D5.3 COMPETENCE PROFILING AND WHITE SPOT ANALYSIS

WP 05

Public Version

4 July 2022

Deliverable 5.3. Competence profiling and white-spot analysis. This deliverable deals with profiling of competences within CCs and analysis of white-spots. Leader IPA, Co-lead UAL, M12, M36, R, Co.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement № 818182

DOCUMENT IDENTIFICATION

Project	SmartAgriHubs
Project Full Title	Connecting the dots to unleash the innovation potential for digital transformation of the European agrifood sector
Project Number	818182
Starting Date	November 1st, 2018
Duration	4 years
H2020 Call ID & Topic	DT-RUR-12-2018: ICT Innovation for agriculture – Digital Innovation Hubs for Agriculture
Website	smartagrihubs.eu
File Name	D5.3 Competence Profiling and White Spot Analysis_public_final
Date	4 July 2022
Version	2.1
Status	Final
Dissemination level	Public Although it is a confidential deliverable, the deliverable is made public with the permission of the authors.
Author	Leader: IPA (main author); Co-leader: UAL
Contact details of the coordinator	George Beers george.beers@wur.nl

LIST OF ABBREVIATIONS

Abbreviation	Explanation
CC	Competence Centre
FIE	Flagship Innovation Experiment
ICT	Information and Communication Technologies
IE	Innovation Experiments
IOF2020	Internet of Food and Farm
KETs	Key Enabling Technologies
NUTS	Nomenclature of Territorial Units for Statistics
RC	Regional Cluster
RTO	Research and Technology Organization
SAH	SmartAgriHubs
SmartAKIs	European Agricultural Knowledge and Innovation Systems
TRL	Technology Readiness Level
VDI	German Verein Deutscher Ingenieure

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

PROJECT SUMMARY

Digital technologies enable a transformation into data-driven, intelligent, agile and autonomous farm operations, and are generally considered as a key to address the grand challenges for agriculture. Recent initiatives showed the eagerness of the sector to seize the opportunities offered by ICT and in particular data-oriented technologies. However, current available applications are still fragmented and mainly used by a small group of early adopters. Against this background, SmartAgriHubs (SAH) has the potential to be a real game changer in the adoption of digital solutions by the farming sector.

SAH will leverage, strengthen and connect local DIHs and numerous Competence Centres (CCs) throughout Europe. The project already put together a large initial network of 140 DIHs by building on its existing projects and ecosystems such as Internet of Food and Farm (IoF2020). All DIHs are aligned with 9 regional clusters, which are led by organizations that are closely related to national or regional digitization initiatives and funds. DIHs will be empowered and supported in their development, to be able to carry out high-performance Innovation Experiments (IEs). SAH already identified 28 Flagship Innovation Experiments (FIEs), which are examples of outstanding, innovative and successful IEs, where ideas, concepts and prototypes are further developed and introduced into the market.

SAH uses a multi-actor approach based on a vast network of start-ups, SMEs, business and service providers, technology experts and end-users. End-users from the agri-food sector are at the heart of the project and the driving force of the digital transformation.

Led by the Wageningen University and Research (WUR), SAH consists of a pan-European consortium of over 160 Partners representing all EU Member States. SAH is part of Horizon2020 and is supported by the European Commission with a budget of €20 million.

EXECUTIVE SUMMARY

This document is the output of Task 5.3 in WP5 Competence Centres and provides the final version of the competence profiling and White Spot Analysis. Competence profiling is used to collect information regarding the available competences within the competence centres in SmartAgriHubs in terms of capabilities, available infrastructure and capacities. The competence profiles will be used to construct a white spot analysis. This analysis will utilize a Problem-Solution Matrix that identifies the technological and services gaps on a regional, national and European level. This document is considered as a "living" document, since it will be updated and expanded throughout the life of the project, particularly given that the new and existing competence centres must add and update their technology solutions and competences profiles in the online SmartAgriHubs Innovation Portal, developed under WP1.

Within SmartAgriHubs network, a pan-European network of excellence of digital competence centres (CC) is established. These CCs are associated with DIHs and provide R&D, technical expertise, laboratory and demonstration facilities, testing and validation, and ICT skills content to users. CCs may include universities, applied research and technology organizations (RTO), laboratories and demonstration farms and entities with important R&D labs, all of them having technology transfer capabilities. These CCs may be local or located outside the region, providing technologies and solutions not available inside a determined region. Given that no single CC can be the main player in all technology fields, strong connections should and would be built amongst the CCs in the SmartAgriHubs network, both within and between the different DIHs.

The first version of the report was available at the end of the first year of the project. Thereafter, the deliverable will be continuously updated using the information uploaded by CCs on the Innovation Portal as well as the FIEs, which is being developed by WP1. It is important to note that this first version is based on the compilation performed in D5.2 *Identification of existing CCs for DIH and IE* (M06) by the University of Almería, of the Technologies deployed in the SmartAgriHubs flagship innovation experiments (FIEs). Such list accounts for those CCs within the FIEs already defined in the proposal, and which had been updated with the information provided in the FIEs execution plans (D3.2, M06).

This is the public version of the deliverable.

1. INTRODUCTION

WP5 is establishing a pan-European network of excellence of CCs associated with DIHs (catalogued in WP4) to provide R&D, technical expertise, laboratory and demonstration facilities, testing and validation, and Information and Communication Technologies (ICT) skills content to users. In SAH, CCs may be local or located outside the region, providing technologies and solutions not available inside a determined region.

One of the main objectives of WP5 is to help build the competence centres (CCs) network and enhance the CCs catalogue, in order to allow ease of access to innovative technologies and services as well as testing and validations infrastructures necessary for the agriculture sector in Europe. Task 5.3, Deliverable 5.3, contributes to this main objective by identifying "gaps" in the provision of services by CCs or where services are available from CCs but are not being applied. In order to do so, competence profiling of competence centres that are members of the network becomes crucial in order to identify their offerings, both in terms of technical abilities and infrastructure.

Competence profiling is used to collect information regarding the available competences within the competence centres through the development of a classification ontology, in terms of capabilities, available infrastructure and capacities. This means that it is not enough to collect information regarding the capabilities of an organisation, in terms of the skills and knowledge, i.e. what they "can do", but also in terms of organisational ability to use these capabilities, i.e. the "resources" needed to perform the capabilities. For example, a competence centre can have skills and knowledge in IoT technologies, which represents the capability. The number of experts/employees able to help various stakeholders with this capability can be one measure used to represent the capacity. This can also be represented through how the skills and knowledge are applied within the Agriculture sector, represented for instance by the systems developed by the competence centre.

The competence profiles will be used to construct a white spot analysis. This analysis will utilize a Problem-Solution Matrix that identifies the technological and services gaps on a regional, national and European level. Using the Problem-Solution matrix, white spots (gaps) are identified and later analysed in order to identify potential competence centres in different regions, which can fulfil the needs within these regions.

Regarding other WPs there are links and synergies with:

- DIH Capacity Building (WP4): The competence profiling of CCs in WP5 can be used by WP4 to help coordinate technologies and technical services provided by the CCs to DIH in order to meet the needs of IE and SMEs across the EU regions. For example, regions that lack certain technical services can be linked to CCs in other regions that provide these services or to learn how to provide such services.

2. COMPETENCE PROFILING

2.1 DEFINITION

Finding appropriate technological partners is of key importance for applying digital technologies for smart agriculture applications. Within the digital innovation hubs network concept, establishing dynamically and rapidly viable partnerships for customised technical design and implementation capabilities becomes a key challenge. It is very important for competence centres to exhibit a level of capability, confidence and trust that will encourage them to be chosen for supply of their technologies and systems and for partnership in new opportunity ventures. Therefore, it is important to describe the capabilities and capacities of the competence centres in a way that builds trust in what they are offering, which can be achieved using a searchable online "Competency Profile". A competency profile is a "document" that captures and identifies the competencies in terms of capabilities, capacities and systems for a specific individual or an organisation. The aim of such a profile is to identify and capture the skills, knowledge, and abilities required to be able to perform a task, role, or function and to organize it in an easily accessible and useful way, as well as demonstrate the (technological) systems they offer to match user's problems or technology gaps.

2.2 COMPETENCE PROFILING IN OTHER DOMAINS

The main field that had developed the concept of competence profiling was manufacturing, especially when dealing with the collaborative network concept in order to establish effective and efficient collaboration for design and development. The majority of CCs in the agriculture sector have a similar focus from the technology point of view to the manufacturing CCs. Learning from the manufacturing domain, which has been one of the first to go through the digital transformation, would be beneficial for the SmartAgriHubs project. Hence, using the experience gained by Fraunhofer IPA in the manufacturing domain in competence profiling and digital technologies classifications and combine it with experience from previous efforts in the agriculture domain is the starting point for elaborating SAHs competence profiling methodology.

In principle, design and development is the process of transforming a set of theoretically ill-defined requirements defined by the customer into a finished product. Various methodologies have been deployed in different application areas and different corporate cultures in order to deal with the complexity of this problem. Since designs have become more complex, it has been necessary to migrate to concurrent methods [1]. Concurrent (or simultaneous) engineering is defined as the systematic approach to the integrated, concurrent design of products and related processes including manufacture and support [2]. In essence, concurrent engineering is related to distributing design and manufacture work between a number of agents [3]. These agents can be either individual experts, R&D organisations, or companies. In the beginning of the design and development process, the tasks are divided into separated modules, which then are almost independently developed. On completion of the separate work, modules are usually pulled together through collaboration between actors within the project.

Focusing on the organisational competence notion, several methods were developed to find suitable partners for such complex projects, to suggest and sustain effective dynamic collaborative networks based on rapidly changing requirements. What is commonly found, however, is the limited "yellow pages" type of information provided about the listed organisations. For example, a list of technology centres that provide Key Enabling Technologies (KETs) in Europe is mapped geographically with an old catalogue style that do not provide the competences of these centres[1].

One example of using competence profiling for creating and sustaining dynamic collaborative alliances is "The West Midlands Collaborative Commerce Marketplace" (www.wmccm.co.uk). It allows to search the competence profiles of manufacturing SMEs and technology centres in order to form "virtual organisations" or "virtual teams" in order to respond to manufacturing business opportunities.

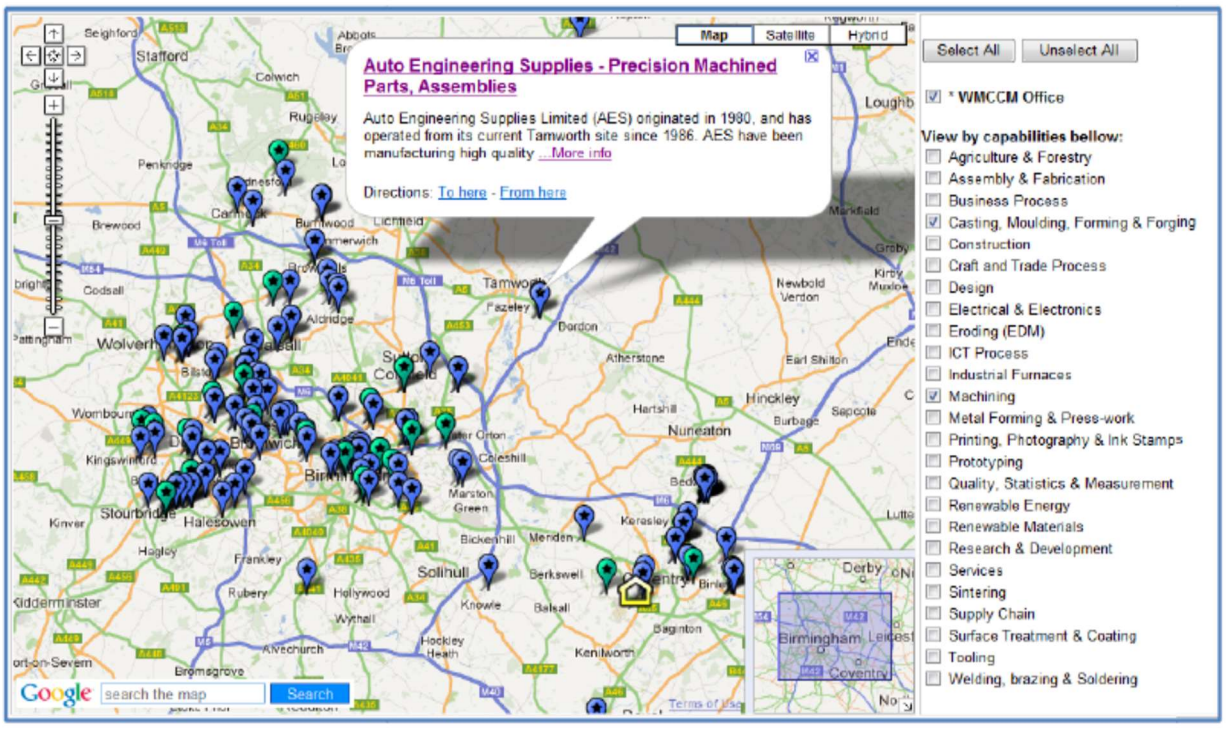

Figure 1: Competency Map for Casting, Moulding, Forming and Forging Capabilities in WMCCM, source [4]

2.3 COMPETENCE PROFILING OF COMPETENCE CENTRES IN SAH PROJECT

For competence centres in SmartAgriHubs, a method has been developed to address the identified requirements of dynamic competence identification, structuring, searching, and matching.

1. **Competence data collection**: Competence profiling is utilised in this step to collect competences and systems related information. In this project, we utilise the competency definition of [5]: "the notion that captures the capabilities represented by the key tangible assets, embodied with the abilities of human beings and their key experience and knowledge", and the following

[1] https://ec.europa.eu/growth/tools-databases/kets-tools/kets-tc/list

definition of systems: "a set of components that takes an input, changes it according to the system's use, and then produces an outcome. It is made up of components that work together to transform, transport, store, or control energy, materials, and information. In this sense, the competency can be interpreted as the organisation's ability to change and to adapt to different situations or market sectors that have the potential for better profitability.
Facilities and experts are always an integral part of any process, whether this belongs to a manufacturing or service operation [6]. They are part of the 'transforming' resources that act upon 'transformed' resources, such as material and information, to produce systems, products and services. Therefore, it can be assumed that there is at least a minimal technical skill and facilities available for each system offered by the competence centres.

Many organisations can have the same capabilities, i.e. the same technology or facilities, yet the skill element in the competence definition indicates how close to the limits of the capability the organisation can drive using its skills. Therefore, soft and hard factors are taken into consideration in order to clarify the capabilities, such as:

- Existing Systems provided
- Awarded standards, such as quality standards
- Key technological capabilities, including technology readiness level (TRL)
- Knowledge of a market/sector: This can be, for instance, Production & Handling categories, such as Arable, Vegetables and Fruits, and Dairy.
- Supply Chain focus, such as logistics.

University of Almeria, WP leader of WP5 has developed in collaboration with the WP5 members a profile template in order to collect the competencies and systems of various competence centres that are part of the SmartAgriHubs network. The main inspirations behind this profile come from SmartAKIS[2] categorization for Smart Farming Technologies (and its online platform) and IoT Catalog[3] so as to build on prior initiatives. The visual identity of the online tool in the shape of a wheel was inspired by Fraunhofer Industrie 4.0 model [7]. An integral part of this profile is the Agricultural Technology Navigator, which allows competence centres to classify competences and systems developed and/or provided by them into their competence profiles. The profile template will be included in Deliverable D5.1.

2. **Normalisation**: The normalisation process serves as a mechanism for validating the information provided by the competence centres. This validation assists towards overcoming the issue of trust and confidence in the provided competencies. Trust and confidence in whether a competence centre has the ability to provide the appropriate technologies or services to a sufficient level of quality. The normalisation happens either through evidence provided by the competence centre or through the assistance of an expert. Hence, this stage ensures comparability among the various competence centres and allows for detection of missing capabilities (white spots) that can be filled through the identification of new CCs and encourage them to join the network.
In SmartAgriHubs, the CCs will be asked to provide evidence regarding their competencies and systems once they register on the innovation portal and list their technologies and systems. This evidence is going to be reviewed by an

[2] https://www.smart-akis.com/
[3] https://www.iot-catalogue.com/

expert from WP5, and if deemed necessary, the CC would be asked to provide more details and evidence.

3. **Making competence information available for searching**: In this step, competence information is stored in the SmartAgriHubs innovation portal repositories, providing the ability for easy, speedy and optimised searching for capabilities available to a given region.
   When unpredicted events occur in the operational phase of a collaboration between a CC and an SME that cause gaps of competences, the required competences can be searched and CCs that provide them will be discovered and provided as a replacement to the collaboration parties.

This ability to acquire and find competence centres through their capabilities is important for the establishment of application experiments for applying to the open calls in SmartAgriHubs project. This is also important for the sustainability of the network, where competence centres are intrinsically motivated to update their competence profiles to make it available to be searched in the innovation portal.

3. WHITE SPOT ANALYSIS

Centuries ago, unexplored spots on a geographical map provided incentives for the development of new technologies: for research of the oceans and continents of our earth, for example, ships as well as navigation technologies were invented and constantly further developed. Today, the white unexplored spots on the globe have largely disappeared, but they are still being discovered in special technology and used for the development of innovative solutions.

3.1 APPROACH & METHODOLOGY

White Spot Analysis in the manufacturing domain

There has been an increasing demand for White Spot Analysis within companies large and small as part of the newly emerging Design Innovation mind-set. The approach of White Spot Analysis was built to give innovation leaders and managers the ability to generate the insights and outcomes of various scenario planning exercises on their own.

A literature review of academic literature and relevant projects documentation was carried out in order to obtain broad understanding of how white spot analysis is used in the manufacturing and IT sectors. In those sectors, white spot analysis is mainly used for analysis of gaps in the patents in order to identify new business opportunities not described through patents yet. The aim of the White Spot Analysis is to identify essential problem-solving principles and using them as a basis for the creativity process [8] [9].

The basic idea of the White Spot Analysis is known at least since the publication of the "Guide Book for Practical Use of: Patent Map for Each Technology Field" of the Japan Patent Office [10]. At that time, all patent maps were manually created. Another example of a White Spot Analysis can be found in a technology report regarding nanotechnology of the German Verein Deutscher Ingenieure (VDI) [11]. Both examples have in common that the introduced patent maps deliver a short overview of technical problems and solutions.

The white spot analysis of the Patents is carried out in two steps: in the first step, the IT-supported extraction of technologies and problems correlations from patent texts is carried out, which are compared using a matrix. In the second step, the free areas in the matrix (white spots) are evaluated in order to determine their innovation potential.

This analysis enables a statement to be made as to whether and which free spaces in the matrix have a certain development potential for a company. All steps in the white spot analysis are shown in Figure 2 below.

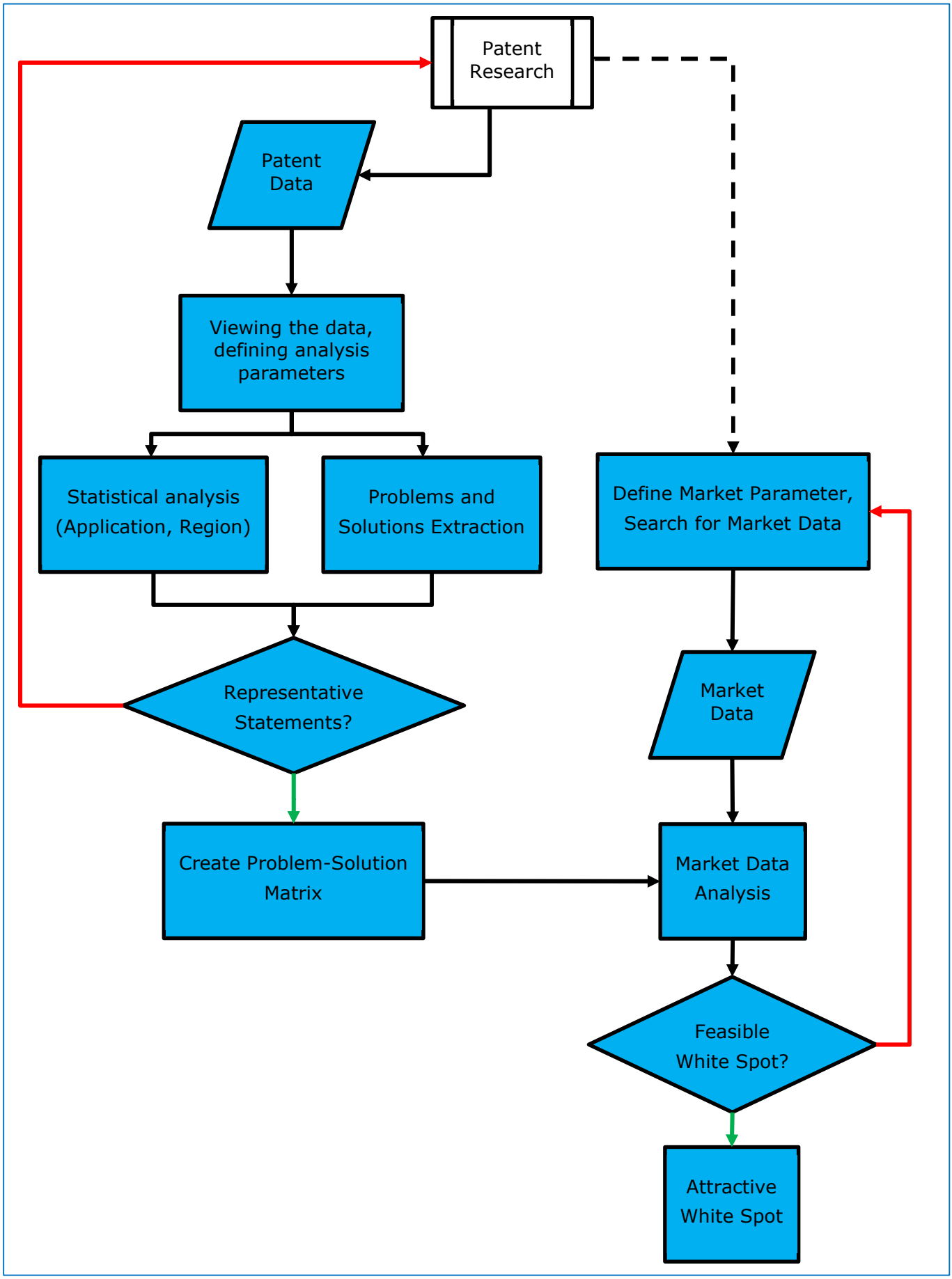

Figure 2: White Spot Analysis for Patent Data, source [12]

At the beginning of the white spot analysis, a patent search is carried out, which makes the data set available for the actual analysis (data transfer via XML format). The first patent search process will not be dealt with in detail here, but the analysis process itself will be the focus of attention. The analysis is carried out iteratively, i.e. some sub-processes are run through several times in order to increase the quality of the results. One of the core problems, however, is the reliability of the research results. With the first simple search queries, only a fraction of the relevant industrial property rights are obtained and thus no reliable statement about the relevant state of the art can be made. Furthermore, a searcher in the relevant subject area must first develop corresponding search terms and logical combinations, if these are not already available.

In SmartAgriHubs, this can be overcome using the technology and systems classification used in the competence profile. This allows for standardised search to be carried out across the terms provided in this classification, which will be updated regularly to reflect the new systems and technologies added by the competence centres.

White Spot Analysis of Competence Centres in SmartAgriHubs

The white spot analysis in SmartAgriHubs project will be used in order to identify the EU regions that are not covered by the existing competence centres, where there are needs for certain technologies and services. This is important to identify new CCs to join the network in a demand-oriented manner, i.e. to cater for the needs of the region. Hence, the white spot analysis will utilize the concept of a Problem-Solution Matrix used by the manufacturing domain, and will identify the technological and services gaps on a regional, national and European level in a similar manner to the White Spot Analysis for Patents discussed earlier. However, the definition of what constitutes a problem and a solution in SmartAgriHubs would be different:

A problem can be represented by a "need" for a certain technological solutions (represented by systems integrating different technologies) or technical services, while the solution can be either the availability of competence centre in the region that can satisfy the need, or a system/experiment that is addressing the technological need.

A Spot in this matrix can take one of the following forms based on different levels of analysis, geographical, technological and application:

1- **"White" Spot**: Absolute absence of technological systems, services and competences in a particular region (both in terms of technology readiness level (TRL) and in application area).
2- **"Grey" Spot**: technological solutions (systems) and technical services exist in the region, but either they are low in their TRL or they cover limited application areas.
3- **"Green" Spot**: The available systems and technical services provided by the competence centre address the needs of the region in a sufficient manner with high TRL levels as well as various application areas.

Extraction of problems and solutions for the identification of White Spot

In order to create the problem-solution matrix, the competency profiles of the competence centres in the network are used to extract the provided technology systems, services and competences (stored in SmartAgriHubs innovation portal) as well as the technical services provided by each competence centre in their region. Once these competences, services and systems are extracted, a technological classification developed by UAL in WP5 to be delivered in D5.1 will be used to categorise the technologies, using different dimensions, such as application sectors or cropping system, TRL/Maturity, and others.

The resulting data would be then form the basis for the problem solution matrix that will also include the geographical coverage of the solutions and services provided by the competence centres. This matrix would then be used to perform the white spot analysis.

4. RESULTS

4.1 PROBLEM-SOLUTION MATRIX

Since the competence profiling template being implemented in the innovation portal at the time of performing the second version of the white spot analysis did not include enough information to perform a meaningful white-spot analysis, we have decided that the problem-solution matrix be based on the classification of technologies used in the FIEs. The list of technologies and keywords used in Table 1 was a preliminary one presented in the kick-off meeting of SmartAgriHubs project by WP5/UAL in order to serve as an example of the complexity of and need for classifying technologies. After this proposal, a preliminary classification of technologies used in the FIEs was carried out using these keywords. The problem-solution matrix, hence, looks into two dimensions. The first dimension is the geographical coverage of the solutions, i.e. technologies available per region and the second dimension is the sectorial coverage of the technologies, i.e. the application sectors of the technologies.

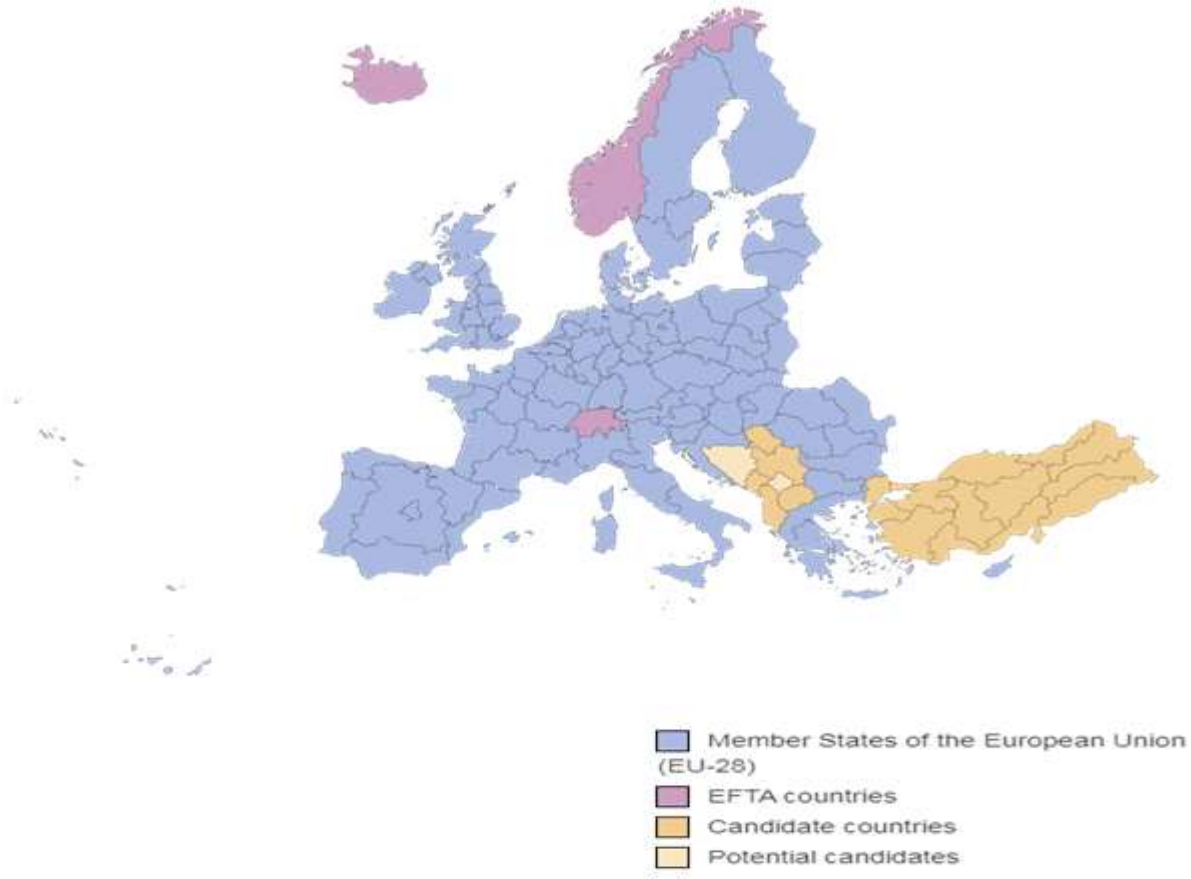

Figure 3: NUTS and territorial typologies

In order to create the first matrix, the Nomenclature of Territorial Units for Statistics (NUTS) is used. NUTS is a geocode standard for referencing the subdivisions of countries for statistical purposes [13]. This standard is developed and regulated by the European Union, and thus only covers the member states of the EU in detail. For each EU member country, a hierarchy of three NUTS levels is established by Eurostat in agreement with each member state; the subdivisions in some levels do not necessarily correspond to administrative divisions within the country. A NUTS code begins with a two-letter code referencing the country, which is identical to the ISO 3166-1 alpha-2 code (except UK instead of GB for the United Kingdom and EL instead of GR for Greece).

Geographical Coverage of the technologies (NUTS Regions Level 1)

Technologies	BE	BG	CZ	DK	DE	EE	IE	EL	ES	FR
Animal Production Technologies and Monitoring	x				x		x		x	
Artificial Intelligence	x						x		x	
Automatic Control (smart Automation)	x								x	x
Autonomous Equipment	x						x			
Autonomous Vehicles										
Autosteer/Controlled Traffic Farming	x									x
Bar-codes, QR-codes, Scanners and Smart Tags										
Big Data & Data Analytics	x						x			
Biometric Sensing Technologies	x				x				x	
Climate Control	x									x
Climate Sensors								x	x	
Communication & Sensors Networks (5G)										x
Computer Vision	x							x	x	
Crop Management	x							x	x	x
Cloud Technology	x						x			x
Dashboards										
Data Access & Authorisation Technologies	x									
Data-driven Technologies	x			x	x		x	x	x	x
Data Storage and persistence, synchronization and data standardization										x
Deep Learning Technologies	x						x			
Digital Commercialization Technologies										x
Digital Health Technologies	x				x					
DSS-Agricultural APPs									x	x
Energy Use Efficiency & Systems Technologies	x			x					x	x
Farm IoT										x
FMIS / Farm ERP	x									x
Food Security Technologies	x				x				x	
GPS and GIS Technologies	x							x	x	
Greenhouse Automation (smart)										x
HPC (High Performance Computing)					x					
Hyper-spectral	x							x	x	
Indoor Farming	x				x					
In Field Wireless									x	
IoT Devices & Connectivity	x							x	x	x
IPM Technologies				x						x
Irrigation/Fertigation Control (smart)								x	x	x
Logistics, Asset & Fleet Optimization (smart)										
Machine Learning	x								x	
Mechatronics										
Modeling & Prediction Technologies	x								x	x
Moisture Sensors								x		
Open SCADA									x	
Optical Technologies								x		
Optimization(S&H)Technologies										x
Photogrametry	x							x	x	
Plant Data										
Precision /Smart FarmingTechnologies				x	x			x		
Precision LivestockFarming	x								x	
Predictive Analytics									x	x
Prescriptions									x	x
Quality Assessment										
Remote Sensing	x							x	x	
RFID-UHG										
Robotics										x
Satellite Imagery & Nanosatellites	x							x	x	
Sensing & Monitoring(Smart)	x			x	x			x	x	x
Sensor Technology	x			x	x				x	x
Soil Sampling, Mapping & Management	x							x	x	
Soil Sensors								x		
Sound RecognitionTechnologies	x									x
Supply Chain Analytics										x
Synthetic Aperture Radar									x	
Traceability & Certification Platforms								x		
UAVs & Aerial Imagery	x							x	x	x
Variable Rate Technology (VRT)	x									
Water Trading Technologies										
Water Use Efficiency & Systems Technologies					x			x		x
Yield Monitors									x	

	HR	IT	CY	LV	LT	LU	HU	MT	NL	AT
Animal Production Technologies and Monitoring		x		x						
Artificial Intelligence				x						
Automatic Control (smart Automation)		x								
Autonomous Equipment										x
Autonomous Vehicles										x
Autosteer/Controlled Traffic Farming										x
Bar-codes, QR-codes, Scanners and Smart Tags										
Big Data & Data Analytics									x	
Biometric Sensing Technologies		x		x						
Climate Control										
Climate Sensors		x		x						
Communication & Sensors Networks (5G)		x		x						
Computer Vision		x		x						x
Crop Management		x		x						x
Cloud Technology				x					x	
Dashboards				x						
Data Access & Authorisation Technologies				x					x	
Data-driven Technologies		x		x					x	x
Data Storage and persistence, synchronization and data standardization				x						x
Deep Learning Technologies										
Digital Commercialization Technologies										
Digital Health Technologies										
DSS-Agricultural APPs				x						
Energy Use Efficiency & Systems Technologies		x		x						
Farm IoT				x						
FMIS / Farm ERP				x						
Food Security Technologies										
GPS and GIS Technologies		x		x					x	x
Greenhouse Automation (smart)										
HPC (High Performance Computing)										
Hyper-spectral		x								
Indoor Farming				x						
In Field Wireless		x		x						
IoT Devices & Connectivity		x		x						
IPM Technologies										
Irrigation/Fertigation Control (smart)		x		x						x
Logistics, Asset & Fleet Optimization (smart)										
Machine Learning										
Mechatronics										
Modeling & Prediction Technologies									x	
Moisture Sensors										
Open SCADA										
Optical Technologies		x								
Optimization(S&H)Technologies										x
Photogrametry										x
Plant Data		x								
Precision /Smart FarmingTechnologies		x		x						x
Precision LivestockFarming										
Predictive Analytics				x						
Prescriptions										
Quality Assessment		x								
Remote Sensing									x	x
RFID-UHG										
Robotics										x
Satellite Imagery & Nanosatellites									x	x
Sensing & Monitoring(Smart)				x						x
Sensor Technology		x		x						
Soil Sampling, Mapping & Management		x		x					x	x
Soil Sensors										
Sound RecognitionTechnologies				x						
Supply Chain Analytics										x
Synthetic Aperture Radar										
Traceability & Certification Platforms										
UAVs & Aerial Imagery									x	x
Variable Rate Technology (VRT)										
Water Trading Technologies										
Water Use Efficiency & Systems Technologies				x						
Yield Monitors										

	PL	PT	RO	SI	SK	FI	SE
Animal Production Technologies and Monitoring			x				
Artificial Intelligence	x	x					
Automatic Control (smart Automation)	x	x					
Autonomous Equipment							
Autonomous Vehicles							
Autosteer/Controlled Traffic Farming							
Bar-codes, QR-codes, Scanners and Smart Tags			x			x	
Big Data & Data Analytics	x						
Biometric Sensing Technologies							
Climate Control	x						
Climate Sensors	x	x					
Communication & Sensors Networks (5G)		x	x				
Computer Vision	x	x					
Crop Management	x	x				x	
Cloud Technology	x						
Dashboards			x				
Data Access & Authorisation Technologies		x	x				
Data-driven Technologies	x		x				x
Data Storage and persistence, synchronization and data standardization	x		x				
Deep Learning Technologies							
Digital Commercialization Technologies							
Digital Health Technologies							
DSS-Agricultural APPs	x						
Energy Use Efficiency & Systems Technologies	x						x
Farm IoT							
FMIS / Farm ERP	x					x	
Food Security Technologies			x				
GPS and GIS Technologies	x	x				x	
Greenhouse Automation (smart)	x						
HPC (High Performance Computing)	x						
Hyper-spectral	x	x					
Indoor Farming							
In Field Wireless		x	x				
IoT Devices & Connectivity	x	x	x				
IPM Technologies						x	
Irrigation/Fertigation Control (smart)	x	x					
Logistics, Asset & Fleet Optimization (smart)						x	
Machine Learning		x					
Mechatronics							
Modeling & Prediction Technologies							
Moisture Sensors							
Open SCADA		x					
Optical Technologies							
Optimization(S&H)Technologies							
Photogrametry		x				x	
Plant Data							
Precision /Smart FarmingTechnologies	x					x	
Precision LivestockFarming							
Predictive Analytics		x					
Prescriptions		x					
Quality Assessment	x					x	
Remote Sensing		x				x	
RFID-UHG			x				
Robotics	x						
Satellite Imagery & Nanosatellites		x				x	
Sensing & Monitoring(Smart)	x	x					
Sensor Technology	x	x					
Soil Sampling, Mapping & Management	x	x				x	
Soil Sensors	x						
Sound RecognitionTechnologies							
Supply Chain Analytics							
Synthetic Aperture Radar		x					
Traceability & Certification Platforms							
UAVs & Aerial Imagery	x	x					
Variable Rate Technology (VRT)		x					
Water Trading Technologies		x					
Water Use Efficiency & Systems Technologies	x	x					
Yield Monitors	x	x					

Table 1: Geographical Coverage of the technologies (NUTS Regions Level 1)

The source of the data used to construct this problem-solution matrix is the classification of technologies used in the Flagship Innovation Experiments (FIE). This draft, for discussion, non-public document was performed by UAL in WP5 as a subtask (ST 5.1.2) of Deliverable 5.1, as well as ST 5.1.1. *Catalogue of technologies used in the Flagship Innovation Experiments*, and shared with WP5 partners for developing other deliverables. Part of this information has been included in the first version of Deliverable 5.2, which also provides necessary information on countries participating in FIEs.

As can be seen from this matrix, there is a significant difference between the EU countries coverage of provided technologies for smart agriculture domain. There are countries, where the competence centres in the SAH network provided technologies and services that cover a wide range of technical needs, while other countries that have few or even none of these technologies. It should be noted that the table is highly influenced by the distribution of CCs in the FIEs and thus biased. It is expected that this will change when more CCs will introduce their technological solutions in the Innovation Portal.

This has resulted, as the matrix shows, in many white spots that need to be filled by competence centres across the EU regions. When NUTS level2 regions are taken into account instead of level 1 (level2 Matrix is provided in the appendix), the matrix looks even sparser than the one showed above. In addition, it can be highlighted that there are technologies not covered in any of the regions, such as Blockchain technology that has great potential in various smart agriculture applications areas, especially addressing issues such as transparency and food integrity.

WP5 team is working already with regional cluster leaders to encourage the CCs in the regions to register in the innovation portal and provide the competences and technologies they provide to fill these gaps based on the technological needs of the farmers. However, these white spots analysis would be revisited once the CCs in the network start filling in their competence profiles as illustrated in section 2.

5. CONCLUSIONS

In this second version of deliverable 5.3, a competence profiling method has been proposed in order to collect data about the competence and services of competence centres in the SAH network.
The White Spot Analysis has been carried out in order to identify the areas where new CCs are needed. A problem-solution matrix using the draft classification of technologies used in the FIEs was constructed in the first version of the white spot analysis. This matrix would be continuously updated with the competence centres filling in their competence profiles in the SmartAgriHubs innovation portal. The resulting matrix showed a big number of white spots across EU regions even on the country level. This was expected at the time of constructing this version of the analysis due to the low number of CCs providing their information into the innovation portal.

Therefore, the following actions would be performed by WP5 team in order to reach this objective:

- Encourage CCs through regional clusters to register in the portal and provide their information available on the Innovation Portal.
- Identification of new agri CCs to join the SmartAgriHubs network to cover the EU regions.
- Continuously update the White Spot analysis based on the competence profile of CCs in the innovation portal.

REFERENCES

[1] J. Kusar, J. Duhovnik, J. Grum and M. Starbek, "How to reduce new product development time," *Robotics and Computer-Integrated Manufacturing,* vol. 20, no. 1, pp. 1-15, 2004.

[2] S. M. Sapuan, M. R. Osman and Y. Nukman, "State of the art of the concurrent engineering technique in the automotive industry," *Journal of Engineering Design,* vol. 17, no. 2, pp. 143-157, 2006.

[3] J. Bal and M. S. Nabavieh, "Competence Management for Collaborative Manufacturing Networks," *Enterprise Interoperability: I-ESA'12 Proceedings,* pp. 219-225, 2012.

[4] J. Bal, A. Issa and X. Ma, "Orchestrating new markets using cloud services," in *Working Conference on Virtual Enterprises*, Berlin, Heidelberg, 2014.

[5] N. Armoutis, J. Bal and M. Swift, "Collaborative networks through competence profiling," in *IEEE International Technology Management Conference (ICE)*, 2007.

[6] N. Slack, S. Chambers and R. Johnston, Operations management. Pearson education., Pearson education, 2010.

[7] R. Neugebauer, S. Hippmann, M. Leis and M. Landherr, "Industrie 4.0-From the perspective of applied research," *Procedia CIRP,* vol. 57, no. 1, pp. 2-7, 2016.

[8] Y. Siwczyk and J. Warschat, "White Spot Analysis: The potential of patent information for research and development," *Proceedings of PICMET'11: Technology Management in the Energy Smart World (PICMET),* pp. 1-9, 2011.

[9] D. Eckelt, C. Dülme, J. Gausemeier and S. Hemel, "Detecting white spots in innovation-driven intellectual property management," *Technology Innovation Management Review,* vol. 6, no. 7, pp. 34-47, 2016.

[10] Japan Patent Office, Guide Book for Practical Use of - Patent Map for Each Technology Field, Tokyo, 2000.

[11] W. Luther and N. Malanowski, "Nanotechnologie als wirtschaftlicher Wachstumsmarkt - Innovations- und Technikanalyse," Zukünftige Technologien Consulting der VDI Techno-logiezentrum GmbH, Düsseldorf, 2004.

[12] Y. Siwczyk , "IT-gestützte White-Spot-Analyse: Potenziale von Patentinformationen am Beispiel Elektromobilität erkennen.," Fraunhofer-Verlag, Stuttgart, 2010.

[13] EuroStat, "Nomenclature of territorial units for statistics (NUTS)," 2016. [Online]. Available: https://ec.europa.eu/eurostat/web/nuts/background. [Accessed 9 7 2019].

6. APPENDIX

Technologies and Keywords	BE1	BE2	BE3	BEZ	BG3	BG4	BGZ	CZ0	CZZ	DK0	DK04	DK05	DKZ	DE1	DE2	DE3	DE4	DE5	DE6	DE7	DE8	DE9	DEA	DEB	DEC	DED	DEE	DEF	DEG	DEZ
Animal Production Technologies and Monitoring		x																				x								
Artificial Intelligence		x																												
Automatic Control (smart Automation)		x																												
Autonomous Equipment		x																												
Autonomous Vehicles																														
Autosteer/Controlled Traffic Farming		x																												
Bar-codes, QR-codes, Scanners and Smart Tags																														
Big Data & Data Analytics		x																												
Biometric Sensing Technologies		x																				x								
Climate Control		x																												
Climate Sensors																														
Communication & Sensors Networks (5G)																														
Computer Vision		x																												
Crop Management		x																												
Cloud Technology		x																												
Dashboards																														
Data Access & Authorisation Technologies		x																												
Data-driven Technologies		x									x	x										x								
Data Storage and persistence, synchronization and data standardization																														
Deep Learning Technologies		x																												
Digital Commercialization Technologies																														
Digital Health Technologies		x																				x								
DSS-Agricultural APPs																														
Energy Use Efficiency & Systems Technologies		x									x	x																		
Farm IoT																														
FMIS / Farm ERP		x																												
Food Security Technologies		x																				x								
GPS and GIS Technologies		x																												
Greenhouse Automation (smart)																														
HPC (High Performance Computing)																						x								
Hyper-spectral		x																												
Indoor Farming		x																				x								
In Field Wireless																														
IoT Devices & Connectivity		x																												
IPM Technologies											x	x																		
Irrigation/Fertigation Control (smart)																														
Logistics, Asset & Fleet Optimization (smart)																														
Machine Learning		x																												
Mechatronics																														
Modeling & Prediction Technologies		x																												
Moisture Sensors																														
Open SCADA																														
Optical Technologies																														
Optimization (S&H)Technologies																														
Photogrametry		x																												
Plant Data																														
Precision /Smart Farming Technologies											x	x										x								
Precision Livestock Farming		x																												
Predictive Analytics																														
Prescriptions																														
Quality Assessment																														
Remote Sensing		x																												
RFID-UHG																														
Robotics																														
Satellite Imagery & Nanosatellites		x																												
Sensing & Monitoring (Smart)		x									x	x										x								
Sensor Technology		x									x	x										x								
Soil Sampling, Mapping & Management		x																												
Soil Sensors																														
Sound Recognition Technologies		x																												
Supply Chain Analytics																														
Synthetic Aperture Radar																														
Traceability & Certification Platforms																														
UAVs & Aerial Imagery		x																												
Variable Rate Technology (VRT)		x																												
Water Trading Technologies																														
Water Use Efficiency & Systems Technologies																						x								
Yield Monitors																														

Technologies and Keywords	EE0	EEZ	IE0	IE04	IE05	IE06	IEZ	EL3	EL4	EL5	EL6	ELZ	ES1	ES2	ES3	ES4	ES5	ES6	ES7	ESZ	FR1	FRB	FRC	FRD	FRE	FRF	FRG	FRH	FRI	FRJ	FRK	FRL	FRM	FRY	FRZ
Animal Production Technologies and Monitoring			X	X	X	X							X																						
Artificial Intelligence													X					X																	
Automatic Control (smart Automation)													X					X			X						X	X							
Autonomous Equipment																																			
Autonomous Vehicles																																			
Autosteer/Controlled Traffic Farming																					X						X	X							
Bar-codes, QR-codes, Scanners and Smart Tags																																			
Big Data & Data Analytics																																			
Biometric Sensing Technologies			X	X	X	X							X																						
Climate Control																					X						X	X							
Climate Sensors								X					X					X																	
Communication & Sensors Networks (5G)																					X														
Computer Vision								X					X					X																	
Crop Management								X					X					X			X						X	X							
Cloud Technology																					X														
Dashboards																																			
Data Access & Authorisation Technologies																																			
Data-driven Technologies								X					X					X			X														
Data Storage and persistence, synchronization and data standardization			X	X	X	X															X														
Deep Learning Technologies																																			
Digital Commercialization Technologies																					X														
Digital Health Technologies																																			
DSS-Agricultural APPs													X								X						X	X							
Energy Use Efficiency & Systems Technologies			X	X	X	X							X								X														
Farm IoT																					X														
FMIS / Farm ERP						X															X						X	X							
Food Security Technologies													X																						
GPS and GIS Technologies						X		X					X					X																	
Greenhouse Automation (smart)																					X						X	X							
HPC (High Performance Computing)																																			
Hyper-spectral								X					X					X																	
Indoor Farming																																			
In Field Wireless																		X																	
IoT Devices & Connectivity								X										X			X														
IPM Technologies																					X						X	X							
Irrigation/Fertigation Control (smart)								X										X			X						X	X							
Logistics, Asset & Fleet Optimization (smart)																																			
Machine Learning						X							X					X																	
Mechatronics																																			
Modeling & Prediction Technologies			X	X	X	X							X								X														
Moisture Sensors								X																											
Open SCADA																		X																	
Optical Technologies								X																											
Optimization (S&H)Technologies																					X						X	X							
Photogrametry						X		X					X					X																	
Plant Data																																			
Precision /Smart Farming Technologies								X																											
Precision Livestock Farming													X																						
Predictive Analytics													X					X			X														
Prescriptions													X					X			X														
Quality Assessment			X	X	X	X																													
Remote Sensing			X	X	X	X		X					X					X																	
RFID-UHG																																			
Robotics																					X						X	X							
Satellite Imagery & Nanosatellites								X					X					X																	
Sensing & Monitoring (Smart)			X	X	X	X		X										X			X						X	X							
Sensor Technology			X	X	X	X							X					X			X						X	X							
Soil Sampling, Mapping & Management								X					X					X																	
Soil Sensors								X																											
Sound Recognition Technologies																					X														
Supply Chain Analytics																					X														
Synthetic Aperture Radar													X					X																	
Traceability & Certification Platforms								X																											
UAVs & Aerial Imagery								X					X					X			X						X	X							
Variable Rate Technology (VRT)																																			
Water Trading Technologies																		X																	
Water Use Efficiency & Systems Technologies			X	X	X	X		X										X			X														
Yield Monitors													X					X																	

Technologies and Keywords	HR0	HRZ	ITC	ITF	ITG	ITH	ITI	ITZ	CY0	CYZ	LV0	LVZ	LT0	LTZ	LU0	LUZ	HU1	HU2	HU3	HUZ	MT0	MTZ	NL1	NL2	NL3	NL4	NLZ	AT1	AT2	AT3	ATZ	PL2
Animal Production Technologies and Monitoring						x					x																					
Artificial Intelligence											x																					
Automatic Control (smart Automation)						x																										
Autonomous Equipment																												x				
Autonomous Vehicles																												x				
Autosteer/Controlled Traffic Farming																												x				
Bar-codes, QR-codes, Scanners and Smart Tags																																
Big Data & Data Analytics																								x								
Biometric Sensing Technologies						x					x																					
Climate Control																																
Climate Sensors			x								x																					
Communication & Sensors Networks (5G)						x					x																					
Computer Vision			x			x					x																	x				
Crop Management			x								x																	x				
Cloud Technology											x													x								
Dashboards											x																					
Data Access & Authorisation Technologies											x													x								
Data-driven Technologies						x					x													x				x				
Data Storage and persistence, synchronization and data standardization											x																	x				
Deep Learning Technologies																																
Digital Commercialization Technologies																																
Digital Health Technologies																																
DSS-Agricultural APPs											x																					
Energy Use Efficiency & Systems Technologies						x					x																					
Farm IoT											x																					
FMIS / Farm ERP											x																					
Food Security Technologies																																
GPS and GIS Technologies			x								x													x				x				
Greenhouse Automation (smart)																																
HPC (High Performance Computing)																																
Hyper-spectral			x																													
Indoor Farming											x																					
In Field Wireless						x					x																					
IoT Devices & Connectivity						x					x																					
IPM Technologies																																
Irrigation/Fertigation Control (smart)			x								x																	x				
Logistics, Asset & Fleet Optimization (smart)																																
Machine Learning																																
Mechatronics																																
Modeling & Prediction Technologies																								x								
Moisture Sensors																																
Open SCADA																																
Optical Technologies			x																													
Optimization (S&H)Technologies																												x				
Photogrametry																												x				
Plant Data			x																													
Precision /Smart Farming Technologies						x					x																	x				
Precision Livestock Farming																																
Predictive Analytics											x																					
Prescriptions																																
Quality Assessment						x																										
Remote Sensing																								x				x				
RFID-UHG																																
Robotics																												x				
Satellite Imagery & Nanosatellites																								x				x				
Sensing & Monitoring (Smart)											x																	x				
Sensor Technology			x			x					x																					
Soil Sampling, Mapping & Management			x								x													x				x				
Soil Sensors																																
Sound Recognition Technologies											x																					
Supply Chain Analytics																												x				
Synthetic Aperture Radar																																
Traceability & Certification Platforms																																
UAVs & Aerial Imagery																								x				x				
Variable Rate Technology (VRT)																																
Water Trading Technologies																																
Water Use Efficiency & Systems Technologies											x																					
Yield Monitors																																

Technologies and Keywords	PL4	PL5	PL6	PL7	PL8	PL9	PLZ	PT1	PT2	PT3	PTZ	RO1	RO2	RO3	RO4	ROZ	SI0	SIZ	SK0	SKZ	FI1	FI2	FIZ	SE1	SE2	SE3	SEZ
Animal Production Technologies and Monitoring														x													
Artificial Intelligence	x							x																			
Automatic Control (smart Automation)	x							x																			
Autonomous Equipment																											
Autonomous Vehicles																											
Autosteer/Controlled Traffic Farming																											
Bar-codes, QR-codes, Scanners and Smart Tags														x							x						
Big Data & Data Analytics	x																										
Biometric Sensing Technologies																											
Climate Control	x																										
Climate Sensors	x							x																			
Communication & Sensors Networks (5G)								x						x													
Computer Vision	x							x																			
Crop Management	x							x													x						
Cloud Technology	x																										
Dashboards														x													
Data Access & Authorisation Technologies								x						x													
Data-driven Technologies	x													x											x		
Data Storage and persistence, synchronization and data standardization	x													x													
Deep Learning Technologies																											
Digital Commercialization Technologies																											
Digital Health Technologies																											
DSS-Agricultural APPs	x																										
Energy Use Efficiency & Systems Technologies	x																								x		
Farm IoT																											
FMIS / Farm ERP	x																				x						
Food Security Technologies														x													
GPS and GIS Technologies	x							x													x						
Greenhouse Automation (smart)	x																										
HPC (High Performance Computing)	x																										
Hyper-spectral	x							x																			
Indoor Farming																											
In Field Wireless								x						x													
IoT Devices & Connectivity	x							x						x													
IPM Technologies																					x				x		
Irrigation/Fertigation Control (smart)	x							x																			
Logistics, Asset & Fleet Optimization (smart)																					x						
Machine Learning								x																			
Mechatronics																											
Modeling & Prediction Technologies																											
Moisture Sensors																											
Open SCADA								x																			
Optical Technologies																											
Optimization (S&H)Technologies																											
Photogrametry								x													x						
Plant Data																											
Precision /Smart Farming Technologies	x																				x				x		
Precision Livestock Farming																											
Predictive Analytics								x																			
Prescriptions								x																			
Quality Assessment	x																				x						
Remote Sensing								x													x						
RFID-UHG														x													
Robotics	x																										
Satellite Imagery & Nanosatellites								x													x						
Sensing & Monitoring (Smart)	x							x																	x		
Sensor Technology	x							x																			
Soil Sampling, Mapping & Management	x							x													x						
Soil Sensors	x																										
Sound Recognition Technologies																											
Supply Chain Analytics																											
Synthetic Aperture Radar								x																			
Traceability & Certification Platforms																											
UAVs & Aerial Imagery	x							x																			
Variable Rate Technology (VRT)								x																			
Water Trading Technologies								x																			
Water Use Efficiency & Systems Technologies	x							x																			
Yield Monitors	x							x																			

Table 2: Geographical Coverage of the technologies (NUTS Regions Level 2)