a user point of view) using the following set of characteristics (each of them including other sub-characteristics):

- Effectiveness – Measuring the accuracy and completeness with which users achieve specified goals.
- Efficiency – Evaluating the resources expended in relation to the accuracy and completeness with which users achieve goals.
- Satisfaction- Aiming to capture the degree to which users are satisfied with the experience of using a product in a specified context of use.
- Safety – Providing the degree to which a product or system does not, under specified conditions, lead to a state in which human life, health, property, or the environment is endangered.
- Usability - The extent to which a product can be used to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.

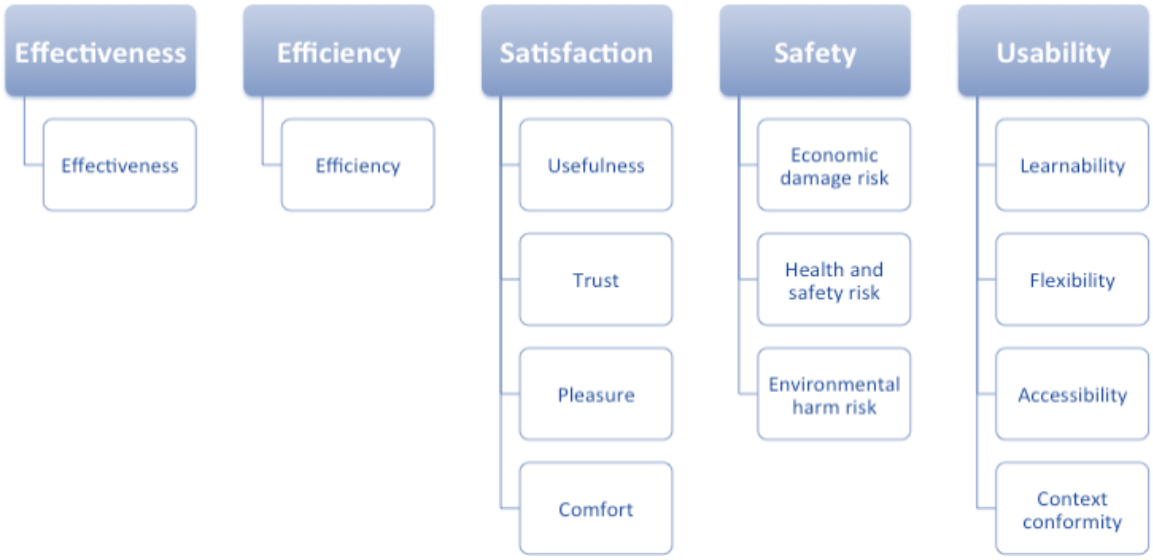


Figure 8: Quality in use model view based on the ISO/IEC 25010:2011 standard.

In PISTIS, not all parts of the model are evaluated, as some are not relevant to the PISTIS case. In essence, a specific questionnaire has been constructed (see Annex I), where questions correspond to the different sub-elements of the Quality in Use model but are not linked 1:1 to these aspects, as it was decided to develop a set of questions that would be more meaningful to demonstrators.

Furthermore, the evaluation process will only concern the features and the experience provided by the current available Alpha release of the platform, and the same exercise will be

performed at the end of each demonstration phase, aiming to identify problems in each release and correct them in the upcoming releases.

The following table presents the qualitative evaluation metrics for evaluating the PISTIS platform from an end-user (demonstrator's perspective), always based on the promised results for this release round (alpha version of the platform).

It is noted that this evaluation will serve as a benchmark, to identify weak points that need to be improved in the subsequent versions of the PISTIS platform, and measure the evolution of the upcoming features against the features evaluated during the alpha version

Sub-characteristics	KPIs	Assessment Statements (Rated in a Scale 1-5)	Urban Planning	Energy Hub	Automotive Hub	All Hubs (average)
A1: Performance Expectancy	Perceived Work Performance Improvement	Using PISTIS will help me improve my work performance.	4.0	2.7	3.0	3.2
	Perceived Productivity Increase	Using PISTIS will increase my productivity.	4.0	2.0	3.6	3.2
	Business Goal Alignment	PISTIS will help me achieve my business goals.	3.5	2.3	3.2	3.0
	Usefulness of Features	PISTIS provides features that are useful for my business needs.	4.3	3.0	3.8	3.7
	Effectiveness of Use	Using PISTIS will enhance the effectiveness of my work.	4.0	2.7	3.8	3.5
A2: Effort Expectancy	Effort Reduction	Using PISTIS will reduce the effort required to complete my tasks.	3.8	4.0	3.2	3.7
	Work Simplification	PISTIS simplifies my work processes.	4.0	3.3	3.4	3.6
	Time Savings	PISTIS saves me time compared to my previous methods/tools for data sharing/exchange.	4.3	2.7	2.8	3.2
	Ease of Learning	Learning to use PISTIS effectively will NOT require a lot of effort.	3.0	2.7	4.2	3.3
	Workflow Optimisation	PISTIS helps me avoid unnecessary steps in my work (such as data treatment, etc.)	4.3	3.0	3.4	3.6
A3: Facilitating Conditions	Availability of Resources	I have the necessary resources (hardware, software, support) to use PISTIS effectively.	4.3	4.0	2.6	3.6
	System Compatibility	PISTIS is compatible with my existing systems and workflows.	3.8	3.7	2.8	3.4
	Access to Training and Support	I have access to adequate training and support for PISTIS.	2.5	4.3	4.2	3.7
	System Availability	PISTIS is available whenever I need to use it.	3.5	3.7	2.4	3.2

Sub-characteristics	KPIs	Assessment Statements (Rated in a Scale 1-5)	Urban Planning	Energy Hub	Automotive Hub	All Hubs (average)
	Tool Integration	PISTIS integrates well with other tools that I use for my work.	2.8	3.0	1.0	2.3
B.1: Complexity	Intuitiveness of Features	It is easy to understand the features and functions of PISTIS.	3.0	4.0	4.2	3.7
	Ease of Navigation	Navigation through the platform is effortless.	3.0	4.0	3.6	3.5
	User-Friendliness	PISTIS is user-friendly.	2.8	4.0	3.4	3.4
	Straightforward Learning	Learning to use the PISTIS is straightforward.	3.0	3.7	3.4	3.4
	Instruction Clarity	Instructions and guidelines provided are clear and helpful.	2.8	4.0	3.4	3.4
B.2: Controllability	User Control	I feel in control when using PISTIS.	3.3	3.7	3.6	3.5
	Ease of Customisation	I can easily customise PISTIS to fit my preferences.	3.5	3.3	2.6	3.1
	Information Accessibility	It is easy to find the information I need PISTIS.	3.5	3.7	3.0	3.4
	Error Recovery	I can easily correct errors or undo actions on PISTIS.	3.0	2.7	2.2	2.6
	User Confidence	I feel confident in my ability to use PISTIS effectively.	3.0	3.0	3.0	3.0
C.1: Usage Intentions	Continued Usage Intention	I am likely to continue using PISTIS in the future.	3.8	3.3	4.2	3.8
	Regular Usage Intention	I intend to use PISTIS regularly for my work.	3.8	3.0	3.2	3.3
	Expansion of Use	I would consider using PISTIS for other tasks or projects.	4.3	3.7	3.4	3.8
	Usage Frequency Intention	I plan to use PISTIS frequently.	4.0	2.3	3.2	3.2
	Workflow Integration	PISTIS will become an essential part of my workflow.	3.3	1.7	2.6	2.5
C.2: User Feelings	User Enjoyment	I enjoy using PISTIS.	3.0	3.0	3.2	3.1
	Task Confidence	I feel confident using PISTIS for my tasks.	3.0	3.3	3.4	3.2
	Operational Enjoyment	The platform makes data exchange operations enjoyable.	3.3	3.0	3.2	3.2
	Expectation Alignment	Using PISTIS aligns with my expectations.	3.0	4.0	2.8	3.3
	Recommendation Likelihood	I would recommend PISTIS to others.	3.8	4.3	3.6	3.9
D: System Quality	Consistent Performance Reliability	PISTIS is reliable and performs consistently.	3.3	3.0	2.6	3.0

Sub-characteristics	KPIs	Assessment Statements (Rated in a Scale 1-5)	Urban Planning	Energy Hub	Automotive Hub	All Hubs (average)
	System Performance Speed	Pages and features load quickly without errors.	3.8	3.3	2.4	3.2
	Visual Design Appeal	PISTIS has a visually appealing design.	3.5	4.3	3.4	3.7
	Interoperability	PISTIS integrates well with other tools or systems I use.	3.0	3.7	2.0	2.9
	Perceived Input Security	I feel secure when entering sensitive information on PISTIS.	3.3	3.0	2.4	2.9
E: Trust and Security	Data Protection Confidence	PISTIS keeps my data secure.	4.5	3.3	3.6	3.8
	Privacy Trust	I trust PISTIS to protect my privacy.	4.3	3.3	3.4	3.7
	Transparency of Policies	PISTIS has transparent data-handling policies.	4.3	3.0	3.8	3.7
	Transactional Security	I feel safe making transactions through PISTIS.	4.5	3.3	3.6	3.8
	Security Incident Responsiveness	PISTIS promptly resolves security issues.	4.0	2.3	3.0	3.1
F: Overall satisfaction with the PISTIS platform	Overall Expectation Fulfilment	The platform meets my expectations.	4.0	4.0	3.2	3.7
	Performance Satisfaction	I am satisfied with the performance of PISTIS.	4.0	3.7	3.0	3.6
	Positive User Experience	PISTIS provides a positive user experience.	3.5	4.0	3.4	3.6
	Quality of Support Services	Support services (e.g., direct communication from developers, tutorials) meet my needs.	4.0	4.0	4.0	4.0
	Perceived Cost-Effectiveness	I feel PISTIS offers good value for its cost (not to be answered now).	2.8	1.3	1.6	1.9

Table 22: Qualitative Evaluation Results per Demonstrator

Based on the average values across all three Hubs, as presented in Table 22 above, the following insights can be derived from the corresponding charts:

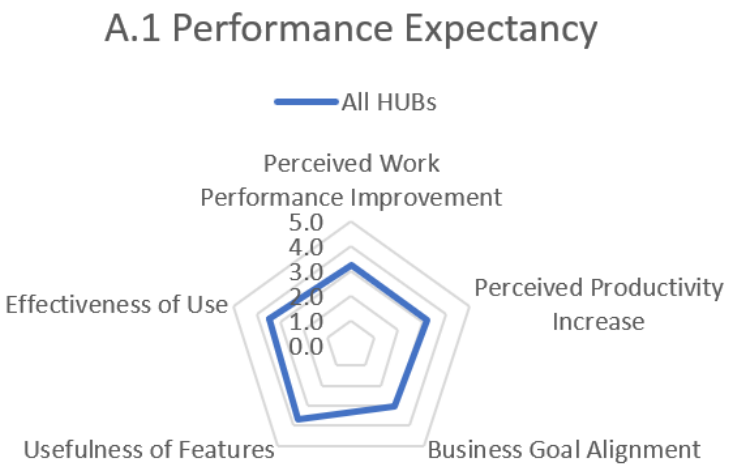


Figure 9: A.1 Performance Expectancy Chart

Based on the "A.1 Performance Expectancy chart above, users across all three hubs perceive that the *Usefulness of Features* is rated highest, closely followed by *Effectiveness of Use*. *Perceived Work Performance Improvement* and *Perceived Productivity Increase* are rated moderately, while *Business Goal Alignment* is rated the lowest.

This suggests that while users find the platform's features quite useful and believe PISTIS supports their work performance, they perceive it as less aligned with overall business goals compared to other aspects.

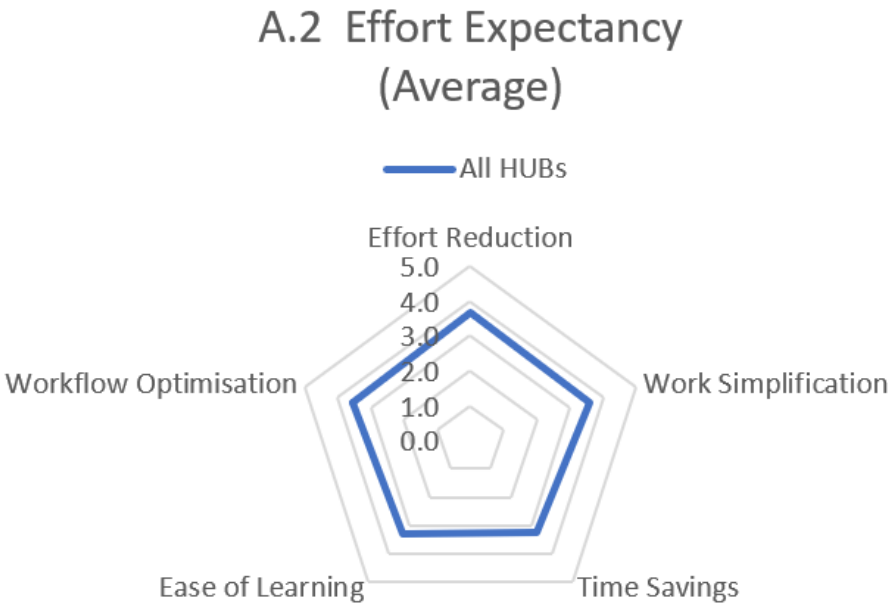


Figure 10: A.2 Effort Expectancy Chart

Based on the "A.2 Effort Expectancy" chart (see Figure 10 above), users across all hubs rate *Work Simplification, Effort Reduction and Workflow Optimisation* as the highest aspects; while *Ease of Learning is* perceived at a moderate level. Time Savings receives the lowest rating among the factors.
This indicates that while users find PISTIS simplifies their work and reduces effort effectively, they perceive it as providing the least amount of time savings compared to its benefits in simplification and effort reduction.

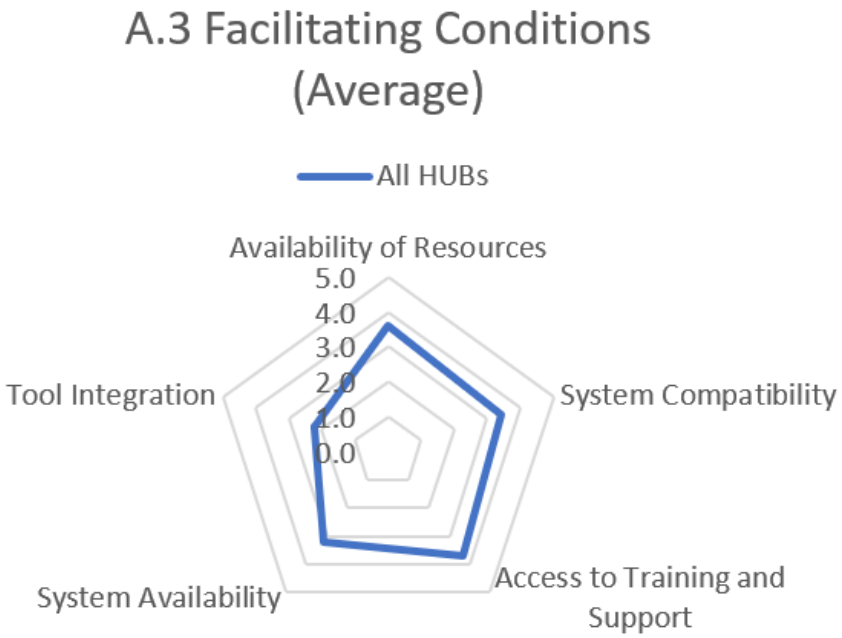


Figure 11: A.3 Facilitating Conditions Chart

Based on the "A.3 Facilitating Conditions" chart, users across all hubs rate *System Compatibility* as the highest facilitating condition. *Access to Training and Support* receives the highest average rating and *Availability of Resources* follows closely which is followed by *System Compatibility* and then *System Availability*. Tool Integration receives the lowest ratings, which is natural for the "alpha" version of the platform.

This suggests that, on average, users find the access to training and support for PISTIS to be the most satisfactory facilitating condition. Tool integration, on the other hand, appears to be an area where users experience the least facilitation.

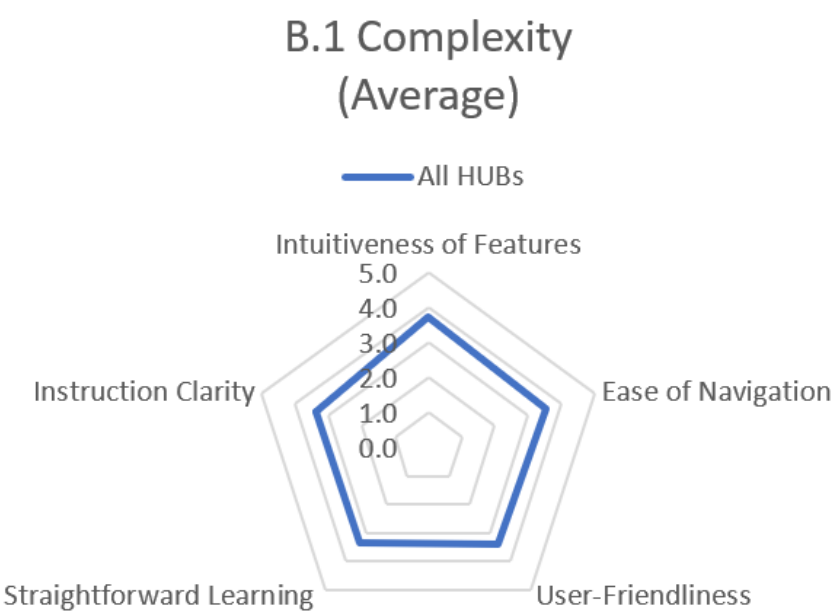


Figure 12: B.1 Complexity Chart

Based on the "B.1 Complexity" chart, users across all hubs rate *Intuitiveness of Features* as the highest, followed by *Ease of Navigation* perceived as the next least complex aspect. *User-Friendliness*, *Straightforward Learning*, and *Instruction Clarity* are rated lower, suggesting they are perceived as having a slightly higher level of complexity. In essence, users find the features themselves to be the most intuitive and the navigation relatively easy, while aspects like overall user-friendliness, straightforwardness of learning, and clarity of instructions are perceived as slightly more complex.

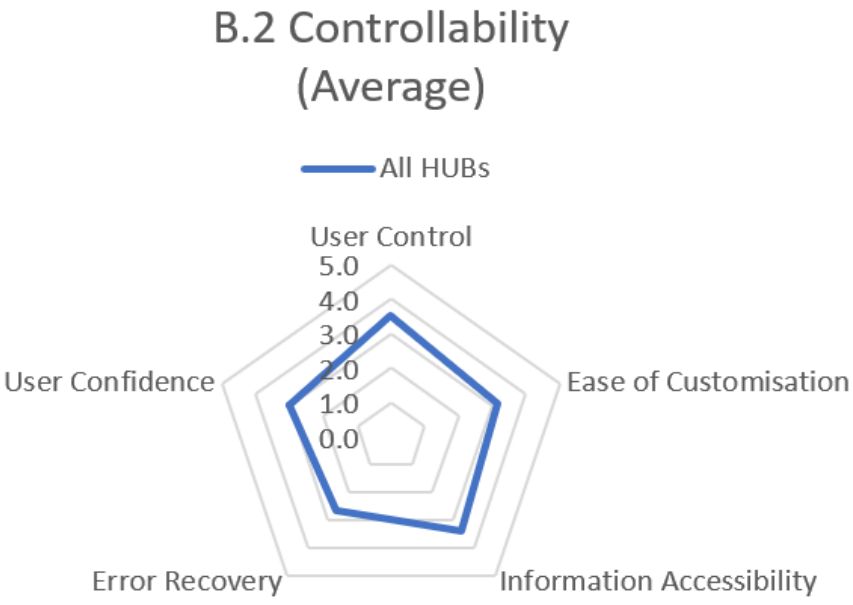


Figure 13: B.2 Controllability Chart

Based on the "B.2 Controllability " chart (Figure 13 above), users across all hubs rate *User Control* and *Information Accessibility* as the highest aspects; followed by *Ease of Customisation* and *User Confidence* which are perceived at a moderate level. *Error Recovery* receives the lowest rating among the factors.
This suggests that while users feel a strong sense of control over the PISTIS platform and find it easy to customise it, as well as information accessibility being perceived satisfactory (all above the mean value (2.5), it is error recovery which is the aspect where users perceive the least amount of controllability.

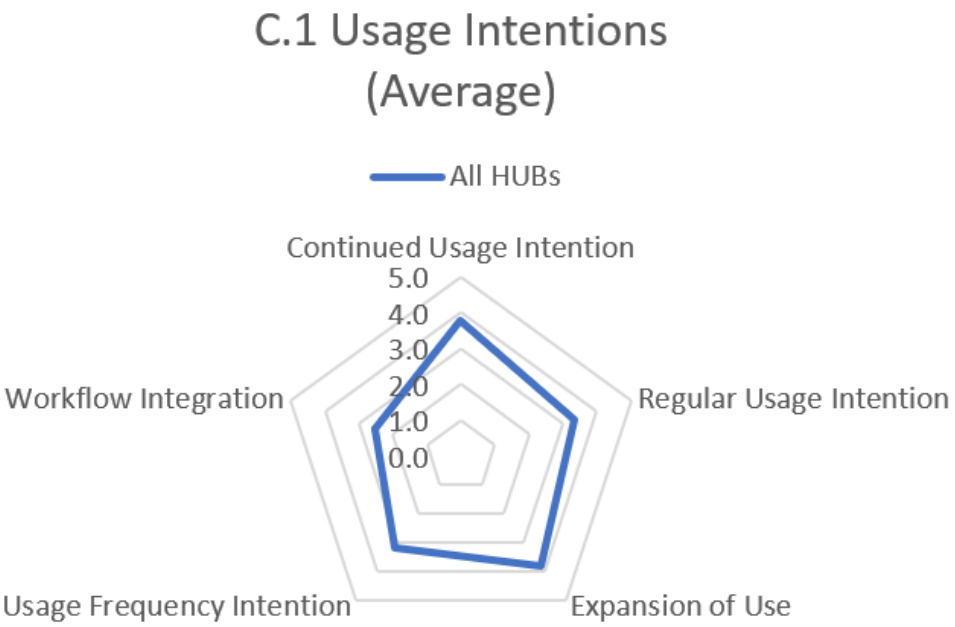


Figure 14: C.1 Usage Intentions Chart

Based on the "C.1 Usage Intentions" chart, users across all hubs rate indicate *Continued Usage Intention* and *Expansion of Use* as the highest rated, followed by *Regular Usage* and then *Usage Frequency Intention*. *Workflow Integration* receives the lowest average rating of 2.5.

This suggests that, on average, users have the strongest inclination to continue using PISTIS and to broaden its application. Their intention for regular usage and increasing how often they use it is slightly less pronounced. Workflow integration appears to be the aspect with the weakest intention among users across the measured hubs.

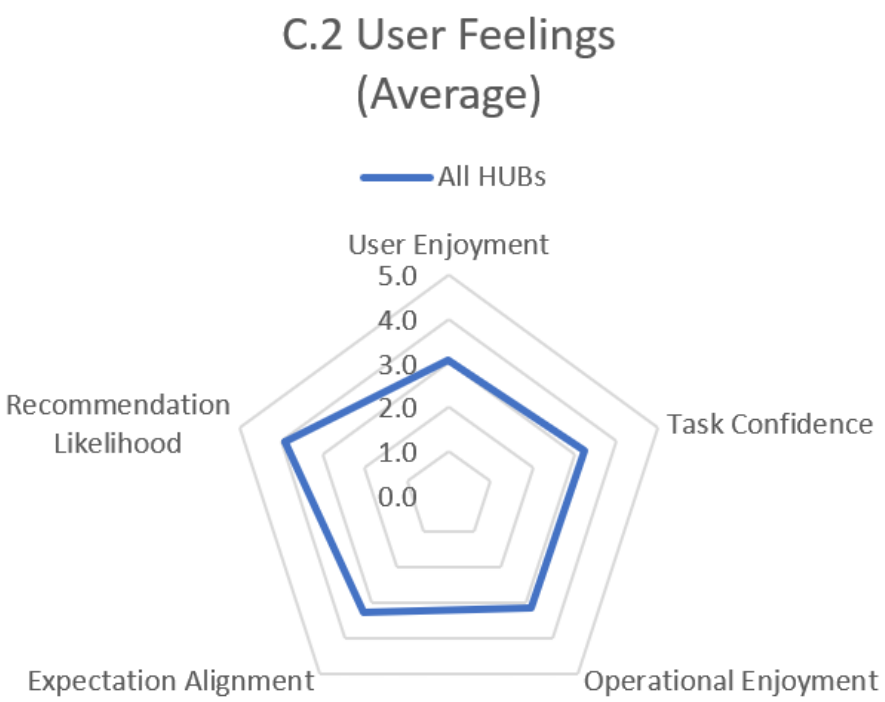


Figure 15: C.2 User Feelings Chart

Based on the "C.2 User Feelings" chart, users across all hubs identify the *Recommendation Likelihood* as the highest rated, followed by *Expectation Alignment*. *Task Confidence*, and *Operational Enjoyment* all share a similar average rating, while *User Enjoyment* receives the lowest average rating.

This suggests that, on average, users are most likely to recommend PISTIS. Their feelings regarding the alignment of the platform with their expectations, their confidence in performing tasks, and their enjoyment of the operational aspects are moderately positive and similar. However, the general users enjoyment in using the PISTIS platform is rated slightly lower compared to these other feelings.

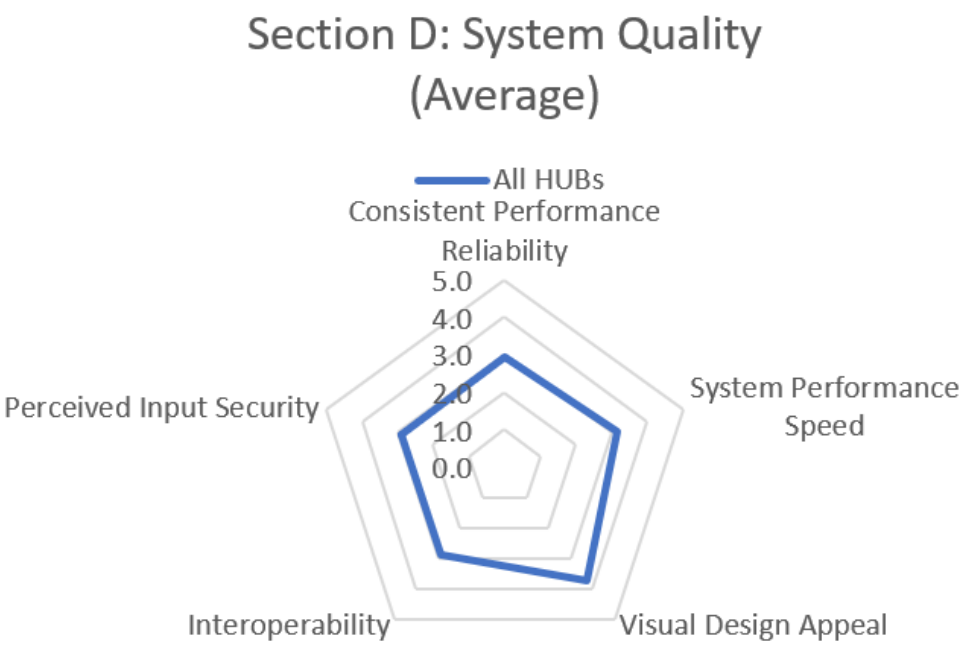


Figure 16: D System Quality Chart

Based on the "D System Quality" chart, users across all hubs rate *Visual Design Appeal* as the highest, followed by *System Performance Speed* and then *Consistent Performance Reliability*. *Interoperability* and *Perceived Input Security* both receive the lowest average rating (while being above the mean value). This suggests that, on average, users find the visual design of the PISTIS platform to be the most appealing aspect. The speed of the system is also rated relatively well. However, users perceive the consistency and reliability of performance to be slightly lower, and they have the least positive perception regarding the system's interoperability with other systems and the security of their input.

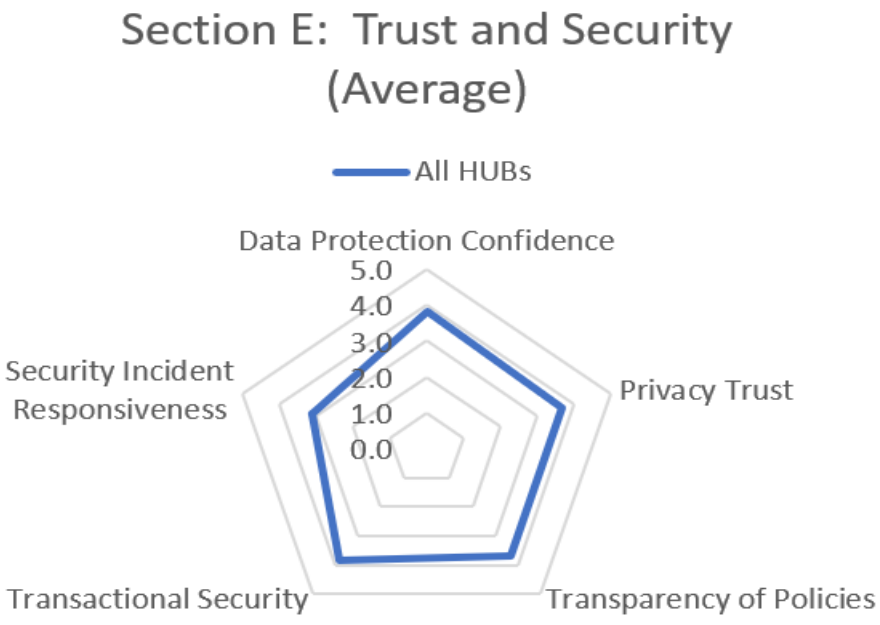


Figure 17: E Trust and Security Chart

Based on the "E Trust and Security" chart (see Figure 17 above), users across all hubs rate *Data Protection Confidence* and *Transactional Security* as the highest; with *Privacy Trust* and *Transparency of Policies* following closely and with *Security Incident Responsiveness* receiving the lowest average rating.

This suggests that, on average, users have the strongest confidence in how their data is protected and in the security of their transactions within the PISTIS platform. They generally trust the privacy aspects and find the policies to be transparent; however, users have a somewhat lower perception regarding the responsiveness of PISTIS in the event of a security incident.

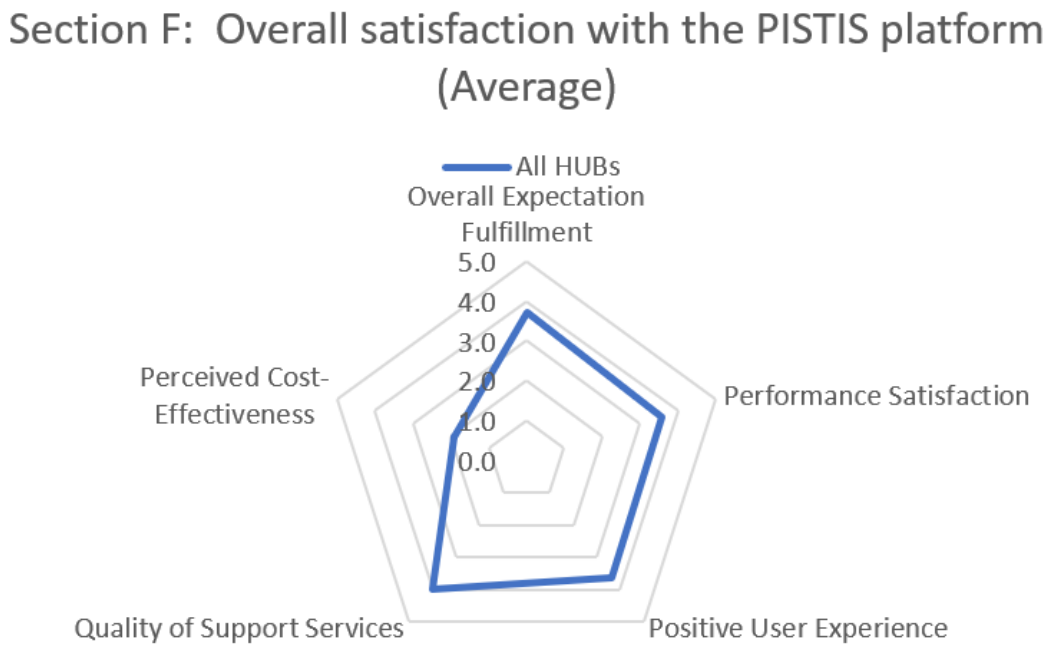


Figure 18: F Overall Satisfaction with the PISTIS platform chart

Based on the "F Overall satisfaction with the PISTIS platform" chart (see Figure 18), users across all hubs rate *Quality of Support Services* as the highest, followed by *Overall Expectation Fulfilment*, and then *Performance Satisfaction* and *Positive User Experience* which share a similar high average rating. *Perceived Cost-Effectiveness* receives the lowest average rating of 1.9.

This suggests that, on average, users are most satisfied with the quality of the support services for their data-relevant tasks. Their satisfaction with how the platform meets their expectations, its performance, and the overall user experience is also quite high. However, users perceive the cost-effectiveness of the PISTIS platform to be significantly lower compared to these other aspects of satisfaction.

9.4.1 Scientific and Technical Objectives Monitoring

Scientific and Technical Objectives (STO)	***Key Results***	***Key Indicators & Quantified Targets***	***Progress made during Alpha version deployment.***
STO.1: To set and implement the underlying foundations for trusted, fair and reliable data sharing, trading and exchanges in a federated manner over a secure, immutable, sovereignty preserving and IPR respecting multi-party data exchange framework.	End Users and Data Spaces Requirements.	>30 State-of-the-art Approaches Studied and Compared.	Work carried out successfully in WPs 1,2 and 3. 52 approaches divided into 9 SotA topics.
	In-depth State-of-the-Art (from technology, market and legal perspectives).	>30 Interviews & >5 Focus Groups.	5 interviews 5 focus groups
	Data Sharing/Trading Lifecycle and Models.	>4 Data Sharing/Trading Workflows.	2 Basic flows for alpha version
	Smart Contract Execution, Enforcement and Governance Techniques & Services.	5 Data Contracts Templates for enriched and derivative data assets.	2
	DLT-Powered Data Value Contract Composition.	1 low emission blockchain network.	1
	Services for trusted, fair and reliable data sharing, trading and exchanges	Alignment with at least 3 global initiatives.	2 (BDVA, DSSC)
	Data Monetisation Schemes.	3 different monetisation schemes.	Beta Version
	Data Investments Models.	>3 Data Investment Models.	Beta Version
	Data NFT and StableCoin Framework & Reference Implementations.	>3 NFT approaches studied. 1 low emission blockchain network.	Final Version
STO.2: To design and deliver appropriate data asset management and governance techniques,	End Users and Data Spaces Requirements.	>30 State-of-the-art Approaches Studied and Compared. Harmonisation of and alignment with >12 widely adopted open standards in	Initial studies made and

Scientific and Technical Objectives (STO)	***Key Results***	***Key Indicators & Quantified Targets***	***Progress made during Alpha version deployment.***
addressing ever-present data interoperability, quality assurance and security challenges that are common to both data providers and data consumers.		the energy, automotive mobility, urban planning sectors.	
	Legitimate and Secure Peer-to-Peer Transfer Mechanisms.	3 open specifications-based data spaces connectors compliant with IDSA, GAIA-X specifications.	Final Version
	In-depth State-of-the-Art Data Management, Interoperability and Curation Techniques & Services.	PISTIS Metadata Standard based on >3 standards.	3 Metadata Schema
	Data Security & Trust Services.	1 blockchain service to ensure transactions validity.	Implemented
	Data Lineage, Observability and Usage Tracking Models & Services.	1 Data Lineage tracking service. 1 Usage Tracking service.	1 Data Lineage tracking service. 1 Usage Tracking service.
	ML/AI-based Derivative Assets Generation and Tracking.	1 Analytics Engine to deliver analytics as assets. 1 Usage tracking service.	1 Analytics Engine to deliver analytics as assets. 1 Usage tracking service.
	Distributed Data Asset Discovery;	1 distributed query engine.	1 distributed query engine.
	Data Models Network Management.	>4 Sectorial, Interconnected PISTIS Data Models.	First version of the PISTIS Data Model (PISTIS-DM) is designed and developed as an integrated data model. Current version of the PISTIS-DM supports three demonstrator hubs with flexibility to be extended as more demonstrators join the PISTIS data space. PISTIS-DM has been tested by integrating into the *Data Enrichment Tool* and performing semantic enhancements to datasets before the made available for trading.

Scientific and Technical Objectives (STO)	***Key Results***	***Key Indicators & Quantified Targets***	***Progress made during Alpha version deployment.***
			For the purpose of interoperability, existing domain ontologies are reused wherever possible. Next version of the PISTIS-DM is planned to provide extended support for domain vocabularies by enhancing the model to support more datasets that are collected from demonstrators.
STO.3: To develop rigorous and fit-for-purpose data valuation and monetisation methods and tools to allow data providers to accrue the right value for the right data at the right time and reach the actual data potential.	End User & Technical Requirements.	>30 State-of-the-art Approaches Studied and Compared.	Studies have been made
	In-depth State-of-the-Art Multi-Facet Data Valuation Assessment Framework.	>10 SotA Approaches studied & compared. ;>5 Data Valuation Perspectives.	21 Studies have been made and 7 Data Valuation perspectives taken.
	Dynamic Pricing Estimation Models & Services.	>3 Dynamic Pricing Methods for Enriched & Derivative Data.	Final Version
	AI-based Data Market Insights.	1 AI based market insights engine.	1 AI based market insights engine.
	XAI-based Monetisation Services.	>3 Remuneration Methods.	2 Remuneration Methods.
	Demand-Supply Matchmaking Models.	3 Demand-Supply Matching Methods.	6
	PISTIS Data Exchange Market, Stablecoin Exchange Desk.	1 facility for monetary value exchange.	Final Version
STO.4: To integrate and serve the novel PISTIS federated data sharing, value accrual and monetisation platform through easily deployable	End-to-end usage scenarios.	>30 State-of-the-art Approaches Studied and Compared.	Studies have been made
	Technical Requirements and MVP.	1 Reference Data Sharing, Value Accrual and Monetisation Platform MVP.	1
	Reference Architecture.	1 Reference Architecture.	1 Reference Architecture.
	Open APIs.	100% usage of Open APIs.	100% usage of Open APIs.

Scientific and Technical Objectives (STO)	***Key Results***	***Key Indicators & Quantified Targets***	***Progress made during Alpha version deployment.***
software, enabling trustful, reliable & interoperable exchanges with a wealth of sources, platforms and data spaces.	Design Blueprints & Plan for Integration.	1 Data Services Blocks with >30 Services/Components. Integration of >7 existing Technologies (Open-source and/or originating from >3 ICT- 13/Data Spaces Projects).	1 Data Services Blocks with 40 Services/Components. Integration of 7 existing Technologies
	Distributed Data Spaces Factory Environments.	Achievement of TRL7 for the PISTIS data factory instances.	TRL6
	Cloud/Centralized Data Trading and Value Exchange /Monetisation Platform.	Achievement of TRL7 for the PISTIS cloud platform.	TRL6
	Software Verification & Validation.	1 software verification and validation methodology and accompanying results.	Yes

Table 23: Scientific and Technical Objectives Monitoring

10 MEETING COMMON CRITERIA ACROSS ALL THE DEMONSTRATION HUBS

This chapter sets out some early indications from the use of the alpha version of the platform of the value of some of the aspects of PISTIS which are common to all the demonstration hubs. The following topics are covered from the standpoint of what the demonstrators are expected to contribute, although the scrutiny will be meaningful for just the first two topics at this stage of the project.:

- The common criteria for the Non-Functional requirements (see Table 24: Format for collection of results regarding common criteria)
- Compliance with legal and ethical aspects.(see Chapter 2 Legal and Ethical Considerations for Demonstrator Hubs above)
- Monitoring the progress made with developing the business model.
- Meeting the business, innovation and exploitation objectives.

10.1 COMMON CRITERIA FOR THE NON-FUNCTIONAL REQUIREMENTS

"Non-functional requirements are in the form of "system shall be <requirement>", an overall property of the system as a whole or of a particular aspect and not a specific function. The system's overall properties commonly mark the difference between whether the development project has succeeded or failed." [28]

The methodology, as set out in D5.1, is to follow is: MoSCoW : Must, Should, Could or Would but as is common for non-functional requirements only the M and C symbols are used in Table 24 below. The table covers the following common criteria which are based on the ISO/IEC 25010 standard.

At this stage of the project it is not possible to provide extensive feedback on progress for achieving the non-functional requirements established for PISTIS. Only a few have been suitable for consideration at the alpha stage and so they will be monitored in the coming period with a full report provided in D5.3

[28] cscbank.info › doc_d_file=2618 Downloaded 23/08/23

10.1.1 Common Criteria for Measurement of Non-Functional Requirements

Common Criteria to be measured	Type	MoSCoW	Description of Metric.	Success criteria for Metric	Results for the Metric and how gathered
Functional Suitability [29]					
F1 - Functional completeness	Qualitative	M	Degree to which the set of functions covers all the specified tasks and user objectives.	All demonstrator functionalities are delivered.	Requirements Backlog
F2 – Functional Completeness	Qualitative	M	Degree to which a product or system provides the correct results with the needed degree of precision.	Demonstrator app provides results as expected.	Questionnaire
F3 - Functional appropriateness	Qualitative	M	Degree to which the functions facilitate the accomplishment of specified tasks and objectives.	All the demonstrator functionalities have a positive impact to the expected demonstrator result.	Questionnaire
Security and personal data protection					
S1. Confidentiality	Quantitative	M	Degree to which a product or system ensures that data are accessible only to those authorised to have access.	Data can only be viewed by the designated users of the application.	Application tests

[29] The demonstrations must provide the required functionality. The whole development must fit the functional requirements discussed throughout the project's development. There needs to be functional completeness, correctness and appropriateness.

Common Criteria to be measured	Type	MoSCoW	Description of Metric.	Success criteria for Metric	Results for the Metric and how gathered
S2. Integrity	Quantitative	M	Degree to which a system, product or component prevents unauthorised access to, or modification of, computer programmes or data.	No changes in backend or data are allowed without proper access.	Application tests
S3. Non-repudiation	Qualitative	M	Degree to which actions or events can be proven to have taken place so that the events or actions cannot be repudiated later.	No actions performed twice by the same event.	Application tests/ log files
S4. Accountability	Qualitative	C	Degree to which the actions of an entity can be traced uniquely to that entity.	All actions performed include the user performing them.	Log Files
S5. Authenticity	Qualitative	C	Degree to which the identity of a subject or resource can be proved to be the one claimed.	Use of an accepted authentication method.	Demonstrators' architecture
Performance efficiency					
P1. Time behaviour	Quantitative	M	Degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements.	Response of system in less than 10 seconds.	Log Files

Common Criteria to be measured	Type	MoSCoW	Description of Metric.	Success criteria for Metric	Results for the Metric and how gathered
P2. Resource utilisation	Quantitative	M	Degree to which the amounts and types of resources used by a product or system, when performing its functions, meet requirements.	Usage of IT resources dedicated to the demonstrator not exceeding 80%.	Log Files
P3. Capacity	Quantitative	C	Degree to which the maximum limits of a product or system parameter meet requirements.	Uninterrupted operation with concurrent 5 users.	Log Files
Reliability/Maturity					
R1. Maturity	Quantitative	M	Degree to which a system, product or component meets needs for reliability under normal operation.	All requests to the system are processed and return information.	Log Files
R2. Availability	Quantitative	M	Degree to which a system, product or component is operational and accessible when required for use.	98% Availability of demonstrator application.	Log Files
R3. Fault tolerance	Quantitative	C	Degree to which a system, product or component operates as intended, despite the presence of hardware or software faults.	Demonstrator Application can operate with maximum of two warning (not crucial) error messages in the backend.	Log Files

Common Criteria to be measured	Type	MoSCoW	Description of Metric.	Success criteria for Metric	Results for the Metric and how gathered
R4. Recoverability	Quantitative	C	Degree to which, in the event of an interruption or a failure, a product or system can recover the data directly affected and re-establish the desired state of the system.	Demonstrator Application has the ability to automatically resume operations after an interruption/failure.	Log Files
Portability					
Po1. Adaptability	Quantitative	M	Degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments.	Demonstrator Application can be used in two different OS platforms.	Demonstrator's Tests
Po2. Installability	Quantitative	C	Degree of effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment.	Demonstrator Application can be used in two different OS platforms	Demonstrator's Tests
Usability					
U1. Appropriateness /Recognisability	Qualitative	C	Degree to which users can recognise whether a product or system is appropriate for their needs.	Demonstrator Application scores of 75% in this aspect.	Questionnaire

Common Criteria to be measured	Type	MoSCoW	Description of Metric.	Success criteria for Metric	Results for the Metric and how gathered
U2. Learnability	Qualitative	C	Degree to which a product or system can be used by specified users in order to achieve specified goals of learning to be able to use the product or system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use.	Demonstrator Application scores 75% in this aspect.	Questionnaire
U3. Operability	Qualitative	M	Degree to which a product or system has attributes that make it easy to operate and control.	Demonstrator Application scores of 75% in this aspect.	Questionnaire
U4. User error protection.	Qualitative	M	Degree to which a system protects users against making errors.	Demonstrator Application scores of 75% in this aspect.	Questionnaire
U5. User interface aesthetics	Qualitative	C	Degree to which a user interface enables pleasing and satisfying interaction for the user.	Demonstrator Application scores of 75% in this aspect.	Questionnaire
U6. Accessibility	Qualitative	C	Degree to which a product or system can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use.	Demonstrator Application scores of 50% in this aspect.	Questionnaire
Compatibility/Interoperability					

Common Criteria to be measured	Type	MoSCoW	Description of Metric.	Success criteria for Metric	Results for the Metric and how gathered
I1. Co-existence	Quantitative	C	Degree to which a product can perform its required functions efficiently while sharing a common environment and resources with other products, without detrimental impact on any other product.	Less than 20% performance drop when demonstrator application is co-hosted with other applications that take 50% of system resources.	Log Files
I2. Interoperability	Quantitative	C	Degree to which two or more systems, products or components can exchange information and use the information that has been exchanged.	Ability of demonstrator App to expose information in JSON format.	Requirements Backlog
Maintainability					
M1. Modularity	Qualitative	C	Degree to which a system or computer program is composed of discrete components such that a change to one component has minimal impact on other components.	At least two different components to be used for the development of specific services of the demonstrator.	Demonstrators' architecture
M2. Reusability	Qualitative	C	Degree to which an asset can be used in more than one system, or in building other assets.	Suitability of at least one component of the Demonstrator application to be reusable elsewhere	Questionnaire

Common Criteria to be measured	Type	MoSCoW	Description of Metric.	Success criteria for Metric	Results for the Metric and how gathered
M3. Analysability	Quantitative	M	Degree of effectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of its parts, or to diagnose a product for deficiencies or causes of failures, or to identify parts to be modified.	100% of the demonstrator's code documented and including probe points for analysis through log files.	Demonstrators' architecture
M4. Testability	Qualitative	C	Degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine whether those criteria have been met.	Automated test covering 50% of the demonstrator's application code.	Demonstrator's Tests

Table 24: Format for collection of results regarding common criteria

KEY: **M**-Must have, **C**-Could have,

10.2 MONITORING THE EVOLUTION OF THE PISTIS PRODUCT AND ITS CONTRIBUTION TO THE DATA ECONOMY

Objective	Targets set	Measures of change: Success criteria	Data Collection Methods, frequency of collection and sources	Alpha platform comments
B.1. Standardised Communication. The PISTIS platform should provide a method for standardised communication between stakeholders, which will ensure efficient and effortless exchange of data.	Open API Calls covering the whole platform communication	All communications done through API calls	Functional Tests of the platform. At the end of each platform release.	All communication performed over APIs
B.2. Real – Time Data Exchange. The platform should facilitate the exchange of relevant data between stakeholders, adhering to agreed-upon key performance indicators and Service Level Agreements	Support at least 1 real-time data exchange method available	Real-time data exchange between stakeholders tested as part of the platform	Functional Tests of the platform. At the end of each platform release.	Not available in the Alpha version
B.3. Automated Data Synchronisation. PISTIS should support the setup of mechanisms to automatically receive specific data sets at regular intervals. For example, daily updates of datasets and operation plans can be received to ensure the availability of up-to-date information for planning and decision-making.	Support 1 scheduled data updating mechanism Support subscriptions on updating datasets as a monetisation method	Scheduled updating of data ingested over PISTIS tested as part of the platform "Subscription" monetisation options available and schedule data transfers between transaction parties	Functional Tests of the platform. At the end of each platform release.	Not available in the Alpha version

Objective	Targets set	Measures of change: Success criteria	Data Collection Methods, frequency of collection and sources	Alpha platform comments
B.4. Data Source Identification. The platform should enable the examination of relevant registry available data sources and identification of the required data.	Support data provenance	Provision of a service to document the provenance and lineage of data	Functional Tests of the platform. At the end of each platform release.	Lineage service is provided
B.5. Data Quality Assessment. The PISTIS platform should enable data providers to assess the quality of the shared data and perform necessary transformations. This ensures that the data meets the required standards and can be used effectively by each data consumer. This requirement strongly depends on the definition of the metrics that assess data quality.	Support 1 data quality assessment methodology and a respective service	Provision of a service to measure quality of datasets	Functional Tests of the platform. At the end of each platform release.	2 Services provided (Metadata quality and Data Quality)
B.6. Licensing and Policies. The platform should support the definition of licensing and policies for using the shared data.	Support of policies for accessing data Support of adding licensing information in smart contracts	Provision of a service to define access policies on available datasets Provision of Smart Contracts incorporating legal information such as licenses	Functional Tests of the platform. At the end of each platform release.	Access Policy Definition and Access Service Provided Smart Contracts engraving licensing terms provided
B.7. Interoperability and data format. The platform should support the agreement on a common information model, data format,	1 common data model per domain (demonstration	Definition of common data models for the demonstrators and a generic one for the metadata	Functional Tests of the platform. At the end of each platform release.	Common Data Model designed

Objective	Targets set	Measures of change: Success criteria	Data Collection Methods, frequency of collection and sources	Alpha platform comments
and protocols. This ensures interoperability and consistency in data exchange	hub) provided (3 in total) 1 common metadata model			
B.8. Data Monitoring and Usage. Data providers should be able to monitor the correct transfer, integrity and usage of data as agreed upon in the licenses. The platform should facilitate this monitoring process and ensure that data is used appropriately.	100% of transactions and data usage monitored	Transactions auditing service returns information for 100% of transactions. Data Usage Tracking service able to provide information for every dataset exchanged	Testing of relevant services. At the end of each demonstration phase.	All transactions are monitored via the auditing and the on/off platform inspector services
B.9. Business Value Evaluation. After interacting with the PISTIS platform, stakeholders should be able to fine-tune data usage, evaluate the business value of the received data, and identify additional data sources that can increase business value. This evaluation helps optimise internal processes and explore potential data sharing opportunities with third parties.	Increased efficiency of one business process. Design of one new service or product. Increase of the customer satisfaction for one service. Increased profit from the organisation data asset related to the	The business value can be estimated considering three types of advantages: cost, differentiation, and focus. In terms of costs, the data from PISTIS must contribute to either increasing the efficiency of the operations or reducing the costs of business processes, for example, in terms of decreasing the additional fees for having the required data from external vendors, thus increasing the number of queries at a reduced cost. In terms of differentiation, the data of PISTIS should contribute to new services or products. Thus, for each data set, the	Depending on the measure of change, that would require quantitative methods (based on analysis of performance, surveys, etc.) or qualitative methods based on interviews, focus groups, etc. For the performance analysis the data should be monitored weekly or monthly. For the qualitative methods every quarter an evaluation could be conducted.	Not applicable for the Alpha version

Objective	Targets set	Measures of change: Success criteria	Data Collection Methods, frequency of collection and sources	Alpha platform comments
	increased revenues from the data sharing. A potential target could be a quarterly increase of 5% of revenues for the overall data asset.	number of new offerings of the organisation should be assessed. In terms of focus, that leads to the quality of services, or the incremental improvement of services and products allowed by the PISTIS data. This could be measured by looking, e.g., at the increase in customer satisfaction for each service or product connected to a PISTIS data set. Also, the focus advantage could be evaluated assessing the information capacity and profitability of the company data asset before and after the use of PISTIS.		
B.10.Data anonymisation. The platform should facilitate the anonymisation of data and removal of business-sensitive information to protect data privacy.	Ability to anonymise datasets for removing PIIs	Elimination of PIIs from datasets using the anonymisation services.	Functional Tests of the platform. At the end of each platform release.	Data Anonymisation service provided
B.11. Semantic enrichment of the data should be supported to make it searchable using keywords, enhancing data accessibility and usability. This enrichment should be performed with respect to the adopted interoperability standards.	Ability to improve the descriptions of datasets	1 facility to allow different manners to semantically enrich data.	Functional Tests of the platform. At the end of each platform release.	Semantic Enrichment service provided
B.12. Data Trading and Acquisition. The platform should provide mechanisms for users to trade and acquire data from/with	Ability to support end to	1 data transfer connector, 1 blockchain to record data trading,	Functional Tests of the platform.	Data Connector, Monetary

Objective	Targets set	Measures of change: Success criteria	Data Collection Methods, frequency of collection and sources	Alpha platform comments
other PISTIS users. This promotes collaboration and knowledge sharing among stakeholders.	end a data transaction	1 blockchain to record monetary transactions.	At the end of each platform release.	Ledger and Data Ledger services provided
B.13. Data Scaling. The platform should support the scaling of data to accommodate large volumes, ensuring efficient processing and analysis.	Ability to scale to accommodate any datasets	1 data store used that is composed of technological elements renowned for supporting scaling.	Functional Tests of the platform. At the end of each platform release.	1 data storage service provided
B.14. Peer-to-Peer Trading Results. The platform should support the transmission and recording of peer-to-peer trading results, enabling users to track and validate their transactions.	1 facility for allowing data transfers	1 data transfer connector	Functional Tests of the platform. At the end of each platform release.	Data Connector Service Provided
B.15 Data and Metadata Publication. The platform should support the publication of data and associated metadata, making it accessible to relevant stakeholders. This facilitates data sharing and trading among users of the PISTIS platform.	1 marketplace exposing data assets and their metadata	1 catalogue infrastructure deployed to each participant to publish their available data (and the metadata related to them)	Functional Tests of the platform. At the end of each platform release.	Marketplace Catalogue service provided
B.16. Transaction Validation Report System. The platform should include a report system for validating transactions, providing users with a clear overview of their trading activities.	1 transaction auditing service	Transactions auditing service returns information for 100% of transactions.	Testing of relevant services. At the end of each platform release.	Transactions Auditing service provided

Objective	Targets set	Measures of change: Success criteria	Data Collection Methods, frequency of collection and sources	Alpha platform comments
B.17. Data Exchange Conditions. The platform should enable agreement on conditions for data sharing, ensuring that stakeholders have agreed upon how and when data will be shared, including considerations for data security, privacy, and legal requirements.	Smart Contract terms	1 smart contract agreement including also legal, usage and security terms	Functional Tests of the platform. At the end of each platform release.	1 Smart Contract Composer service provided
B.18. Data contracts and terms. The platform should support the definition of relevant data contracts, details, terms of use, and pricing policies. This ensures clarity and agreement among all parties involved in data sharing. This requirement is fulfilled with the execution of the processes of data contract preparation and contract signing.	Smart Contract terms	1 smart contract agreement including also legal, usage and security terms	Functional Tests of the platform. At the end of each platform release.	1 PISTIS license model designed
B.19. Smart Contract Creation. The platform should enable the creation of smart contracts between users, automating and ensuring the execution of agreed-upon terms and conditions.	Smart contract creation for all data exchanges	1 smart contract execution engine	Functional Tests of the platform. At the end of each platform release.	1 Smart Contract Execution Engine provided
B.20. Storage of Contracts and Validation Results. The platform should provide a secure storage mechanism for storing smart contracts and validation results, ensuring transparency and traceability of peer-to-peer transactions.	Secure contract information retaining mechanism	1 blockchain to hold all contracts	Functional Tests of the platform. At the end of each platform release.	1 Data Ledger service provided

Table 25: Criteria for monitoring the evolution of the PISTIS product as a key contributor to the Data Economy.

11 Business Aspects

11.1 Progress in Meeting the Business, Innovation and Exploitation Objectives .

Business, Innovation and Exploitation Objectives (BIEO)	***Key Results***		***Key Indicators & Quantified Targets***
BIEO.1: To deploy, operate and validate a reference industrial data sharing, value accrual and monetisation platform within a set of representative demonstrator hubs that implement diverse data and intelligence sharing scenarios and substantiate multi-stakeholder added value in real-world business problem and validate a reference industrial data sharing, value accrual and monetisation platform within a set of representative demonstrator hubs that implement diverse data and intelligence sharing scenarios and substantiate multistakeholder added value in real-world business problems.	Trusted Data and Intelligence Sharing within the three hubs.		Monetisation aspects are part of the Beta version. Sharing within three hubs has taken place. Beta Version Set out in D5.1. Being enhanced for Beta version 11 added value scenarios and analytics apps in 4 sectors (mobility, urban planning, energy, automotive) across 3 Demonstrator Hubs described. Set out in D5.1 3 data marketplaces and 1 open data space integrated for interoperable data exchange. Beta version.
	Cross-Demonstrator Data Spaces.		
	Project Verification and Validation Framework.		
	Data Assets Documentation.		
	Detailed Pilot Execution Plans and Impact Assessment.		
	In-depth Data Landscaping.		
BIEO.2: To diffuse, replicate and scale up the PISTIS offerings, bringing forward novel data sharing-driven business models and satisfying emerging / explicit needs of a wide range of stakeholders.	Data Sharing-driven Business Models.		32 of >50 Detailed Data Asset Profiles to be shared/traded. Advanced planning for focus for 3 living lab workshops organised per demonstrator hub which will be reported in D5.3 11 data sharing-driven Business Model Innovations to be reported in D5.3. Initial Exploitation Plan provided in D7.2 and progress being made in more precise Data Market Analysis with 2 analysis provided.
	Monetisation and Business Innovation Analysis for the Demonstrators.		
	Exploitation and Business Innovation Planning		
	Activities (incl. sustainability plan and financial strategy plan with cost breakdowns and future projections).		

Business, Innovation and Exploitation Objectives (BIEO)	*Key Results*		*Key Indicators & Quantified Targets*
	PISTIS Adoption Guidelines.		Replication activities to >3 sectors. D5.3
	Scale-up Roadmap.		10 public success stories for data sharing per industry/hub. D5.3
	Dissemination & Communication, Liaison & Standardisation Activities.		Dissemination & Communication KPIs defined in D6.1.[30] Progress made.
	Engagement Activities through Living Labs.		Commenced.
	Collaboration with the Data, AI & Robotics PPP Projects (ICT-13 and Data Spaces Projects).		Commenced and EUDATA+ is creating impetus.
	Continuous DIHs, Industry and SMEs Stakeholder		Commenced.
BIEO.3: To cultivate a data-sharing mentality within the organisation by fostering data sharing-related skills and technology competences, and understanding the "shared" data value concept.	Data Sharing Maturity Assessment Framework.		>12 Data Sharing Maturity Assessment Examples. Will be provided in D5.3
	Training Material (Interactive Documentation & Walkthroughs).		>7 Lectures with 45' duration in the PISTIS MOOC have been progressed.
	Platform Online Documentation Mini-Site /Wiki		Provided covering the Alpha version.
	Open Access MOOC.		>100 End Users completing the PISTIS MOOC. D5.3
	Open Training Workshops & Webinars.		>95% End User/Trainee Skills Improvement. D5.3
	End Users Training Days.		>5 Open Training Workshops & Webinars. Progressed
	End User Performance Assessment.		Further Education & Training KPIs defined in D6.1. Progressed
			For the alpha version.

Table 26: Meeting the Business, Innovation and Exploitation Objectives

[30] D 6.1 - Dissemination, Communication, Liaison, Training and Living Lab Plan - PISTIS (pistis-project.eu)

11.2 Evaluation of the Business Models

In addition to the progress set out above in moving towards achieving the "Business, Innovation and Exploitation Objectives" for PISTIS, another task faced is for the demonstrators to give input into the creation of the business models which are being produced by WP7, but which will be evaluated within WP5.

WP5 is charged with paying special attention on assessing the cost-efficiency and viability of the new business models to be developed by the project in WP7

Clearly, it is too early in the project to come to any conclusions but this will become more in focus in the final stages of the project and results will be reported fully in D5.3.

Knowledge regarding the overall PISTIS exploitation strategy has been built up, following the production of D7.1 and D7.2. This provides a solid base to build on in the creation of the business models which we will be subsequently be evaluating in WP5.

The planned work in the period leading up to and building upon the release of the more mature Beta version of the platform is covered in Chapter 12 Next planned Steps. This includes an outline of the strategy which will be adopted to ensure that the eleven business plans, along with their evaluation process, contribute to the maximum towards the overall exploitation strategy for PISTIS, whilst providing lessons learned to assist in this process.

11.3 Monitoring the evolution of the PISTIS product and its contribution to the Data Economy

The criteria for monitoring the evolution of the PISTIS product as a key contributor naturally overlap with the criteria for monitoring the evolution of the product as a key contributor to the Data economy, However, in addition to the status for these criteria, reported in Table 25, above, other factors need to be considered and these are highlighted in the following chapters and in particular, in Chapter 12 which addresses the opportunities afforded once the platform is more mature.

11.4 Business Value Planning and the Demonstrators

The introductory chapter summarised most of the work to be carried out in Task 5.7 – Demonstrators Continuous Evaluation, Impact Assessment and Lessons Learned – which set in operation the verification and validation framework defined in T5.1, following the launch of the demonstrators. Data collection, regarding the experience of the demonstrator partners with the PISTIS platform, has been conducted and will continue to be conducted.

In the early stages, including for this deliverable, the evaluation was very much focussed within the consortium, to help it make real progress for when the wider business community get involved at the Beta version stage.

During its course, this task provides individual, aggregated and comparative assessments of pilot results, considering the performance, efficiency and effectiveness of the PISTIS Data Exchange Market, focusing on interoperability, user acceptance and engagement in data sharing, cost-efficiency, etc. A few preliminary observations have been made in preceding chapters on these topics, but without a robust mature platform, we are just scraping at the surface and laying the foundations for the forthcoming evaluation.

But, there are also other aspects of this Task 5.7 which cannot be undertaken significantly until the Beta version is available. Some proposals for the improvement actions and interventions for enhancing the exploitation process have been made, and are reported in the following chapter, but building upon such ideas requires a more mature platform.

And clearly, the emerging evaluation strategy for assessing the cost-efficiency and viability of the new business models being developed by the project in WP7 requires significant progress to have been made in their development, given the very wide range of approaches which are likely to be taken.

11.4.1 Cross-cutting Instances and Business Value

Task 5.6 deals with the deployment of PISTIS instances which are considered horizontal to the core demonstrators. As such, an instance to trade weather data is being developed (by partner UBIMET), while two other instances are also being developed, one for serving selected open data via connecting to the EU Open Data Portal (to be hosted by FGH) and one domain agnostic, to act as a playground by the Living Lab participants (to be hosted by SPH).

The three cross-cutting supporting initiatives can be seen as having the potential to create considerable additional value to the three core demonstration hubs. There are clear examples in Chapters 3, 4 and 5 above, of how the more mature Weather instance can contribute, introducing weather data into core use-cases. This was planned for in the DoA and in the design of the use-cases and hence the good progress already made.

However, the contributions which the Living Lab and the Open Data Factory can make will only emerge in due course. Both rely on having a more mature version of the platform and will only be of significant value once we have the Beta version functioning.

In general, these three instances contribute to enhancing the climate in which the project is evolving by asserting values and approaches which are vital for PISTIS to be a success. Already, observations have been made on how the climate is conducive to collaboration.

Thanks to the environment created by PISTIS, there is value in gathering information about the expected use of the platform by other Hubs. In this way, it is possible to identify requirements and possibilities that were not initially considered. Furthermore, this can

provide additional information when it comes to valuing the data. Collaboration with the other hubs may results in a cross-use of developed artifacts from the use cases (e.g., a traffic risk manager operating in the city of Athens may use parts of the automotive hub solution).

This collaboration between the core hubs and with the weather instance contributes to creating a Data Sharing Culture, which should result in fostering data sharing and interoperability, contributing to a more integrated ecosystem for airport and urban operations, within Hub 1, but also embracing other input from elsewhere.

The shared data and insights should lead to the development of novel new business models and opportunities.

Weather Factory

The weather instance, unlike the other two cross-cutting factories which are still to function, has been fully engaged in the demonstration preparations and has been involved in all the data requirements identification processes and in many aspects, has been treated similarly to the treatment of the core hubs, with regard to preparation activities and readiness for the release of the alpha version. However, much of this substantial work has been reported through the contributions made within the three core hubs.

Several use-cases already utilise weather data from UBIMET and these include:

- Baggage Handling Management
- Transfer Passengers Management
- Aircraft Turnaround Process
- Public Transportation Planning Support.
- Energy Investment Deferral
- Increasing the hosting capacity of the grid
- Traffic quality assessment
- Driving Style and Risk Assessment

This list will be lengthened with usage by other internal and external stakeholders encouraged through the Living Labs activity.

Living Lab Experimentation Factory

This factory is “domain agnostic”, to act as a playground by the Living Lab participants (to be hosted by SPH).

The plan for later in the project is that a set of targeted living lab engagement workshops will be conducted, coordinated by the task leader and organised by the demonstration partners to:

- Raise awareness, engagement and acceptance of stakeholders, including also the preparation and distribution of appropriate material,
- Involve end users in the requirements definition activities of the project,

- Train users and contribute to the adoption of the PISTIS concept and operation in the project's demonstrators,
- Involve all stakeholders in the evaluation of PISTIS results.

The demonstrators will own a mechanism for conducting this shared experimentation process and these experiments will contribute to the marketing approach.

Towards the end of the project, an overall impact assessment and evaluation of PISTIS will be carried out involving all stakeholders of the PISTIS Living Lab, to achieve the holistic assessment and collaborative devising of the project results. Benchmarking and impact assessment will be based on the requirements identified at the beginning of the project, while the strengths and weaknesses of the project will also be seen from this perspective.

Open Data factory

A third factory acting in a cross-cutting way will serve selected open data via connecting to the EU Open Data Portal and being hosted by FGH. It must be noted that the EU's Open Data Portal[31] provides access to over 1.8 million data sets.

The selection of topics for which Open Data can contribute will hinge on the nature of the Business Models being developed but every opportunity will be taken to bring on board data from this rich source.

Contribution to the business models

Whilst individually, these "contributors to business value" are of great benefit to the eventual exploitation of PISTIS, it is in the later stages of the project that their real value will be appreciated and how they will come together to enhance all the business models being developed and covered in Chapter 11, Business Aspects.

11.5 Contracting and Monetisation

Other than simple internal technical testing and in the planning of collaboration with external stakeholders, little else could have been scrutinised until the platform is mature enough to also impress external stakeholders and stimulate internal ones into fully understanding the benefits of these processes. The alpha version did not include these aspects.

11.6 Lessons Learned

The Lessons Learned will be another valuable contribution in terms of creating business value.

T7.5 aims to extract the lessons learnt from the demonstration and impact assessment phase in WP5; technical ones but mainly business ones coming from the operation of PISTIS platform

[31] The official portal for European data | data.europa.eu

at the project's demonstrators. Those lessons learnt shall be formulated as methodological adoption guidelines to foster the scaling-up, wide replication and uptake of the PISTIS Data Exchange Market across the EU.

A prominent example of contribution to the goals of the call is to provide guidelines for the eventual support of the Stablecoin. The adoption guidelines will be embedded into the training material produced in WP6.

Therefore, in this deliverable we will only describe the working methodology within WP5 activities, while contents and results of the Lessons Learned collection will be presented in deliverable D7.3. The demonstrators in the coming period will be expected to provide input into the five stages elaborated for gathering Lessons Learned, although only the first two stages can be addressed prior to the release of the Beta version.

These are:

1. Gather Lessons Learned from Demonstrators
2. Formulate Methodological Adoption Guidelines
3. Stakeholder Validation and Feedback
4. Integrate Guidelines into Training Material
5. Dissemination and Scale-Up Planning

Activity 1. consists of collaborating with WP5 to collect insights from the demonstrators, focusing on technical challenges, business strategies and stakeholder engagement; analysing data and feedback from the demonstrators to identify success factors and areas for improvement in platform operation; documenting key learnings for Demonstrators and Use Cases.

Activity 2. consists of translating the lessons learned into practical, actionable guidelines for platform adoption and scale-up, including technical recommendations (e.g., integration steps, interoperability standards) and high-level business guidelines (e.g., monetisation strategies, operational best practices); exploring the potential support of the Stablecoin, addressing its feasibility and integration into the PISTIS ecosystem.

We have established a working group involving the following related tasks: T5.7 (Demonstrators Continuous Evaluation, Impact Assessment, and Lessons Learned), T7.3 (PISTIS Platform Business Plan Design and Market Entry Preparation) and T7.4 (Monetisation and Business Model Design for Demonstrators and Onboarded Organisations).

In this way, the respective task activities will be conducted in a coordinated manner, ensuring greater methodological consistency and avoiding unnecessary duplication of efforts/time wasted.

The interviewees who have been identified will represent all 11 Use Cases and perspectives of data user and data seeker will be taken. Questionnaires will be distributed online in phases.

Regarding the questionnaires, we have identified a specific area of collaboration with T7.4:

that task aims to explore possible business models arising from the use of the platform and, as a result, includes a questionnaire with many overlapping aspects with that of T7.5.

For this reason, it was decided to proceed jointly by organising common interviews with the eleven Use Cases. The intention is for it to be completed for the first time and then periodically updated — e.g., every two to three months — so that the Lessons Learnt can be collected in an evolving manner. The updates can take place either through a partial re-submission of the questionnaire or by organising dedicated workshops.

12 NEXT PLANNED STEPS

This and the following two chapters consider "What Next?"

This chapter will briefly cover aspects of what has already been planned within WP5 for the final stages of the project. It will cover the implementation of **what was already anticipated** for the next steps for the project which will result in the evaluation of the Beta version and its subsequent transformation into the final product.

But the following Chapter 13, Widening the Scope as the Project Matures, will delve into what could not have been planned in any detail at the start of the project and which requires the existence of a more mature platform to be taken forward. **We will be looking to extend the scope of the project as envisaged in the DoA in several directions.**

Aspects to be covered include: the business planning process and how we will look to evaluate this, the environmental implications and how these will be scrutinised along with the projects influence on policy making and how that will also be evaluated, its social impact and its impact for smart cities and how all these aspects can be evaluated.

The following Chapter 14, Use of the PISTIS Theory of Change, takes an overview of this extension process. Underpinning how we will tackle this extension of the scope for PISTIS as the project matures is the project's **Theory of Change**[32] and we will consider how its usefulness and focus changes as the project matures and this will give an insight and structure into what is being envisaged for the final stages of the project. Essentially it tells the story of how the project is expected to bring about the desired results rather than just describing the results.

The more general stages set out in the Theory can be divided into intermediate actions, which contribute to bringing about the desired overall results and this provides the framework for how we will widen the scope of PISTIS in the more mature phases of the project.

Currently the project is in its Third Phase. This is the Verification, Validation, Demonstration & Impact Assessment of the PISTIS platform. This will be followed by the Fourth Phase which is

[32] This is reproduced as Annex 3

centred on WP6 and WP7 and which is Training, Knowledge Diffusion, and Market Entry Preparation, but to which WP5 makes a significant contribution.

We are clearly at a watershed in the project, with a much more holistic approach needing to be taken, building on the work which has been carried out across all the WPs in PISTIS to date.

It is an interesting phase and the structuring of the non-technical work packages ensures that we will progress with a joined-up and holistic approach.

We will also refer to some work which would have been premature to have been covered in the demonstration planning set out in D5.1 but which now needs focussing upon in the coming period. We are concerned principally with those contributions which the demonstrators can make to achieving some of the more holistic goals for PISTIS. These include how we will deal with the business plans, with environmental topics and how we will contribute to influencing policy. We also need to turn to how we will evaluate these important contributions.

12.1 Training

In addition, PISTIS will continue to develop content for the open MOOC and perform a set of training activities to support the skills development for those stakeholders that embark on data sharing and are interested in deploying and leveraging the PISTIS solution. We will also recommend material provided elsewhere where deemed of value to PISTIS.

12.2 External stakeholder input

PISTIS aspires to further validate its results through knowledge gained from external stakeholders, providing further insights on the market readiness of the PISTIS exploitable assets. Input from the WP5 Living Labs will be instrumental in this. As the Beta version emerges, the Living Lab will invite stakeholders of the different data spaces to engage in order to acquire direct feedback from parties external to the consortium, who will form a potential customer audience at the end of the project.

12.3 Lessons Learned

WP5 will continue to contribute further to the Lessons Learned and will provide the basis for success stories (a KPI), adoption guidelines and providing a focus for scale-up activities. Work will be planned through the working group established by the three tasks- T5.7, 7.3 and 7.4 referred to earlier. In this way, the respective task activities will be conducted in a coordinated manner, ensuring greater methodological consistency and avoiding unnecessary duplication of efforts/time wasted.

12.4 FACTORY CONSOLIDATION

Having tested the Alpha version and provided feedback, the work within WP5 will focus on the deployment of the Pistis factories at each demonstration site, according to the original plans, with the additional deployment of factories to cover Open Data, Living Lab experimentation and the Weather instance.

In the development of the Beta version of the platform, everything found of value in these deliberations concerning the alpha version in relation to improving the platform, will be embraced. The PISTIS Theory of Change will continue to be utilised in the coming months to make any amendments to shape the course of the next phases of the project, in order to make improvements and increase our chances of success.

12.5 IMPACT ASSESSMENT

Towards the end of the project, an overall impact assessment and evaluation of PISTIS will be carried out with input coming from the Living Labs.

During its course, T5.7 will continue to provide assessments of pilot results, considering the performance, efficiency and effectiveness of the PISTIS Data Exchange Market, focusing on interoperability, user acceptance and engagement in data sharing, cost-efficiency, etc. Whilst evaluation needs to widely assess the business models being developed, we will also pay special attention on assessing their cost-efficiency and viability.

Existing KPIs and targets of relevance to WP5 include:

- Holding more than three living lab workshops organised per demonstrator hub;
- 11 data sharing-driven Business Model Innovations;
- Replication activities to more than 3 sectors;
- Providing more than 10 public success stories for data sharing per industry/hub.

Additionally, WP5 will provide much of the “ammunition” to help achieve the Dissemination & Communication KPIs.

12.6 NEW KPIS

In strengthening the evaluation framework, we will also focus on “defining additional quantified KPIs to enable the holistic assessment of the project impact per demonstrator hub, such as contributing towards the European Green Deal Strategy and the EU’s commitment to global climate action for the Energy hub”. We will need to deliver appropriate instruments for the uniform collection of the additional evaluation data .

A dialogue between all partners on the topic of what new KPIs would be of value for evaluating progress once the release of the Beta version occurs, resulted in a lengthy list of suggestions. The list will be further discussed and finalised, covering how they will be measured and verified and these new KPIs recorded at a PISTIS Plenary meeting prior to the release of the Beta

version. A crucial factor in determining them will be the focus for each of the eleven business models being developed within Task 7.4.

In addition to the requirement for WP5 to carry out the evaluation of these business models and the need to dedicate new KPIs to this process, the resulting business models will all contribute to the holistic progress for PISTIS and also towards the business model for the project level platform exploitation. Further, the evolving strategies for exploitation at the use-case level will throw up new opportunities to make further progress, and with that a requirement to measure the success in taking these new directions.

Complementing the existing KPIs and the KPIs being planned is the very extensive checklist, provided as an appendix to D5.1, which has 170 indicators listed, taken from the DoA and all aspects of this list will be considered in the closing period of the project.

We will be considering new KPIs under six headings which together will enable us to make a more holistic assessment for PISTIS which are: technical, economic, environmental, political, social and business.

Of particular value will be those which will contribute to the evaluation of the overall project impact in the cross-cutting environmental, social and political domains. With the growing maturity of the project, the process for measuring the environmental and political impact will be finalised and many of the building blocks have already been put in place.

Having shifted from planning for the implementation and evaluation of the Alpha version, the required steps to achieve our wider goals for the Beta stage deployment will be decided upon and with it, decisions taken on introducing the new relevant KPIs. In focus here will be the direction which the project is taking, rather than just on the final products.

A feature of any time-constrained project is that the KPIs are restricted in terms of being measurable, as the projects end before the full exploitation phase is underway and therefore, before answers to some of the questions being posed become available. As a consequence, we will be looking to more short-term indicators to assure the project teams that they are going in the right direction. As the eco-systems in which PISTIS operate start to grow and merge, the ambition will extend to scrutinising this process. What we are concerned with here, and which is covered in greater detail in Chapter 14, are the intermediary steps which can be filled in to make our Theory of Change, already providing the holistic overview for PISTIS, more detailed and valuable.

In addition to the approach already established and described above, new topics need to be scrutinised as the project matures and their impact to be assessed and evaluated. These are covered in the following chapter.

12.7 PREPARATION FOR MARKET ENTRY

This last phase of the project's methodology aims at successfully diffusing the knowledge developed by the project, engaging with relevant initiatives to promote the adoption of the project's results and preparing for market entry of the most mature results. This is followed by a constant analysis of the market, and by devising a detailed exploitation strategy that takes advantage of the emerging market opportunities and sets in motion all the necessary mechanisms for the effective operation, exploitation and go to-market preparation of the product. Particular emphasis is placed on the demonstrator organisations (and thus the corresponding market segments / data spaces) represented in PISTIS, as this will help reduce any exploitation risks.

The evolving detailed business model and plan, accompanied by a set of lessons learnt and business cases deriving directly from the experience of the project's demonstrators along with experiences drawn from the Living Lab with the PISTIS outcomes, will all be utilised to increase the reception by the community and gain market acceptance, as well as to elaborate on novel data sharing-enabled business models.

Whilst we have looked at the areas we were able to consider in detail during the alpha phase, and touched upon the business advantages as a basis for exploitation, in the coming period we will delve deeper into the business aspects and the potential for focussing exploitation and marketing efforts around the demonstrators and their eco-systems. WP5 is tasked with enhancing the basic demonstration activity as laid out in the DoA with T5.7 established to do this. The focus will be upon those improvement actions, interventions and measures to be applied in order to maximise chances of a successful exploitation.

T7.4 is Monetisation and Business Model Design for demonstrators and onboarded organisations. "PISTIS will help individual organisations or clusters of organisations enhance their current (and anticipated) business plans with added value coming from the PISTIS platform. The consortium will need to work closely with them and understand their existing business models and see how the PISTIS platform business model can fit into them, to ensure the steep uptake and acceptance, not only in technical, but also in business attractiveness terms."

It could be a business operation line created or renovated as a result of the data-driven intelligence acquired from using the PISTIS platform, or an additional revenue stream generated from data sharing or a sale channel for innovative data services designed to satisfy the needs of the involved data value chain stakeholders.

This exercise will be offered to the demonstrator organisations in the project initially but will be open to any other organisation that would be willing to use it towards the end of the project.

Having a common understanding of the core business model for each of the use cases will enable WP5 and WP6 activity to bring in the most relevant new stakeholders.

12.8 NON-MARKET DRIVEN EXPLOITATION

We will also be able to consider other “exploitation” aspects, such as knowledge sharing, contribution to standards, contributions to EU policy, environmental benefits and social benefits etc. These will all have attention focussed upon them in the final phases of the project as it matures. These aspects will be taken into account in the choice of stakeholders to be involved in the WP5 Living Labs programme.

13 WIDENING THE SCOPE AS THE PROJECT MATURES

With the evolution of the platform, we can now consider those elements of the project which required a more mature basis for them to be considered in any depth. This chapter will look at a wide range of planned impacts which have been “parked” until now and these include:

- The business planning process and how we will look to evaluate this,
- The environmental implications and how these will be scrutinised
- The project’s influence on policy making and how that will also be evaluated,
- Its social impact
- Its impacts for smart cities and how these can be evaluated.

13.1 WIDENING THE SCOPE WITH NEW STAKEHOLDERS

Given the multifaceted nature of the stakeholders and their wide and heterogeneous expertise, the stakeholder engagement strategy also required a multifaceted, wide, and heterogeneous approach. Such strategy began with an in-depth evaluation of the PISTIS project, assessing its capabilities to extend to external fields beyond those initially instigated hubs and use cases. The task to introduce improvement actions to assist in the exploitation process, underpins the need to widen the demonstration scope for the final period. This section explores the potential for widening the scope of the project's demonstrators in the final period.

Two relevant recommendations emerging from the preparatory work carried out in the exploitation work-package point to:

- The fact that the driver of data sharing is not always data monetisation and that there is a multitude of data purchase and delivery modes which should be considered and included.
- And that we are operating in a very dynamic environment and so ongoing work on market analysis needs to stay relevant.

This requires the Identification of high performance and competitive advantage for PISTIS within the data space landscape, initially focussing on where we are already active.

This stage is pivotal in understanding the project's alignment with specific use case needs. Prior efforts have focused on identifying the needs of individual demonstrators, creating

relevant data landscapes, and determining functional requirements for the platform components. We need to fully understand how the platform aligns with the needs of all the users and demonstrators, including those of those newly-attracted to the platform, and whether all components effectively address potential shortcomings. Widening the scope as planned will be beneficial.

Also, in parallel with introducing new stakeholders to deploy PISTIS and new data sources, the consortium may wish to consider the potential for introducing new technologies from some of those stakeholders as the ecosystems grow.

In parallel with identifying specific user needs, we will plan to facilitate platform usage. Attracting new users and stakeholders hinges on their motivation and familiarity with the PISTIS platform. A major obstacle in data trading platforms is the reluctance to share owned data due to fear of asset loss. This, coupled with a lack of understanding of how data platforms operate, can significantly affect PISTIS's appeal.

To address these concerns and increase user adoption, we will introduce an interactive game during living lab activities. This game, using a hypothetical and simplified scenario, will help new stakeholders familiarise themselves with PISTIS mechanisms and functionalities. By reducing concerns and demonstrating ease of use, we aim to boost the platform's attractiveness.

In addition to the stakeholders which the demonstration hubs have identified as being suitable for inclusion in the demonstration activity at an early stage, there are several other key sources for continuing this drive to improve the core activity.

There are also the three cross-cutting instances which each can bring something to the table to make improvements through the access to Open Data and to Weather Data, along with the Living Lab being able to be used as an experimental entry for the identified stakeholders and as a magnet to attract potential stakeholders.

13.1.1 Seamless inclusion of new stakeholders

There are two main advantages for PISTIS in terms of making the process of enticing new stakeholders smoother.

- Stakeholders interested in testing the PISTIS platform will be **given access** to it to test it themselves via the Living Lab Factory, complemented by the Open Data Factory.
- And crucially, the PISTIS platform. PISTIS provides a **ready-to-use data space** and monetisation solution with a modern, service-based architecture. From the alpha version onward, it includes automated, container-based deployment of PISTIS services, compatible with any cloud infrastructure. This significantly lowers the barrier for organisations to adopt PISTIS. Each member of a PISTIS-enabled data space can choose their preferred hosting infrastructure and deploy their share of PISTIS services with **minimal effort**.

Organisations can adopt PISTIS in various ways, depending on their needs.

1) Creating a Private Data Space: An existing ecosystem of organisations can deploy and integrate PISTIS within their infrastructure to establish a shared data space. This enables secure and trusted data exchange without requiring members to understand PISTIS's underlying technologies. New organisations can join or leave the ecosystem seamlessly. The scale of such an ecosystem is flexible, and participating organisations retain full sovereignty over their data space.

2) Enabling Data Trading Within an Ecosystem: Similar to the first model, but with organisations actively trading data within the ecosystem.

3) Building a Public Data Trading Platform: An organisation can create a public data trading and monetisation platform powered by PISTIS, incorporating a stablecoin for transactions. Other organisations can join the platform to buy or sell data by installing the necessary PISTIS services within their cloud infrastructure.

13.2 WIDENING THE SCOPE OF THE CORE DEMONSTRATORS

With regard to extending the scope of the core demonstrators, new stakeholders can be attracted to PISTIS by introducing themes with wider appeal.

Cross-cutting themes can be identified to pool the work from the distinct hubs and from the cross-cutting instances in a joined-up approach, to tackle specific issues, such as having a focus on environmental topics, sustainability, smart cities etc. For example, work on reducing emissions within the Automotive hub is equally valid within the Athens Mobility hub and equally so when combined for any smart city.

Further inspiration will come from the application areas being demonstrated by the sister projects[33] to PISTIS and collaboration through the EUDATA+ initiative which is bringing all the work together at both a technical and a business level, in addition to work at the dissemination level. PISTIS participation in the Business Group is influencing the strategy to seek out the synergies, both in terms of overlapping demonstration scenarios and in potential cross-fertilisation and the utilisation of technology being developed by sister projects to enhance both their and PISTIS's demonstrations. And as a consequence, the potential for a successful exploitation.

WP5 will also collaborate with WP6 and WP7 to identify new projects and initiatives which may have exploitable synergies with PISTIS, once the marketing focus has been refined further.

The focal point for enhancing the Beta demonstrations will lie with the eleven business models which are in the pipeline and which are being created by Imperial in the capacity of Task-

[33] The Calls monitored include HORIZON-CL4-2021-DATA-01-01, HORIZON-CL4-2021-DATA-01-03, HORIZON-CL4-2022-DATA-01-04, HORIZON-CL4-2022-DATA-01-01 and HORIZON-CL4-2022-DATA-01-05.

Leader for "T7.4 Monetisation and Business Model Design for Demonstrators and Onboarded Organisations."

This sets out to help individual organisations or clusters of organisations enhance their current (and anticipated) business plans with added value coming from the PISTIS platform. Evaluation will also pay special attention on assessing the cost-efficiency and viability of these new business models developed by the project in WP7.

Key will be the input from "Task 6.3 Liaison Activities and Strategic Partnerships" which is making use of the consortium's partners contacts and involvement in several other projects (from a technical perspective, focusing on projects running under the GAIA-X, IDSA, AI4EU[34], EOSC[35] initiatives) towards engaging stakeholders and establishing strategic partnerships for knowledge sharing in order to exchange experiences, lessons learnt and overall build a strong relationship. These can be turned into more concrete technical collaborations, again, with opportunities afforded by participation in EUDATA+. Equally, the task can be approached from the end-user perspective and projects and initiatives focussing on mobility, energy, smart cities etc will be in focus or newly introduced cross-cutting themes.

The consortium will need to work closely with those initiatives identified and understand their existing business models and see how the PISTIS platform business model can fit into them, to ensure the steep uptake and acceptance, not only in technical, but also in business attractiveness terms. It could be a business operation line created or renovated as a result of the data-driven intelligence acquired from using the PISTIS platform, or an additional revenue stream generated from data sharing or a sale channel for innovative data services designed to satisfy the needs of the involved data value chain stakeholders. This exercise will be offered to the demonstrator organisations in the project initially but will be open to any other organisation that would be willing to use it towards the end of the project. Again, with the Living Labs playing an important role.

13.3 Widening the scope: Non-Monetary Valuation of Data

A significant sector for data usage is the public sector. One of the four pillars of the Digital Decade is "Digitalisation of public services" and the digital transformation of the public sector.

Such a simplified approach to the deployment of PISTIS "out of a box", as outlined above, should be welcomed by a smart city, as the ready-to-use solutions will be equally valuable to a public administration and possibly have the advantage of being able to be understood by the decision makers more readily. Equally, having exemplars to ease communication within an administration is very valuable, giving confidence to adopt them, whilst allaying fears of the unknown.

[34] About AI4EU | AI-on-Demand

[35] Home | European Open Science Cloud - EU Node

Smart cities do have to purchase data on occasion (and often it is their own data which has been harvested by outside organisations through their outsourcing contracts!). And they rely also on acquiring open data. However, there is scope to add another novel approach with a further, different focus alongside the creation of another novel business model which takes into account the different perspective which a public authority would adopt in relation to data, its usage and its value. A starting point would be the work which the SAFE-DEED[36] project referred to in scrutinising the non-monetary values for data[37].

Whilst the global economy is increasingly more reliant on data, with businesses adopting data-enabled decision-making practices in the form of analytics or machine learning, public authorities are hampered by the limitations which the current mechanism for valuing data imposes upon them. Market forces and monetary values leave many aspects of running a public administration excluded. Whilst the market is employed by a public administration for much of its activities- purchasing materials and services etc, it is not the primary method of coordination with hierarchical controls on one hand and with a great reliance on networking, a combination of the three models of coordination which are required to "run" the public administration.[38]

A hierarchy is as how we commonly use it, with instructions communicated by being passed down so that something happens. The key concepts in market coordination are enforceable contracts and property rights and communication in a market is through prices, which serve as the basis for behaviour of both buyers and sellers. However, Networks are characterised by the complementarity of member's interests and the reaching of an agreement between them. Coordination and agreement within networks are achieved through discussion rather than through the impersonal mechanisms which work in markets and hierarchies.

Views of data as an asset and the steady emergence of data markets depend on the capability of quantifying the value of data. In PISTIS we are already tackling many of the difficult issues associated with data sharing and the "data-as-an-asset approach" whilst focusing on assigning a price tag for data, which is complicated. This is due to the basic properties of data and the multiple value chains that it can generate.

The public sector has a different view on data and why valuable and scarce resources should be spent on handling data. The use cases within PISTIS have considerable value for a smart city and access to the data eco-systems evolving within PISTIS and to those linked to existing data spaces will be of tremendous value to a smart city. We should examine the introduction of a data valuation process that recognises and integrates the contextual nature of data value, together with data quality and data utility assessments.

[36] SAFE-DEED | Safe Deed

[37] Data Valuation and Its Applications for Smart Cities Mihnea Tufiș, Eurecat Technology Center of Catalunya Barcelona in https://doi.org/10.13052/rp-9788770227995

[38] G. Thompson, J. Frances, R. Leva£ic, and J. Mitchell, Eds., MARKETS, HIERARCHIES AND NETWORKS. The Coordination of Social Life. Newbury Park: SAGE Publications, 1991.

The value of data can be reported in a multi-faceted scorecard, which allows for an exploration of data value at different levels of aggregation. We could subsequently explore how cities can benefit from the multitude of data they harvest in the process of digitalisation, and we argue that these benefits can be enhanced if cities were to have a mechanism for a more concrete understanding of the value of their data.

The role of ICT solutions in achieving goals specific to smart city transformation is now indisputable. For example, in mobility, ICT-based solutions could reduce commuting by 15%–20% and in with energy, cut greenhouse gas emissions by 10%–15%, and this at a rate of only 12% of city data currently being analysed and used for decision-making and management.[39]

We have shifted from recording data about a selected subset of activities, to generating data about nearly every aspect of our lives. The success of a data-centred initiative lies in unlocking the value that data can generate in each context and with respect to the problem being solved. Thus, the necessity to develop a process for establishing the value of data arises. Ideally, such a process should generalise to any kind of data, application domain, or economic sector.

In the context of smart cities, its benefits would be manifold: Municipalities should be able to understand the value chains generated by the data they are collecting. Consequently, they would be able to map the data value chains to practical outcomes and quantify their impact in the communities. A transparent methodology for data valuation could help develop a fair and responsible ecosystem around data markets in the public sector context.

Market values can still be used where appropriate- for example, transformed data may be sold on the market as with a company. But essentially we are looking at a model of coordination built on networks. Attard et al have produced a suitable data model to embark from. Work from Cambridge University concludes that the economic characteristics of data and the data economy mean the market alone will not unlock data's full potential value.[40]

It could be argued that the existing market for data is recognising the need for networking to lubricate the market activities, as witnessed by the emergence of new platform data market canvasses having such relationships as a pre-requisite.

13.4 Improving the valuation methodology

Very often, data valuation is directly associated with a financial estimation of the value of data. This stems from a widely spread view of data as an economic asset including:

- Data collected by National Statistics Agencies
- Data collected as part of transparent government initiatives

[39] Attard, J., Orlandi, F., & Auer, S. (2017). Exploiting the Value of Data through Data Value Networks. *Proceedings of the 10th International Conference on Theory and Practice of Electronic Governance*, 475–484. https://doi.org/10.1145/3047273.3047299

[40] The Value of Data - Policy Implications - Bennett Institute for Public Policy

- Data collected by cities as part of efforts to implement smart cities – air quality, water quality sensors, public transportation routes and load

These data are data about communities and primarily destined to be used to improve the lives of communities. Some of these data end up in the hands of data brokers and are essential to their dataset offerings, as they complement and usually improve the quality of other data sources.

It is paramount that we are able to provide a methodology for valuating this kind of data, in both a monetary and non-monetary way. Monetary valuation does not capture the full social and economic benefits of data.[41] It is well known that non-monetary valuations are challenging, as they rely on qualitative (potentially subjective) impact of data. In her landscape of methods for data valuation, Slotin[42] has the merit of looking beyond financial methods (cost-, market- or income-based) and to also introduce a class of methods which she refers to as "impact-based". Here the "value is determined by assessing the causal effect of data availability on economic and social outcomes, or the costs in terms of inefficiencies or poor policy decisions due to limited or poor-quality data". These methods rely on storytelling and are very context dependent, however if properly implemented they can show both human impact and return on investment.

In PISTIS, the improved methodology behind the FAIR Data Valuation Services will force data stakeholders to look beyond the monetary value of the data transaction in which they engage. The collection of context-specific information, the identification of data value networks[43] and the definition of goals for data collection will require data stakeholders to think in terms of the business value the data opens. From here, the next step is to perform the same exercise considering the societal or environmental impact. To achieve this, we propose an adaptation of the Big Data Management Canvas, as a tool to keep tabs on such impact and connect it to the quantifiable dimensions of data value.

There are a wide range of examples arising from the PISTIS demonstrations and these will be augmented as new stakeholders are attracted. Examples from the Athens Hub point to impacts such as that on congestion around the airports, the impact on time people are wasting in traffic, a better environment for travellers waiting at the airport, the impact of tourism over public services, local businesses and communities, impacts on noise levels and air quality, impact on road casualties and many more.

[41] OECD. (2013). Exploring the Economics of Personal Data: A Survey of Methodologies for Measuring Monetary Value (OECD Digital Economy Papers, No. 220). OECD.
[42] Slotin, J. (2018). What Do We Know About the Value of Data? Global Partnership for Sustainable Development Data.
[43] Attard, J., Orlandi, F., & Auer, S. (2017). Exploiting the Value of Data through Data Value Networks. Proceedings of the 10th International Conference on Theory and Practice of Electronic Governance, 475–484. https://doi.org/10.1145/3047273.3047299

13.5 The Eleven new Business Models

As referred to earlier In Chapter 11, Task 7.4 has to provide eleven business models. It is still premature to determine how best we should go about the evaluation of these novel business models, but by being closely involved in the planning for these, through workshops being held with the demonstration sites, a clear understanding of their aims and ambitions will emerge and shape the methods which we will utilise for their evaluation, which will be reported in D5.3.

A business model describes an organisation and how it functions to achieve its goals, such as profitability, growth, or social impact. It serves as a framework outlining how an organisation creates, delivers, and captures value. This includes the strategies, operations, and economic mechanisms that drive the business, and it identifies key components such as the value proposition, target customer segments, revenue model, cost structure, and resources.

We rely on a grounded cognition framework stressing that a successful business model must align with the needs and perspectives of various stakeholders. While business model concepts can be challenging to grasp, using specific tools called "boundary objects" (artifacts or tools that help bridge communication gaps between different stakeholders) can bridge communication gaps and help managers and their stakeholders. These objects serve as practical tools that enable stakeholders to interact with and understand complex ideas, using mechanisms like sensory experience, language, and cognitive processing. Moreover, feedback from stakeholders plays a vital role in shaping the business model's viability. Interestingly, this approach suggests that cognitive limitations, rather than hindrances, can stimulate business model improvements by highlighting knowledge gaps. It proposes a shift in how organisations should be evaluated, suggesting that business model coherence—rather than just competitive advantage—offers a more holistic view of an organisation's potential.

The PISTIS platform aims to facilitate interaction between data providers and consumers, creating value by making data accessible to users who can benefit from it. In this context, the business model of PISTIS involves the sharing, exchange, or sale of data between different parties.

The purpose of this research is to develop 11 distinct business models for organisations, with a focus on the three hubs of the PISTIS demonstrators: The 11 business models will not replicate the use-cases as several will share the same business model, giving us scope to use this process to enhance the exploitation potential and look at other sectors and cross-cutting opportunities.

This research initially aims to evaluate the current business models of each demonstrator, analysing how they create and capture value, and identifying any necessary changes to adopt the PISTIS platform. Additionally, the study will assess the business model of the PISTIS platform itself, exploring how developers and users can adopt it.

Data will be collected through interviews and focus groups with platform managers, data providers, and other stakeholders from each of the three demonstrator hubs. The goal is to gather insights into the business model dynamics, the role of technology, data governance, and partnerships within each industry. Key informants will be selected based on their knowledge of their organisation's current business model and the PISTIS platform. Once selected, potential interviewees will be contacted and provided with initial information about the study, including a list of key topics to be covered during the interviews. A semi-structured interview guide will be used to ensure consistency.

At the same time, the need to expand the reach of PISTIS into three or more new sectors will be considered. Synergies with the existing business models being developed may shape the choice of new sectors, particularly where the models overlap in new cross-cutting areas.

All interviews will be recorded and fully transcribed. The data analysis will involve summarising and structuring the qualitative content, with the initial coding scheme developed inductively based on theoretical considerations.

The findings will provide an overview of the current business models of the demonstrators, along with actionable recommendations for platform developers, policymakers, and organisations in the mobility, energy, and automotive sectors. These recommendations may include strategies for effective monetisation, regulatory compliance frameworks, and technologies that support data security and privacy in each domain.

13.6 INITIAL THOUGHTS ON HOW THE BUSINESS MODELS WILL BE EVALUATED

To evaluate a business model, one should examine its underlying cognitive schema, the attentional processes guiding its development and change, and the structural logic behind the design of activities and value creation. Identifying opportunities to shift the schema using executive attention and creative cognitive processes (analogical reasoning and conceptual combination) is crucial for fostering innovation.

Assessing a business model can be approached through the concept of **business model coherence** and the use of **boundary objects** to ground abstract concepts in the experiences of managers and stakeholders.

13.6.1 Business Model Coherence

To assess a business model, we will look at Business model coherence, which is the degree to which a business model aligns with the needs, expectations, and perspectives of both internal stakeholders (team members) and external stakeholders (customers, partners, investors). To assess coherence, the focus is on:

- Stakeholder Alignment: Check how well the business model addresses the needs, goals, and values of various stakeholders.

- Consistency Across Components: Evaluate how well the business model components (value proposition, target customer, channels, revenue model, etc.) fit together and reinforce each other.

Business model coherence is also shaped by how stakeholders communicate about the model.

- Social Mechanisms: Evaluate how discussions around the business model happen. Are there open dialogues, or do stakeholders feel alienated? Collaboration and feedback from various stakeholders can highlight areas for improvement.
- Language Mechanisms: Assess whether the language used to describe the business model is clear and shared across stakeholders. Misalignment in terminology could indicate a need for clarification or adjustment.

Business model coherence draws from both internal (team) and external (customers, partners, investors) perspectives. To assess the business model, gather both types of input to ensure a comprehensive evaluation:

- Internal Evaluation: How well does the business model align with the capabilities, resources, and strategy of the business? Is there a strong fit between the model and the business's internal goals?
- External Evaluation: How well does the business model align with market demands, competition, and customer preferences?

13.6.2 Boundary Objects

Boundary objects, as tools or representations of the business model, can be used to facilitate communication and understanding among stakeholders. These objects might include diagrams, prototypes, or documents that depict the business model. Assessing a business model can involve:

- Assessing Stakeholder Interaction with Boundary Objects: Evaluate how stakeholders interact with these representations. This includes how easily they understand the model, communicate about it, and identify gaps or incoherence.
- Using Mechanisms of Grounding: Boundary objects help ground the business model in sensory, social, emotional, and cognitive experiences. Consider how these mechanisms are being used to facilitate the understanding of the business model's effectiveness.

Cognitive Processing

- Intuitive Processing: This involves gut feelings or quick, subconscious evaluations of the model. For instance, does the business model "feel right" in terms of customer needs, market fit, or viability?

- Deliberate Processing: This involves more analytical thinking. Are stakeholders able to critically evaluate the business model, look at data, and assess it through discussions and detailed analysis?
- Look for Areas of Uncertainty: Are there aspects of the business model that remain unclear or underdeveloped? For example, are customers uncertain about the value proposition or the pricing structure?
- Explore Missing Information: What vital information or insights from stakeholders (customers, suppliers, etc.) have not yet been integrated into the model?

Finally, assess whether there are signals that the business model should be changed or pivoted. This involves evaluating if there is increasing ***incoherence*** in how the business model is perceived or if stakeholder feedback points to significant adjustments.

- Indicators of Incoherence: These might include frustration from customers or confusion from stakeholders, where the business model does not match expectations or market conditions.
- Feedback for Pivoting: If the business model does not seem to work as expected, consider feedback from boundary object interactions and cognitive processing. A pivot might be necessary if the current model lacks the potential for sustainable value creation.

However, there are aspects of the evaluation process with regard to the business models which will remain unclear until the models begin to take shape, although the principles set out above will provide the fundamental starting point.

13.6.3 Specific features of PISTIS which will further shape the evaluation process

We can also point to three aspects of the evaluation process which differ from a standard process.

Timescale

The nature of the task in creating business plans, which in normal circumstances would be evaluated once they were implemented fully, is different within a time-constrained project. The project will have finished before the business plans have the opportunity to be fully scrutinised as to their suitability. It seems more beneficial to the project to treat the evaluation of the business plans in a different way. However, it is customary to start with a qualitative analysis at the beginning as quantitative analysis is normally not so readily available at the start of the process, and this is pertinent to the PISTIS business models.

Costs and revenues

Business models need a prediction of revenue. One aspect of Task 5.7 is: “Evaluation will also pay special attention on assessing the cost-efficiency and viability of new business models developed by the project in WP7.” Similarly, an expectation from WP7 is that ”resources and

costs associated with the deployment and usage of PISTIS in all the demonstrators and therefore costs to implement the selected use cases." The focus for PISTIS is to be able to determine more accurately the value or data, and without that missing ingredient, inputs will be less clear. But hopefully this will enhance the likelihood of having more realistic financial projections.

Dual functions of T5.7

Two aspects of task 5.7 overlap- the need to improve the demonstrations to ensure business success, whilst at the same time evaluating the business models designed to achieve that success. Questions posed regularly in relation to evaluating the business plans, will have two functions. One to assist in the evaluation process and the other to determine how to improve the business plans alongside improving the demonstrations themselves and thus increasing the likelihood of a successful exploitation stage.

In such a context, a business plan could also be viewed as a Theory of Change covering the business model and its implementation and to understand what is expected and what steps need to be taken. Questions will also be raised concerning the topics of importance to PISTIS, covering sustainability, legality, ethics, security, risk analysis etc. The whole concept is based around communicating an idea or a strategy and the process will be equally valuable in dealing with new stakeholders as well as the existing ones.

13.7 MONETISATION AND SMART CONTRACTING

As with the evaluation of the proposed new Business Models, any attempt to determine the evaluation approach in detail will be in no way better placed than at the proposal stage and would be theoretical. Exposure to the evolution of the contracting mechanisms and with that, the approach to monetisation, will bring about the opportunity to understand contracting and monetisation in a PISTIS setting and enable the optimum direction to be taken for evaluating progress made.

The methodology implemented by the PISTIS FAIR Data Valuation Services, will support the evaluation of the Platform as a whole. Thus, the transaction amount, on one side, will reflect the actual investment in a data asset. At the same time, the collection during the early stages of data valuation of information related to the purpose of the data acquisition will reflect on the kind of technical or business outcomes that the data transaction should enable. Finally, these will be better detailed as part of information artefacts produced during data valuation, such as the Big Data Management Canvas[44], which will allow prospective consumers to connect the actual investment – transaction value, technological effort – to a fine-grained impact over different aspects of its business.

[44] Kaufmann, M. (2019). Big Data Management Canvas: A Reference Model for Value Creation from Data. Big Data and Cognitive Computing, 3(1), Article 1. https://doi.org/10.3390/bdcc3010019

One of the focal points for influencing policy (discussed below) lies in influencing the Data Act and at M33 as the Beta version emerges, the recommended model contractual terms (MCTs) for data sharing (including access and use) and standard contractual clauses (SCCs) for cloud computing and other data processing services will be available.

13.8 ENVIRONMENTAL IMPACT

In the PISTIS Theory of Change it is anticipated that by providing a "low-energy and resource-friendly infrastructure for data management and contract enforcement", a societal impact will be that there will be increased trust in renovated data spaces regarding security, privacy and IPR safeguarding, and a decrease in resource utilisation and emissions. In turn, the stated goals including contributing to a growing data eco-system and creating new eco-systems will be achieved.

Measuring the environmental impact of a product or company is a complex task. Whilst it is not possible and not within the scope of PISTIS to precisely evaluate the project's environmental impact, such as the energy consumption required and foreseen for running the various products and/or business models in different eco-systems arising from the project, we set out below the approach we will take to demonstrate the overall positive effect which PISTIS will have upon the environment and sustainability, whilst considering the effect of the PISTIS platform itself. This will be elaborated in the period prior to the Beta version release and key indicators will be determined at that point.

Here we can provide the background as to how and what we will be evaluating with regard to the environmental impact of PISTIS. With the launch of the Beta version, much more becomes possible with the anticipated influx of new stakeholders, with a criteria for selecting some of them being their current expertise in these matters. Any pre-planned environmental benefits expected by the demonstrators will be augmented with the availability of new sources of data as the demonstration activity is strengthened. More knowledge on non-monetary values of data will have been gained to bring to the discussions. The Living Labs will provide further inputs.

The use of AI, as well as the conceptualisation of PISTIS as a federated infrastructure, which means reusing already established data and computing infrastructures owned by the stakeholders, as well as the selection of resource-respective DLT technology with zero energy consumption consensus mechanisms (going away from Proof of Work or Proof of Stake methods), will also have a direct contribution into building more environmentally friendly services, in line with the principles of the EU's Green Deal, but at the same time guaranteeing the robustness, efficiency and effectiveness of the overall infrastructure. A significant achievement in 2023 was the development and implementation of a science-based methodology for measuring the net environmental impact of digital solutions, facilitated through the European Green Digital Coalition.

Moreover, the utilisation of low-energy consuming technologies, like novel DLTs with almost zero energy footprint for their consensus tasks provides a safety barrier for the project in case legislation puts obstacles in the utilisation of energy-hungry blockchains.

We can look at the environmental aspects of PISTIS in several ways and these are set out below.

13.8.1 Minimising the environmental effect of the PISTIS platform

As part of the PISTIS project's remit, we are utilising low-energy and resource friendly infrastructures for the data management and contract enforcement, utilising a low-energy blockchain infrastructure. This will effectively decrease subsequent PISTIS end-user resource utilisation and emissions for those thus adopting PISTIS. Experience will be gleaned from the EUDATA+ sister projects in the drive to minimise the environmental effect of the platform-potentially utilising the enRichMyData tool [45], which monitors and reduces energy consumption estimating and tracking carbon footprints.

But the key starting point is the recognition that data is a non-exclusive good and can be utilised *ad infinitum* within the right circumstances and it is these circumstances which PISTIS is striving to provide.

13.8.2 Examining the environmental impact at the demonstration sites.

We can look at how the demonstration partners themselves can benefit in sustainability terms through use of the platform. Each hub can readily provide details of how they anticipate environmental gains in their activities and with the release of the Beta version, further benefits should be identified.

Energy Hub

As of today, there are no solutions in the market that integrate as many sources as possible of data, not only energy-related but also from other fields, to support their transaction along with a variety of tools for their processing. Therefore, it represents the ideal synergy between the technology that can drive flexibility markets and the exchange of energy data and the visibility of the platform, as it technologically supports significant changes in the electricity markets.

At present, and at a national level, discussions are underway not only about how flexibility markets will be structured, but also about the necessary elements for coordination and data management. In this regard, PISTIS addresses one of the most pressing needs: providing a centralized coordination point where all market participants can connect and interact efficiently.

Grid bottlenecks are emerging as a major challenge in the energy transition, already slowing down the expansion of wind and solar power in multiple European countries.

[45] Home - enRichMyData

The energy transition towards renewables requires additional flexibility options in the electricity system, to coordinate resource-dependent generation and demand. The management and control of this flexibility needs an advanced digital ecosystem for the communication between organisations and devices. The Common European Energy Data Space will facilitate the participation by flexible energy resources as set forth by the EU action plan on digitalising the energy system. Its presence can only be advantageous to PISTIS and in its contributions to sustainability.

DATA CELLAR[46] and OMEGA X[47] are also projects to investigate within this eco-system.

DATA CELLAR aims to create a federated energy data space that will support the creation, development and management of local energy communities in the EU whilst OMEGA X is addressing the current problem of low availability of data for innovative uses in the energy sector and beyond. OMEGA-X will collaborate with stakeholders to identify where energy-based service improvements and innovation are required, and how OMEGA-X could potentially be used and adopted to address these needs. UPCAST[48] has contributions of value.

Automotive Hub

The automotive demonstrator hub will support environmentally friendly, safe, and efficient mobility and transport, whilst directly promoting the European Green Deal. In a second activity, the data is also used for driver coaching, applying gamification approaches such as awarding points or ranking drivers according to their personal driving style to create competition for the most environmentally friendly and safest drivers. The data will be used to provide concrete data-driven services to individual drivers (driver coaching), businesses (corporate mobility management for green driving), and public administrations (urban emission modelling). All of which make direct contributions to sustainability in themselves.

TRAFFICON designs initiates and realises dynamic traffic solutions with state-of-the-art technologies and adaptable components, aimed towards easing the pressure on urban areas and promoting environmentally-friendly mobility.

There is no event-based driver risk assessment available on the market that integrates a variety of historic and current data sources. The availability of such a system (as will be developed in this use case) will make a significant contribution to the EU Road Safety: Towards Vision Zero program.

Finally, the use of AI, as well as the conceptualisation of PISTIS as a federated infrastructure, which means reusing already established data and computing infrastructures owned by the stakeholders, as well as the selection of resource-respective DLT technology with zero energy consumption consensus mechanisms will also have a direct contribution into building more environmental-friendly services, in line with the principles of the EU's Green Deal, but at the

[46] www.datacellarproject.eu
[47] www.omega-x.eu
[48] https://www.upcast-project.eu/

same time guaranteeing the robustness, efficiency and effectiveness of the overall infrastructure.

Aviation, Mobility and local economy

As with the automotive hub, re-use of data in a federated infrastructure, as well as the selection of resource-respective DLT technology will also have the same environmental benefits, as will the collaboration help in fostering a culture of data sharing and interoperability, contributing to a more integrated ecosystem for airport and urban operations. It is anticipated that there will be a move towards more sustainable operations due to this enhanced efficiency and resource utilisation.

In relation to its ESG[49] performance, Athens International Airport is already in line with industry standards and best practices and seeks to maintain its position as a low-carbon frontrunner. The sustainability strategy of Athens airport is subject to periodic review to ensure optimal integration of all aspects of the Airport's operations and its stakeholders' interests.

Establishing a balanced business model is at the core of Athens International Airport's approach to sustainability. Within this framework, Athens International Airport has assessed its economic and social footprint in terms of its contribution to the GDP and to employment on a national and regional level.

Emissions data is also an opportunity as passengers are becoming more environmentally sensitive. Companies like Skyscanner have implemented a green choice policy[50] informing passengers of flights to their destination that are at least 6% more environmentally friendly than others. So, when a visitor to the Skyscanner website searches for flight options they are labelled with a green leaf if they are a more environmental choice. There are passengers committed enough to the environment to pay a premium fee for having a less negative impact on the environment. Offsetting passenger carbon emissions is also a hot topic at the moment, and thus, an opportunity.[51]

13.8.3 Contributing to existing environmental eco-systems

The DoA also specifies that the evaluation framework should also focus on defining additional quantified KPIs in the environmental sphere to help enable the holistic assessment of the project impact per demonstrator hub, such as contributing towards the European Green Deal Strategy and the EU's commitment to global climate action for the Energy hub.

IDC a partner in the Green Deal Data Space Project. The GREAT[52] project, funded by the EU's Digital Europe Programme[53] which aims to establish the *Green Deal Data Space*

[49] ESG performance measures how well a company upholds environmental, social and governance values.
[50] https://www.skyscanner.net/environment
[51] https://www.skyscanner.net/environment
[52] Home - GREAT Project
[53] https://digital-strategy.ec.europa.eu/en/activities/digital-programme

Foundation and its Community of Practice which builds on both the European Green Deal and the EU's Strategy for Data. The project will deliver a **roadmap for implementing and deploying the Green Deal Data Space**, an infrastructure that will allow data providers and initiatives to openly share their data to tackle climate change in a multidisciplinary manner.

The Green Deal Data Space is designed as an open ecosystem for resilience and sustainability and is geared towards optimising the circular economy and transparency of supply chains.

In the exploitation strategy already set out in D7.2 attention is already drawn to the potential of Sustainability Tracking: Exchanging data related to resource use and environmental impact with regulators and sustainability auditors to ensure compliance with environmental regulations and improve energy efficiency. Practical use-cases can deal with the problems of supply chains and emissions data that will soon have to be reported and which PISTIS should be able to help with.

Earlier, we have identified some of the wide range of potential collaborators, many of which will have involvement in environmental initiatives, which can benefit from Pistis outputs.

13.9 Smart Cities: Mobility and Urban Planning

Already a core of use-cases within the PISTIS demonstrations can contribute directly to enhancing Smart Cities, particularly in Mobility and Urban Planning. Collaboration with the other hubs may result in a cross-use of developed artifacts from the use cases (e.g., a traffic risk manager operating in a city may use parts of the automotive hub solution tested in Graz and Frankfurt.)

With the Beta version available, new stakeholders can include additional smart cities, those providing project results from sister projects, such as UPCAST which deals with the city of Thessaloniki, and newly identified projects chosen for specific purposes in addition to those selected from a basic exploitation perspective.

Similarly, new data sources can be sought to increase the PISTIS potential, not in purely economic terms, but in social and environmental terms.

One of the biggest hurdles in sustainable urban planning has been the lack of direct access to environmental data at a local scale. Vast amount of information are available such as that collected by Copernicus, the Earth Observation component of the EU Space Programme. This can support urban planners with spatial planning related to land use and transportation, but also with planning activities related to climate change adaptation and mitigation at neighbourhood scale. The CURE project is an example.[54]

The Earth Observing System Data and Information System (EOSDIS) is a data-sharing initiative by NASA that manages and provides access to Earth science data from various satellite

[54] http://cure-copernicus.eu

missions. This initiative facilitates the utilisation of crucial environmental and climate data by scientists, researchers, and the general public, enabling them to conduct scientific analyses and research in these fields.[55]

Smart City Athens is already recognised as one of the EU's 100 Net-Zero cities, which are being promoted and funded to reach net zero as lighthouses.

The city is moving towards climate neutrality through initiatives that include indicatively, the upgrade of municipal buildings in terms of energy efficiency and energy consumption. Also the first superblock of Athens is currently implemented under the Net Zero Cities project ASCEND.[56]

13.10 OTHER ECO-SYSTEMS

As the project matures, more eco-systems which the PISTIS use-cases belong to and can both contribute to and derive benefit from, will be added to the list of potential stakeholders. Examples include eco-systems involved in sustainability and environmental issues, with the weather aspects of PISTIS being a solid entry point.

More specialised eco-systems can also be identified, such as covering all airports.

The existence of specific data spaces will also act as a catalyst to consolidating the role for PISTIS and for developing new eco-systems.

13.11 PLANNING FOR THE SUSTAINABILITY AND ENVIRONMENTAL EVALUATION

With the arrival of the Beta version, the detailed plans which will be produced in the interim period will be implemented and this will be subject to an overall impact assessment and evaluation of PISTIS. We will ensure that the approach to the environmental issues will be included in the deliberations.

We will be able to utilise a variety of sources for contributions to the evolving strategy.

These will include:

- Specific discussions within the PISTIS Living Lab programme
- Input from the Lessons Learned and Business Strategy interviews with partners
- Inputs from the EUDATA+ partners
- Input from new stakeholders, specifically targeted for their expertise in such matters
- General desk research

[55] Earthdata - NASA - Open Science.
[56] https://netzerocities.eu/athens-pilot-activity-ascend/

Detailed planning will also embrace the environmental strategies and measures for compliance with all legislation for the entity which will take PISTIS forward, taking into consideration of the partner's existing strategic environmental planning.

PISTIS is fortunate in having access to advice from a global leader in developing environmental strategies, with ATOS being a partner and expert in Sustainable Digital Transformation.

Businesses active in various sectors set themselves a measurable sustainability target. It is important to follow this up with a strategy that clearly describes priorities that are made and actionable steps that are taken to improve the environmental and societal impact. It is imperative to address sustainability issues and challenges and work towards long-term success. Demonstrating sustainable practices has become essential to continue being relevant and strategically competitive in the current dynamic world. And this will equally apply to whatever company structure established to take forward PISTIS.[57]

The components would include the following:

- Strategy development and Roadmap, including science-based net-zero targets aligned to the Science Based Targets initiative.
- Risk & Scenario Analysis
- A plan to assess the physical and transition risks faced by a company and support development of mitigation strategies.
- NetZero Transformation to adapt organisations to be able to work towards achieving net-zero emissions.

All the above will be reported in more detail in D5.3.

13.12 SOCIAL IMPACT OF PISTIS

In the coming period, the social impact of PISTIS will also come into scrutiny and the first steps will be taken as to how best to record and evaluate what impact there may be.

In scrutinising the non-monetary value of data as set out in section 13.3 above, we open up many areas where there will be social benefit arising from our work, We have touched on environmental benefits etc elsewhere. There we will be contributing in terms of addressing "data for the public good".

The impact-based approaches show the strong role of storytelling in promoting value. Ultimately, demonstrating the relationship between data investments and outcomes that affect people's lives is what resonates best. Their most significant drawback is context specificity, which can limit their influence. However, strong illustrative cases that policymakers can relate to on a human level may still be most influential. If it is possible to show both the human impact and the return on investment, we may have a winning combination

[57] *https://eviden.com/solutions/sustainability/strategy-and-advisory/*

The impact-based approaches are easier to understand and communicate. By linking to real-life outcomes, they show how investments in systems can translate into meaningful impacts. They can also show that while investments in systems may take longer to bear fruit, they are foundational to the realisation of so many other goals.[58]

The public good character of open data, and the network effects of the positive externalities that arise as data is combined with other data, means increasing access to data will increase its societal value.

Bringing non-monetary values into consideration provides a tool to consider the social impacts of PISTIS and its effect on sustainability and the environment etc.

- Building from the existing Environmental Impact strategies of the PISTIS partners.
- Focussing on the environmental footprint of the PISTIS Platform technology.
- Scrutinising the environmental benefits of utilising PISTIS within the demonstration settings.
- Scrutinising the overall potential impact with wider stakeholders' involvement and exposure to more eco-systems.
- Linkage with relevant significant EU environmental initiatives.

13.13 INFLUENCE ON POLICY

It has been acknowledged that PISTIS is well-positioned to influence Data policy in EU by contributing to the development, implementation, and adjustment of Data policy measures through the delivered work. PISTIS contributes to "Europe for the Digital Age" with an essential contribution to data management and the data sharing ecosystem by providing a framework for enterprises and SMEs to trade, manage and share and monetise data in a private, secure manner. Indeed, PISTIS is the acronym for "Promoting and Incentivising Federated, Trusted, and Fair Sharing and Trading of Interoperable Data Sets."

PISTIS centres around the Digital Decade Policy Programme 2030, which guides and gives direction to the EU's digital transformation and sets up a monitoring and cooperation mechanism to achieve the common objectives and targets for Europe's digital transformation. Also, with the growing convergence of data and the environment in terms of policy goals, contributing to the Green Deal is made easier. The Digital Decade sets out concrete targets and objectives and provides a governance framework and mechanisms for collaboration, both between the Commission and Member States and among Member States.

[58] Slotin, J. (2018). What Do We Know About the Value of Data? Global Partnership for Sustainable Development Data.

It focuses on four main points, accompanied by a monitoring process with all four being pertinent to PISTIS with opportunities to use the projects experience to help monitor and influence the policy making process:

1. A digitally skilled population and highly skilled digital professionals
2. Secure and sustainable digital infrastructures
3. Digital transformation of businesses
4. Digitalisation of public services and digital transformation of the public sector.

A framework was set up to track progress and to make adjustments at the national and EU level and the reporting process includes providing recommendations for further actions and efforts. The process also includes national roadmaps, with recommendations to address existing gaps. Member States update their national roadmaps by reviewing and adjusting planned actions, measures, and investments, taking into account the Commission's recommendations and other inputs.[59]

Of interest to PISTIS is that the Commission will also start preparing the review of the Digital Decade policy programme, foreseen for June 2026.

13.13.1PISTIS influence on the Digital Decade

This section points to how we are pursuing this objective of influencing policy making in the PISTIS project. The intention is two-fold: To contribute to policy making through feeding back our experiences and observations in carrying out the project and also to encourage take-up of existing policy driven initiatives through providing exemplars.

However, the project is in a privileged position in its ability to influence policy. It is not an outsider trying to make its voice heard, but an insider within a movement which itself is a direct result of earlier policies being adopted from previous experiences of projects like PISTIS. Indeed, PISTIS itself cites numerous projects on which it has been built upon. And in this situation, we have a direct audience within the EU who are organised to gather feedback and to pay attention to the results of the work they themselves have instigated and to determine how these results may affect what happens next in policy terms.

A policy maker, or policy actor, is a broad term that covers different people responsible for formulating or amending policy. Mapping out the relevant stakeholders is part of understanding the policy landscape with which we want to engage with. And along with knowing who we want to engage with is also planning when and how it should be done.

Many researchers have strong incentives to influence policymaking and recommendations as to how to approach this have been suggested following a systematic and synthesised scrutiny

[59] https://ec.europa.eu/newsroom/dae/redirection/document/106687

of the existing literature. This has been, the 'how to' advice in the academic peer-reviewed and grey literatures.

This advice[60] has been condensed into eight main recommendations: (1) Do high quality research; (2) make your research relevant and readable; (3) understand policy processes; (4) be accessible to policymakers: engage routinely, flexible, and humbly; (5) decide if you want to be an issue advocate or honest broker; (6) build relationships (and ground rules) with policymakers; (7) be 'entrepreneurial' or find someone who is; and (8) reflect continuously: should you engage, do you want to, and is it working?

The overall dissemination objectives are designed to ensure the long-term impact of the project results on the target audience toward improving European leadership in the global data economy. WP6 recognises that this aspect is the most ambitious target of dissemination: it focuses on delivering key messages to key decision and policymakers so that the PISTIS findings and results are taken up and have an impact on future policies or practices.[61] Significant attention is paid to this in D6.1 and D6.2.

The ambition set out in this deliverable in the case of policy makers is that: "They will be provided with evidence based on the project's impact assessment of how the PISTIS paradigm delivers benefits at multiple levels for the data economy and for the society, putting them in a position to better understand and promote regulations to further strengthen the EU's innovations capacity and promote the adoption by the Member States and companies of a fairer, performant, greener, smarter and trusted data management environment that relies on EU Data Spaces."

13.13.2Dissemination towards the European Commission

Institutional EU websites will be used to promote the project results at European level to policy makers, researchers, and a vast variety of experts. The Consortium plans to appear at least twice on one of the following channels:

- Horizon Magazine: the EU research and Innovation Magazine spreading the latest news and features about science and innovative research projects funded by the EU
- Research and Innovation Success Stories: a collection of the most recent success stories from EU-funded Research & Innovation
- CORDIS (Community Research and Development Information Service): European Commission's primary public repository and portal aimed at disseminating information

[60] International Network for Governmental Science Advice <https://ingsa.org/resources/oliver-2019/>

[61] D6.2 - Dissemination Activities Report, Training Material and MOOC - First Report

on EU-funded research projects and their results. This will also include the CORDIS News and Events and CORDIS Wire.

The use of these channels is coordinated with the European Commission, asking for support – if needed – to reach and interact with the channel "owners".

We will also monitor the currently open consultations launched by the EU.[62]

Section 4.1.1.11 in D6.2 reports on progress up to M21 in the European Commission channels and by collaborating with the Project Officer, the Consortium is continuously seeking opportunities to be promoted through these European Commission's channels and events.

However, a major impediment to ascertaining the success of our endeavours is that much of the effect on policy will not be obvious until after the project has been completed.

13.13.3Expert Group of European Commission on Data Sharing & Computing Continuum

One very direct measure in establishing how we can affect policy lies in the activities of Expert Group of European Commission on Data Sharing & Computing Continuum (Article 41 Data Act). Consortium member Arthur's Legal provides an Expert to this group and hence PISTIS has a direct channel to feed viewpoints into the group.

The outcome will not be a Directive- but a set of guidance for what should be in contracts. Before the Data Act starts to applying from 12 September 2025, the Commission will recommend model contractual terms (MCTs) for data sharing (including access and use) and standard contractual clauses (SCCs) for cloud computing and other data processing services.

These models intend to help organisations, public and private, big and small, that may lack readily available knowledge and other resources to draft and negotiate out fair contractual clauses for data sharing or for cloud computing. [Art. 41: Model contractual terms (MCTs) and standard contractual clauses (SCCs)]

This timing will coincide with the launch of the PISTIS Beta version and its requirements for using smart contracts. The Commission (alongside the Expert Group and various other stakeholders) is currently in the process of finalising the model terms which is followed by internal review and sign-off processes within the Commission; these are envisioned to be formally published in Summer 2025. Hence, whilst the PISTIS smart contracts will certainly leverage the findings of the Expert Group and be drafted in line with the most recent best practices in this area, they will not necessarily be based on the Data Act model terms, as such, the decision-making process in determining them should throw up further useful insights.

Already, input has been provided to the process. In November/December 2024, the Commission has hosted a Series of Webinars with businesses, policymakers, lawyers, and

[62] Have your say - Public Consultations and Feedback

experts discussing the development of the drafts Standard Contractual Clauses for cloud computing contracts and Model Contractual Terms for data sharing. So, some interim drafts have been shared with those participants and commented upon.

13.13.4Policy at other levels

Above we have discussed contributing to policy at the EU level. Individual partners may have the opportunity to contribute at their respective national levels. However, the demonstration activity provides opportunity to contribute at other levels.

At the "smart city" level, great emphasis is played on having exemplars and best practice to follow. The current drive is to establish 100 Net-Zero cities[63] to be provided with additional resources to make real progress which can be emulated more widely across the EU. It is not just the city of Athens which is in a position to influence this movement, being a net-zero city itself, other use cases covering smart city solutions involving urban planning, mobility, energy, safe driving etc. can also contribute through this channel.

However, the reality though is that policy making is inherently messy. An appreciation of this complexity and that policy making will probably occur at different timescales to that of PISTIS can help us be proactive and to spot the opportunities to know when to engage.

Understanding the policy process comes down in the end mainly to an appreciation that it is infinitely variable and contingent, that this interplay of factors is happening, and that it is essential to be responsive to this, to work within this complex system and its emergent features, and to try to sense how the dynamics are playing out.[64]

Our work involving SMEs, particularly through the Living Labs may also contribute to European Data Union Strategy in drawing upon "existing data rules to ensure a simplified, clear and coherent legal framework for businesses and administrations to share data seamlessly and at scale, while respecting high privacy and security standards." Our interactions will take place with them within this framework.

At the demonstration level, the automotive hub as well as being able to make a significant contribution to the EU Road Safety: Towards Vision Zero program, it will also support environmentally friendly, safe, and efficient mobility and transport, directly promoting the European Green Deal.

This too will be a focus for the Energy Hub as it will contribute towards the European Green Deal Strategy and the EU's commitment to global climate action.

[63] Home - NetZeroCities

[64] Guidance note 2: Understanding the policy process | University of Oxford

14 USE OF THE PISTIS THEORY OF CHANGE

A **Theory of Change** explains the links between activities and outcomes and how and why the desired change is expected to come about, usually based on past research or experiences and in this instance, the thinking behind the evolution of the PISTIS project, brought together in the DoA.[65]

A definition is that a Theory of Change evaluation "*involves the specification of an explicit theory of 'how' and 'why' an initiative might cause an effect which is used to guide the evaluation. It does this by investigating the causal relationships between context-input-output-outcomes-impact in order to understand the combination of factors that has led to the intended or unintended outcomes and impacts.*"[66]

There is a difference in the use of the PISTIS Theory of Change from the time it is being developed as a tool for shaping the evaluation process, to when the evaluation process has started. At the design stage, it helps formulate the questions to focus upon. But at the evaluation stage, its focus shifts and one aspect of this can be seen in its use to inform the evaluation criteria. Questions can be raised which help address the topics listed above and those raised by stakeholders.

At this stage of the project, there is a need to see if any changes need to be made to the planned activity, to either compensate for problems arisen or to improve the eventual outcomes. Part of the Theory of Change is to check that it still holds true and what may need to be adapted to meet changing circumstances and as a result of interactions with stakeholders.

In general, and at the highest level, we can say that our Theory of Change model is based on the logic of the DoA. Our work will have three outcomes:

- We will provide mechanisms for stakeholders to have greater control of their data.
- We will provide tools and technical support to improve the data industry.
- We will provide a catalyst effect on the data eco-system.

These will combine to create a data-sharing culture, enhancing the EU Data Eco-system and supporting the evolving Data Spaces. In turn, this will all contribute to achieving the following goals:

- Growing the Data Market

[65] See D5.1, Chapter 3. "PISTIS Theory of Change and Logic Models" sections 3.2 and 3.4. The PISTIS Theory of Change itself is represented in Appendix 3 of this document. whilst section 4.2 in D5.1 covers the use of the Theory of Change to inform the evaluation questions.

[66] I. Vogel, "Review of the use of 'Theory of Change' in international development Review Report," [Online]. https://assets.publishing.service.gov.uk/media/57a08a5ded915d3cfd00071a/DFID_ToC_Review_VogelV7.pdf. [Accessed 13 May 2021].

- Growing the Data Economy
- Improving the Data Industry
- Contributing to a growing eco-system
- Creating new data eco-systems
- And in the process, contributing to EU Policy and Strategy and sharing knowledge generated.

Simply put, theories of change explain how the project is expected to bring about the desired results rather than just describing the results.

Theory of Change at the evaluation phases

Scrutiny of the PISTIS project at this stage of the project should embrace the following aspects of the Theory of Change.

1. We should re-scrutinise the stated expected impacts from the project derived from the project purpose or goal / objective statement, which should be comprehensive, with all the main causal pathways being represented and the causal linkages between results made explicit.
2. Where necessary, intermediate results should be added where the 'leap' from one result to another misses out important intermediary steps. Most frequently, these will be 'intermediate states' between direct outcomes and impact. For example, several of the contributions to creating a data-sharing culture in the EU require more detail in how they will be achieved, which would not have been possible without gaining the experience of working within this environment over the last two years. For example, "Creating new data eco-systems" and in the process, "contributing to EU Policy and Strategy".
3. Any missing stakeholders involved in the change processes need to be identified as well as how they affect or are affected by the changes. With the approaching release of the Beta version, which will be of tangible interest to outside stakeholders, these potential early adopter for PISTIS are being identified and approached. An extended range of additional projects from which PISTIS may benefit if cooperation takes place, is being drawn up in the period leading up to the Beta version release.
4. Finally, it should be measurable. The Theory of Change should present (or clearly reference) indicators for the direct outcomes and, ideally, for the intermediate states and impact in the main causal pathways. Again, this would have been guesswork at the outset of the project, but now additional targets can be set and new KPIs added.

It is fair to say that the overall PISTIS Theory of Change still holds true. Some stakeholder feedback, particularly from reviewers alongside developments in the overall EU Data Landscape has provided additional opportunity to focus planned activities and go into more detail with some aspects of the project to help achieve our goals.

The Theory of Change has been scrutinised at evaluation stage with the following topics being considered in finessing the evaluation criteria.

Strategic Relevance. We concluded that the project still meets the needs of the EU and what lessons learned may be of value to it with the review process backing this up - "the proposed pathway to achieving the expected outcomes and impacts remains credible across scientific, economic/technological, and societal dimensions."

We anticipated that at this stage of the project, set out in D5.1, that we would need to ask such questions as "How do we meet the high-level policy goals promised in the DoA? Are we contributing to such concepts as the European Data Strategy objectives and especially European Common Data Spaces as the project call is built around these concepts?"

Quality of Project Design. How well are stakeholders being involved in the project design processes? We need to verify whether key stakeholders are being properly identified and provided with opportunities how different stakeholders can affect or be affected by project results. We are entering the Beta stage of the project where such scrutiny and direction will be vital.

Effectiveness: Achievement of outputs. While the assessment of achievement of outputs should cover all the PISTIS project's outputs, as set out in the DoA, and those outputs added to by possible project revisions, it will be impossible to assess all project outputs with the same level of detail. The Theory of Change at the evaluation stage can be used to determine which project outputs are most essential for achieving the project's direct outcomes. The assessment of the achievement of outputs can then focus on the most critical outputs and verify whether these meet the requisite characteristics and quality as set out in D1.3.

Achievement of direct outcomes. Direct outcomes are defined here as changes resulting from the use of project outputs by key stakeholders. The direct outcomes of the project are expected to result directly from the outputs, so the accountability of the PISTIS project team for their achievement is high. Outcomes are often changes in capacity and behaviour at the individual, industrial and institutional levels and this will hold true for PISTIS.[67] Whilst it is impossible to assess in detail many of these outcomes, a set of priorities is being drawn up in readiness for the final evaluation of PISTIS and emphasis will now be placed on those impacts identified as being the most significant from the stakeholder perspective.

Internal logic of the project and its Impact.

The PISTIS Theory of Change at the evaluation stage can be used to assess the internal logic of the project. The evaluation will also verify whether the project outputs are logically connected (from cause-to-effect) to the intended direct outcomes. It can also be used when assessing the extent to which direct outcomes have been achieved and whether all necessary drivers and critical assumptions have been adequately considered and also to be used to assess whether the direct outcomes are logically connected along the various causal pathways to the

[67] United Nations Environment Agency, "evaluation-criteria-and-ratings," [Online]. Available: https://www.unenvironment.org/about-un-environment/evaluation-office/our-evaluation-approach/evaluation-criteria-and-ratings. [Accessed 21 JAN 2021].

intended impact. It is in this aspect that adding extra steps into the causal links will help determine activity to ensure everything expected to happen, actually does happen.

Catalytic role, replication and scaling-up. For assessing the replication potential and the roadmap to take-up of the project, using the PISTIS Theory of Change, the evaluation will focus on those direct outcomes, drivers and assumptions that are most necessary for replication and take-up of project results.

Thus, it can be checked to see whether replication and up-scaling have been built into the causal pathways and whether the necessary drivers and assumptions promoting replication and take-up have been adequately considered in the project's intervention logic. It is expected that those most valuable in this process towards sustainability will be present and playing their role in further take-up of the projects results. The reliability of this assessment can be enhanced by looking for early evidence of replication or up-scaling during the project lifetime.

Paramount in this aspect is the evolution of the business models from Task 7.4 and the Theory of Change will be a factor present in the shaping of these business models and the response to areas identified as being the most promising for sustainability being focussed upon.

Sustainability. The assessment of sustainability is concerned with verifying whether the necessary conditions are in place for the continuation of the project benefits after PISTIS has ended. The Theory of Change during the evaluation process can be used to inform an assessment of whether sustainability has been built into the causal pathways and whether the necessary drivers and assumptions affecting sustainability have been adequately considered in the creation of the project's intervention logic and subsequently translated into action during the implementation phase.

Formulation of recommendations to enhance replication. The Theory of Change can now also be used in offering a 'prediction' of how the project might be adjusted to maximise results in a different implementation settings. This is where demonstrations morph into the basis for a spreading eco-system and raises questions of how we can engage with wider evolving eco-systems. Initially the PISTIS demonstrators were in isolation. How well they are integrated into wider eco-systems will become another indicator for success. Considerable progress has been made in this respect.

Ethics self-evaluation. The PISTIS Theory of Change at evaluation has the demonstrators utilise the PISTIS Data and AI Risk Assessment Framework defined in D9.1 – OEI Requirements No.1, in their risk assessment in relation to the ethical and legal issues associated with the use of the specific features of PISTIS platform in the context of Business to Business data sharing and monetisation in each demonstration hub, and eventually to enable the demonstrators and technical partners to develop and implement necessary technical and organisational measures to enhance the project's compliance with the legal requirements and the ethical principles identified in D1.1 - PISTIS Operation Principles and Context Detailing which will complement the project legal and ethics monitoring activities carried out as part of Task T8.4 - Project Legal and Ethics Requirements Management. The results of the alpha stage assessment can be seen in Table 5 in section 2.1 above.

Stakeholder participation and cooperation. The PISTIS Theory of Change at the evaluation stage can verify whether it includes a satisfactory approach for sharing information and encouraging cooperation with partners, national/local project stakeholders and other EU projects and programmes once the demonstrations have started. In using the Theory of Change at the evaluation stage, stakeholder analysis should assist not just in the identification of the key stakeholders, but also their respective roles, capabilities and motivations in each step of the causal pathways from activities to achievement of outputs, direct outcomes and intermediate states towards impact. As the project matures, the importance of interacting with the existing stakeholders and bringing on board new stakeholders will increase.

15 OVERVIEW OF THE ALPHA VERSION EVALUATION AND CONCLUSIONS

This final chapter provides an overview of the feedback and observations which were gathered during the evaluation period which ran between M24 and M28.

We are satisfied with the evaluation results gained from implementing the Demonstration and Evaluation Plan, which was set out in D5.1. We have successfully tested the PISTIS Alpha version which was designed as a working prototype to be tested internally, in order to evaluate the core functionalities of the system, as were identified in WP2 and WP3.

A general definition of what an alpha version in software development constitutes, is that it is an early, pre-release version which will usually not include all planned features and which may still contain bugs, as it is not intended to be tested by the public, but as set out in the DoA, by a limited group of internal testers associated with the demonstration sites and who were familiar with the overall project.

This is in contrast to the effort to be undertaken in ensuring a much wider testing base and with regard to the enhanced features which will be available, for when the evaluation of the Beta version commences with its availability at M33. And the much wider scope for its evaluation.

Although the Alpha version is a low fidelity prototype, aimed to interconnect the different components to implement the basic data marketplace scenario in which one organisation offers a dataset in the csv format, another buys it and the data get delivered, the underpinning concepts and the focus for the project remain the same throughout the project.

The demonstrators have achieved all that they set out to achieve in this phase of the project and have created firm foundations for addressing the implementation of the Beta version of the platform at M33. Below, we reflect on and summarise the results which the project has achieved so far. It can be said that all is well-prepared for the next phase which is on schedule as planned.

15.1 Legal and Ethical Considerations for Demonstration Hubs

Every effort has been paid to guide the technical partner responsible for the operation of the PISTIS platform, as well as the demonstrators, in implementing the project use cases in compliance with the legal requirements and ethical principles that have been identified in the previous project deliverables of D1.1 and D9.1. Emphasis has been placed on this as it has been recognised as the main facilitator and enabler of trust in data spaces.

The operators and the users of data space are aware as to how to take into account various ethical and legal considerations to ensure responsible and lawful use of data and to create a level of comfort and trust among data space users.

In the preparations for the testing of the Alpha version all the relevant legal and ethical considerations have been taken into account during the planning process.

Building on these legal and ethical considerations, the evaluation of PISTIS solutions will be carried out with the aim to promote the operationalisation of the ethics-by-design-and-by-default approach, supporting the project compliance with the ethical principles constituting the core of the EU digital legislation and policies, and elaborating on lessons learnt for the PISTIS operations in real-life environments.

Further relevant legal developments and any new ethics principles applicable to the relevant technologies will be monitored and the framework will be updated accordingly.

The demonstrators have indicated that they understand fully the challenges outlined in the Framework and are well prepared to meet them and all the principles established in D9.1 have been adhered to in developing the use cases. The demonstrators are aware of and will consider that relevant activities will be in compliance with the AI Act. And for the Beta version, the demonstrators will put in place measures to ensure that there is no infringement of intellectual property rights over the datasets handled as well as ensuring that the data sharing agreements to be used by the demonstrators in PISTIS once the Beta version is available will contain fair, reasonable and non-discriminatory terms.

The demonstrators are aware of and are compliant with all relevant data protection laws. It is anticipated that more attention and action will be required to ensure compliance with the relevant rules with the development of the Beta version.

The demonstrators are aware of the applicable requirements under the AI Act and will endeavour that relevant activities are carried out in compliance with the AI Act. For the Beta version, the demonstrators will put in place measures preventing infringement of intellectual property rights over the datasets handled as well as ensuring that the data sharing agreements to be used by the demonstrators in PISTIS once the Beta version is available will contain fair, reasonable and non-discriminatory terms.

The demonstrators are aware of and are compliant with all relevant data protection laws. It is anticipated that more attention and effort will be required to ensure compliance with the relevant rules with the development of the Beta version.

All these legal and ethical considerations are captured in "Table 5: Checklist for Legal and Ethical Accountability." All the risks identified and listed in Chapter 2 have been scrutinised and as would have been expected from the internal alpha version evaluation process, any which were applicable for this phase of the project have been satisfactorily assessed with no remedial action required.

15.2 Demonstration Activity

From Chapters 3, 4 and 5, it can be seen that the three Demonstrators have tested the alpha version in the planned way, in terms of their use cases and the treatment of data involved and that the results were a success. The foundations are now in place to turn to utilising this demonstration activity in order to focus and drive forward many of the actions which are required to make PISTIS a success.

As Chapter 7 established, all the aspects of the evolving platform which were available in the alpha version have been tested successfully.

These actions will include focussing on the additional functionalities set out for the Beta version of the platform and the continuing of the testing process which was established for the alpha version. But additionally, a more holistic approach will be taken with activity being planned to contribute to the work required to provide the business plans, lessons learned, training material, network building etc. Plans are well developed to enable this change of emphasis to be implemented in the final stages of the project.

15.3 Technical Results

All aspects of the platform that had been in the backlog for the alpha version have been successfully delivered and tested within the integrated PISTIS platform. This achievement marks a milestone in the project's progression, reflecting the comprehensive efforts and meticulous planning of the involved teams to ensure that every component is seamlessly integrated and functioning as intended.

Given the complexity and the high number of components involved, integration as well as the transformation of the overall platform installation into an automated deployable package, the overall required effort amounted to higher numbers than the initial estimations. Nevertheless, the decision taken to automate deployment ensures that the future deployment process will be highly more efficient and scalable, enabling future updates and expansions to be implemented with greater ease and reliability.

15.4 IMPACTS

The impacts expected are well established and set out in D5.1. Additional KPIs have been determined, with new ones being considered as the project evaluation becomes more nuanced. However, it is premature to scrutinise the existing KPIs and expected impact at the Alpha version stage. Indeed, most impacts can only come from gaining the momentum expected with the arrival of the Beta version of the platform. The main impact has been establishing the firm foundations for real progress to be made and for the exploitation of the results.

We are confident that these foundations are on track and that the progress is on schedule to achieve the wide range of impacts which we have set to be achieved for the project

15.5 USER INTERFACES

A notable characteristic of the PISTIS platform's architecture stems from its evolutionary development, where many constituent components were based on or adapted from previous implementations. Consequently, each of these components initially came equipped with its own distinct user interface, often built using different technologies and adhering to varied design paradigms. This resulted in a heterogeneous user experience across the platform, presenting a potential challenge for users needing to interact with multiple functions potentially having disparate visual styles and interaction patterns.

To address this and move towards providing users with a more cohesive and unified experience, the consortium worked towards selectively refactoring the user interfaces of several key existing components, migrating them to a modern stack utilizing Nuxt.js and Vue.js. Concurrently, a mandatory principle was established requiring all newly developed components for PISTIS to be built using this same Nuxt.js/Vue.js framework from the outset. As a result of these efforts, the alpha version now offers a considerably more consistent look and feel across its different sections. While this represents a significant step forward in usability, the process of complete UI convergence is ongoing, with further improvements and refinements planned for the next versions to enhance visual and interactive consistency even more.

15.6 BUSINESS INNOVATION AND EXPLOITATION PROGRESS

The period leading up to the release of the Beta version will be important for having a solid basis for finalising the business plans. First deliberations have taken place both in designing the plans and in how they will eventually be evaluated. A process has been developed for engaging with the business plan owners to ensure that the plans are based on existing strategies where appropriate, along with the first thoughts on how the evaluation of these business models will take place.

15.7 LESSONS LEARNED.

In the early stages of the project, “lessons learned” were very much focussed upon assisting the technical teams with the testing of the alpha version of the platform and were fed into the process. Any other observations will be captured in the process for gathering lessons learned from a more holistic point of view, which has just commenced and the strategy for this is set out in section 11.6 above.

15.8 CONCLUSIONS

D5.1 established a plan for carrying out the alpha version trials. This has been followed successfully. The Evaluation Framework has been utilised as envisaged. This was limited to the extent that the alpha version was also limited in its design at this stage of the project.

Plans have been established to implement the Beta Version and to utilise the established Evaluation Framework. Both the plans and the framework are being extended to cope with the new requirements brought about by the more mature state of the project.

A solid Legal and Ethical Framework is in place and this has been implemented and will be in constant use for the duration of the project, as well as underpinning any planned exploitation activities.

New stakeholders have been identified and will be reassured with the legal framework in place, alongside the technical security of the platform.

Throughout all these distinct testing phases – component, flow, and integration – a continuous cycle of testing, bug identification, tracking, and resolution was maintained. All significant bugs identified during these phases, particularly those uncovered during integration testing, have been addressed and resolved. This enables the demonstrators to carry out their testing.

The technical testing at the three demonstration hubs progressed with no major issues discovered. The platform passed its tests, whilst the expected recommendations for improving the user interfaces were taken onboard and will be implemented. And this was despite the increased effort required to create and test the platform with the need to bring in a wide range of components, each with existing interfaces, alongside the key innovation of enabling an automatic deployment of the platform.

It was recognised that the project is at a watershed and that a much more holistic approach needs to be followed in the later stages of the project. A catalyst for this will be the WP7 Business Plans with a focal point being the Living Labs which will be organised at the demonstration level and be pivotal in scaling-up activities. The business plans will be evaluated in WP5 and first thoughts on how to proceed with the plans and with the mechanism for evaluation have been gathered. We rely on a grounded cognition framework stressing that a successful business model must align with the needs and perspectives of various stakeholders. While business model concepts can be challenging to grasp, using specific tools called

"boundary objects" can bridge communication gaps and help managers and their stakeholders.

Other new evaluation topics have been discussed as the project matures, including the evaluation of the business models and these will be finalised prior to the release of the Beta version, along with a raft of relevant new KPIs.

We have returned to the PISTIS Theory of Change, which still holds true, with more intermediate actions being identified in order to add granularity to it, and to shape the increased activity as a result of having a more mature platform.

Crucially, we are now ready to expand our activities in all directions with networking activities well advanced. As required in T5.7, this deliverable proposes “improvement actions, interventions and measures to be applied for successfully paving the exploitation path of the project”. The task now is to implement all that has been discussed and planned.

APPENDIX 1. SUMMARY OF ACTIONS INVOLVED AT A USE-CASE LEVEL, FOR EACH HUB.

SUMMARY OF ACTIONS WITHIN USE-CASE #1.1 DURING ALPHA PHASE.

Before interacting with the PISTIS platform:

- All actors within this use case will be involved in the definition of relevant data contracts, details, terms of use, pricing policies etc and need to agree on conditions for data sharing, but for the Alpha phase this is too early to do this.
- AIA & OAG have examined relevant registry available data sources and identified the data that will be needed to support Goldstar, whilst defining licensing and policies to use the data. This Data identification process will be ongoing.
- The data providers are engaged in Data Quality assessment, transformation & analytics activities.

The first stage of interaction with the PISTIS platform following the decision to share data (entire dataset or preliminarily a sample, as deemed necessary) through PISTIS was to provide the following data: see Table 7: Data Landscape: Baggage Handling Management.

The second stage relates to the output retrieved from PISTIS with the checking of example data for data format, data characteristics, compliance with requirements and standards, match with user needs, etc. by Goldair and AIA and their subsequent retrieval of data.

The third stage is for Goldair and AIA to retrieve the output from PISTIS, checking example data for data format, data characteristics, compliance with requirements and standards, its match with user needs, etc. and subsequently to receive the data.

The fourth stage is the Data quality assessment and generation of new analytics (through PISTIS or offline), and this includes:

- Data quality assessment, data decryption and - if necessary – preprocessing.
- Analysis and combination of traffic data to derive predictive analytics and optimise baggage transfers.
- Analysis and combination of traffic and weather data to compute predictive analytics of potential delays.
- Data providers monitoring that data is correctly transferred and that it is used as agreed in the licences.
- And the new analytics are made available through PISTIS if requested.

And finally, after the interaction with PISTIS and to be reported in D5.3:

- Fine tuning the data usage, evaluating the business value of the data received, and identifying additional data to increase this business value.
- Developing algorithms and business logic that will use the input to provide useful and exploitable results, feeding internal systems with data.

Improving internal processes and exploring data sharing with third parties.

SUMMARY OF ACTIONS WITHIN USE-CASE #1.2

Before interacting with the PISTIS platform:

- Define relevant data contracts, details, terms of use, pricing policies.
- Examining relevant registry available data sources and identifying the data that will be needed.
- Agreement on conditions for data sharing.
- Data quality assessment, transformation & analytics.
- Define licensing and policies to use the data.

Step 1 - Input provided to PISTIS:

- Decision to share data (entire dataset or preliminarily a sample, as deemed necessary) through PISTIS.
- Flight status data, handler data-stamps, arrival/departure/transfer Bag number.
- Transfer passenger number and destination, Passenger Transfer Message (PTM), type of connection.
- Passengers with disabilities and reduced mobility (PRM), Immigration – Customs Clearance numbers and waiting times.
- Minimum connecting times data.
- Flight schedule and day of operations updates data.
- Weather data.

Step 2 - Output retrieved from PISTIS:

- Check example data for data format, data characteristics, compliance with requirements and standards, match with user needs, etc.
- Retrieve data.

Step 3 - Data quality assessment and generation of new analytics (through PISTIS or offline):

- Data quality assessment, data decryption and - if necessary – preprocessing.
- Analysis and combination of traffic data, minimum transfer data, Customs Clearance processing times, etc. to derive predictive analytics and optimise passenger transfers.

- Analysis and combination of traffic data, minimum transfer data, Customs Clearance processing times, and weather data to compute predictive analytics of potential delays.
- Data providers monitor that data is correctly transferred and that it is used as agreed in the licences.
- The new analytics are made available through PISTIS if requested.

Step 4 - After the interaction with PISTIS:

- Fine tuning data usage, evaluate the businesses value of the data received, identify additional data to increase business value.
- Develop algorithms and business logic that will use the input to provide useful and exploitable results, feeding internal systems with data.
- Improving internal processes, Exploring data sharing with third parties.

SUMMARY OF ACTIONS FOR USE-CASE #1.3: AIRCRAFT TURNAROUND PROCESS.

Before interacting with the PISTIS platform:

- Define relevant data contracts, details, terms of use, pricing policies.
- Examining relevant registry available data sources and identifying the data that will be needed.
- Agreement on conditions for data sharing.
- Data quality assessment, transformation & analytics.
- Define licensing and policies to use the data.

Step 1 - Input provided to PISTIS:

The first stage of interaction with the PISTIS platform following the decision to share data (an entire dataset or preliminarily a sample, as deemed necessary) through PISTIS will be to provide the following data.

- Flight status data, handler data-stamps, arrival/departure/transfer Bag number.
- Transfer passenger number and destination, PTM Message, type of connection.
- Passengers with disabilities and reduced mobility (PRM), Immigration – Customs Clearance numbers and waiting times.
- Minimum connecting times data.
- Flight schedule and day of operations updates data.
- Weather data.

Step 2 - Output retrieved from PISTIS:

- Check example data for data format, data characteristics, compliance with requirements and standards, match with user needs, etc.
- Retrieve data.

Step 3 - Data quality assessment and generation of new analytics (through PISTIS or offline):

- Data quality assessment, data decryption and - if necessary – preprocessing.
- Analysis and combination of traffic data, minimum transfer data, Customs Clearance processing times, etc. to derive predictive analytics and optimise passenger transfers.
- Data providers monitor that the data is correctly transferred and that it is used as agreed in the licences.
- The new analytics are made available through PISTIS if requested.

Step 4 - After the interaction with PISTIS:

- Fine tuning data usage, evaluate the business value of the data received, identify additional data to increase business value.
- Develop algorithms and business logic that will use the input to provide useful and exploitable results, feeding internal systems with data.
- Improving internal processes, Exploring data sharing with third parties.

SUMMARY OF ACTIONS FOR USE-CASE #1.4: PUBLIC TRANSPORTATION PLANNING SUPPORT.

Before interacting with the PISTIS platform:

- Define relevant data contracts, details, terms of use, pricing policies.
- Examining relevant registry available data sources and identifying the data that will be needed.
- Ensure that PISTIS use has interoperability with airport internal systems.
- Data anonymisation and removal of business sensitive information.
- Semantic enrichment of the data to make it searchable, also using keywords.
- Agreement on conditions for data sharing.
- Data quality assessment, transformation & analytics, licensing, and policies to use the data.

Step 1 - Input provided to PISTIS:

- Decision to share data (entire dataset or preliminarily a sample, as deemed necessary) through PISTIS.
- Public transport timetables (buses and metro) data.
- Public transport vehicle data and occupancy (static) data
- Metro station incoming / outgoing passengers' data and bus geolocation data (currently available for previous day).
- Historic data (e.g., flight schedules, gate/terminal usage), inbound/outbound passenger per hour.
- Timestamps, Aircraft load factors.
- Transport modal split.
- Weather.

Step 2 - Output retrieved from PISTIS:

- Check example data for data format, data characteristics, compliance with requirements and standards, match with user needs, etc.
- Retrieve data on public transport movements and occupancy.
- Receive data on expected visitors flows based on destination locality.

Step 3 - Data quality assessment and generation of new analytics (through PISTIS or offline):

- Data quality assessment, data decryption and - if necessary – preprocessing.
- Compute predictive analytics to optimise vehicle availability from/to the airport.
- Data providers monitor that data is correctly transferred and that it is used as agreed in the licences.
- Set up algorithms to receive specific data sets automatically on regular intervals (e.g., daily update of the datasets/operation plan).
- The new analytics / services are made available through PISTIS if requested.

Step 4 - After the interaction with PISTIS:

- Improve planning and decision making of public transport.

SUMMARY OF ACTIONS FOR USE CASE #1.5: INSIGHTS FOR CITY COMMERCIAL BUSINESSES.

Before interacting with the PISTIS platform:

- Define relevant data contracts, details, terms of use, pricing policies.
- Data anonymisation and removal of business sensitive information.
- Semantic enrichment of the data to make it searchable, also using keywords.
- Anonymisation of the city businesses registry and provide it for export.
- Agreement on conditions for data sharing.
- Data quality assessment, transformation & analytics, licensing, and policies to use the data.

Step 1 - Input provided to PISTIS:

- Decision to share data (entire dataset or preliminarily a sample, as deemed necessary) through PISTIS.
- Timestamps.
- Mobility/touristic/business registry.
- Number of expected visitors.
- Destination of visitors.
- GIS info on location, district, address, floor.

Step 2 - Output retrieved from PISTIS:

- Check example data for data format, data characteristics, compliance with requirements and standards, match with user needs, etc.
- Receive data on expected visitors flows based on destination locality.

Step 3 - Data quality assessment and generation of new analytics (through PISTIS or offline):

- Data quality assessment, data decryption and - if necessary – preprocessing.
- Compute analytics to predict expected visitors flows based on destination locality.
- Data providers monitor that data is correctly transferred and that it is used as agreed in the licences.
- The new analytics / services are made available through PISTIS if requested.

Step 4 - After the interaction with PISTIS:

- Notify local businesses.
- Create an open public call for local businesses to participate, to provide feedback.

SUMMARY OF ACTIONS WITHIN USE-CASE #2.1 HOSTING CAPACITY OF THE GRID.

Before interacting with the PISTIS platform:

- Agree on a Common Information Model (CIM), data format and protocols.
- Prepare data on grid topology, DERs location, DERs generation, historical data on grid events and user consumption, and pre-processing to produce forecasts.
- Semantic enrichment of the data to make it searchable.
- Data quality assessment, transformation & analytics.
- Price signals (before the flexibility market operation).
- Define licensing and policies to use the data.
- Implement APIs/mechanisms to automatically transmit data, also in real time if necessary.
- Implement APIs/mechanisms to automatically retrieve data, also in real time if necessary.
- Check and eliminate unnecessary GDPR-relevant information in data.
- Anonymise study-relevant personal data (e.g., energy consumption, DER production and location).
- Data publication preparation.
- Data value estimation and monetisation scheme definition.
- Identify flexible assets in the grid.

Step 1 - Input provided to PISTIS:

- Decision to share data (entire dataset or preliminarily a sample, as deemed necessary) through PISTIS.
- Transmit grid data through PISTIS.
- Transmit weather data through PISTIS.
- Provide flexibility market results (after the flexibility market operation).
- Geographical definition of the portion of grid susceptible of being potentially congested (and therefore derive on a requirement of flexibility).
- Location of DERs with aim of providing their flexibility.
- The Transmission of data from field sensors and IoT is communicated directly with Cuerva's services.

Step 2 - Output retrieved from PISTIS:

- Check example data for data format, data characteristics, compliance with requirements and standards, appropriate match with user needs, etc.
- Retrieve grid data (including both network topology, prosumers data, energy consumption, etc).
- Retrieve weather data.

Step 3 - Data quality assessment and generation of new analytics (through PISTIS or offline):

- Data quality assessment, data decryption and - if necessary – preprocessing.
- BAMBOO uses grid and weather data and uses it to compute analytics and predictions on flexibility.
- CARTIF uses grid data to analyse hosting capacity.
- CUERVA uses weather data to improve predictions of energy generation.
- Data providers monitor that data is correctly transferred and that it is used as agreed in the licences.
- The new analytics are made available through PISTIS.

Step 4- Output retrieved from PISTIS and generation of new analytics

- Data quality assessment, data decryption and - if necessary – preprocessing.
- CARTIF combines and analyses grid data, prosumers data, flexibility validation data to generate new insights and predictions of network hosting capacity.
- Data providers monitor that data is correctly transferred and that it is used as agreed in the licences.
- The new analytics are made available through PISTIS.

Step 5 - After the interaction with PISTIS:

- CUERVA uses the analytics and predictions generated by BAMBOO, CARTIF to create action plans for upgrading the network, leveraging flexibility to reduce network events in the context of increased DERs connections.

- OMIE shares the results of the flexibility markets with all the participants (CUERVA as the requester and providers who have resulted in being assigned in the auction), so that CUERVA could use them to optimise the use of the grid.

SUMMARY OF ACTIONS WITHIN USE-CASE #2.2

Before interacting with the PISTIS platform:

- To find agreement on the type of information, e.g. data format, that will be exchanged, communication protocols and other technical requirements.
- Data Enrichment.
- Data Anonymisation.
- Data Quality Assessment.

Step 1 - Input provided to PISTIS:

- Transmit grid topology data.
- Transmit grid investment data.
- Transmit grid events (historical) data.
- Transmit user consumption (historical) data.
- Transmit DERs generation data.
- Provide historical data (results, prices) of previous auctions carried out on these congested zones (before the flexibility market occurs).
- Provide flexibility market results (after the flexibility market has been carried out).
- Transmit flexibility aggregated data.
- Data Ingestion (tool + several connectors to important data sources/ data spaces).
- Geographical definition of the portion of grid susceptible of being potentially congested (and therefore derive on a requirement of flexibility).
- Location of DERs with aim of providing their flexibility.

Step 2 - Output retrieved from PISTIS:

- Data Ingestion (tool + several connectors to important data sources/ data spaces).

Step 3 - Data quality assessment and generation of new analytics (through PISTIS or offline):

- Analytics/Insights Engine (the tool and scripts for data quality analysis).
- Use Case specific data Analytic for investment economic data.

Step 4 - Output retrieved from PISTIS and generation of new analytics.

- Data and Metadata Publication.
- Data Trading and acquisition from/to another PISTIS user.

Step 5 - After the interaction with PISTIS:

- Digital Twin creation

- Flexibility market results
- Report system for the results.
- Long-term Flexibility forecasting
- Use Case specific data Analytic for investment economic data.
- Data scaling
- App / interface for the DSO

SUMMARY OF ACTIONS WITHIN USE-CASE #2.3

Before interacting with the PISTIS platform:

- To find agreement on the type of information, e.g. the data format that will be exchanged, communication protocols and other technical requirements.
- Data Enrichment
- Data Anonymisation
- Data Quality Assessment

Step 1 - Input provided to PISTIS:

- Transmit grid topology data.
- Transmit user consumption data.
- Transmit DERs generation data.
- Peer to peer trading results.
- Data Ingestion (tool + several connectors to important data sources/ data spaces).

Step 2 - Output retrieved from PISTIS:

- Data Ingestion (tool + several connectors to important data sources/ data spaces).

Step 3 - Data quality assessment and generation of new analytics (through PISTIS or offline):

- Analytics/Insights Engine (the tool and scripts for data quality analysis).
- UC specific data Analytic for investment economic data.

Step 4 - Output retrieved from PISTIS and generation of new analytics:

- Data and Metadata Publication.
- Transmit flexibility aggregated data.
- Data Trading and acquisition from/to another PISTIS user.

Step 5 - After the interaction with PISTIS:

- Digital Twin creation.
- Report system for the validation of the transaction.
- Power flow calculation.

- Smart contract creation between users.
- Use data to feed algorithms that will help the grid distributor to improve the management of the grid. To use data generated by the grid to solve problems not directly related to electricity.
- Storage of the contracts and validation result.

SUMMARY OF ACTIONS FOR USE-CASE 2.4: MONETISATION OF DATA.

Before interacting with the PISTIS platform:

- To find agreement on the type of information, e.g. data format, that will be exchanged, communication protocols and other technical requirements.
- Data Enrichment
- Data Anonymisation
- Data Quality Assessment

Step 1 - Input provided to PISTIS:

- Transmit digitalisation cost data.
- Transmit grid O&M operation data.
- Transmit data infrastructure cost data.
- Data Ingestion (tool, plus several connectors to important data sources/ data spaces).

Step 2 - Output retrieved from PISTIS:

- Data Ingestion (tool, plus several connectors to important data sources/ data spaces).

Step 3 - Data quality assessment and generation of new analytics (through PISTIS or offline):

- Analytics/Insights Engine (the tool and scripts for data quality analysis).
- UC specific data Analytic for investment economic data.

Step 4 - Output retrieved from PISTIS and generation of new analytics.

- Data and Metadata Publication
- Data Trading and acquisition from/to another PISTIS user

Step 5 - After the interaction with PISTIS:

- Establishing the value of data that will be monetised or traded in any of the use cases.
- Definition of processes for the valorisation of data
- Studies dedicated to data valorisation.
- Smart contract creation between users

- Use data to feed algorithms that will help the grid distributor to improve the management of the grid. To use data generated by the grid to solve problems not directly related to electricity.
- Storage of the contracts and validation result

SUMMARY OF ACTIONS FOR USE CASE #3.2: DRIVING STYLE & RISK ASSESSMENT

Before interacting with the PISTIS platform:

- Prototypical implementation of a system that can warn drivers based on a risk computed from historical data sources termed “D-TRAS - Digital Platform for Traffic Safety Risk Prediction” consisting of:
    - A set of preliminary, internal data sources (dockerized data services) for testing purposes containing locations/clusters of brake, acceleration and curve events gained from past trip data).
    - A server-based implementation (connects several data services and combines the output to compute driver warning events).
    - And a client implementation (mobile app for smartphones that connects to the server and displays computed risk-relevant events based on the driving context that are ahead of the driver’s driving route and finally warns drivers).
- Pre-processing (in each data-service) to fit the data into the data model of the software products, e.g. uniform time series with the aim to compute driving-risk relevant events from raw data (e.g. time series data on past trips > location of brake events with meta information > brake event clusters).
- Visual analytics of historical data on single trips and extracted driver-risk events (trip data visualiser).
- Agreement on conditions for data sharing with CARUSO and UBIMET.
- Define relevant data contracts, details, terms of use, pricing policies.
- Development of semantic enrichment for the shared data sets using a common ontology (ORM - data service ontology).

Step 1 - Input provided to PISTIS:

- Decision to share data (entire dataset or preliminarily a sample, as deemed necessary) through PISTIS.
- Automation of event detection, driving style analysis and risk computation.
- Mobile app including a kit that is connecting to the service platform to query the relevant information.
- Provision of driving style & risk data.

- Implementation of APIs/mechanisms to automatically transmit weather data, also in real time if necessary.
- Real-time information, raw weather data via continuous data stream.
- Integration of weather data via VIF app/dashboard.
- The provision of weather parameters and associated risks such as road icing conditions and low visibility.
- Access use of smart contracts and crypto currencies.
- Street graph data.
- Accident hotspot data.
- Live Weather Data.
- Historical Weather Data for Styria.
- Anonymised Connected Car Data.
- Personalised Connected Car Data (using synthetic data).

Step 2 - Output retrieved from PISTIS:

- Access to new and relevant data sources (including a data catalogue to search for information).
- Improved and simplified mechanisms for and gaining access to new data sources to improve the driving risk prediction and driver warning solution.
- Integration of further data sources into the solution: Street graph data, accident hotspot data, live Weather Data, historical Weather Data for Styria, anonymised Connected Car Data, and personalised Connected Car Data (using synthetic data).
- Improved Server Platform integrating further data-services and establishing a risk-model that takes advantage of the data stemming from this new data-services.
- Improved Client-based systems (and user experience – UI/UX) targeted at end users-
- Vehicle drivers: Improved mobile warning app and risk model.
- Transportation managers: Dashboard allowing them to interact with driver-risk relevant information on a map.
- Developers: Dashboard to simulate drives (virtual drivers) and illustrate the computation of driving risk and generation of warnings based on the available data (allowing to select different risk models) allowing to experiment with different parameters.
- Improved mechanisms for and allowing to share data generated in the use case with other partners (where applicable to sell data to further stakeholders).
- Data providers monitor that data is correctly transferred and that it is used (in the solution) as agreed in the licences.

Step 3 - Data quality assessment and generation of new analytics (through PISTIS or offline):

- Data quality assessment, data decryption and - if necessary – preprocessing.
- Visual exploration of driving risk data to develop automated data quality analysis and improvement.

- Calculation of events (relevant to the calculation of driving risk) from raw data (e.g., trip data or anonymised trip data) to feed into risk prediction models and quality assessment of event data.
- Queries events with a geo-spatial key computed on the driver's app and assessment of the quality of geo-spatial data.
- Computation of a cone for risk calculation depending on the driving speed and other input parameters and assessment of the quality of the cone computation.
- Novel means of event filtering and risk calculation taking advantage of the additional data fed into the system and assessing the quality of the computed risks.
- Improved means of driver warnings computation and visualisation and assessment of the quality of driver warnings.
- The new analytics are made available through PISTIS.

Step 4 - After the interaction with PISTIS:

- Improved driving style and driver risk assessment solution that can more realistically infer a driver's risk (to be evaluated with real drivers in a small-scale study).
- Calculation of events (relevant to the calculation of driving risk) from raw data (e.g., trip data or anonymised trip data) to feed into risk prediction models.
- Compute: risk score for drivers considering their driving style, geo-location and time and driving style out of vehicle movements.
- Sell service: Alert drivers using a mobile app based on the risk events in their driving corridor and show risk-events to risk managers on a map (event dashboard) and let them explore.

SUMMARY OF ACTIONS FOR USE CASE #3.1: TRAFFIC QUALITY ASSESSMENT

Before interacting with the PISTIS platform:

- Pre-processing to fit the data into the data model of the software products, e.g., uniform time series.
- Agreement on conditions for data sharing.
- Define licensing and policies to use the data.
- Data quality assessment, transformation & analytics.
- Integrating a road graph (e.g., OSM).
- Data harmonisation.

Step 1 - Input provided to PISTIS:

- Decision to share data (entire dataset or preliminarily a sample, as deemed necessary) through PISTIS.
- Processed data made available for querying through API.
- The Integration of floating car data (if available).
- Provision of driving/car and accidents data.

- Provision of safety data.
- Provision of driving data.
- Provision of live weather data.
- Transmit vehicle sensor data/connected Car Data (fuel consumption, risk, driving styles).
- Transmit street graph data.
- Transmit public transport data.
- Data visualisation dashboard for urban analytics and (Corporate) mobility management.

Step 2 - Output retrieved from PISTIS:

- Retrieve the data (sample or entire data set).

Step 3 - Data quality assessment and generation of new analytics (through PISTIS or offline):

- Implementation of data resolution, calculation of hotspots and calculation of correlations/recommendations.
- Data quality assessment, data decryption and - if necessary - preprocessing
- Combine spatial data and live traffic data.
- Interact through the database through a web-app (frontend).
- Interact through a Service oriented Architecture (e.g., APIs).
- Monitoring system checking that data is correctly transferred and that it is used as agreed in the licences.
- The new analytics are made available through PISTIS.
- Data will be combined (e.g., weather data and traffic flows) and analysed, including statistical and geospatial analysis.

Step 4 - After the interaction with PISTIS:

- Data will be modelled for user interaction through GUI.
- The results will be made available for platform users.
- Consider options on how to display risks or make risks visible to drivers.

APPENDIX 2: PISTIS TAM QUESTIONNAIRE

PISTIS TAM Questionnaire

Please indicate your level of agreement with the following statements using the scale below:

- 0 – Not Applicable
- 1 - Strongly Disagree
- 2 - Disagree
- 3 - Neutral
- 4 - Agree
- 5 - Strongly Agree

I. PERCEIVED USEFULNESS

Performance Expectancy

1. Using PISTIS will help me improve my work performance.
2. Using PISTIS will increase my productivity.
3. PISTIS will help me achieve my business goals.
4. PISTIS provides features that are useful for my business needs.
5. Using PISTIS will enhance the effectiveness of my work.

Effort Expectancy

1. Using PISTIS will reduce the effort required to complete my tasks.
2. PISTIS simplifies my work processes.
3. PISTIS saves me time compared to my previous methods/tools for data sharing/exchange
4. Learning to use PISTIS effectively will NOT require a lot of effort.
5. PISTIS helps me avoid unnecessary steps in my work (such as data treatment, etc.)

Facilitating Conditions

1. I have the necessary resources (hardware, software, support) to use PISTIS effectively.
2. PISTIS is compatible with my existing systems and workflows.

3. I have access to adequate training and support for PISTIS.
4. PISTIS is available whenever I need to use it.
5. PISTIS integrates well with other tools that I use for my work.

II. PERCEIVED EASE OF USE

Complexity

1. It is easy to understand the features and functions of PISTIS.
2. Navigation through the platform is effortless.
3. PISTIS is user-friendly.
4. Learning to use the PISTIS is straightforward.
5. Instructions and guidelines provided are clear and helpful.

Controllability

1. I feel in control when using PISTIS.
2. I can easily customize PISTIS to fit my preferences.
3. It is easy to find the information I need PISTIS.
4. I can easily correct errors or undo actions on PISTIS.
5. I feel confident in my ability to use PISTIS effectively.

III. Behavioural Intention to Use

Usage Intentions

1. I am likely to continue using PISTIS in the future.
2. I intend to use PISTIS regularly for my work.
3. I would consider using PISTIS for other tasks or projects.
4. I plan to use PISTIS frequently.
5. PISTIS will become an essential part of my workflow.

User Feelings

1. I enjoy using PISTIS.
2. I feel confident using PISTIS for my tasks.

3. The platform makes data exchange operations enjoyable.
4. Using PISTIS aligns with my expectations.
5. I would recommend PISTIS to others.

IV. System Quality

1. PISTIS is reliable and performs consistently.
2. Pages and features load quickly without errors.
3. PISTIS has a visually appealing design.
4. PISTIS integrates well with other tools or systems I use.
5. I feel secure when entering sensitive information on PISTIS.

V. Trust and Security

1. PISTIS keeps my data secure.
2. I trust PISTIS to protect my privacy.
3. PISTIS has transparent data-handling policies.
4. I feel safe making transactions through PISTIS.
5. PISTIS promptly resolves security issues.

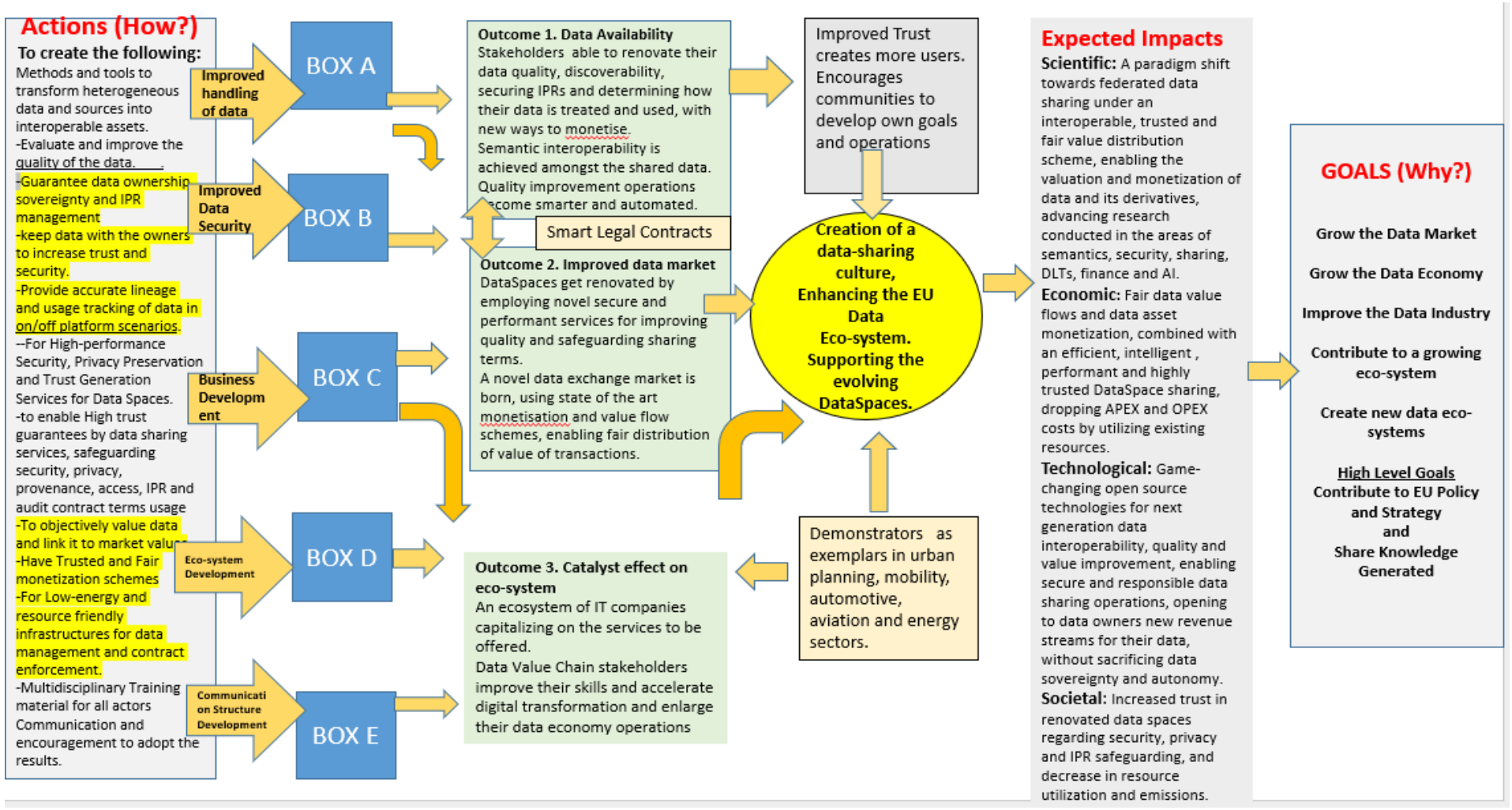
VI. Overall satisfaction with the platform.

1. The platform meets my expectations.
2. I am satisfied with the performance of PISTIS.
3. PISTIS provides a positive user experience.
4. Support services (e.g., direct communication from developers, tutorials) meet my needs.
5. I feel PISTIS offers good value for its cost (not to be answered now).

VII. Open Questions

1. (Open-ended) What do you like most about PISTIS?
2. (Open-ended) What do you like least about PISTIS?
3. (Open-ended) Is there anything you would change or improve about PISTIS?

APPENDIX 3. PISTIS THEORY OF CHANGE



BOX A	BOX B	BOX C	BOX D	BOX E
• Sectorial Data Models • Pistis Metadata Repository • Methods for data Ingestion • Methods for data transformation • Methods for data enrichment • ML-based Data Quality Assessment methods	• Federated Data Sharing through peer-to-peer data exchange • Lineage tracking IPR safekeeping and contract enforcement modules, all provided as the background knowledge for the bundles to be part of the PISTIS Data Space Factory environment. • Exchange Log based on Blockchain • Data Monetisation Options (NFT + Data Investment schemes) • Data Contract Monitoring and Management • Data Usage Monitoring and Management • Interconnection with DataSpaces	• Data Security and Trust bundle • Distributed ledger technologies (DLT) • Access Policies • Identity Provider • Searchable Encryption Scheme	• A set of methods to drive the multi-dimensional valuation of data, the fair dynamic pricing of it, the definition of the market dynamics and the core features and the creation of novel data investments schemes (such as the Stablecoin, NFTs and Data Investment), to deliver the necessary data-sharing features that will be provided by the bundles of the PISTIS Data Trading and Value Exchange/Monetisation platform. • Data Market Insights service • Low Energy Blockchain infrastructure	• Demonstrations in five settings (3 demonstrator hubs with 12 partners + 3 more deployments with cross-domain data (weather data/open data)) and be used by the Living Lab as well. • Publications in scientific journals and international conferences. • 1 Business model targeting market entry and adoption of PISTIS by the Data Spaces. • 4 Business Models and Monetisation strategies (3 demo hubs + weather demonstrator). • MOOC and Training Material • Engagement of DIHs in the demonstrator dissemination activities

Figure 19: Key to the "Boxes" in the Theory of Change above.