SMART4ALL

SELFSUSTAINED CROSS-BORDER CUSTOMIZED CYBERPHYSICAL SYSTEM EXPERIMENTS FOR CAPACITY BUILDING AMONG EUROPEAN STAKEHOLDERS

Co-funded by the Horizon 2020 programme of the European Union

WHITE PAPER

SMART4ALL Project Task Forces in Action: Overview, Achievements & Impact in South & Eastern Europe

Coordinator

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΛΟΠΟΝΝΗΣΟΥ
UNIVERSITY of the PELOPONNESE

voros@uop.gr

www.marketplace.smart4all-project.eu

Abstract

This white paper delves into the pivotal role played by Task Forces within SMART4ALL project dedicated to main four pillars, namely the **digitized transportation, digitized agriculture, digitized environment**, and a myriad of sectors encapsulated under "**digitized anything**". By examining the role, initiatives and tangible outcomes of each Task Force, this paper illuminates the profound impact on both the SMART4ALL project developments, the **Marketplace** dynamics and the **vision** of the SMART4ALL project for the future.

Executive Summary

The SMART4ALL project aims to bring innovative technologies like **CLEC CPS** and **IoT** to various sectors, focusing on **underrepresented businesses and sensitive social groups**. It has established **task forces** for Digitized Transport, Agriculture, Environment, Anything, and **SMEs**, each playing a crucial role. These task forces analyze, monitor, and facilitate activities, including **matchmaking** for collaborations and providing **coaching** to PAEs. Key achievements include the development of tools like the **SMART4ALL Assistant for SMEs' digital transformation**, a plethora of **Marketplace artifacts**, and successful **funding** for projects. Challenges such as IoT affordability, connectivity, data management, and cybersecurity were identified and addressed. The project's impact spans technology transfer, SME empowerment, collaboration formation, skill development, economic growth and job creation across Europe's innovation landscape, showcasing a successful **bridge between academia and industry**. Lessons learned are domain-specific, with a focus in this summary on the broader, generic challenges identified.

Contents

Project Background & Objectives

SMART4ALL represents an **extensive network of Digital Innovation Hubs** for boosting technology and business development in South, Eastern and Central Europe.

SMART4ALL strengthens the capabilities of European stakeholders via the development of **self-sustained, cross-border experiments** that transfer knowledge and technology between academia and industry. The project focuses on CLEC CPS and the IoT, uniting a distinct set of features to harmonize diverse cultures, policies, geographic regions, and application domains under a shared vision.

Over the past 4 years, the project has achieved the following main objectives:

1. **Bringing innovative** CLEC CPS and the IoT **technologies** to underrepresented business sectors, with a focus on innovations that have the potential to transform production, security, transportation, agriculture, and virtually all aspects of modern industrial activity.
2. Unlocked the potential of South-Eastern parties' by connecting them to **investors** across value chains and regions, aiming to accelerate CLEC CPS/IoT solutions **development and industrialization** by completing the implementation of a program of (PAE) that provided **financing** to knowledge-intensive SMEs with focus on CLEC CPS and the IoT and with involvement of SEE SMEs and their collaboration with other SMEs and research institutions across Europe and in diversified business sectors.
3. Created and provided **innovative tools** to enhance the utilization of CLEC CPS and IoT technologies across Europe. This included offering a

Marketplace (MaaS - Marketplace as a service), comprehensive documentation and application notes, access to funding, networking opportunities and digitalization roadmaps.

4. Ensured the **long-term sustainability and expansion** of SMART4ALL experiments and DIHs cluster beyond the project duration. This was achieved by facilitating the **brokerage** of Pathfinder Application Experiments (PAEs), attracting paying customers for commercial services post-project, continuing to assist beneficiaries in accessing financing for later-stage development, and promoting the MaaS platform within the wider ecosystem.

5. Bringing innovative CLEC CPS and the IoT technologies in the lives of sensitive social groups, aiming to enhance the **independence and inclusion of vulnerable individuals** facing challenges related to age, gender, disability, ethnicity, or other factors.

6. Supported the **European Commission Digital Skills & Jobs policy**, by focusing on underrepresented sectors of the European economy and underfunded areas, such as **South and Eastern Europe**. The project intended to create **employment opportunities** for people, SMEs and companies that wish to enter the digital era through the consortium, that includes Universities and Research institutes from Central, South and Eastern Europe which in turn can play a critical role in **bridging the digital gap**, not only in the specific areas, but in Europe as well.

Project Task Forces and Key Achievements

SMART4ALL established **four Task Forces** (specialized groups of experts in both the supply and demand side) at the outset of the project, dedicated to the thematic pillars of SMART4ALL. The role of the four Task Forces is to customize SMART4ALL services to each thematic pillar supporting the whole

value chain: from ideation and matchmaking, to prototyping and exploitation support.

The four task forces are: **Digitized Transport, Digitized Agriculture, Digitized Environment, Digitized Anything** and one supporting task force for SMEs (see Figure 1).

Digitized Transport Task Force (DTTF)	**Digitized Agriculture Task Force (DAgTF)**
Leader: DLR. Members: TALTECH, PUT	Leader: ATB. Members: REZOS, FTN
Digitized Environment Task Force (DETF)	**Digitized Anything Task Force (DATF)**
Leader: S&C. Members: PSP, MTU	Leader: BME. Members: UPZ, MRG, UPV
SMEs Task Force (STF): SEEU (Leader), AVN, MAR, DPN, RP	

Figure 1 - The four task forces of SMART4ALL with the supporting SMEs Task force

The four Task Forces of SMART4ALL are tasked with establishing a set of MaaS offerings tailored to each thematic pillar of SMART4ALL.

The responsibilities of DTTF, DAgTF, DETF, and DATF were to **implement and monitor the technical, financial and Business Development** aspects for each of the four thematic areas of the SMART4ALL project. The second main role of these Task Forces was to execute targeted brokerage activities between potential third party applicants, to **seek third party applications with high impact potential** (e.g. to maximize the participation of SMEs and mid-caps in the open calls), and to **bring together applicants with complementary expertise.**

The role of the **SMEs Task Force** (STF) was to oversee the SMART4ALL activities and provide specific technical expertise related to PAE execution and Marketplace. Also, STF did provide feedback to the project from the start-up and SME point of view.

Throughout the project lifespan, the leaders of the four Task Forces gathered feedback regarding the added value of the Marketplace and

offered insights on the Marketplace services and tools tailored to their respective verticals.
In the subsequent section, key achievements and success stories of specific Task Forces are outlined.

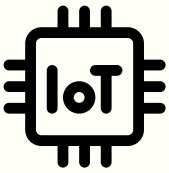
Digitized Transport

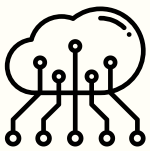
The digitized transport taskforce has its core areas in (commercial) **transportation of passengers using innovative and novel technologies.** These technologies encompass various domains such as land, air, water, and space. The following sections discuss the vision, market analysis, and value chain analysis for the thematic area of Digitized Transport.
The goal of the digital transportation transformation is to **empower emerging and established institutions and companies in Southeast Europe**. This involves identifying key industry sectors, the types of stakeholders within these sectors, and technologies that can provide added value to these stakeholders. These stakeholders are matched with established partners (i.e. from the European Union). The process involves identifying key challenges in the context of digitized transportation for said stakeholders, addressing these challenges with suitable tools, and identifying the services which will propel the stakeholders and release their potential for a digital transformation.
Opportunities within digitized transportation can be realized by engaging key stakeholders, including Original Equipment Manufacturers (OEMs), Tier-x Suppliers (Tier 1, 2, and 3), and Digitized Technical Providers (Software & Hardware), across various industry sectors.

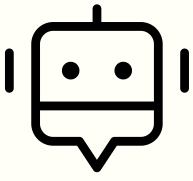
These sectors include:

- Automotive
- Aeronautical
- Maritime
- Rail
- Logistics
- Mobility

Key enablers of digitization in Digitized Transport







Several technologies are driving the digitization of the transport industry. These include:

- **Internet of Things (IoT)**: IoT devices such as sensors and GPS trackers are being used to track shipments in real-time, optimize routes, and monitor vehicle health.
- **Big Data and Analytics**: The vast amount of data generated in the transport industry is being analyzed to optimize operations, improve efficiency and predict maintenance issues.
- **Artificial Intelligence (AI) and Machine Learning (ML)**: AI and ML algorithms are being used for tasks such as predictive maintenance, route optimization, demand forecasting, and automating customer service.
- **Blockchain**: Blockchain technology is being explored for its potential to improve transparency, security, and traceability in supply chains and logistics operations.

Role of the Digitized Transport Task Force in SMART4ALL project

The role of the Digitized Transport Task Force in the project was to facilitate initiatives and activities pertaining to the digitized transport domain. This involved analyzing existing tools, conducting research, and assessing the overall ecosystem. Furthermore, the Task Force identified several opportunities and challenges that could benefit future projects within the digitized transport sector. The expertise has also been provided in the form of coaching to PAEs as well as contribution to the Marketplace and other activities related to the project SMART4ALL.

Success Stories in Digitized Transport

The **DIHs** working in the digitized transport area could offer a **collaborative ecosystem** where stakeholders can access expertise, validate technologies, collaborate on innovation projects, access market opportunities, develop skills, and shape the future of transportation through digital transformation. By providing a **comprehensive suite of support services** and **fostering an open innovation culture**, DIHs could catalyze innovation and drive positive impact across the entire transport value chain.

During the lifespan of the project, there have been several **success stories** within the Digital Transport domain. SMART4ALL has funded external projects in three rounds through transfer experiments initiatives (cascade funding) called KTE (Knowledge Transfer Experiments) with a duration of 3 months, FTTEs (Focused Technology Transfer Experiments) and CTTEs (Cross-domain Technology Transfer Experiments) both with a duration of 9 months. Detailed information about all domains can be found in **SMART4ALL home page (www.smart4all-project.eu)** under Winner's menu option. **Videos** from successful stories can be found under **SMART4ALL Youtube channel.**

In addition to external funded projects, there have been internal PAE (Pathfinder Application Experiments).

Below, one can find several links (to SMART4ALL Youtube channel and web page) to some selected funded projects where the reader can jump in to get further project details and find contact information as well:

- **TempSens** - Digitized Transport 2nd FTTE - Development of innovative RFID temperature based system in agri-food cold supply chain: https://youtu.be/aOttdeFdYWw
- **TUNNLL** - Digitized Transport 2nd KTE - A next-generation mass transit system: https://youtu.be/bQfjZz1rzHM
- **Ship-mAInt** - Digitized Transport 3rd KTE - Application of an Artificial Intelligence data analytics in the Ship Maintenance Prediction: https://youtu.be/Y214AkDgxfM
- **ITHACA** - Digitized Transport 3rd CTTE - AutomatIon of THe electricAl vehicle ChArging: https://youtu.be/nSEHqOrCHpA

Identified Challenges for Digitized Transport

The following technical challenges relevant to SMART4ALL have been identified:

The OEM challenges

Original Equipment Manufacturer (OEM) challenges lie in their ability to evaluate and integrate emerging technologies and trends at early stages, often at low Technology Readiness Levels (TRLs), which can potentially provide a competitive edge. Creating generic solutions to serve a range of diverse projects can be challenging. Examples include the necessity for a reference, reusable, and shareable infrastructure for testing Advanced Driver-Assistance Systems (ADAS) in the automotive domain, or for developing cybersecurity measures for avionic systems in the aviation domain. These infrastructures are characterized by the multitude of systems they need to encompass.

Supplier challenges

Supplier challenges consolidate around evaluation and integration of middle TRL level technologies. The deficiency here lies in pre-evaluation of potentials to invest. Although there is a vast number of possibilities that enable research organizations and universities working together with industry, the industrialization of the research, or low TRL technologies is still the biggest challenge.

Start-ups in transportation

For the startups in the transportation domain, a common challenge is navigating the extensive industry network, which often makes it difficult to identify the right contacts for business development. An illustration of this challenge is the presence of a few startups offering tools for embedded high-performance computing. Despite this, the adoption and

use of these tools remains minimal.

Transportation is a regulated domain

In spite of the friction in this very fast changing technology landscape, the regulatory bodies are under the challenge to identify the impacts of the new technologies to safety and security. While there are cases where they move very fast, and even take the lead, like AI in aviation, it usually takes longer than the expectation of the industry to find the means of compliance for new technologies for making them safe and secure.

Cybersecurity Threats

With increased digitalization, the transport industry faces heightened cybersecurity threats. The transport industry relies heavily on digital systems for tracking shipments, managing logistics, and processing payments. Cyberattacks such as data breaches, ransomware attacks, and phishing attempts pose significant risks to the integrity and security of these systems. Companies must invest in robust cybersecurity measures, including encryption, firewalls and intrusion detection systems, to safeguard their digital infrastructure and sensitive data.

Data Privacy Concerns

The digitized transport sector generates vast amounts of data, including customer information, shipment details, and operational data. Protecting the privacy of this data is paramount, especially with the implementation of regulations such as the General Data Protection Regulation (GDPR) in the European Union. Companies must adhere to strict data protection regulations and implement measures to secure sensitive information, including data encryption, access controls, and data anonymization techniques.

Skills Shortage and Training Needs

The rapid pace of technological innovation in the digitized transport sector has created a demand for skilled professionals with expertise in

areas such as data analytics, cybersecurity, and software development. However, there is a shortage of qualified talent with specialized digital skills, leading to recruitment challenges and talent gaps within the industry. Companies must invest in training and development programs to upskill existing employees and attract new talents with the necessary digital competencies.

Vision for the future in Digitized Transport

The vision for digital transformation within the digitized transport taskforce is expressed as leveraging opportunities around (commercial) transportation of passengers with novel technologies.

The **main services envisioned** for digitized transportation are **shareable infrastructures/testbeds** to test, validate and demonstrate advanced technologies, connecting with startups, research centers, and universities to develop innovative solutions that match the stakeholders needs and challenges, and **mentoring and coaching for public funding.**

Potential technologies that could leverage opportunities and drive transformation in the digitized transportation sector include:

- Air Vehicle Simulator (AVES) for cutting edge flight research
- ARTIS - Autonomous Rotorcraft Test bed for Intelligent Systems, for the development and evaluation of technologies and components for the automatic and autonomous flight
- In-flight Systems and Technology Airborne Research (iSTAR), for advancements in the digitalization of air transport
- AIM, which is a research infrastructure for future intelligent transportation and mobility services.

- Test bed Lower Saxony for Automated and Connected Mobility.

Digitized Agriculture

The digitized agriculture taskforce focuses on leveraging the opportunities for **farmers**, **workers and other stakeholders affiliated with agriculture**. The following sections discuss the vision, market analysis, and value chain analysis for the thematic area of digitized agriculture.

The aim for a digital agriculture transformation is to help farmers, workers, and other persons affiliated with agriculture by identifying the key stakeholders and the technologies that can offer an added value to the agriculture sector. The process involves identifying key challenges in the context of digitized agriculture for those stakeholders, addressing these challenges with suitable tools, and identifying the services which will propel the stakeholders and release their potential for a digital transformation.

The values the general project carries are the following:

- Innovation
- Digitalization
- Digital transformation
- Synergism
- Capacity-building Funding

Opportunities within digitized agriculture can be realized by engaging key stakeholders, including technology providers, farmers and technology developers, across various industry sectors. These sectors are:

- Crop production
- Livestock farming
- Agriculture machinery/equipment

Key enablers of digitization in Digitized Agriculture

When attempting to identify key enablers in Digitized Agriculture, it's crucial to recognize the **diversity of the economic landscape within the agricultural sector**. Studies have highlighted several drivers contributing to this variability, such as:

- education and training of farm population (e.g. digital skills)
- demographics of farm population
- environmental and climate conditions
- governmental policies and investments
- farm size

Therefore, the current state of digitalization in agriculture also varies significantly and thus the expected key enablers. In general, farming today still relies to a large degree on traditional and expert knowledge rather than on automated processes. Accordingly, one technology that can be expected to have a significant impact on digitalisation in agriculture is the **emergence of foundation models in deep learning** that include or are tailored to agricultural use cases, as these can provide the required knowledge and expertise. The advantage of foundation models is that they, once trained, can be made available and provide value e.g. by providing **decision support with as little hardware as a smartphone**. At the same time, they can drive **high-end automation and robotics**, providing the knowledge that used to be expert knowledge in a digital form. The key enabler for this technology itself is the wider availability of **open datasets** and the adoption of **open data policies** in the agricultural domain. In addition, **training and education on digital technologies** will also be essential as it is a key factor for productivity of agricultural businesses. A task that might again be facilitated by the advances in AI through e.g. easily understandable presentation of information and interaction with users. Another major factor that can address both technical advances, robustness and usefulness, as well as the training of farmers in digital technologies is the inclusion of farmers in the development processes of new technology through tools like **co-creation, living labs and real-world application farms** for **continuous and integrated testing**.

Role of the Digitized Agriculture Task Force in SMART4ALL project

The Digitized Agriculture Task Force was established to oversee the progress of the project in the realm of digitalization within agriculture. Among its primary responsibilities was monitoring project activities and ensuring the fulfillment of agriculture-related Key Performance Indicators (KPIs) and deliverables. It closely tracked the progress of funded Pathfinder Application Experiments (PAEs) and applications received through open calls in the field of digitized agriculture, assessing their technical and economic readiness and potential impact.

Additionally, the Task Force played a pivotal role in utilizing insights gained from this monitoring process to **identify pain points and derive actionable strategies**. For instance, it closely monitored application numbers and the success rates of applications specifically within the agricultural domain. An observation made early on was the relatively high number of applicants from non-South-Eastern Europe (SEE) countries, such as Germany, with some submissions lacking a partner from an SEE country.

In response, the Digitized Agriculture Task Force opted to shift its dissemination strategy in non-SEE countries. Instead of broadly promoting the open calls, efforts were targeted towards potential applicants with existing connections to SEE or those seeking to establish such connections. A stronger emphasis was placed on matchmaking and networking opportunities in these dissemination endeavors.

Moreover, when application rates were lower than expected, members of the Task Force intensified their role as brokers for matchmaking, utilizing the matchmaking system integrated into the SMART4ALL platform. This proactive approach aimed to enhance collaboration and partnership formation within the digitized agriculture sector, ensuring the successful development and implementation of innovative projects.

An important feedback we received, supported by statistics from open call monitoring, is that a personal contact that existed or was initiated prior to the application is more likely to result in a completed application compared to one brokered solely for the purpose of an open call application. Additionally, the Digitized Agriculture Task Force organized and/or contributed to webinars and workshops focused on topics such as digitized agriculture and successful application writing. These events aimed to provide guidance and support to potential applicants, leveraging the SMART4ALL marketplace and Moodle webpage to make this information widely accessible.

Success Stories in Digitized Agriculture

During the lifespan of the project there have been several success stories within the Digital Agriculture domain. As previously noted, SMART4ALL has funded external projects in three rounds and there have been internal PAEs (Pathfinder Application Experiments).

Below, one can find several links (to SMART4ALL youtube channel and web page) to some selected funded projects where the reader can jump in to get further project details, the reader will find contact information as well:

- **MilkTrack** - Digitized Agriculture 2nd FTTE - NIR sensor & tracking platform for daily diary processing: https://youtu.be/pUokeqKOyws
- **DIGIPLANT** - Digitized Agriculture 2nd KTE - Digital plant nutrition services for farmers in the SEE: https://youtu.be/22Pb-XUu_1M
- **GREEN IoT** - Digitized Agriculture 3rd KTE - Automated IoT-based Greenhouse management system: https://youtu.be/AoDcmfPoIQ8
- **ViTech** - Vision Technology for CPS in Peri-urban Agriculture by FTN & MoDrone: https://youtu.be/nxy4q-KH7Xg

Identified Challenges for Digitized Agriculture

The challenges for digitalisation in agriculture are also manifold and vary by region and type of businesses or farms. A general problem in many use cases is the complexity of the given problems (natural, semi-structured to unstructured environments, with dependencies on various uncontrolled variables). Hence, the technology is frequently at the forefront of innovation, which often leads to higher development costs and, consequently, higher end-user prices. At the same time, profit margins for agricultural products are often low, limiting the options for investment in new, potentially unproven technologies. Another factor at play here, which ties into the previously mentioned point, is the necessity for robustness in these advanced technologies. Many digital technologies and especially those that are expected to have the highest economical impact

in agriculture aim at reducing manual effort and thus the requirement for workforce. On the other hand, operations like harvesting or fertilization are time-critical. This situation has led to the current scenario where digital technologies are frequently utilized for decision support rather than complete automation. The availability of technical support becomes crucial, especially considering that complex systems that are challenging to replace or repair often face skepticism. Furthermore, several obstacles hinder the widespread deployment of any solution in this context. These include the absence of standards, low backward compatibility, as well as geographical, climatic, and socio-economic dependencies inherent in agricultural practices. Moreover, general challenges that are applicable across various domains of digitalization also come into play. These include the ability to integrate data of varying quality, temporal and spatial scales, the capability to derive meaningful insights from the vast amount of data and the availability of basic connectivity infrastructure.

Vision for the future in Digitized Agriculture

One way to increase sustainability and efficiency in agriculture is to **shift toward a technology driven, knowledge-based agriculture**. Performing more frequent monitoring to identify timely and locally precise interventions with maximal positive impact to the yield can **reduce environmental impact while maximizing efficiency**. That implies to capture detailed soil and crop data, to analyze this data to decide on the optimal intervention and to carry out precision interventions specifically targeting small plots or even individual plants. Automation of the 'dull and dirty' tasks not only improves working conditions but an also help to support equality in

the field. Achieving this requires a combination of expert domain knowledge in agriculture and in various technical fields like **sensor systems and interface technology**.
SMART4ALL and the Digitized Agriculture Task Force is in the unique position of being able to provide expertise or access to experts from these fields through the extensive network and ecosystem of SMART4ALL. It gives access to this expertise through services like coaching, matchmaking and the marketplace, which can give start-ups and small and medium-sized enterprises an advantage when developing and monetizing new inventions. Through the infrastructure of its partners, it can facilitate testing and proving the robustness of new solutions and products. The Marketplace can also serve as a repository for data exchange and sharing either through direct hosting, or linking of existing data repositories.

Digitized Environment

The digitized environment taskforce focuses on areas in infrastructure, public places, and the general environment with novel technologies. These technologies stem from the domains of the general environment. The following sections discuss the vision, market analysis, and value chain analysis for the thematic area of the digitized environment.
The aim for a digital environment transformation is to pinpoint key industry sectors and technologies that can provide added value to these sectors.

This process entails identifying primary challenges within the context of a digitized environment, addressing these challenges with appropriate tools, and identifying services that will drive digital innovation for an enhanced digitized environment.

The values the general project carries are the following:

- Innovation
- Digitalization
- Digital transformation
- Synergism
- Capacity-building Funding

Opportunities within a digitized environment can be realized by activating matching stakeholders, such as Technical Providers (SW & HW), Service providers, and Government and Public Institutions from the different industry sectors. These sectors are:

- Industry 4.0
- Smart Buildings & Smart Cities
- Smart energy grids
- Environment monitoring

Key enablers of digitization in Digitized Environment

Key enablers for a more sustainable and efficient environment encompass a range of factors, from operational enhancements to sustainability initiatives. Operational procedures in the aforementioned sectors are well-established; however, achieving traceability and fine-tuning of procedures can be challenging without the means to make visible all the details impacting the entire procedural chain. To achieve fine-grain visibility of the procedural chain, two approaches can be taken: **acquiring real-life data** or **simulating procedures to match reality**. In both cases, a substantial

amount of data is generated, necessitating the creation of analysis tools or frameworks - whether tailored specifically for the task or more generalistic in nature - to comprehend how to enhance each environment.
Taking profit of above sector division, let's highlight in a more fine granularity the enablers and its triggers:

Industry 4.0: Main driver for industry is to enhance productivity of the manufacturing process, as well as the supply chain. First step is **data collection through the use of industrial and IoT devices**, then a myriad of technologies, mainly based on artificial intelligence, enabling the analysis of the data collected to derive insights on the behavior of manufacturing processes, not only product optimisation in terms of throughput while maintaining quality, but also important is to avoid disruptions of the manufacturing gear through establishment of preventive actions. Besides **data collectors**, **augmented and virtual reality** are playing an important role to enhance user interaction within the industry.

Smart buildings: Main drivers for this sector are those technologies that enhance their operation and sustainability while maintaining (or even enhance) occupants comfort. As above, data collection through IoT devices that makes visible user behavior, in addition to known building day-by-day procedures are crucial for the establishment of automation technologies.

Smart Energy Grids: Main driver for this sector is the ability to supply energy at the lowest cost possible, thus providing energy to its clients at the best (low) price possible. This is enabled thanks to those technologies that allow prediction of energy consumption (energy prognosis), manage peak demands and maintain infrastructure obsolescence away in time. Other key drivers are towards the enablement of the prosumer market. The key technologies are thus ones enabling real-time data collection from **smart meters, sensors, IoT devices, digital controls** coupled with advanced AI algorithms.

Environment monitoring: Main driver for this sector is the ability to analyze the current state of the air, water and soil in order to propose improvement measures, or to track a particular pollutant over a period of time. Technologies that enable this sector are then those that monitor environmental parameters like humidity, temperature, noise and air pollution (for instance parameters specially of interest in cities are CO, PM, NOx among others), wastewater and garbage, emissions from industrial areas and run-off from agricultural areas. IoT devices, real-time monitoring and artificial intelligence data driven algorithms are among others technology enablers for this sector.

Role of the Digitized Environment Task Force in SMART4ALL project

The role of the Digitized Environment Task Force in the project was to facilitate initiatives and endeavors within the digitized environment domain.

This involved thorough analysis of existing tools, research, and the broader ecosystem. Furthermore, the Task Force identified various opportunities and challenges that could be advantageous for upcoming projects in the digitized environment sector.

The Task Force also provided valuable expertise through coaching for Pathfinder Application Experiments (PAEs) and contributed to the Marketplace and other SMART4ALL-related activities. Throughout the project implementation, the Task Force closely monitored the progress of digitalization initiatives in the environment sector. This included monitoring activities within the project to ensure the achievement of environment-related Key Performance Indicators (KPIs) and deliverables.

Additionally, the Task Force closely tracked the advancement of funded Pathfinder Application Experiments (PAEs) and applications received through open calls within the digitized environment domain. This monitoring encompassed evaluating their technical and economic maturity, as well as assessing their impact on the sector.

Success Stories in Digitized Environment

During the lifespan of the project there have been several success stories within the Digital Agriculture domain. As previously noted, SMART4ALL has funded external projects in three rounds and there have been internal PAEs (Pathfinder Application Experiments).

The subsequent section provides links (to SMART4ALL Youtube channel and web page) to some selected funded projects where readers can access further project details and find contact information:

- **AWSMS** (Internal PAE - UMT): Youtube
- **TONI-AI** (1st CTTE): Youtube and Presentation from the "Success stories" subsection on the Open Calls section of the website
- **Real-time detection of pedestrians using Thermo-Vision** (Internal PAE - PUT): Youtube
- **ArtWater** (2nd KTE): Youtube. Project description
- **ERMES** (2nd CTTE): Project description and Presentation on Genova Smart Week 2022 (Youtube)
- **BUBATT** (Internal PAE): Youtube
- **HARC** (Internal PAE - UPV): Youtube
- **ASPIRE** (3rd KTE): Youtube
- **Marinara** (2nd KTE): Youtube and Presentation on the Innovation Space
- **dFlow** (3rd KTE) : Project description
- **InjectStrap** (3rd KTE) : Project description
- **Uwabeo** (3rd KTE) : Project description
- **BC4GRID** (3rd CTTE) : Project description

The reader can explore more details about the aforementioned projects, along with others, in the latest Digitized Environment Newsletter issued here. Additionally, information about these projects can be found in the TV coverage of a special session held in Tirana on February 23rd, 2024, focusing on the convergence of Digitized Environment and Agriculture.

Identified Challenges for Digitized Environment

The identified challenges within the digitized environment can be summarized in:

- **IoT hardware and software:** Sensing solutions need to be affordable, scalable, and interoperable for large-scale deployment.

Combination with **digital twins** in different industrial applications and environment monitoring are of interest while **new autonomous devices** are being developed to visualize more fine granularity within sector procedures.

- **Connectivity**: More research is needed to develop communication technologies and protocols that consume less power and increase the range of communication, for example in buildings where coverage could be decreased due to internal/external walls or long coverage in case of remote installations in environmental monitoring.
- **Data storage**: The quantity of data produced is large and requires the support of cloud services. Managing huge amounts of data from IOT devices while ensuring privacy is a big challenge for IOT solutions.
- **Data collections and analysis**: Software platforms must allow the acquisition of data from heterogeneous sources (modbus, BACnet, OPC, RestAPI, etc.) and its combination with data acquired from external services (for instance weather forecast, traffic and navigation systems, etc.). Data analysis from the different information sources, using AI techniques will allow to identify issues, patterns, deviations, faults and opportunities for operational improvements and cost reduction.
- **Interoperability**: Most of the existing commercial IoT platforms of traditional market players are proprietary solutions without a common interface for sharing data.
- **Cybersecurity**: Preventing intrusions (to data gathering systems and actuation devices as well as automation engines), illegal access from an external actor or information manipulation is key for trustability of technology.
- **Sustainability**: The environmental footprint of the technological solutions is an important factor to consider while developing and

deploying them. Concepts like circular economy are increasingly being applied to this sector in addition to the environmental regulatory requirements.

- **Difficult for non-IoT expertise**: Installing and maintaining IoT devices requires lots of investment and specialists.

In addition, following specific challenges for monitoring have been identified which makes global commercial exploitation of digitized environmental monitoring technologies more cost intensive and a barrier for market entry:

- **Environment monitoring** requires the use of a large variety of sensors to measure different environmental parameters
- **Power supply** requires a larger and more expensive infrastructure. Battery life of autonomous sensors remains low depending on the application and frequency of usage
- **Design of complex sampling and measurement operations** are needed to ensure that monitoring results are accurate and can match those of analytical instruments
- **Segmentation of the market** along with diverse monitoring and sampling methods are a challenge for manufacturers and commercializing companies
- **Inconsistencies in regulations and standards** in various countries regarding the manufacturing of pollution monitoring products
- **Lack of uniform global air, water and other environmental quality standards** and certification requirements. For example, the standards for pollutants in the EU as per the European Environment Agency are different compared to the ones specified by the US EPA. This is in addition to the distinct certification requirements for sensors in different parts of the world.

Vision for the future in Digitized Environment

Based on feedback and inputs from various internal stakeholders, the following common tools were identified to address the challenges described previously:

- **New IoT hardware and software:** There is an important demand for new sensors for assessing quality in air, soil, and water, both indoors and outdoors, noise detection, odor emissions, pesticides, chemicals (large variety), dioxin, temperature etc. New kit tools are needed for creating basic IoT prototypes using microcontroller boards
- **Data Transmission**: There is a need for more powerful devices and communication channels. Need for expertise on different types of communication systems: wifi, low-pan, mobile, Lora, BT, etc.
- **Data storage**: System to tackle a myriad of data, formats and information to enable easy to process it after storage
- **Data analysis**: Open-source solutions for creating IoT platforms which integrate different IoT devices that use different communication protocols and formats and must allow functionality like: Data analytics, Data collection, Data management, Data visualization, Connectivity management, and Device management
- **Interoperability and cyber security**: Need knowledge for developing standard protocols for communicating different IoT platforms, while experts are needed for the creation of strong security mechanisms at booth IoT platforms and devices
- **Make it easy for newcomers**: IoT starter kits makes it easy to introduce IoT into this sector for the creation of proof of concepts

- **More public and private investment** to set up regional and national digital innovation hubs to promote further innovation and exchange of innovation technologies between universities and industry for their wider exploitation
- **Establish uniform environmental standards** across regions and countries and their strict enforcement by governments. This will foster wider adoption and deployment of solutions which will generate the financial resources for further technology innovation
- **Government agencies and industry** can work to create more public awareness on water pollution and environmental quality monitoring. This would create demand for low cost IoT based monitoring solutions in addition to the traditional market of industry and government environment monitoring bodies
- **Accelerate adoption of sustainable energy**: The tools must enable Smart Cities and Communities because it allows homes to adapt their energy systems to the most sustainable source of energy available; having the flexibility to integrate Distributed Energy Resources (DER) such as rooftop solar.

Digitized Anything

The digitized anything taskforce focuses on leveraging opportunities in the area of innovative sensors, actuators and human interactions, internet of things (IoT), big data (i.e. publicly and privately accessible data), and data analyses on the edge or in the cloud, including Artificial Intelligence, not restricting itself to only Neural Networks (NN) but alternative MI technics,

with novel technologies.

The goal of a digital transformation in any sector is to pinpoint the crucial industry segments, the stakeholders involved in these segments, and the technologies that can bring added value to the transformation. This process entails identifying the main challenges related to digitalization for citizens and stakeholders, tackling these obstacles with appropriate tools, and determining the services that will drive the stakeholders forward and unleash their potential for a digital revolution. At its core, "digitized anything" entails the gathering, utilization, and processing of existing big data to enhance communication, foster interoperability among devices and applications, and create a society that is digitally interconnected.

The values the general project carries are the following:

- Innovation
- Digitalization
- Digital transformation
- Synergism
- Capacity-building Funding

Opportunities within Digitized Anything can be realized by activating matching stakeholders, such as end users, owners, operators, and system integrators, from the different industry sectors. These sectors are:

- Health and medical,
- Digitized society
- Manufacturing
- Retail
- Education
- Finance
- Others

Key enablers of digitization in Digitized Anything

Identifying key enablers in the realm of Digitized Anything is a challenging task due to the vast diversity within the economic landscape. The ecosystem of "anything" encompasses a wide array of drivers, tools, and technologies, each finding its unique place within this expansive domain. Consequently, the anticipated key enablers predominantly hinge on traditional expertise and specialized knowledge rather than automated processes. In this vertical, universities and research centers have made significant contributions towards experiments and projects, playing a pivotal role in driving innovation and progress.

Role of the Digitized Anything Task Force in SMART4ALL project

The role of the Digitized Anything Task Force within the project was to facilitate initiatives and activities related to digitized areas that were not specifically covered by other task forces, particularly focusing on cross-area projects. This task force, within the ecosystem of SMART4ALL, encompasses a membership of more than 940 individuals. The extensive breadth of the

Digitized Anything application domain, spanning multiple sub-domains, explains its significant representation among members. The Digitized Anything Task Force also contributed expertise through coaching for Pathfinder Application Experiments (PAEs) and actively participated in the SMART4ALL marketplace and related project activities. Throughout the project implementation, the task force closely monitored the progress of digitalization efforts across various cross-domain projects. This included tracking activities within the project to ensure the achievement of related Key Performance Indicators (KPIs) and deliverables.

Furthermore, the task force closely monitored the advancement of funded Pathfinder Application Experiments (PAEs) and applications received through open calls within the Digitized Anything domain. This monitoring encompassed evaluating their technical and economic maturity, as well as assessing their impact within the project ecosystem.

Success Stories in Digitized Anything

Throughout the project duration, notable successes have emerged within the realm of Digital Anything. As previously mentioned, SMART4ALL has supported external projects through three funding rounds, along with internal Pathfinder Application Experiments (PAEs).

Below, you'll discover links to selected funded projects from the SMART4ALL initiative, directing you to the SMART4ALL YouTube channel and webpage. These links provide an opportunity to delve deeper into specific project details, where contact information for further inquiries is also available:

- **NFB VR** (Neurofeedback Virtual Reality) 2nd KTE - Digitized Anything: https://youtu.be/BAd60NKKP0k
- **BLETEXT** 3rd KTE - Digitized Anything: https://youtu.be/afJaBxF4FX8

- **AIRR** - AI Resource Recommender by TUD & InAccel - Digitized Anything): https://youtu.be/6zVy2Qs0U0Y
- **REMOCLEC** - ARM-Based CLEC & IoT Remote Laboratory - Digitized Anything): https://youtu.be/i2nZ52hzmO8

Identified Challenges for Digitized Anything

Challenges for Digitized Anything are in line with previous verticals. The challenges identified within the realm of Digitized Anything can be summarized as follows:

- Introduction of **digital twins** in different industrial applications
- **Connectivity technologies and protocols** that consume less power and increase the range of communication
- **Data collection, storage and analysis**: Tools and platforms that run on the edge and have Machine Learning and Artificial intelligence capabilities
- **Interoperability**: Most of the existing commercial IoT platforms of traditional market players are proprietary solutions without a common interface for sharing data
- **Cybersecurity** as the final touch to the growing market of Digitized anything solutions.

Vision for the future in Digitized Anything

Drawing from feedback and insights provided by various internal stakeholders, the following common tools were identified to tackle the aforementioned challenges:

- **New IoT hardware and software**: There is an important demand for new sensors which can be used in various IoT implementations.
- **Data Transmission, Storage and Analysis**: There is a need for more powerful devices and communication channels as well as storage and analysis on the edge or "fog".
- **Interoperability and cyber security**: Need knowledge for developing standard protocols for communicating different IoT platforms, while experts are needed for the creation of strong security mechanisms at booth IoT platforms and devices.
- **Make it easy for newcomers**: IoT starter kits specifically designed for the project type, makes it easy to introduce IoT into this sector for the creation of proof of concepts.
- **More public and private investment** to set up regional and national digital innovation hubs to promote further innovation and exchange of innovation technologies between universities and industry for their wider exploitation.

SMEs Task Force

UNIVERSITETI I EVROPËS JUGLINDORE
УНИВЕРЗИТЕТ НА ЈУГОИСТОЧНА ЕВРОПА
SOUTH EAST EUROPEAN UNIVERSITY

AVN
INNOVATIVE TECHNOLOGY SOLUTIONS

marseco
captains of development & sales

DataProgNet
Software Development Company

redpitaya

The SMEs Task Force was established to oversee the project's progress in **integrating SMEs into the four aforementioned** verticals supported by the project. One of its primary responsibilities was to monitor project activities and ensure the achievement of SME-related Key Performance Indicators (KPIs) and deliverables.

Additionally, the task force closely monitored the progress of funded Pathfinder Application Experiments (PAEs) and applications received through open calls across all verticals, assessing their technical, economic maturity, and impact. Another important role of the Task Force was to leverage insights from this monitoring to identify challenges and take necessary actions.

Furthermore, the Task Force provided valuable feedback for **coaching templates** used by external PAEs, and **streamlined the reporting process** to enhance its usability for SME applicants.

The SMEs Task Force also placed a heightened emphasis on matchmaking and networking opportunities during dissemination efforts. In instances where application rates were low, task force members increased their efforts as brokers for matchmaking, utilizing the SMART4ALL platform's matchmaking system.

Moreover, the task force played a crucial role in providing business coaching for external PAEs, offering a valuable **business perspective** for all technical experiments and providing applicants with insightful feedback.

Another significant contribution was made to the Marketplace, particularly in the form of application notes for various tools and middlewares listed in the Marketplace and WIKI. Additionally, the task force organized or contributed to **webinars and workshops focused on successful application writing**, utilizing the SMART4ALL Marketplace and Moodle webpage to ensure broad accessibility to this information.

An additional role of the SMEs Task Force was to provide reviews for moodle courses generated within Work Package 5 by other SMART4ALL project partners. This feedback helped to refine the courses prepared and hosted on the moodle service.

Success Stories in SMEs Task Force

The success of the SMEs Task Force is synonymous with measuring the success of the entire project. Presented below are tables detailing Key Performance Indicators (KPIs) directly related to the role of SMEs in the project. These tables serve as factual evidence to support the achievements of the task force and the overall project success.

Table 1 displays the KPIs (from WP6) related to the funding of SMEs through cascade funding for the three open calls (OC). It is evident that the project has successfully met the targeted indicators, which include funding for SMEs from the project.

INDICATORS	THRESHOLD	1st OC	2nd OC	3rd OC
SMEs, startups and mid-caps participating in granted PAEs	60%	68%	64%	74%
SMEs, startups and mid-caps participating in granted PAEs from South and Eastern European countries	40%	40%	47%	57%
Industrial beneficiaries participating in granted PAEs	65%	75%	79%	74%
SMEs, strat-ups and mid-caps participation in Open Calls	50%	64%	60%	76%
SMEs, strat-ups and mid-caps participation in Open Calls from South and Eastern European countries	>50%	47%	49%	49%
Industrial partners participating in open calls	60%	81%	79%	77%
Submitted applications against started applications	Not defined	29%	36%	57%

Table 1 - KPIs for SMEs funding from open calls

KPIs (from WP2) related to the inclusiveness/reach of SMEs in the final project are shown in Table 2. Clearly the reach of the project and the ecosystem building has overcome the minimum threshold identified in the project.

INDICATORS	THRESHOLD	Total amount
SMEs, startups and midcaps reached	1500	> 1500
SMEs, startups and midcaps in SMART4ALL DIH	100	557
SMEs in SMART4ALL Consortium	10	10
Digital Skills growth: Organization of summer school	4	8
Digital Skills growth: Organization of technology training oriented open courses	4	4

Table 2. KPIs for SMEs reach and ecosystem building

Key Performance Indicators (KPIs) from WP5 related to Marketplace contributions are crucial for the sustainability of the project, with over 200 artifacts currently available (Table 3). Beyond just listing the tools in the Marketplace, the SMEs Task Force has contributed 5 application notes for selected tools and middleware frameworks. These notes follow a tutorial approach to simplify the application of these tools and technologies for SMEs, startups, and mid-caps. These application notes can be accessed on the wiki page of the SMART4ALL project.

INDICATORS	THRESHOLD	Total amount
Agriculture number of artifacts	30	19
Transport number of artifacts	20	19
Environment number of artifacts	40	10
Anything number of artifacts	40	127
Number of users	-	293
Activity statistics: number of countries	-	54

Table 3. KPIs for artifact distribution among verticals

Vision for the future in SMEs in digital transformation

A crucial aspect in ensuring the sustainability and efficiency of the project, while also considering the needs of SMEs for digital transformation, is to provide tools and services beyond the project funding period.

SMART4ALL partners have tasked the SMEs Task Force with developing a solution for SMEs in the form of a Roadmap towards digitalization. Hence, the legacy of SMART4ALL for SMEs, in addition to the ready-made tools, Marketplace artifacts, case studies, and courses, includes the **Digitalization Roadmap tool known as the "SMART4ALL Assistant".**

The system will prompt SMEs to complete a questionnaire that serves as a diagnostic tool to assess their digitalization needs based on the verticals they are interested in. Using the diagnostic data, the back-end service of the Marketplace will analyze the information and generate a tailored Digitalization Roadmap for the SME. Subsequently, a coaching session will be scheduled with one of the SMART4ALL coaches to finalize the roadmap. Further details about the tool and the process can be found in Figure 1.

The generated document will encompass the needs of the SME, including both technical and human resource capacities, as well as funding and business opportunities. This final document will serve as a Digital Roadmap for the SME, providing specific guidelines, tools, opportunities, and access to E(DIH) for support. The latest version of the tool is powered by an **AI Chatbot** and is **hosted within the Marketplace.**

SMEs Roadmap Application Process

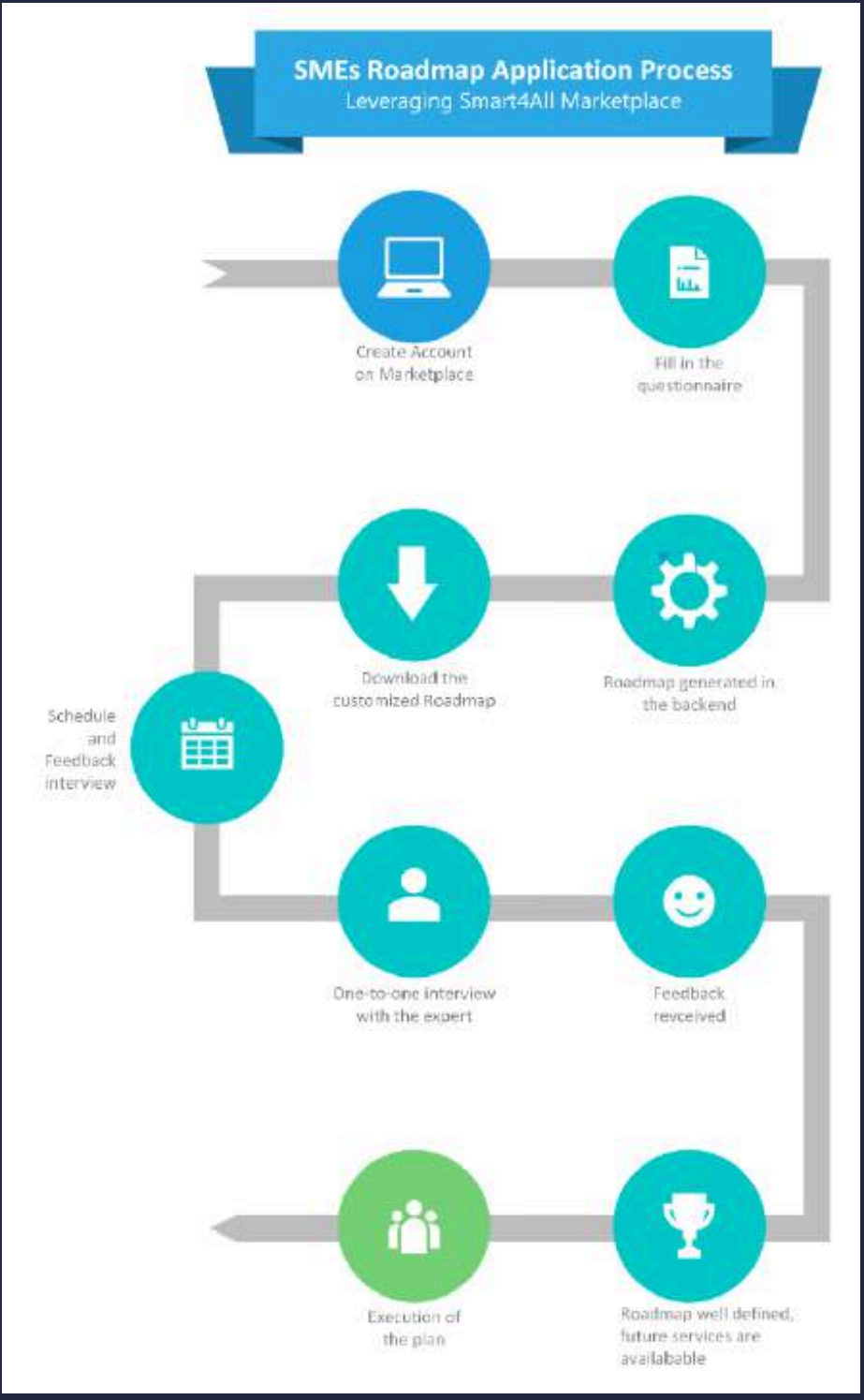


Figure 2 - SMEs Roadmap Application Process

Overall Impact of Technology Transfer and Cross-Border Collaboration

Here is a summary of the combined impact of the achievements across all task forces in the SMART4ALL project:

- Almost **300 artifacts in the Marketplace**, including tools, middleware frameworks, and application notes.
- A significant number of technologies transferred from academia to industry, leading to **new products or services** in the market.
- Development of the "**SMART4ALL Assistant**" as a Digitalization Roadmap tool for SMEs.
- The project supported SMEs in their digital transformation journey, resulting in **increased operational efficiency and competitiveness**.
- Facilitation of **matchmaking and networking** opportunities for SMEs, researchers, and industry partners.
- Provision of **webinars, workshops and coaching sessions** for SMEs and stakeholders.
- Support for SMEs in accessing **funding and business opportunities**.

The SMART4ALL project has had a significant impact on the European innovation ecosystem by facilitating technology transfer, empowering SMEs for digital transformation, fostering collaborations, building capacities, and driving economic growth. These achievements not only demonstrate the project's success in bridging the gap between academia and industry but also highlight its role in **driving innovation, competitiveness and sustainability** in various sectors.

Hub-in-a-hub service

SMART4ALL offers an **online tool** for **(European) DIHs, excellence hubs and other clusters** for showcasing their consortium partners on an interactive map integrated to the SMART4ALL network.
Hub-in-a-hub service, available through the Marketplace (www.marketplace.smart4all-project.eu/hub-network), uses filters for displaying DIHs in a separate mode on the SMART4ALL network, which allows the user to search for specific (E)DIHs/ other hubs & clusters and find out their members and contact details.

2 Digital Innovation Hubs and 2 Excellence hubs have already joined hub-in-a-hub:

- iDEMO Digital Innovation Hub
- its4Health Digital Innovation Hub
- Metacities Excellence Hub in Southeastern Europe
- Veles - The Smart Excellence Hub in SE Europe

Join hub-in-a-hub

Lessons learnt from the SMART4ALL project

Throughout the project's task forces, numerous lessons have been learned and challenges identified, all of which are well-documented in the final reports. The extensive list of these lessons and challenges is specific to each domain. Therefore, as an overarching recommendation of this white paper, the focus is placed on the generic challenges.

These generic challenges that apply across all verticals are, but not limited to:

- **Need of technological consultancy**. Many SMEs need support at the time of improving their products or processes. However, in many cases, their workload is so high that they do not find the time to finish implementing R&D to improve their processes or products. Other companies do not even know about **R&D potential solutions** that could work for them. Also, investing in the manufacturing industry involves a high risk as the solutions are usually in TRL7. Therefore, SMEs would need to be offered **technological assessments, demos, disruptive technologies** that can be applied to their sectors, so their positive effects can be demonstrated before acquiring the technology.
- **Lack of resources**. CPS and IoT technologies need big investments as they require **infrastructures**. SMEs consider investing in R&D as a high risk, especially in low TRL´s. The same happens with banks, as they don't understand high risk innovation profiles and consequently do not provide solutions to invest in R&D.
- There are **few public funding calls** and each time they are more competitive. National funding is viewed as not very appealing in

in financial terms and European calls are seen as very difficult to adapt to the companies´ reality. SME´s think twice before applying, because there is a lot of paperwork involved and funds are received late. In addition, in previous programmes, only the development of products was financed, and not manufacturing processes.

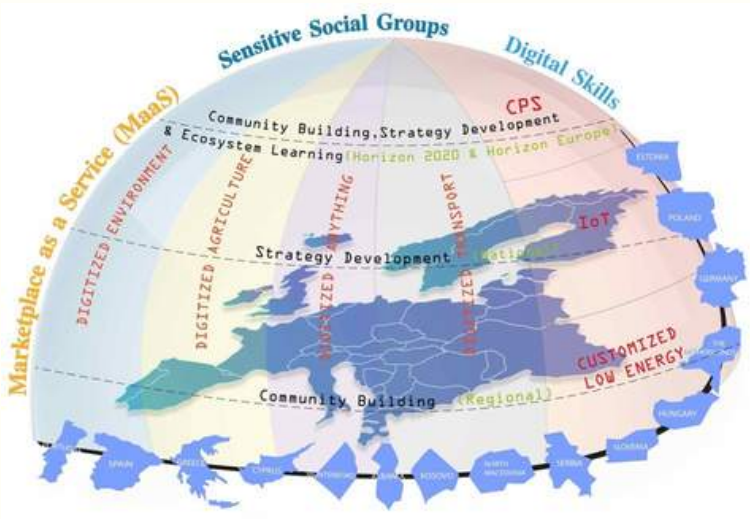
- There is a **low use of alternative funding** that is not given by banks or public entities. Currently it is easy for start-ups to finance themselves through accelerators or through venture capital, but it is not the case for SMEs, as their margins are lower.
- **Lack of qualified personnel** (inadequate human resources). The ICT sector has not received a sufficient number of trained technical personnel for a long time. Education cannot keep up with the new Science, Technology, Engineering and Mathematics (STEM) job openings. In addition, personnel have a lot of experience in certain production processes, older technologies, etc. but they need training in new technologies, which is the most requested service when SME's are asked.
- **Security and safety**. Currently, the most sought after topic is data and system security in the ICT field including SMART4ALL specific areas, the second one is safety, reliability, and dependability. Lack of knowledge, well-developed practices, solutions, etc. in security and safety slows down development and increases the risks taken by stakeholders.
- **Management and operational cost**. They are not considered in some development, and therefore, the long-term viability of solutions cannot be proven.
- **Design for battery-based operation**. Alternative power sources (e.g. solar) and low-power consumption have their own challenges, they are both very hard to optimize in the short project durations.

- **Long-term viability of projects**. Typical R&D projects, experiments, etc. may be done without the long-term viability of the project, but real applications must be operated long-term, for years, in a way that all stakeholders find them viable from the point-of-view. Unfortunately, IoT applications fail in this respect sometimes, and they cannot provide the expected gains and they stopped prematurely.

Conclusions and Future Outlook

Overall, the SMART4ALL project has played a pivotal role in fostering innovation, addressing challenges, and exploring opportunities in the digitized transportation, agriculture, and environment sectors. Through its task forces, the project has facilitated collaboration, provided support for PAEs, and contributed to the advancement of digitalization in these vital sectors.

This white paper encapsulates the key points discussed regarding the SMART4ALL project's impact on digitization in transportation, agriculture, and the environment, as well as the challenges and opportunities inherent in these sectors.



Authors

NIKOLAOS VOROS

University of Peloponnese

Greece

CHRISTOS ANTONOPOULOS

University of Peloponnese

Greece

BOJAN LUKIC

German Aerospace Center

Germany

KATERINA LAMPRAKOPOULOU

Patras Science Park

Greece

ALBERTO FERNANDEZ

Sensing & Control Systems

Spain

TJARK SCHUTTE

Leibniz Institute for Agricultural Engineering & Bioeconomy

Germany

ADRIAN BESIMI

South East European University

North Macedonia

XHEMAL ZENUNI

South East European University

North Macedonia

Research Innovation Action Project Number: 872614
Start Date of Project: 01/01/2020
Duration: 48 months
Overall Budget: 8.660.872,50 €
EU contribution: 7.997.647,50 €

CONTACT US

Prof. Nikolaos Voros
SMART4ALL Project Coordinator
University of Peloponnese
Electrical & Computer Engineering Department
Embedded Systems Design & Applications Laboratory

voros@uop.gr

www.marketplace.smart4all-project.eu