Encouraging AI Adoption by SMEs: Opportunities and Contributions by the ICT49 Project Cluster

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***Abstract*— Today's rapidly changing marketplaces are constantly bringing new ways of transforming business operations and require companies to be flexible and dynamic. Toward this direction the use of Artificial Intelligence (AI) tools and techniques has the potential to bring significant value by transforming business operations and increasing their efficiency. Companies are already benefiting from AI solutions such as prescriptive analytics to enhance customers' experience or achieve optimal use of limited resources. This paper analyses the opportunities and challenges deriving in the context of introducing AI solutions in Small and Medium Enterprises (SMEs) in different sectors of activity (matchmaking, earth observation, energy services, planning services, cyber physical services, digital innovation hubs) by reviewing the research design, methodology and expected results of six Horizon 2020 European projects: AI4Copernicus, AIPlan4EU, BonsAPPs, DIH4AI, I-NERGY and StairwAI. The overarching goal of these projects is the enhancement of the European AI-on-Demand (AIoD) platform by mobilising the European AI community to support businesses and sectors in accessing expertise, knowledge, algorithms and tools for successfully applying AI and thereby generating market impact.**

Keywords*— *Matchmaking, Earth Observation, Energy Services, AI Planning, Cyber Physical Services, Digital Innovation Hubs, AI-on-Demand platform, AIoD

I. INTRODUCTION

Today's rapidly changing technologies are constantly bringing new ways of transforming business operations and require companies to be flexible and dynamic. The recent explosion of innovative and out-of-the-box Artificial Intelligence (AI) tools and services are bound to disrupt every business domain possible [1]. Companies are already seeing the benefits from AI solutions such as prescriptive analytics to enhance the experience of their customers or optimise the use of limited resources. These AI tools and mechanisms are continuously evolving and will trigger further innovation thus requiring businesses to prepare.

SMEs are the heart of European economies: They represent 99% of all businesses in the EU, they are responsible for more than half of Europe's GDP and employ around 100 million people [2]. However, SMEs are struggling more than large companies to keep up with the rate of digital transformation. Across SME companies, lack of talent with appropriate skills, technological infrastructure and access to AI enablers, data availability and accessibility, along with uncertain or low expectations for return on AI investments are among the most significant barriers to AI adoption [3]. In particular, SME barriers include:

- High costs and lack of resources to be invested: deploying AI solutions requires investments to be made by companies; SMEs rarely have such resources, with AI still remaining a costly system.
- Uncertainty about AI benefits: since AI adoption may not deliver immediate benefits and productivity gains, thus raising sunk costs before a growth potential is achieved, SMEs are reluctant to uptake innovations that could result in losses on a short run due to limited revenues and cash flow.
- Lack of trained employees: training employees to interact with AI-based solutions and seeing them as complementary tools rather than competitors is crucial to allow SMEs to experience growth.
- Reputational and legal risks: these concern the ethical risks connected to AI, with SMEs being often too slow to react to the damages that might be caused by such reputational and legal harms.

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- Lack of data culture and weak data management practices: SMEs are less well prepared to valorise their data, and, although they produce a great volume and variety of data, they often lack the ability to collate, manage and protect them. Moreover, they lack the practices to use complex AI and ML systems.
- Weak data management practices: SMEs often lack data management policies and practices that could allow them to use complex AI and ML systems.
- SMEs providing services and technologies for smartening grid hardware and assets perceive data access to be a 'difficult topic' due to uncertainty about legal requirements and see the lack of common standards as another critical barrier.
- SMEs providing services for the energy markets and commercial non-regulated energy stakeholders see regulatory barriers (lack of EU-level harmonised flexibility services requirements) as particularly relevant, including current structure of the energy market inflexible and insecure, discouraging the entry of new players.

SMEs can benefit from AI solutions in a variety of main areas, i.e. Customer Engagement, Business Operations, Talent Management/Hiring and Financial Reporting. What facilitates the implementation of AI is the fact that not only can companies across many verticals gain value from them, but they also have universal applicability.

Nonetheless, successfully implementing such solutions requires planning and preparation, a coherent business strategy, strong data management processes, a strong understanding of the companies' technology and systems' capacity and needs and the will to engage with the required technology, policy and ethical expertise.

The EU ICT49 cluster projects [4] aim to facilitate the implementation of AI solutions by focusing on different challenges. The ICT49 call is the successor and continuator of the H2020-ICT-2018-20 call which resulted in the project "A European AI On Demand Platform and Ecosystem" [5]. The ultimate goal of this project has been the development of a European AI-on-Demand platform mobilising the European AI community to support businesses and sectors in accessing expertise, knowledge, algorithms and tools to successfully apply AI thereby generating market impact. The AIoD platform aims at creating value, growth and jobs for Europe through a collaborative ecosystem, which unites the AI community, promotes European values and supports research on human-centered and trustworthy AI.

The ICT49 projects build on the AIoD platform to facilitate the integration of AI into applications and consolidate the ecosystem by bringing in a larger user community as well as by reinforcing the service layer of the platform to ensure it is a compelling solution for users from non-tech sectors. The ICT49 projects contribute to the platform providing AI-related knowledge, algorithms, tools, access to related infrastructures, equipment, data resources and expert support.

There are six different ICT49 projects in total targeting different areas, namely StairwAI[1], AIPlan4EU[2], BonsAPPs[3], AI4Copernicus[4], I-NERGY[5] and DIH4AI[6]. These EU-funded projects focus on AI adoption and solution development across different European regions, businesses and public services. These projects are run by 72 European organisations from 17 different European countries and connect a broad network ranging from SMEs and DIHs, to regional and national associations and researchers. The common aim of these projects is to address common challenges in digitisation through AI and examine possible solutions by bringing together different stakeholders, exchanging of experience and facilitating cooperation and networking between regions and cities. To this end, they support the implementation and development of AI solutions, including up-skilling opportunities and infrastructure to facilitate the economy's and society's digital transition.

II. The AI-on-Demand Platform Vision

The AI-on-Demand platform seeks to act as a resource to facilitate European AI research and innovation. Its objective is to support all solutions and tools that contribute to the ecosystem of excellence and trust, which define the European Vision of AI [5]. The AIoD will mature to add AI assets and tools to be used by the broader community to upskill and transfer knowledge to innovation sectors. It will supply new services and a marketplace for non-experts, so that they can experiment and deploy AI solutions in their own workplaces.

III. EU projects reinforcing the AIoD

A. AI4Copernicus

Copernicus is the European programme for monitoring the Earth. It consists of a set of systems that collect data from satellites and in-situ sensors, process these data and provide users with reliable and up-to-date information on a range of environmental and security issues. The Earth observation satellites that provide the data of Copernicus are the Sentinels, which are developed for the specific needs of the Copernicus programme. The access to Sentinel data is regulated by EU law and it is full, open and free. Copernicus data and their derived products, as these are being offered via Data and Information Access Services (DIAS), Thematic Exploitation Platforms (TEPs), and independent services, have become indispensable in multiple financially and socially crucial sectors as diverse as agriculture, security and transport.

The recent report "Towards a European AI4EO Research & Innovation Agenda" of the Φ-lab of the European Space Agency (ESA) [6] states that currently AI for Earth Observation (AI4EO) is mainly "computer vision applied to very high-resolution satellite imagery" and stresses the importance of a "European collaborative effort" to "provide a digital environment for researchers and innovators to rapidly prototype new AI4EO applications, including tools, clean quality-controlled

[1] https://stairwai.nws.cs.unibo.it/

[2] https://www.aiplan4eu-project.eu/

[3] https://bonsapps.eu/

[4] https://ai4copernicus-project.eu/

[5] https://i-nergy.eu/

[6] https://www.dih4ai.eu/

training data sets, computing power and access to EO data, training material and expertise". AI4Copernicus works towards the vision set out by the Φ-lab report, while also aligning with developments of the more recent Destination Earth (DestinE) initiative, which involves the collection and promotion of datasets, methodologies and services to create and refine high-resolution digital twins of the Earth for innovation and research.

The main objective of AI4Copernicus is to make the AIoD platform, the platform of choice for users of Copernicus data along the value chain (scientists, SMEs, non-tech sector). AI4Copernicus achieves this objective by reinforcing the AIoD platform service offering with AI4Copernicus datasets, tools, and services. Further, the project establishes an open calls mechanism encouraging participation from the domains of Agriculture, Energy, Security and Health. It also reaches out to new user domains and boosts use of the platform through additional use cases and small-scale experiments. The project has specifically the following objectives: i) to expand and deepen the integration of AIoD with DIAS platforms to enrich the AIoD service offering and enable far-reaching innovation; ii) to kickstart the innovation cycle by incentivising diverse AIoD and Copernicus communities to solve real problems of business and societal value; and iii) to drive the evolution, uptake, and impact of all involved platforms (AIoD and the DIAS platforms).

AI4Copernicus aims to enable Copernicus DIAS users to perform highly sophisticated AI operations on large and high-valued Copernicus datasets. To meet its objectives, AI4Copernicus operates on three levels: First, it generates added-value bootstrapping services and resources; second, it facilitates the integration of the aforementioned AIoD computational components on DIAS platforms in an extensible and reusable way; and finally it facilitates the extension of the AIoD catalogue in order to increase the impact, reach and sustainability of AIoD as a platform and as an ecosystem. AI4Copernicus foresees financial support to be directed to third parties via open calls for AI-enabled EO use cases (larger-budget projects, involving consortiums with at least one non-technology user) and small-scale experiments (smaller, single-beneficiary experimental projects targeting technology-advanced users). These third parties will be European SMEs, startups, and individuals (developers, researchers and citizens).

From a technological perspective, AI4Copernicus goal is to semantify searching over and managing large Earth-observation data via generic services and provide domain specific services and resources as building blocks to help bootstrap larger projects via the Open Calls. In particular, the AI4Copernicus consortium provides a set of services from the Security, Agriculture, Energy and Health communities for the open call projects [7], [8]. These bootstrapping services aim to reduce the time and resources of the bidders in different tasks, such as data access, pre-processing, labelling datasets, ML algorithm definition. In addition, AI4Copernicus offers a linked data suite of semantic tools [9], [10] that allows to handle linked data at every step of the linked data pipeline, and provides Open Call winners with access to DIAS and the AIoD Platform resources in a streamlined manner, offering support all along. AI4Copernicus has already uploaded several AI assets to the AIoD platform, including:

- A security bootstrapping service, containing a collection of pipelines for the preprocessing and change detection computation of Sentinel-1 and Sentinel-2 products in order to facilitate the integration of Sentinel data in AI processing chains. All pipelines, based on SNAP and GDAL, are available as dockerized applications.
- An agriculture bootstrapping service containing a collection of pre-processing harmonisation tools and deep learning models for the crop classification task. All the pipelines, based on python, are available as dockerized applications.
- A service to train segmentation models for Sentinel-2 patches, which allows users to train models in order to segment several types of areas related to the agriculture topic: crop types, land cover road extraction, etc. The service is available as a dockerized application.
- A health bootstrapping service, which is being developed to address current public health and air pollution (or air quality) challenges using Earth observation and in-situ measurement data. It offers a downscaling of CAMS air quality model data and is available as a dockerized application.
- A Semantic-Web toolkit, which is a suite of tools for handling Geospatial Linked Data, working together as a Linked Data pipeline. These tools allow for transformation, querying, interlinking, federating, and visualising big linked geospatial data and are distributed as open source.

More contributions to the platform are expected in the forthcoming months (e.g., AI Assets, Case Studies, Articles, etc.) with material from the Open Calls projects, which will be linked to the AI4Copernicus project page.

AI4Copernicus enlarges the AIoD ecosystem with the Copernicus community, one of the largest and most vibrant open user communities, which includes scientists, SMEs, non-tech users, public sector organisations etc., from Europe and the world, facilitating the provision of a wide range of on-demand Earth-observation AI services and creating added value at an economic, societal, scientific and environmental level for all participants and the wider community. At the same time, AI4Copernicus relaxes one of the key challenges for the Earth Observation community, which is to "harness the full power of new technologies such as AI in collaboration with new players in the ecosystem including ICT companies, startup and data and EO scientists". As such, AI4Copernicus facilitates the co-creation of shared value between AI-driven and data-driven communities in an effective way, aiming to create a sustainable competitive advantage for both communities and their participants as well as the European industry at large.

B. AIPlan4EU

AI Planning is a subarea of artificial intelligence concerned with identifying a course of actions to achieve an objective. It has many different use cases, e.g. in agile manufacturing, robotics, logistics automation, or agriculture. AI planning is not purely data-driven but bases its decisions on a predictive model of the underlying

system, so in contrast to other AI techniques, it can offer guarantees on the correctness and quality of the solutions.

Despite the existence of many planning systems that are mature in terms of science and technological development, there are still barriers that impede their practical application. For example, it can be hard to identify the appropriate techniques for a given planning problem, there are no shared standards to use them, and there is no easy access to expertise on how to encode domain knowledge into a planner. The AIPlan4EU project aims to address these obstacles in several ways:

First, by developing a uniform, user-centred framework to access the existing planning technology. This planning framework is an open-source Python library [11], supporting the creation and modification of planning problems, flexibly using procedural and declarative paradigms. The library spans many different flavours of AI planning, such as numeric or temporal planning. There are integrations for a wide choice of planning engines that can easily be installed and used in a uniform way.

Second, by implementing bridges that connect the framework with established industry standards used in different application domains such as logistics automation or flexible manufacturing. The development of these bridges builds on actual real-world use-cases and distils generic patterns and functionalities for the entire application domain. These generic bridges will make it easy to apply planning technology, supporting quick implementation and a fruitful exploitation of technology.

Third, by devising concrete guidelines for innovators and practitioners on how to use this technology. There will be a "planning cookbook" that will help new adaptors to understand, analyse and frame their use-case from an AI planning perspective and make suitable modelling choices to get the best possible benefit from the technology. Moreover, there will be case studies that demonstrate how the unified planning library has been used for the real-world use-cases of the project, e.g. a robotics application by one of the project partners [12].

Last, by making planning available as a service on the European AIoD platform. The unified planning library will not only be accessible on the AIoD platform as a downloadable resource, but it will also be available on the experiments platform, where it can be used to integrate planning technology as a service to other AI components. All efforts of the project are driven by the needs of actual real-world use cases, both from within the project consortium and recruited by means of cascade funding. The outcomes of the AIPlan4EU project are made available as assets on the AIoD platform.

C. BonsAPPs

BonsAPPs helps SMEs digitalise by allowing them to access, implement and deploy AI on Edge devices in an easy and affordable way. BonsAPPs aims to transform AI development from a cloud centric model, dominated by large internet companies, to an edge device centric model through the Bonseyes Marketplace and ready-to-use AI services. BonsAPPs does this by offering a series of modular services, such as experimentation, model compression, optimisation, benchmarking, and deployment on hardware and security, that will increase AI usage among enterprises and SMEs which currently lack internal innovation capabilities.

BonsAPPs is a continuation of the EU-funded Bonseyes project[7], focusing on enabling Europe to become a leading global player for low-power and distributed data processing in the coming "AI-as-a-Service" economy. BonsAPPs will set up and demonstrate, via 20 FSTP-funded Use Cases, a fully functional and scalable AI-as-a-Service (AI-aaS) within the AIoD platform, which will allow end users (specially SMEs and non-tech users lacking internal innovation capacities) to easily engage with AI Talents ('data scientist', 'developers' 'integrators') into an open innovation cycle leading to the development and pilot deployment of AI at the Deep Edge Apps and Solutions, as well as further commercialisation via non-exclusive licencing models.

BonsAPPs will allow users to develop AI solutions to solve real-world industry challenges at the deep edge that requires a number of AI artefacts and services produced by different stakeholders. BonsAPPs will offer a series of modular services — such as experimentation, model compression, optimisation, benchmarking, and deployment on hardware and security to solve such challenges. AI developers and platform providers will be accessible on the BonsAPPs services layer to respond to these challenges, leveraging on the Bonseyes AI Marketplace and its ecosystem to deliver end-to-end, containerized, ready-to-integrate and re-usable solutions that will also be integrated and interoperable with the AIoD platform.

The Bonseyes AI Marketplace (BMP) will be used as the exploitation platform to connect researchers, developers, and companies to procure, collaboratively build, and trade AI Applications, facilitating and speeding up collaboration between researchers and industry to develop and deploy AI-based solutions for real-world challenges defined by the industry.

D. DIH4AI

The DIH4AI Project aims to build and connect regional platforms driven by Digital Innovation Hubs (DIHs) and artificial intelligence in order to create a pan-European AI toolbox and experimental facility. The project has established a network of AI DIHs to provide ecosystem-business-technology-transformation services to local SMEs and GovTech companies. It also focuses on developing a Regional-European Interoperability Framework to facilitate bidirectional knowledge flow and data sharing between DIHs and the central AIoD Toolbox, ensuring Findable, Accessible, Interoperable, and Reusable (FAIR) principles for AI assets.

Through the DIH4AI initiative, a methodological framework for cross-DIH collaboration has been established, supported by the Interoperability Framework. Several experiments have already confirmed the interoperability of the platforms, leading to the creation of Interoperable On-demand Platforms for innovative AI solutions in Europe. The Interoperability Framework consists of three levels: a Portal level for cross-platform interoperability, a Data level for data sharing based on Data

[7] https://www.bonseyes.eu/

Sovereignty principles, and a Cloud level for sharing resources. The methodological framework for cross-DIH collaboration involves co-defining schemes and processes with DIH representatives, identifying areas where cross-border collaboration can deliver tangible benefits.

By adopting these tools, existing AI DIHs can collaborate and share knowledge, bridging the digital divide and promoting AI-driven digital innovation in regional sectors. SMEs can become part of a European cluster of DIHs, developing their own competences in AI. The AI Catalogue on the AIoD platform provides valuable assets for SMEs, and the DIH4AI project aims to improve accessibility for SMEs by offering associated services through Digital Innovation Hubs. The project also contributes to the AIoD platform by publishing experiments results and producing content for the Observatory on Society and Artificial Intelligence.

DIH4AI aims to address the challenges faced by SMEs in the AI landscape, ensuring their competitiveness, ethical values, and access to data assets and AI tools. Digital Innovation Hubs have emerged as a European instrument to support SMEs in adopting AI technologies, and DIH4AI aims to establish a link between DIHs and the AIoD service platform to benefit SMEs on a larger scale.

The project supports SMEs by establishing a network of AI-on-demand innovation and collaboration platforms through regional DIHs specialized in AI. These platforms provide ecosystem-business-technology-transformation services to local SMEs and tech governmental agencies. By accessing the services and products offered on the AIoD platform, SMEs can benefit from the resources and expertise available within the DIH4AI consortium.

Overall, the DIH4AI project aims to foster AI innovation, collaboration, and accessibility for SMEs in Europe, creating a strong network of DIHs and promoting the adoption of AI technologies across various sectors.

The DIH4AI project Digital Innovation Hubs have been developing a total of 34 experiments, categorised in a 6-level taxonomy (L-BEST). These services/experiments offered by the DIHs are divided into: L: Legal and Ethical services; B: Business services; E: Ecosystem services; S: Skills services; T: Technology services. DIH4AI currently has 9 technological services being developed focusing on aspects such as Digital Twinning, Technology-based risk management, AI based platforms,etc.

Among the most meaningful technical solutions of the project, it is worth mentioning the "Platform-as-a-service for accountable evidential translation[8]" (PIANAI), which is a novel solution developed by the consortium partner Fortiss, that aims to counter the complexity and dependability challenges resulting from distributed accountability. By using Federated Learning techniques, PIANAI allows to collaboratively train models without transferring data to a centralised location Federated Learning (each entity keeps its data private), and to build new application and models, without having the data leave the premise of each organisation.

Another relevant technological experiment can be found in the AI chatbot developed within the SCALE experiment. In this regard the DIH4AI project has published a scientific paper on the methodology of leveraging intelligent chatbots which support the admission process in universities [13].

E. I-NERGY

I-NERGY [14] will revolutionize the exploitation of AI analytics and data technologies in the activities and businesses related to energy, by providing the means for knowledge extraction, as well as fine-grained business intelligence services to interested EPES (Electrical Power and Energy System) stakeholders. To realize its vision, I-NERGY develops, adapts, and deploys a framework for building next-generation AI-enabled energy analytics, which from a technical point of view consists of:

- An AIoD Interconnection layer, including open APIs for making available I-NERGY technology enablers to the AIoD community;
- A Data Services layer, encompassing modules related to data/models/resources' interoperable sharing among different data hubs;
- An AI Trained Models Layer which will encapsulate the ML/DL/RL models that will be created and provided to be used in different contexts and use cases;
- An AI Energy Analytics Applications Layer, providing a set of AI-powered analytics tools as a service to enable the design and creation of energy analytics applications.

On top of the I-NERGY framework, the project shall define AI energy analytics and digital twins' services, which - grouped under the 'Energy Commodities Networks', 'Distributed Energy Resources' and 'Energy Efficiency and Non-energy related Services' categories will be tested and validated within 9 pilot hubs [15]. Additional business cases will result from the interaction of different EPES stakeholders and software developers via the I-NERGY OCs that will select 25 Technology Transfer projects to be funded under I-NERGY's Financial Support to Third Parties programme. I-NERGY pilots' and TTP use cases range from improved efficiency and reliability of electricity networks operation and optimised management of grid and non-grid owned assets [16] to optimal risk assessment for energy efficiency investments planning and new socially and environmentally sustainable business models.

In line with its objectives, I-NERGY will have an impact on i.) enriching and optimising the AIoD service offer and reinforcing its sustainability and ii.) boosting the deployment of AI-based solutions and services, enabling a larger user community to reap the economic benefits of AI, especially SMEs and non-technology sectors. I-NERGY data-driven AI services will enable energy operators and energy consumers and citizens to gain significant operational/efficiency benefits, while in parallel contributing to integrating larger share of renewable, reducing the environmental footprint of the energy value chain activities [17], mitigating climate change effects,

8 https://aiexp.ai4europe.eu/index.html#/marketSolutions?solutionId=a90b4145-51ec-4345-be5f-21d2c8e9a214&revisionId=c4624a34-affb-417b-b004-d30809697b49&parentUrl=marketplace#md-model-detail-templat

enhancing social cohesion of local communities and creating new 'green' jobs.

With regard to SMEs, and apart from providing cascade funding mechanisms for stimulating SME innovation towards added value AI Services, I-NERGY will introduce novel decentralized open business models that will allow non-traditional industrial stakeholders, (e.g. equipment/smart meters manufacturers, automation companies, SME P2P DLT/Blockchain solution/service providers) to capture value from their extended and scalable data-driven metering infrastructure solutions, whereas it will develop specific third party regulatory compliant Data-as-a-Service solutions that will facilitate smaller energy stakeholders to make available, federate and provide legacy data sets through their platforms.

I-NERGY services cover the entire energy value chain and include the following:

- Predictive Maintenance Service
- Operation planning
- Digital Twin for DER / DPSIM
- Digital Twin for Electrical Communities
- Energy Flexibility Forecasting and Demand Response
- Anomaly Detection in citizen patterns from Smart Meters
- Energy Efficiency Action Plans Evaluation and Prioritisation
- Decision Support for energy action plans and policies
- Forecasting Changes in Solar Radiation

These services and tools will be shared through the AIOD platform services including AIOD catalog and experiments that allow their extension and reuse from third parties and stakeholders.

F. StairwAI

StairwAI envisions enriching the AIoD platform for service users. Although the platform continues to bring substantial advantages for developers, data scientists, and researchers, it has been recognised that currently it is out of reach of many low-technology users. StairwAI's overall objective is to become a stairway to AI for low-technology users, and SMEs in particular. The project will enrich the AIoD platform services through a service layer that enables natural multi-language interaction and performs horizontal matchmaking, i.e., an automatic mapping between user requirements into AIoD platform assets to meet users' business needs. It is anticipated that this service layer will boost the overall adoption of the AIoD platform and cement its long-term sustainability by becoming an indispensable access point to business.

Additionally, in order to enable the adoption of existing AI techniques in SMEs and low-tech industries, it is essential to identify and dimension the hardware resources needed in terms of edge devices, cloud resources, and HPC infrastructure. StairwAI will support a sustainable market building on automatic mechanisms for provider discovery and hardware resource dimensioning that, given an application or service corresponding to a set of AI algorithms and end user preferences, identifies the best algorithms to be deployed and the hardware resource provider(s) to satisfy end user needs. StairwAI will have an impact on providers of hardware resources, including large companies, SMEs, and public institutions, that will find a marketplace on the AIoD platform for monetising their resources and expanding their business models.

StairwAI's two main objectives are to provide a service layer for the AIoD platform and to use AI to enhance the AIoD platform. In particular the service layer will comprise multi-lingual interaction; AI asset discovery; community profiling; people-to-people matching; job offer-demand search; hardware dimensioning; physical resource provider marketplace; and trustworthy AI and fairness. The AI to enhance the platform includes natural language processing and automatic translation; matchmaking and constrained optimization; knowledge representation and ontologies; recommendation systems; and machine learning.

The two main outcomes of StairwAI are to consolidate the AIoD ecosystem by bringing in a larger user community, especially from the non-tech sector, and to reinforce the service layer of the platform. StairwAI will foster the involvement of low-tech users and SMEs in all vertical sectors by easing the use of, and interaction with, the platform. The reinforcement of the AIoD platform service layer is achieved through the development of a multi-lingual interface, an AI asset discovery, and dimensioning the hardware resource needs of the users.

IV. LESSONS LEARNT FROM THE OPEN CALLS (OCS)

All ICT49 projects have been executing financial support to third parties and OC in line with the conditions set out in part K of the General Annexes. A minimum of EUR 2 million in funding per project has been dedicated to it, with grants between EUR 50 to 200k per third party. Financial Support to Third Parties, also known as Cascade Funding, is a solution implemented by the European Commission to distribute public funding. It is available for specific programmes and intends to generate projects having a budget to assist the beneficiaries (third parties), e.g start-ups, scale-ups, SMEs and/or mid-caps, in the uptake or development of digital innovation.

There are some particularities to this solution: funding comes from public money, and the process is closely monitored. However, the project is managed by a consortium of public and private entities that are highly specialized in the particular topic; this ensures that the selected third parties are as competitive as possible in that area. Additionally, cascade funding usually involves not only funding but also (technical and business) mentoring and there is the intention to facilitate contact between all third parties that receive funding. This means that FSTP overall offers the final beneficiary (start-up, scale-up, SME, midcap) funding, mentoring, relevant networking possibilities and the opportunity to implement a technical solution that is relevant to them and could have been more difficult (or impossible) to implement otherwise.

Despite ICT49 projects common vision to foster the adoption of AI via use cases experiments and predefined rules mentioned above, each project defined the OC according to its objectives (with a focus on testing the

service layer of the AIoD platform). Thanks to this diversity, the OCs that were launched by the ICT49 group aimed at different types of beneficiaries leading to a redistribution of FSTP funding to a variety of sectors, types of entities and geographic coverage.

Based on the information gathered from the OCs executed until July 2022 and the information shared in the ICT49 FSTP Working Group by each project's OC Manager, the following lessons learnt have been deduced with regard to the legal type and role of applicants, the TRL and sector/vertical, the OCs' specific requirements, the selection process and type of support, the connection with the AIoD platform, and the OC outcomes:

Fig. 1. Status of the ICT49 Open Calls

Legal type of applicants. Among the 11 OCs that were closed by July 2022, almost all of them focused on companies, particularly SMEs. Some OCs had an option for natural/individual persons to apply. In the cases of AI4Copernicus 2nd OC for Citizens and AIPlan4EU OCs for Use Cases the focus was on defining the challenges/use cases. In the case of BonsAPPs OC for AI Talents, natural persons were allowed to apply as the project was targeting the AI supply side, pursuing to engage AI specialists that would develop AI solutions. Other types of institutions allowed, included Research and Technology Centers (BonsAPPs 1st OC for AI Talents, allowing the participation of research teams) and DIHs (DIH4AI 1st OC for extending the DIH Network ecosystem with DIHs providing technical support).

Role of applicants. An interesting difference can be noticed in the applicants' profiles as per the role. Each ICT49 project defined its OC scope using 2 main roles: *i.) Technology provider / Innovator*: a group of open calls focused on finding an innovator that would develop AI solutions. A Technology Provider could be defined as any entity which designs, (re-)builds, programs, installs, modifies, distributes, or supplies systems and/or technology for AI. AI4Copernicus OCs for SMEs, AIPlan4EU Innovators OC, BonsAPPs AI Talents OC, DIH4AI 1st OC, I-NERGY 1st OC had a focus on this role. *ii) Adopter / Use Cases / Challenge owners*: a second group of open calls focused on defining the challenges/use cases that could be solved by Innovators. Such applicants are companies interested in improving their products, services, or value chains with AI / defining the challenge. AI4Copernicus OCs for Citizens, AIPlan4EU Use Case OCs, and StairwAI OC for low-tech SMEs were defined by their focus on this role.

Some projects conducted additional OCs to define the challenge that would be solved by innovators selected in another type of OC (AI4Copernicus, AIPlan4EU). Other projects looked for applicant projects involving directly Innovators with institutions that could support them in AI Solutions development (DIH4AI). Another example is BonsAPPs where AI Talents developed AI Solutions to be reused in an upcoming call for Adopter SMEs.

TRL. TRL was applied mostly in the open calls for Technology Providers type of applicants. Only 2 out of the 6 ICT49 projects applied the filter for the TRL level.

Sector/Vertical. The range of sectors is quite wide. Those outstanding in many projects are Energy (AI4Copernicus, I-NERGY) Healthcare (AI4Copernicus, BonsAPPs), and Manufacturing (BonsAPPs, DIH4AI). AIPlan4EU and StairwAI applied no sector focus. In AIPlan44EU the key was to apply AI planning to a wide variety of sectors, whereas in the case of StairwAI, which aimed to reach low-tech SMEs, the sector was wide open.

OC Specific requirements. It is important to underline that some OCs had specific requirements for applicants that allowed them to narrow down the applications. In most cases, the scope was focused on testing the tools that are being developed by each project for the AIoD platform. In particular: *AI4Copernicus* presupposed the use of technologies available in the AI4Copernicus platform. *BonsAPPs* had as requirement the development AI Solutions with Bonseyes Marketplace tools. *AIPlan4EU* pursued the creation of a robust collection of planning engines within the Unified Planning Framework (UPF). *DIH4AI* required the testing and validation of the DIH L-BEST Service Pipeline in the "AI Providers" (and, possibly, "AI Users") Customer Journeys. *StairwAI* presupposed the testing, validation and feasibility assessment of AI resources offered by StairwAI to improve low-tech SMEs products, services or value chains. *I-NERGY* has as requirement the development of building blocks and applications for new AI algorithms/services and small-scale experiments (prototypes) using own resources that address the developments and implementation of technology and systems applicable to a set of specific cross-sectorial challenges in the Energy Sector.

Selection Process. All projects applied the obligatory stage of eligibility and external evaluation. Most of them further organised a Consensus Meeting. Additional phases included optional interviews (AIPlan4EU) and a Jury Day (StairwAI). Many projects have underlined that the process of signing the Sub Grant Agreements with the beneficiaries has been very time-consuming.

Type of support. All OCs included different types of support, with the particularity of DIH4AI in which direct support was provided by the DIH(s) involved in the applicant consortium. Available funding has been quite similar in most projects (60k EUR per ticket per third party - a justification would be needed otherwise). Grants higher than this amount (e.g., AI4Copernicus or DIH4AI) involve

consortia in which the grant is divided so that the amount of 60k EUR is never exceeded. BonsAPPs and StairwAI have implemented voucher procedures. In those cases, beneficiaries (Adopters) have been able to select AI Talents and HPC Cloud services from a validated pool of suppliers. Those services have been contracted and paid directly by Adopter and reimbursed at the end of the project. As per support programmes, the typical duration is 6 months with the exception of AI4Copernicus whose programme lasted 16 months.

Connection with AIoD. An important note was made concerning the commercial use of the applications to be developed that had to be defined already at the OC stage.

Open Call Outcomes. So far, all projects achieved satisfactory results in terms of applications submitted that allowed to select the highest potential applicants. The 1st BonsAPPs OC for AI Talents, StairwAI OC for Pilots and 1st I-NERGY OC for Technology Transfer are the ones with the highest number of applications submitted.

When reviewing OC results, it is important to take into account the type of applicant. It can be observed that OCs for consortia (AI4Copernicus, DIH4AI) have had a lower number of submissions. Thus, is reasonable as when at least 2 companies have to be involved, it is more complex to create a proposal. Consortia OCs can be compared to the rest of OCs for individual companies (BonsAPPs, StairwAI) in terms of how successful they have been if one considers the number of SMEs engaged in the OC instead of the number of proposals submitted.

It is further relevant to consider the availability of the proposed solutions and their potential for reuse. All projects have specifically called for unified systems, the production of building blocks to be readily available for other uses, or other solutions that ensure the effectiveness of the proposed solutions, the interoperability and the ease of integration for future users.

V. Conclusions

This paper analyses the opportunities and challenges that derive in the context of introducing AI solutions in SMEs in different sectors of activity by reviewing the research design, methodology and expected results out of six Horizon 2020 European projects. The paper presents how these projects are enhancing the AIoD platform by mobilising the European AI community to support businesses and sectors in accessing expertise, knowledge, algorithms and tools for successfully applying AI and thereby generating market impact.

The results from the OCs reveal that the AIoD platform has relevant potential, yet its strategy and vision must be defined to improve service offers and OC descriptions. Without a clear vision, there is the risk that it ends up as a catalogue of outdated or not reusable assets, when it could be an attractive environment for applicants. Moreover, creating a joint ecosystem of SMEs in need of support after their participation in the OC projects to be sustainable in a synergistic way with the growth of the AIoD platform and the AI4Europe project, and enabling long-term planning for joining world-class or organising relevant events, while also allowing links with key European SME Associations would be particularly beneficial for OC participants. Last but not least, joint efforts could go beyond dissemination and platform building towards data and tools exchange or running joint calls as happened between BonsAPPs and StairwAI.

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