



**SMART
AGRI
HUBS**

**D 3.5 TECHNOLOGY
COMPONENTS
IDENTIFICATION II
PUBLIC VERSION**

WP 3

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SmartAgriHubs

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LIST OF MAIN ABBREVIATIONS

Abbreviation	Explanation
CC	Competence Center
DIH	Digital Innovation Hub
FIE	Flagship Innovation Experiment
IE	Innovation Experiment
KPI	Key Performance Indicator
RC	Regional Cluster
SAH	SmartAgriHubs
WP	Work Package

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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 Digital Innovation Hubs (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 startups, 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

The SmartAgriHubs (SAH) project, under the H2020 program and led by Wageningen University and Research, aims at progressing the digital transformation of the European Agri-Food sector. SAH uses a multi-actor ecosystem to build upon the excellence, knowledge and innovation that is present all over Europe in start-ups, SMEs, business and service providers and end-users. Specifically, SAH aims at strengthening and maturing the services of Digital Innovation Hubs (DIHs) and Competence Centres (CCs) throughout Europe. The main purpose of DIHs and CCs is to support digital innovations in agri-food, in the form of Innovation Experiments (IEs). SAH is currently funding 28 Flagship Innovation Experiments (FIEs) and 26 Innovation Experiment (IEs) resulting from the Open Calls (OCs). New ideas, concepts and prototypes are further developed and introduced into the market. The SAH project does not claim to determine the best (non-) technological solutions, but all stakeholders and (F)IEs can learn from the chosen solutions for the specific agri-cultural challenges of each (F)IE. All (F)IEs are bringing together DIHs, CCs, solution providers, and end-users that benefit from each other while learning about the possible ways to facilitate the innovation process and validating different approaches, in diverse settings and regions. The SAH project also creates opportunities to share gained experiences.

This deliverable D3.5 II “Technology Components Identification” presents the key technological and non-technological components of the 28 FIEs and assesses the reusability of each. Also 13 new IEs, resulting from the Open Calls, are presented accordingly. The analysis was realised with a report template for each innovation experiment that was designed in close collaboration of Work Packages (WPs) in the project. The components are listed, together with their progress and the support that was received or is still ongoing. The main focus was on the reusability, final TRL, end-users, dissemination and promotion and collaborations.

In total, 108 technological (72%) and 42 non-technological components (28%) were identified at this stage of the SAH project (October 2021). The majority of the identified components (90 out of 150 components, 60%) address multiple agri-food sectors. At least 232 deployment sites are involved in the SAH project with at least 161 farms. Farmers are also identified as one of the main group of beneficiaries.

86% of all identified components are reusable, i.e. 89 technological (82%) and 41 non-technological ones (98%) ($n_{\text{total}} = 130$). 67% of the reusable technological components ($n = 60$) are already available on the market.

The visibility of all reusable components is guaranteed by the (F)IEs themselves, the SAH network, and by the several WPs of the SAH project by a detailed list and video of all reusable components, the IoT catalogue and the organization of several contacts between (F)IE coordinators, DIHs and other stakeholders.

This is the public version of the deliverable.

1. INTRODUCTION

The general aim of the H2020 project SmartAgriHubs is to realise the digitisation of European agriculture by fostering an agricultural innovation ecosystem dedicated to excellence, sustainability and success. A network of agricultural Digital Innovation Hubs (DIHs) and Competence Centres (CCs) is being developed and supported. The DIHs offer a variety of technical, ecosystem-, or business-related services at local level to farmers and other stakeholders in the agri-food chain. The delivered services will help to accelerate the digital transformation of the European agri-food sector.

At the start of the SmartAgriHubs project, 28 Flagship Innovation Experiments (FIEs) were chosen and help to broaden the network and connect DIHs, CCs, end-users, technology providers, NGOs, local/regional government, etc. A multi-criteria, multi-stage inclusive approach was applied to select the most suitable FIEs, as multipliers of the value proposition of our pan-European network of DIHs. This approach is clearly described in the first iteration of Deliverable 3.5 "Technology components identification". All FIEs are shown in an Annex of the proposal and in Deliverable 3.2. In each FIE at least one DIH and CC are involved to provide one or more services.

The FIEs develop and further validate innovative digital tools, materials and good practices. The SAH project does not claim to determine the best (non-)technological solutions nor guarantees the usability of the solutions in another context, but all stakeholders and FIEs can learn from the chosen solutions for the specific agricultural challenges of each FIE. The (non-)technological components are chosen based on the in-house knowledge, experience and tools of the DIHs, CCs and other partners within the FIEs and are further developed and tested within the FIEs in order to tackle the FIEs' agricultural issues.

As identified in the first version of this Deliverable 3.5, technological components are very diverse ranging from hardware and sensors over data models, algorithms and data processing to data hubs, API management and software solutions. Reusable non-technological components are procedures or workflows, trainings, networking, business models as well as knowledge and services. The reusability of these components is estimated by the FIE coordinators and partners. Whether the overall solution or related components is really reusable as such, is to be validated when it is being used by a number of other systems and users. Very often this will require modifications.

SmartAgriHubs also offers funding to Digital Innovation Hubs (DIHs) through Open Calls. This includes the overall life-cycle for developing, setting-up, offering, providing, testing, validating, refining as well as enhancing services for digital transformation and innovation.

The first open call was to support the organization of hackathons or hackathon-type of activities or setting-up new innovative cases, all tackling the effects of the COVID-19 crisis. This RESPOND Open Call resulted in 21 new sub-grants in 2020, i.e. 8 SMEs supporting new innovative cases, included in this deliverable, and 13 DIHs organizing hackathons.

Secondly, funding could be requested by DIHs for organizing hackathons or hackathon-type of activities, contributing to the restart of the European agri-food economy with a short or medium-term impact on the effects of the COVID-19 crisis. This RESTART Open

Call resulted in 5 new sub-grants, of which 2 were already finished and analyzed in this deliverable. The last round was in September 2021.

The next Open Call is organized for Digital Innovation Hubs that are supporting the realisation of Innovation Experiments (IEs), mobilising the related stakeholders, and facilitating the access to Competence Centre related services. This EXPAND Open Call resulted already in 6 new cases, of which 3 cases started and were analyzed in this deliverable. This call is still open until June 2022.

Recently, the SERVICE open call was launched in September 2021. Digital Innovation Hubs can request funding for the services they deliver.

In this second iteration of deliverable D3.5 "Technology components identification" both the reusable technological and non-technological components from the (F)IEs are analyzed to further monitor these components, their solutions and their reusability. Synergies between (F)IEs and new collaborations are also identified. At this stage of the project, the dissemination and promotion of the reusable components as well as their TRL and end-users are key.

This iteration builds on the first version of Deliverable 3.5 I (September 2019) and Deliverable 3.6 "Common challenges analysis and technology reusability exploitation" (October 2020). This deliverable results from the work in Task 3.3 "Technology support and synergies" and further adds to reaching the Key Performance Indicators (KPIs) of the monitor and coordination work package (WP 3). The relevant KPIs are (1) the reusable components delivered and used by FIEs, (2) the number of farms involved, (3) the number of solutions that are introduced into the market, and (4) successful connections of CCs with FIEs through DIHs.

First, the chosen approach and methodology to collect all useful information about the technological and non-technological components of the (1) FIEs and (2) new IEs as well as input from (3) Regional Cluster leads and co-leads are described (Chapter 2). All data are analyzed and shown in Chapter 3. Finally, some overall conclusions, with the focus on the relevant KPIs of the monitor team (WP 3), are drawn (Chapter 3). Raw input from all (F)IE coordinators and RC leads and co-leads can be found in the confidential version of this deliverable in the Annex.

2. APPROACH & METHODOLOGY

2.1 TECHNOLOGICAL AND NON-TECHNOLOGICAL REUSABLE COMPONENTS OF FLAGSHIP INNOVATION EXPERIMENTS

In Deliverable 3.5 I "Technology components identification" (September 2019) both FIEs' technological and non-technological components and the reusability of them were identified using a predefined template. Also information about their fulfilment, support, target audience etc. was collected. Deliverable 3.6 "Common challenges analysis and technology reusability exploitation" (October 2020) again analysed the reusability data, through a FIE-specific prefilled template, with a focus on received and requested support, availability, users, favoured stakeholders and the promotion plan. A summary of both deliverables is given below, with the focus on the reusability results.

Deliverable 3.5 I "Technology components identification"

D 3.5 I "Technology components identification" collected the technological and non-technological components and the reusability of them, of the 28 Flagship Innovation Experiments from the start of the project, i.e. November 2018 till September 2019. A template was made through the collaboration of several work packages. The components, the progress and received or needed support were asked. Also the reusability and the target audience and release date were requested. The reports resulted in the identification of 112 components, the majority of them being technological (n = 75) as is to be expected in a project on digitalisation in agriculture. The identified technological components are very diverse and vary from hardware and sensors over data models, algorithms and visualization solutions. Also a lot of non-technological components (n = 37) were mentioned. They can be categorized as procedures or workflows, trainings, networking, business models and price settings as well as knowledge and services. Some components belong to both technological and non-technological or span multiple subcategories. The fulfilment rate, i.e. percentage of available components, of the technological components was higher than of the non-technological ones (55% versus 30%). This coverage might shift during the project and will be analysed in the next iteration of this deliverable (M36). The support of the CCs and DIHs was already quite developed with a 61% CC support and 43% DIH support. However, the DIHs and CCs should further expand their services and gain maturity. The support of DIHs was more focused on the non-technological components. The majority of components (89%) were reusable according to the FIEs and can be used in several sectors (63%) even beyond agriculture, resulting in a large impact of the developments of the FIEs and the reusable parts within it. Only one third of the components were sector-specific. Differences among regions were observed, but depend on the number of FIEs within the regions. Also region-specificity was noted related to the support of DIHs and CCs. And they were advised to look closely into the specific components of their region in order to tailor their services. Digital Innovation Hubs, CCs as well as the FIEs will benefit from this deliverable. Synergies will be identified and fast progress will be made. Also the other work packages used the results, e.g. support for the Innovation Portal and IoT catalogue (Communication team, WP 1), maturity model of DIHs (DIHs team, WP 4), CCs' services (CCs team, WP 5) and collaborations among regional clusters (Monitoring team, WP 3). In a second iteration of this deliverable (M36) the progress will be compared and components that are occurring at different stages of the development process will be

identified. The focus will be on further monitoring of technological and non-technological components as well as corresponding solutions and reusability.

Deliverable 3.6 "Common challenges analysis and technology reusability exploitation"

This specific deliverable D3.6 "Common challenges analysis and technology reusability exploitation" aimed (1) to further identify and rank challenges experienced during the execution of the FIEs and to analyse solutions and (2) to collect reusability data with the focus on received and requested support, the availability, users, favored stakeholders and the promotion plan. The SAH project does not claim to determine the best (non-) technological solutions, but all stakeholders and FIEs can learn from the chosen solutions for the specific agricultural challenges of each FIE.

The predominant ranked issues are related to the FIE execution, management, participants or general remarks. Fifty-eight percent of the problems are already solved, especially challenges about participants, technology, data collection and privacy, FIE execution, communication and general issues. The SAH work packages, regional clusters, FIE coordinators and their partners, and future initiatives can learn from this deliverable to continue or improve services and to circumvent some issues.

In total, 76 technological and 38 non-technological components were collected. The percentage of fulfilment increased in comparison with September 2019. Support from current CCs and DIHs is often present and mainly satisfying. However, more support from CCs and DIHs is requested, especially for technological components, but can be mainly covered by current CCs and DIHs. A high number of components are reusable: 103 out of 114 components, with 28 new available tools. The majority of reusable components are situated in the arable sector. Half of the non-technological components can be used in 5 or 7 sectors, making them not sector-specific. Additional support is requested for the promotion of the reusable components. Also a large need for trainings is observed with topics: (reusability) promotion, exchange of knowledge, data sharing, the FIEs' overall solution and business plans. Also public events should be organized for farmers, advisors and agronomists.

In the current and final iteration of Deliverable 3.5, a summary will be given of the project's reusable components, both technological and non-technological, obtained during the entire project, with emphasis on the dissemination and promotion, final TRL, end-users, and collaborations. Input is derived from the Final Progress Report of the 28 FIEs. The following parts of the Final Progress Report were valuable for this deliverable (some parts were also more thoroughly analysed in Deliverable 3.4 Periodic evaluation of the IEs performance, Deliverable 3.7 Report on maximization of IEs market take-up, and Deliverable 3.8 Success stories from IEs):

- Reusable technical components concerning the entire project duration (M17- end month) (Table 1)

Table 1: Reusable technical components concerning the entire project duration (M17 – end month) from the FIEs' Final Progress Report.

	Name of the component 1
Component owner (FIE, company...)	<i>[Please indicate the reusable technical component's owner]</i>
Type of Component	<i>[Please classify the component in a category like sensor, actuator, gateway, other wireless devices,</i>

	<i>IoT platform, FIWARE, end-user related application]</i>
Number of Deployed Units per site	<i>[Please insert the number of used units per site]</i>
Deployment Site(s)	<i>Please indicate on how many deployment sites/farms the component was tested. Please refer to No. from Area/Facilities from the Deployed components table 3.2]</i>
How is it reusable?	<i>[Please explain how this component can be reused and if it is available against payment. Also indicate if this reusable component already existed at the beginning of the SAH project (and is just further developed and/or validated during the FIE execution) or is totally new.]</i>
When it will be reusable?	<i>[Please estimate when the component will be available for reuse and if it will be available against payment.]</i>
Whom it concerns	<i>[Please explain who is the end user of this component and who is already using it (add numbers): farmers, technological companies, software developers, advisors, DIHs, CCs, retailers, consumers, other FIEs or other.]</i>
Start TRL of the component	<i>[Please indicate the start TRL (beginning of SAH project).]</i>
Current TRL of the component	<i>[Please indicate the current TRL.]</i>
Support DIHs	<i>[Please write some keywords for DIHs or indicate if no support is received.]</i>
Support CCs	<i>[Please write some keywords for CCs or indicate if no support is received.]</i>
Reusable component impacted sectors	<i>Animal production <input type="checkbox"/></i> <i>Dairy <input type="checkbox"/></i> <i>Arable <input type="checkbox"/></i> <i>Fruit <input type="checkbox"/></i> <i>Vegetable <input type="checkbox"/></i> <i>Aquaculture <input type="checkbox"/></i> <i>Novel foods <input type="checkbox"/></i>
Promotion plan	<i>[Please explain how the reusable component is already promoted and what the future promotion plan for exploitation is. Also indicate if this technical reusable component can be added in the IoT catalogue.]</i>

- Please indicate if a reusable technological component(s) from your FIE was already reused/replicated by (an)other SAH FIE(s)?
- Have you reused/replicated technological component(s) from another SAH FIE, or another organization outside of SAH?

- Reusable non-technical components concerning the entire project duration (M17-end month) (Table 2)

Table 2: Reusable non-technical components concerning the entire project duration (M17 – end month) from the FIEs Final Progress Report.

	Name of the component 1
Component owner (FIE, company...)	<i>[Please indicate the reusable non-technical component's owner]</i>
Type of Component	<i>[Please classify the component in a category like business model, services, mentoring, customer intimacy, skills and education, community building, visioning and strategy development]</i>
How is it reusable?	<i>[Please explain how this component can be reused and if it is available against payment. Also indicate if this reusable component already existed at the beginning of the SAH project (and is just further developed and/or validated during the FIE execution) or is totally new.]</i>
When it will be reusable?	<i>[Please estimate when the component will be available for reuse and if it will be available against payment.]</i>
Whom it concerns	<i>[Please explain who is the end user of this component and who is already using it (add numbers): farmers, technological companies, software developers, advisors, DIHs, CCs, retailers, consumers, other FIEs or other.]</i>
Support DIHs	<i>[Please write some keywords for DIHs or indicate if no support is received.]</i>
Support CCs	<i>[Please write some keywords for CCs or indicate if no support is received.]</i>
Reusable component impacted sectors	Animal production <input type="checkbox"/> Dairy <input type="checkbox"/> Arable <input type="checkbox"/> Fruit <input type="checkbox"/> Vegetable <input type="checkbox"/> Aquaculture <input type="checkbox"/> Novel foods <input type="checkbox"/>
Promotion plan	<i>[Please explain how the reusable component is already promoted and what the future promotion plan for exploitation is.]</i>

- Please indicate if a reusable non-technological component(s) from your FIE was already reused/replicated by (an)other SAH FIE(s)?
 - Have you reused/replicated non-technological component(s) from another SAH FIE, or another organization outside of SAH?
- Flagship Innovation Experiment impact (see also Deliverable 3.4 II Periodic evaluation of the IEs performance)
 - Flagship Innovation Experiment overview
 - Collaboration with Digital Innovation Hubs

- Collaboration with Competence Centres
- Collaboration with other Flagship Innovation Experiments
- Collaboration with other initiatives, projects, companies etc. outside SAH
- Demonstration activities (see also Deliverable 3.7 Report on maximization of IEs market take-up and Deliverable 3.8 Success stories from IEs)

The template of the Final Progress Report was sent to the FIE coordinators a few months before their end date. Flagship Innovation Experiments that did not yet end were asked to complete this template before the 17th of September 2021 (and will be requested to make a 2nd iteration when ending). In the monthly Regional Cluster meetings, organized and hosted by the monitor team (WP 3), the templates were also introduced to the FIE coordinators and the RC leads and co-leads. WP 3 was in charge of the collection of the Final Progress Reports, actively supported the FIE coordinators and partners and checked the quality of the reports.

All collected data were inserted in an Excel spreadsheet in order to make pivot tables and graphs and to perform analyses with a focus on the dissemination and promotion of reusable components, and their final TRL, end-users and collaborations.

2.2 TECHNOLOGICAL AND NON-TECHNOLOGICAL REUSABLE COMPONENTS OF NEW INNOVATION EXPERIMENTS (OPEN CALLS)

Through the open calls, new Digital Innovation Hubs became part of the SAH network. The new IEs, supported by these DIHs, offered the project additional technological and non-technological components. In the current and final iteration of Deliverable 3.5, a summary will also be given of these Open Call project's reusable components, both technological and non-technological. Input is derived from the Mid-term or Final Reports from the DIHs of the different Open Calls. The following parts of the Reports were valuable for this deliverable and were analysed:

RESPOND Open Call (data from the Final Report of the innovative cases supported by the SMEs):

- Software and hardware components developed and/or used
- From all developed components described in question 5, is there any that can be used by other entity? (e.g. one segment of the code)
 - If yes, please indicate the reusable component

RESTART Open Call (data from the Mid-term Report of the new IEs, originated from the hackathons supported by the DIHs):

- Components
 - If relevant, please list technological and non-technological components (software, hardware components) developed and/or used.
 - If relevant, please list all reusable components (available for replication by other parties) delivered within your innovation experiment (both technological and non-technological).
 - If relevant, please indicate if reusable components listed above were already reused/replicated by other innovation experiments within or outside the SAH project.

- If relevant, please indicate if you have reused component(s) from other entities for the need of your innovation experiment. If yes, please specify which component and by whom it was developed.

EXPAND Open Call (data from the Mid-term Report of the new IEs, supported by the DIHs):

- Please list all reusable technological components delivered within your innovation experiment (Table 3).

Table 3: Reusable technological components delivered within the innovation experiment from the Expand mid-term report.

	Name of the component 1
Component owner (FIE, company...)	<i>[Please indicate the reusable technical component's owner]</i>
Type of Component	<i>[Please classify the component in a category like sensor, actuator, gateway, other wireless devices, IoT platform, FIWARE, end-user related application]</i>
Number of Deployed Units per site	<i>[Please insert the number of used units per site]</i>
Deployment Site(s)	<i>Please indicate on how many deployment sites/farms the component was tested. Please refer to No. from Area/Facilities from the Deployed components table 3.2]</i>
How is it reusable?	<i>[Please explain how this component can be reused and if it is available against payment. Also indicate if this reusable component already existed at the beginning of the SAH project (and is just further developed and/or validated during the FIE execution) or is totally new.]</i>
When it will be reusable?	<i>[Please estimate when the component will be available for reuse and if it will be available against payment.]</i>
Whom it concerns	<i>[Please explain who is the end user of this component and who is already using it (add numbers): farmers, technological companies, software developers, advisors, DIHs, CCs, retailers, consumers, other FIEs or other.]</i>
Start TRL of the component	<i>[Please indicate the start TRL (beginning of SAH project).]</i>
Current TRL of the component	<i>[Please indicate the current TRL.]</i>
Support DIHs/CCs	<i>[Please write some keywords for DIHs/CCs or indicate if no support is received.]</i>
Reusable component impacted sectors	Animal production <input type="checkbox"/> Dairy <input type="checkbox"/> Arable <input type="checkbox"/> Fruit <input type="checkbox"/> Vegetable <input type="checkbox"/> Aquaculture <input type="checkbox"/>

	Novel foods <input type="checkbox"/>
Promotion plan	<i>[Please explain how the reusable component is already promoted and what the future promotion plan for exploitation is. Also indicate if this technical reusable component can be added in the IoT catalogue.]</i>

- Please indicate if any of your reusable technological components listed above were already reused/replicated by other innovation experiments within or outside the SAH project.
- Please indicate if you have reused technological component(s) from other entities for the need of your innovation experiment. If yes, please specify which component and by whom it was developed.
- Reusable non-technological components (Table 4).

Table 4: Reusable non-technological components delivered within the innovation experiment from the Expand mid-term report.

	Name of the component 1
Component owner (FIE, company...)	<i>[Please indicate the reusable non-technical component's owner]</i>
Type of Component	<i>[Please classify the component in a category like business model, services, mentoring, customer intimacy, skills and education, community building, visioning and strategy development]</i>
How is it reusable?	<i>[Please explain how this component can be reused and if it is available against payment. Also indicate if this reusable component already existed at the beginning of the SAH project (and is just further developed and/or validated during the FIE execution) or is totally new.]</i>
When it will be reusable?	<i>[Please estimate when the component will be available for reuse and if it will be available against payment.]</i>
Whom it concerns	<i>[Please explain who is the end user of this component and who is already using it (add numbers): farmers, technological companies, software developers, advisors, DIHs, CCs, retailers, consumers, other FIEs or other.]</i>
Support DIHs/CCs	<i>[Please write some keywords for DIHs/CCs or indicate if no support is received.]</i>
Reusable component impacted sectors	Animal production <input type="checkbox"/> Dairy <input type="checkbox"/> Arable <input type="checkbox"/> Fruit <input type="checkbox"/> Vegetable <input type="checkbox"/> Aquaculture <input type="checkbox"/> Novel foods <input type="checkbox"/>
Promotion plan	<i>[Please explain how the reusable component is already promoted and what the future promotion plan for exploitation is. Also indicate if this technical reusable component can be added in the IoT catalogue.]</i>

- Please indicate if any of your reusable non-technological components listed above were already reused/replicated by other innovation experiments within or outside the SAH project.
- Please indicate if you have reused non-technological component(s) from other entities for the need of your innovation experiment. If yes, please specify which component and by whom it was developed.

The monitor team (WP 3) was also responsible for the collection of these reports and supported the coordinators and DIHs. All collected data were inserted in an Excel spreadsheet and analyses were performed as described for the FIEs.

2.3 REGIONAL IMPACT AND CROSS-BORDER COLLABORATIONS

The Regional Clusters' Annual Progress Reports were used to collect extra input about the cross-border collaborations.

The following part of the RC Annual Progress Reports was valuable for this deliverable and was analysed:

- Are cross-border collaborations (with other RCs or other (F)IEs) organized and/or established including your RC?

Beside input from the RC Annual Progress Reports, also parts from the Final Progress Report from the FIEs is used for this section. This information is already described above.

The monitor team (WP 3) collected all requested input and thoroughly analysed the data. More detailed information is also shown in Deliverable 3.4 Periodic evaluation of the IEs performance.

3. RESULTS AND CONCLUSIONS

3.1 TECHNOLOGICAL AND NON-TECHNOLOGICAL REUSABLE COMPONENTS OF FLAGSHIP INNOVATION EXPERIMENTS

All 28 FIEs delivered their reports with the bundle of technological and non-technological components over the entire SAH period. The SAH project does not claim to determine the best (non-) technological solutions, but all stakeholders can learn from the chosen solutions for the specific agricultural challenges of each FIE.

In total, 71 technological and 39 non-technological components were identified. The number of technological components slightly decreased compared to the last evaluation round (n = 76, 2020) as some are now described as one component. The identified technological components are very diverse and vary from hardware and sensors including energy challenges, over data models, algorithms and data processing and storage to datahubs, API management and software and visualization solutions. One extra non-technological component was identified compared to 2020 and they can be categorized as procedures or workflows, trainings, networking, business models and price settings and knowledge and services. Also facilities are mentioned, which can be both a technological and non-technological need. Some components also span multiple of these categories as they describe a full solution instead of very specific parts.

The FIEs are spread over different sectors and are not exclusively addressing one sector. They are mainly located in the arable sector (n = 14 FIEs), followed by animal production (n = 10 FIEs), the dairy sector and fruit sector (n = 6 FIEs), the vegetables sector (n = 4 FIEs), and aquaculture (n = 1 FIE).

The technological components are mainly situated in the arable sector (25 %), closely followed by technical ones in the vegetable (22 %) and fruit (20 %) sectors (Figure 1).

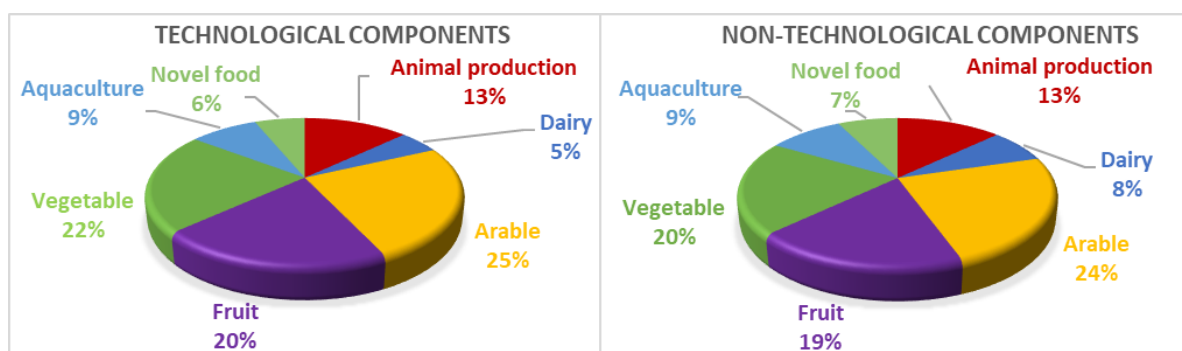


Figure 1: The technological (left) and non-technological components (right) spread across different agricultural sectors in 2021.

The non-technological components follow the same trend with arable on top (24 %), followed by the vegetable (20 %) and fruit (19 %) sectors though differences are very small (Figure 1). No major changes were observed or expected compared with previous analyses (2019 and 2020). What stands out when analyzing in more detail, is that a lot of FIEs indicated that their components address multiple sectors. Only 36 of the 110 components were sector-specific, 46 covered between 2 and 4 sectors, while 19 components address all agricultural sectors or even broader. Examples of these are business

models, IoT sensors, workflow diagrams and API connectors. This shows the potential of the FIEs developments for the whole agri-food sector.

Differences among regions can be observed in the number of components although this obviously also depends on the number of FIEs per region (Figure 2).

Iberia and South-East Europe show the largest increase in number of components which might also be due to a slower start of the FIEs. The highest number of components, when the number of FIEs per regions are taken into account, can be seen in France and South-East Europe. Also, some FIEs mentioned a few components, while others have split them into different smaller parts, meaning these numbers might not be a one-to-one representation of the work being done or the size of the challenges encountered.

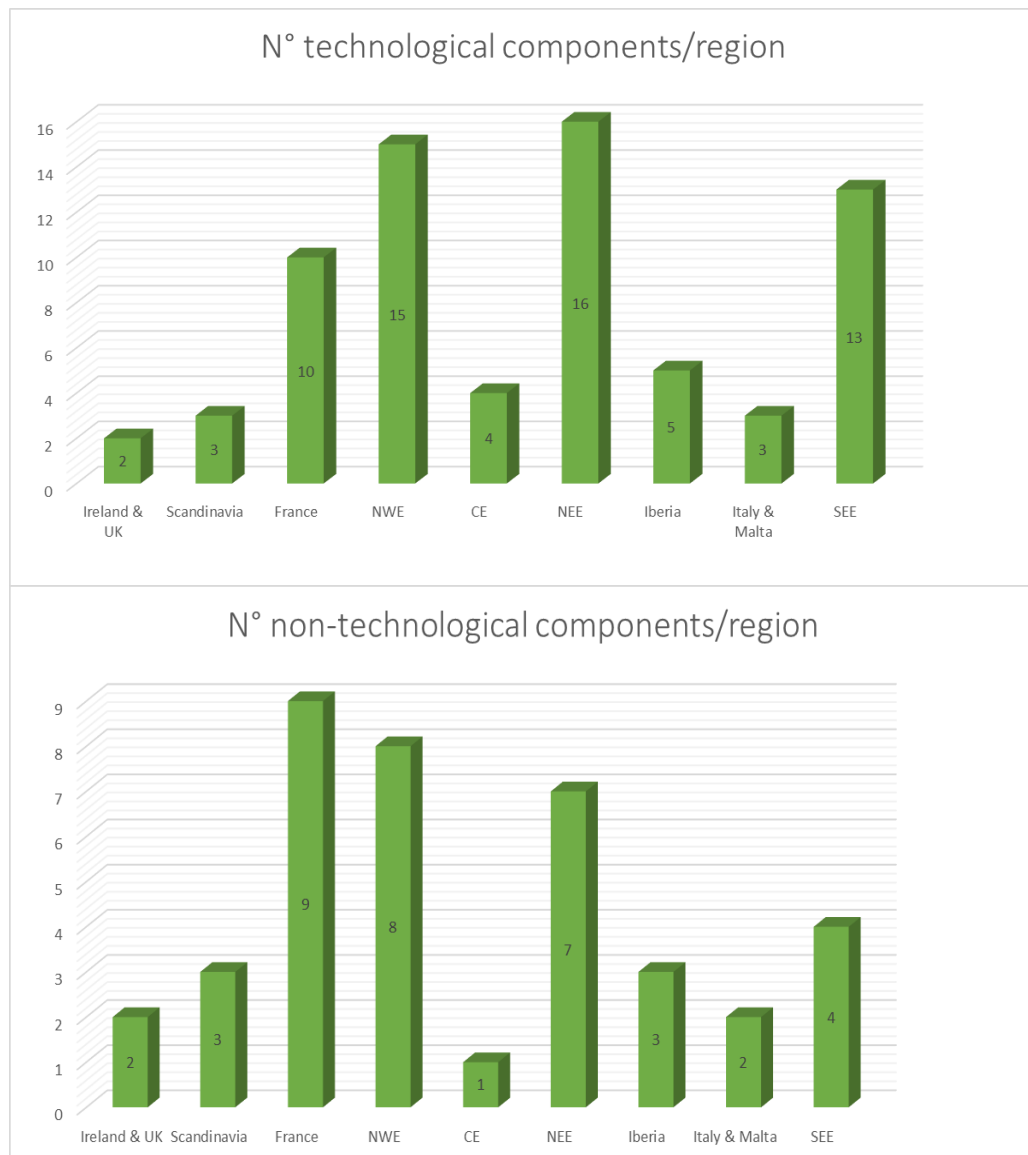


Figure 2: Number of technological (top) and non-technological components (bottom) per regional cluster in 2021.

All (non-)technological components were already tested during the execution of the FIEs on more than 217 deployment sites, of which 156 farms. Most of the technological components (n = 58) were tested on several deployed sites with some of them on more than 30 different farms.

During the execution of the FIEs, support was received by CCs and DIHs. In total 23 FIEs indicated they had a good collaboration with 1 to 2 DIHs and 24 FIEs indicated that they received a lot of support from 1 to 3 CCs.

CCs gave services related to the technological components (68%) though also to the non-technological ones (79%) (Table 5). A large part of these components still have a relation with the technical aspects, such as software development manuals, technical protocols and training, domain knowledge added to algorithms, etc. Also, there is not always a very clear distinction between CC and DIH services as they can be related to the same institute.

DIHs mainly delivered services concerning the non-technological components (69%) and less about the technological ones (57%).

Already at the beginning of the project CCs and DIHs were involved in the execution of the FIEs and were part of the SAH community. An increase in support is observed in comparison to previous iterations due to the extension of the SAH network.

Table 5: Support of Competence Centers (CCs) and Digital Innovation Hubs (DIHs) already received for each technological and non-technological component.

	Receiving CC support		Receiving DIH support	
	YES	NO	YES	NO
Technological components	48	23	40	31
Non-technological components	31	8	27	12

The support given by Digital Innovation Hubs (DIHs) and Competence Centers (CCs) within the SAH project is very diverse. This proves that DIHs and CCs offer a very wide range of services and can play a diverse role for the FIEs. The services, indicated by the FIE coordinators, delivered by DIHs and CCs can be found in Figure 3 and 4. Mainly dissemination, network building and communication were delivered by DIHs (Figure 3). We can conclude that a lot of DIHs focus on the ecosystem, but also workshops, development and technological support is given.



Figure 3: Word cloud of services of DIHs delivered during the last part of the SAH project.

The Competence Centre form the cornerstone of the Digital Innovation Hubs in the SmartAgriHubs network. They provide the digital technological infrastructure of the DIH by offering advanced technical expertise, access to the latest knowledge and information on digital technologies, as well as test facilities such as labs, pilot and experimental facilities, and other technological and scientific infrastructure. The services offered by CCs, indicated by the FIEs, vary from giving expertise and organize trainings to technical assessment, technological consultations and development of a network (Figure 4).



Figure 4: Word cloud of services of CCs delivered during the last part of the SAH project.

Reusability means that components, both technological and non-technological, can be replicated or reused by another party (e.g. an FIE), even outside the SAH network. This reusability is estimated by the FIE partners themselves, whether the solution is really reusable as such, is to be validated when it is being used by a number of other systems and users. Very often this will require modifications, but in essence the possibilities of reusing the solutions and the willingness to share it is already a good starting point. The reusability of both the technological and non-technological components is very high (109 out of 110 components, 99%) (Figure 5). The FIE coordinator however confirmed that the non-reusable component will become reusable at the end of their experiment. The increase in comparison to previous iterations (2019: 89%, 2020: 90%) was hoped for as several FIEs already ended (n = 12) or are in their final stage (n = 12). In total, 83 of these 109 reusable components are already available (October 2021), 6 will become available at the end of 2021 and 20 will be available at the end of the project (M48, November 2022).

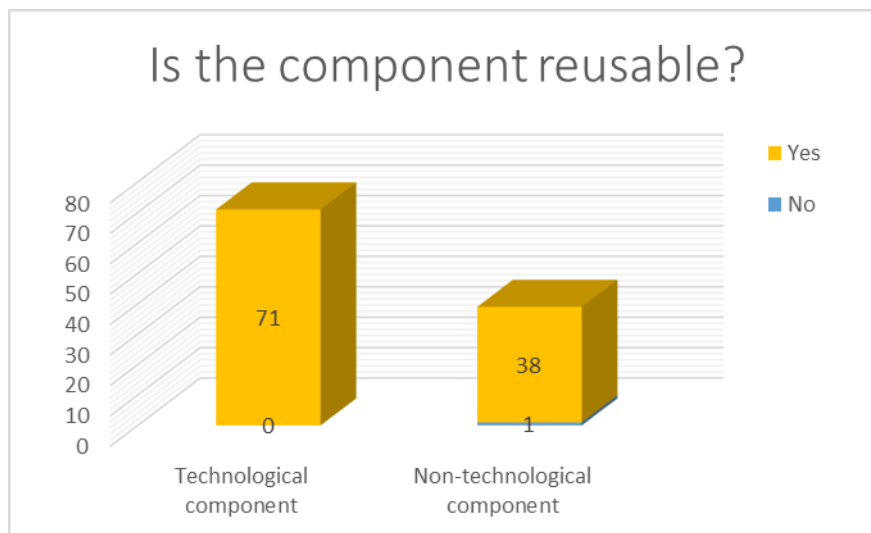


Figure 5: Number of reusable technological and non-technological components over all 28 FIEs (Flagship Innovation Experiments).

All these reusable developments are (or will be) available either via open source access (n = 39), paying services (n = 53) or free exchange of knowledge and experiences (n = 17).

When we look at the market readiness level, 47 out of 71 (66%) reusable technological components were indicated to be market-ready (TRL \geq 8). This was not asked for the non-technological components, as these can be reused, but can't always be put on the market. In the beginning of the project, there were already some reusable technological components with a high TRL (TRL \geq 8) (n = 21), but these were further validated and tested. We can conclude that 26 new reusable technological components were made market-ready during the SAH project. This number will probably increase even more towards the end of the project and we aim to have 50 new reusable technological components on the market.

According to the FIE coordinators, farmers (29 % of the beneficiaries) benefit most from developed technological components and technological companies (26 %) benefit most from non-technological ones, although closely followed by farmers (23%) (Figure 6).

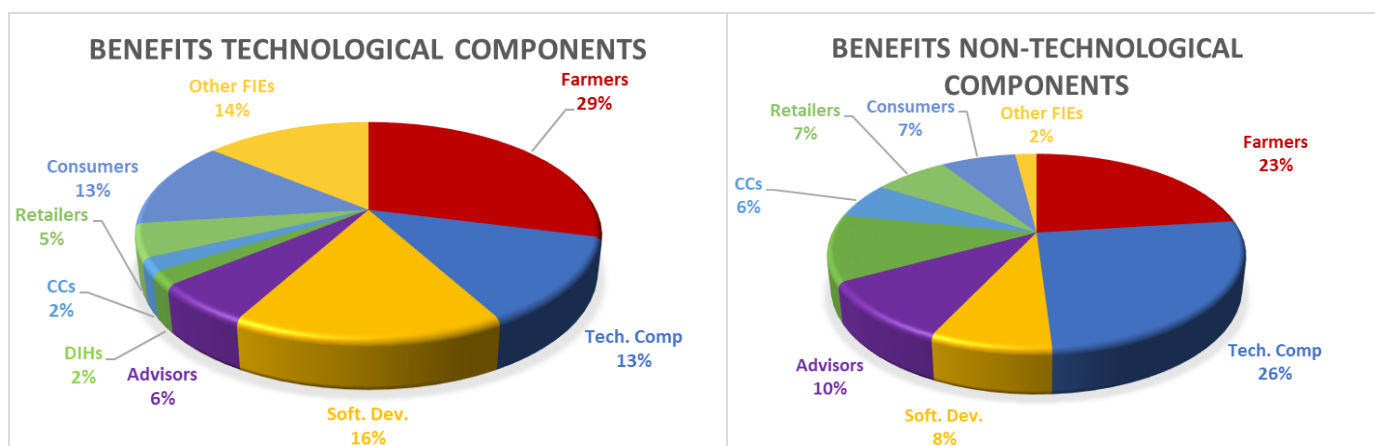


Figure 6: Who benefits from the technological (left) and non-technological components (right)?

In total 4 FIE coordinators indicated that their reusable components were already used by other FIEs. More details can be found in the confidential version of this deliverable.

The FIE coordinators were also asked if they reused components from outside the SAH network. Nine FIEs indicated that they reused some technological components. More details can be found in the confidential version of this deliverable.

The demonstration and promotion activities of the FIEs were checked. Overall, 15 coordinators indicated they organized live events, including trainings, demonstrations, live shows and seminars. Eleven FIEs organized online events, like discussion groups, online trainings and webinars. Also 2 videos, 1 poster and 1 article in total were created. Demonstration activities were not yet organized by 5 FIEs. More details can be found in the confidential version of this deliverable.

A more detailed description of all demonstration activities can be found in Deliverable 3.7 Report on maximization of IEs market take-up and Deliverable 3.8 Success stories from IEs.

The monitor team (WP 3) supports the FIE coordinator to foster their innovations and brings them to the attention of other FIEs, the SAH ecosystem and even beyond. A list of all reusable (non-)technological components and a guiding video were made by the monitor team and will be available on the SAH Innovation Portal. Reusable technological components will also be visible in the IoT Catalogue (resulting from the IoF2020 project). Furthermore, contacts between FIE coordinators and DIHs were established by the monitor team (WP 3).

Also, during meetings of Regional Clusters, hosted by the monitor team (WP3), and through the Open Calls (WP 2), the reusable components will further gain visibility.

3.2 TECHNOLOGICAL AND NON-TECHNOLOGICAL REUSABLE COMPONENTS OF NEW INNOVATION EXPERIMENTS (OPEN CALLS)

Reports with the information about software and hardware components used within the 8 IEs from the RESPOND Open Call were all well received. In total, 29 technological components were identified and are very diverse, e.g. platforms, algorithms, consumer communication tools, a delta robot, new applications for a smartphone etc.

The technological components are mainly situated within the fruit sector (29 %), closely followed by the animal production (19 %) and dairy (16 %) sectors. Of all the components, 21 were sector-specific. The others address 5 and more sectors.

The technological components are further developed in IEs from 4 regions: 5 in in RC Ireland & UK, 4 in RC France, 18 in RC North-West Europe, and 2 in RC Iberia.

Ten out of these 29 technological components are reusable (34%) and already available on the market.

From the RESTART Open Call, input from 2 new IEs was collected. Only 1 technological component was identified, an event platform software tool, within region North-West Europe.

According to the IE coordinator, the software tool can be reused (100%), though this is not yet the case, in various sectors: animal production, arable, dairy, vegetables, fruit, aquaculture and novel food. The tool is already available for free.

Both IEs did not reuse any existing component or technology.

Input from 3 new IEs from the EXPAND open call was also analyzed. In total, 7 technological and 3 non-technological components were identified, e.g. a camera system, a wine pallet, etc.

Two of the new IEs are located in Belgium (RC North-West Europe), developing 4 technological and 2 non-technological components, and one IE is in Spain (RC Iberia), delivering 3 technological and 1 non-technological component.

The technological components are mainly situated in the fruit sector (32 %), followed by the arable (18 %), dairy and vegetables (13 %) sectors. The non-technological components mainly address the dairy and arable sector (both 22 %).

During the execution of the IEs, all (non-)technological components were already tested on 15 deployment sites.

All IE coordinators described a good collaboration with DIHs. Support from CCs was given in only one IE.

All (non-)technological components are reusable (100%). Two technological components are already available on the market whereas the other ones will be at the end of the project (or later).

According to the IE coordinators, beneficiaries vary from farmers (2 technological components), food logistic hubs (1 technological component), milk and potato industry (1 technological component) to stakeholders (1 non-technological component), DIHs and CCs involved in F2F (1 non-technological component), order pickers (1 non-technological component), carriers (1 non-technological component), warehousemen (1 non-technological component) and research organizations (3 technological components).

Two technological and 1 non-technological component were already reused by another IE. Two IE coordinators indicated that they reused technological components from another SAH FIE or another organization outside SAH. More details can be found in the confidential version of this deliverable.

3.3 REGIONAL IMPACT AND CROSS-BORDER COLLABORATIONS

The economic impact of all FIEs is very diverse and goes from an increased market value over resources/time efficiency to reduction in energy use. Out of the 28 FIEs, 22 indicated that they already reached the target value. Some FIEs did not yet achieve the pre-set goals as they are not finalized and still performing field tests (e.g. to lower fuel consumption).

The environmental impact of 21 out of the 28 FIEs was already reached, e.g. to decrease pollution and increase nutrient and fertilizer efficiency. Not achieved pre-set target values are caused by FIEs who are still ongoing (e.g. to reduce pesticides and water consumption, to lower ammonia emissions).

A social impact can be expected from 26 FIEs spread over all RCs and 20 FIEs already reached their target value. Examples are a better consumer confidence and awareness and reduced digital exclusion. Pre-set goals that are not yet reached are due to non-finished FIEs (e.g. to reduce work-load).

The impact of the FIEs is more thoroughly described in Deliverable 3.4 Periodic evaluation of the IEs performance.

Collaborations with Digital Innovation Hubs went very well. A good to very positive experience was described by 96% of the FIE coordinators.

Nine FIEs indicated that they would have benefit from additional DIH services during the execution of their FIE such as

- extra training material (images of classified habitats) in order to better train machine learning algorithms,
- extra (digital) experimentation infrastructure and demo farms and companies,

- support for creating new services or products by SMEs,
- processed research findings,
- strategy development services, and
- a quick and effective inventory of other DIH products and services.

In the near future, DIH support will remain important and 18 FIE coordinators already described their needs:

- Collaborations among and a stronger usage of the network of all DIHs and FIEs based on common or complemented technologies are key.
- Also, collaboration and meeting tools, and supporting tools and services for farmers are requested. The current tools and platforms should be further developed and validated.
- Furthermore, the extension and promotion of the network with a focus on the end-users and more (digital) test facilities are demanded.
- Obtained results and innovative solutions should be promoted with a focus on the (financial) sustainability and an overview of available technologies.
- Also, access to funding, and support with project, business and strategy development were mentioned.
- The entire agri- food sector will benefit from a continuous enhancement of knowledge and expertise.

The expected support from Competence Centres was already covered in all except one FIE. In the latter experiment additional own funding will be made available to support the further execution of the FIE.

The monitor team (WP 3) is in close contact with all (F)IE coordinators and collected their needs and topics for trainings.

The following trainings are currently available on the online platform Curatr of the DIH team (WP 4) (DIH Exchange Program) and are available for registered DIHs:

- Maturity assessment
- Business planning
- Business models and strategy
- Financing
- Marketing Engagement

Webinars are also already organized and covered the following items:

- Building joint tools for sustainable digital agri business
- Governance for Digital Innovation Hubs
- Strategy development for Digital Innovation Hubs
- Ecosystem analysis for Digital Innovation Hubs
- Business models for Digital Innovation Hubs
- Platform service business models in agriculture (organized by IoF 2020)
- Price setting for IoT solutions (organized by IoF 2020)
- European test farm network (organized by IoF 2020)
- Consumer behaviour (organized by IoF 2020)

All mentioned webinars are available on the SAH Innovation Portal (Training section) for registered companies.

Collaborations among FIEs within their Regional Cluster was established by 14 FIEs whereas cross-border collaboration, though within the SAH network, occurred 8 times among 7 FIEs. More details can be found in the confidential version of this deliverable.

And a more detailed analysis of other regional collaborations concerning demonstrations, knowledge transfer, etc. can be found in Deliverable 3.4 Periodic evaluation of the IEs performance.

Also collaborations outside the SAH project were organized by half of the FIEs and mainly concerned exchange of expertise and experience, services and technical support, e.g. sensor data, platforms..., network building, general project support and meetings and workshops. Also, collaborations with follow-up projects were mentioned.

3.4 OVERALL CONCLUSIONS

This deliverable aimed to identify and analyze the technological and non-technological components as well as the reusability of them in each FIE for the second time and in some new IEs for the first time. The following take home messages can be considered.

In total, 108 technological (72%) and 42 non-technological components (28%) were identified at this stage of the SAH project (October 2021). The largest part of the identified components being technological as was expected in a project on digitalisation in agriculture.

The majority of the identified components (90 out of 150 components, 60%) address multiple agri-food sectors.

At least 232 deployment sites are involved in the SAH project with at least 161 farms. Farmers are also identified as one of the main group of beneficiaries.

86% of all identified components are reusable, i.e. 89 technological (82%) and 41 non-technological ones (98%) ($n_{total} = 130$). This number (and %) will further increase as some (F)IEs are not yet finished and new IEs from the Open Calls will also deliver reusable components. However, due to the nature of the hackathon-type of activities from the RESTART Open Call, the work is addressing rather very early stage of requirements analysis and solution design.

67% of the reusable technological components ($n = 60$) are already available on the market.

The visibility of all reusable components is guaranteed by the (F)IEs themselves and by the several WPs of the SAH project through the organisation of (digital) events, trainings, seminars, etc. and the development of promotional material. The monitor team (WP 3) also made a detailed list and video of all reusable components. These tools and the IoT catalogue will be available on the SAH Innovation portal. Also, contacts between (F)IE coordinators, DIHs and other stakeholders are organized.

The support from DIHs and CCs, participating in (F)IEs, is very well received. The corresponding WPs (DIH team, WP4; CC team, WP 5) will thoroughly check the requested needs from the coordinators and cover these topics in their further training offer.

Collaborations within the SAH project were already established among 23 (F)IEs. Also, collaborations outside the SAH project were organized at least by 15 (F)IE coordinators.