DIGITISATION: ECONOMIC AND SOCIAL IMPACTS IN RURAL AREAS

D3.4 SHOWCASE TECHNOLOGY

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ELENI TOLI (ATHENA), PANAGIOTA KOLTSIDA (ATHENA),
CHRISTOS MARINOS-KOURIS (ATHENA), CLAIRE HARDY (HUTTON),
LEANNE TOWNSEND (HUTTON), MANLIO BACCO (CNR)

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Authors	Eleni Toli (ATHENA), Panagiota Koltsida (ATHENA), Christos Marinos-Kouris (ATHENA), Claire Hardy (HUTTON), Leanne Townsend (HUTTON), Manlio Bacco (CNR)
Work Package Leader	ATHENA
Project Coordinator	UNIPI

Table of contents

1 Introduction

This report presents how to integrate critical values of the digitisation process and apply these values during the various phases of digital solutions development, testing, and adoption. It showcases this in a practical way, by presenting two proof-of-concept solutions delivered by DESIRA. The report presents thoroughly the *DigiCroft* virtual farm and the *Chatbot* technologies and displays their technical features, design perspectives and their wider social and economic impacts, perceived as system disruptors, aiming to juxtapose the technology design characteristics with integrated digitisation practices, as defined from the DESIRA's standpoint.

DigiCroft is a virtual training platform designed to help crofters access information on training opportunities. It was developed based on the concept of virtual engagement, to widen access to information on agricultural demonstration activities. DigiCroft is an interactive and fully immersive environment that is used as a signpost to direct users to resources and training opportunities, while also examine the unique nature of crofts, identify best practices on virtually reproduced crofting scenarios, help in pinpointing training needs while doing so in an interactive and entertaining gaming-like manner. The platform assists crofters in recreating and increasing access to on-farm demonstration and enables the finding of opportunities in a timely and efficient manner.

The ***Chatbot*** is an automated system that communicates with users through messaging platforms and can manage simple tasks such as providing information or guiding users through processes. It reduces the workload of operators and provides immediate responses to users. The system architecture is modular and open source, consisting of a chatbot component based on the Botpress framework and a custom software layer. Each interaction with users is stored in a database, and IT staff can manage requests through a web application. The Chatbot has the potential to contribute in the optimization of resource allocation, reduce costs, and improve financial security for external actors while increasing community participation in land management.

These two technologies that will be furtherly described in the sections below, have been selected as model examples that represent the technology entity through which the process digitisation is instigated in given social contexts. The DESIRA project operated on the premise to explore and frame how and in what ways digital transformation occurs in the settings of forestry, agriculture, and rural areas. The two selected technologies, each one through its own unique attributes, will enable the showcasing of terms and concepts that were developed throughout the lifespan of DESIRA and provide a spectrum of potential practical digital transformation activities. In DESIRA 'technology' has been used as the factor whose breakdown allows to progress a system thinking methodology and define 'change' by *constructing* complex and adaptive systems characterized from their cyber-physical traits and interactions, and subsequently *dissecting* them to identify how routines and rules are reconfigured, what outcomes are anticipated or unanticipated and how this in turn creates winners and losers. For this report the term Digital Game Changer is resurfaced and can be further defined through the examination of the endo and exo impacts the two featured technologies bring. The report provides in depth technical details, features, design aspects and user-technology interactions to enable the theoretical transposition of these two technologies, as technical entities, into a Socio-Cuber-Physical

(SCP) system and allow the investigation of which values-utilities and attributes valorize them for becoming integral part of an SCP system and how their utilization impacts-alters the interrelations of the system's entities while also shifts the system's dynamics and expands its boundaries.

2 Showcase Technologies

2.1 A Chatbot for Consorzio Toscana Nord

The administerial institution "Consorzio Toscana Nord" (CTN), located in the Tuscany Region, central Italy, manages the river basins and several hydraulic systems and infrastructures within the same area. The area of reference extends in approximately 360.000 hectares, and it is characterised as mainly mountainous. Land abandonment and the simultaneous occurrence of numerous extreme natural events in the last years, such as floods and landslides, are having negative impacts on the hydraulic and geological system of the area. In order to address this issue, CTN has introduced during the last years several digital tools (e.g., a WhatsApp channel and a Web-GIS tool) to facilitate communication with citizens in the area aiming mainly to receive maintenance requests. The number of intervention requests received daily by CTN is high in certain periods of the year, leading to high upkeep effort required by the IT personnel that processes and manages such requests.

In the context of the DESIRA project, a digital tool, in the form of a chatbot, has been co-developed to support the management of such requests. The key objective is to partially automate the process, from citizens' reporting to the implementation of appropriate intervention measures. The two main tasks that need to be addressed are the following ones:

The **first task** relates to enabling citizens to report activities as well as provide guidelines for the request creation, monitoring, and modification of requests. Therefore, to streamline the amount of work needed by the IT personnel and the down time the citizens are experiencing when submitting requests.

The **second task** relates to partially automating the management of intervention requests through the development of a web application. This software solution, is capable of providing IT staff with a tool for viewing, analyzing, modifying, organizing and archiving the reports provided by users through the Chatbot.

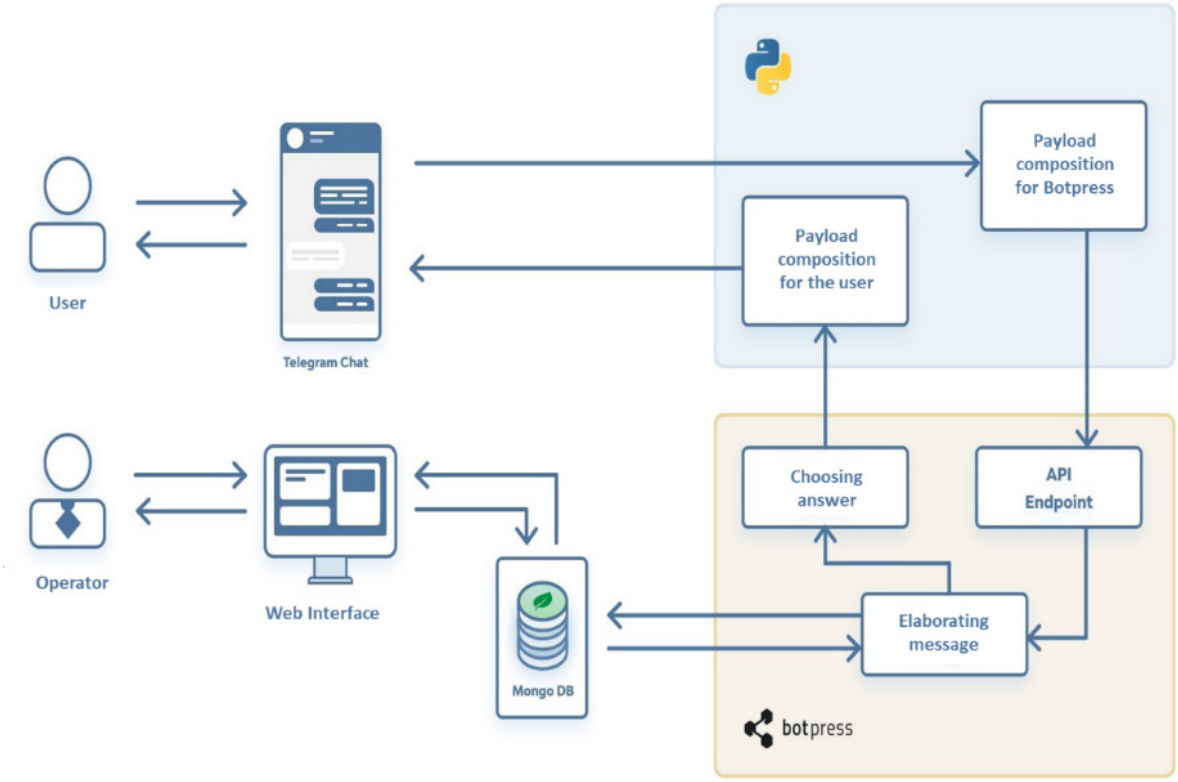
2.1.1 General description of the Chatbot

A chatbot-like system is a familiar and easy-to-use experience based on common messaging systems, thus being rather well accepted also in case of limited digital skills. Furthermore, it has the potential for drastically reduce the operator's workload: in fact, by automating the management of simple tasks, such as requests for information or guiding users through specified processes, operators are free to address other tasks and intervene only when the Chatbot is no longer able to meet the user's needs. Finally, a further advantage is the possibility for users to access the service at any time and with immediate response.

The aforementioned web application is the other half of the system, intended for the IT staff in charge of managing the intervention requests. The overarching system architecture is modular and is based

on the use of open-source components. Figure 1 shows the main modules in use and how they are connected.

Fig. 1: architecture of the proposed system



The main features and functionalities of the tool can be summarized as follows:

- In order to open a new intervention request, the user opens the Telegram application and starts a conversation with the Chatbot;
- The conversation is guided by a workflow defined in an instance of the Botpress[1] framework (yellow box in Fig. 1), connected to the Telegram API through a custom software layer (blue box in Fig. 1). The custom software layer, written in Python and based on the Python-Telegram-Bot[2] open-source library, allows non-text messages to be sent, such as photos and geographical coordinates. This component forwards messages between Telegram and the Botpress instance, each time creating an appropriate payload for the recipient;
- Each interaction with users passes through the custom software layer and then reaches the Botpress instance, which processes the request based on the defined workflow. An interaction is composed of multiple request-response exchanges, and data collected from users is then stored

1 https://botpress.com
2 https://python-telegram-bot.org

in the form of a report in a MongoDB3[3] database instance (the open version has been used, namely community server);

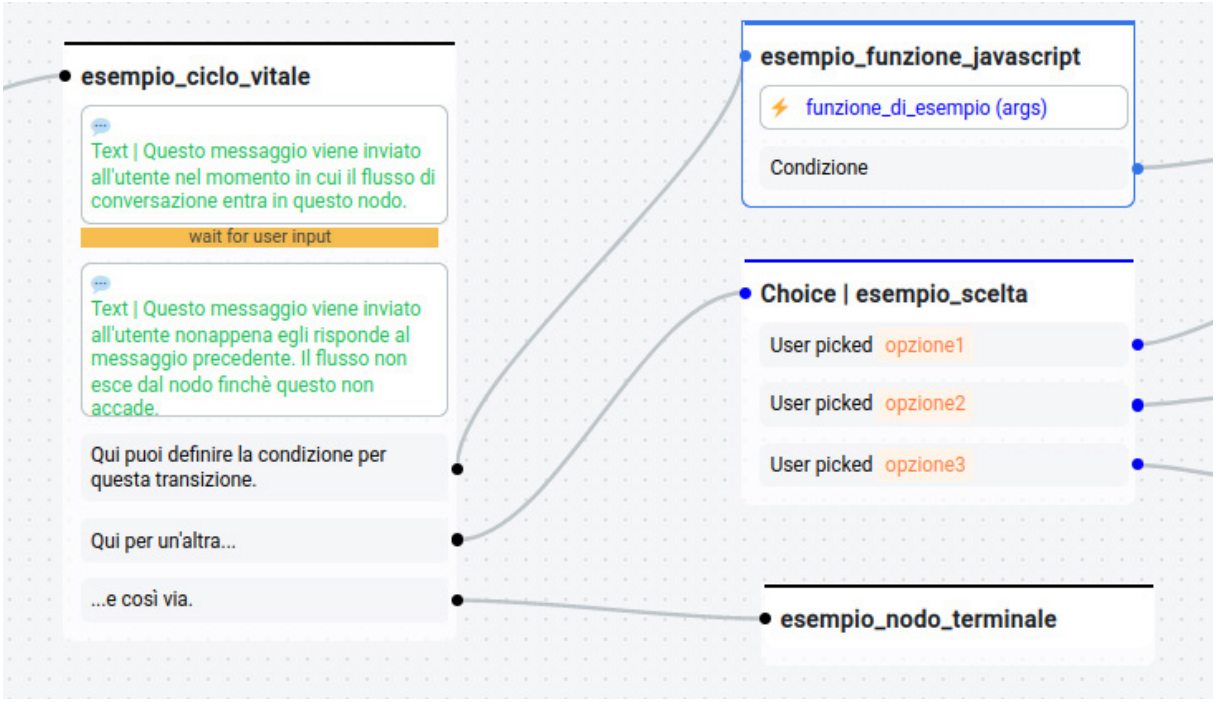
- The IT staff sees received requests through the web application, connected to the MongoDB instance, to manage the request.

The Chatbot is available online (Italian language): https://t.me/inlinekb_bot although not currently in use by CTN; it will be fully presented in the following sections.

2.1.2 Choice of the framework for the Chatbot's development

Before proceeding to present the most relevant interaction scenarios among users (citizens) and the Chatbot, it is worth explaining why the Botpress framework has been selected for use. It is important to underline that a key requirement has been considered since the very beginning: the possibility for IT staff to modify the behaviour of the Chatbot easily and quickly, in order to adapt the tool to changing conditions over time. In this case, the decision takes the form of selecting tools using graphical interface to code conversations (see Fig. 2) instead of being forced to resort to code writing only.

Fig. 2: coding the behavior of the bot through an easy-to-use graphical interface (Italian language)



Three different open-source projects have been considered as potential candidates for the implementation of the bot, namely *Rasa*[4], *RedBot*[5], and *Botpress*. These projects offer the possibility to code the behaviour of the bot, which translates into 1. defining the series of questions to be posed to

3 https://www.mongodb.com/try/download/community
4 https://rasa.com
5 https://red-bot.io

users, 2. managing the request-response exchanges, 3. accessing and saving data from and to external databases, and 4. supporting the use of Telegram as messaging solution.

Rasa offers a strong potential in the field of (Natural Language Processing) NLP-based solutions, which implies that the framework offers the possibility for users to asks questions or write statements in natural language, and the system would learn from previous interactions. Rasa refers to the latter as conversation-driven development (CDD), a technique for continuous improvement of an AI-based Chatbot by listening to users' requests. Despite the potential usefulness of the feature, Rasa has been discarded because CDD is hard to code and it does not offer a graphical interface, thus not meeting the key requirement set above.

RedBot and Botpress offer similar solutions, both meeting the requirement of a graphical coding interface. Thus, an additional requirement has been considered to define which open-source solution better fits Chatbot's purposes. The Botpress framework, accounts for more users that form an online community compared to RedBot, representing thus a solution which is able to provide both a large reactive user community and clearer user documentation. Those additional considerations have led to choosing the Botpress framework as the preferred solution for this tool.

A final consideration is related to the use of Telegram instead if the more popular Whatsapp that as a messaging solution is more commonly used in Italy. Watsapp does not offer any free programming options to design and build chatbot-based systems. On the other hand, Telegram provides open and simple interfaces to program the exchange of messages with users, and its use does not involve the payment of fees for both users and service providers.

2.1.3 Chatbot's operation and functionalities

The following workflow briefly describes the features and possible interaction scenarios between the user and the Telegram-based Chatbot:

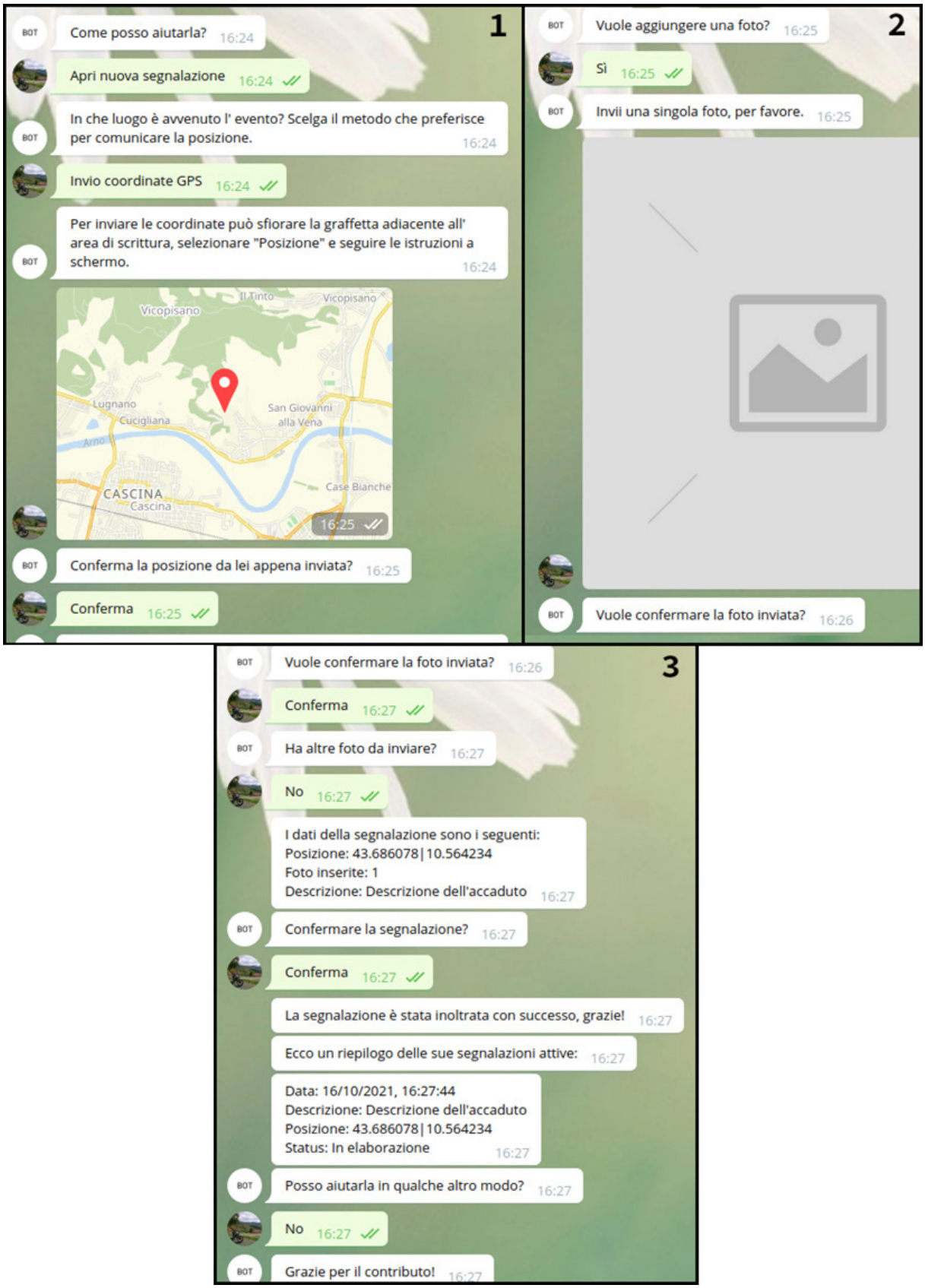
1. *User registration* (Figure 3): In order to keep track of the reports of each user and offer the possibility to modify or delete them, as well as to allow the CTN operators to directly contact the authors of the same, the user must first complete a registration process before entering a report. After registering, the user gets full access to the Chatbot features and is registered in the DB instance with a unique ID.
2. *Creation of an intervention request* (Figure 4): Creating a new report is initiated by requesting from the user how to provide the location associated with the report. The Chatbot allows the sending of GPS coordinates or a textual description of the site. Once this is done, the user is asked for a brief description of the event, followed by the option to send photographs of the area to be checked.
3. *Modification of an intervention request*: When the user chooses this option, the Chatbot lists the active alerts (i.e., those still to be closed by the IT staff after evaluation and/or intervention) made by the user, inviting to select the one to be possibly modified or deleted. Once a report has

been chosen, the modification process continues until the user decides to confirm the changes made, cancel them, or delete the report.

4. *Monitoring of intervention requests*: Through this function, the user can view their reports, choosing whether to receive a summary of the reports, that are active, or archived, Reports under evaluation by the IT staff are marked and the user receives a notification on this action.

Fig. 3: PLAID virtual farm proof of concept

Fig. 4: creation of an intervention request (Italian language)



2.1.4 Chatbot's operational administration

In what follows, focuses on the main steps and stages that describe how the IT personnel manages basic functions of the Chatbot.

1. *User Login*: Accessing by using a web browser, the operator logs in to the system (scenario 2 below). This phase is relevant for security purposes by allowing those with the right credentials to access the reports and the system to keep a log of performed actions.
2. *Main Panel* (Figure 5): it shows the requests for interventions received through the Chatbot, identified on the panel with the name "Reports" and displayed in a table. The latter is the main widget of the screen, directly related to the information extracted from the database. The status assigned to each report (in processing, completed, etc.) can be read. Once clicked, each record enables access to two additional sub-panels:
   - Info Form (green box in Figure 5, right): it is a sub-panel to view detailed data about the report, including images, the description of the event, information on the GNSS position, and the unique ID of the report, as well as information on the user who submitted the report;
   - Modifiable Data Form (yellow box in Figure 5, bottom left): it is a sub-panel made up of several widgets that allow adding or modifying some information of the report, such as the addition of a specific title or notes by the operator, as well as modifying the "Status" (pending, completed, archived, contacted user, etc.) of the report.

Also, it is possible to archive requests after evaluation or after a completed intervention. Archived requests are moved into the archive subsection (scenario 3 described below).

3. *Archive Panel* (Figure 6): This panel, containing the list of archived reports, is similar to the main panel. However, there are some differences; the state of each report before archiving is visible, in order to keep a log of decisions and carried-out actions. Furthermore, two actions are presented in the form of buttons, allowing for the definitive deletion of the report from the database, and the possibility to unarchive the report and bring it back into the Main Panel.
4. *Administrator Pages*: they are two sub-panels, called "Status Management" and "Operator Management", which allow an administrator user to make changes to the web application. In the "Status Management" sub-panel it is possible to insert and modify the status labels to be assigned to the records from the main panel. In the "Operator Management" sub-panel, the administrator can manage and add new operators able to access the Chatbot.

Fig. 5: Domesticated farm animals in the open grazing area in the DigiForest

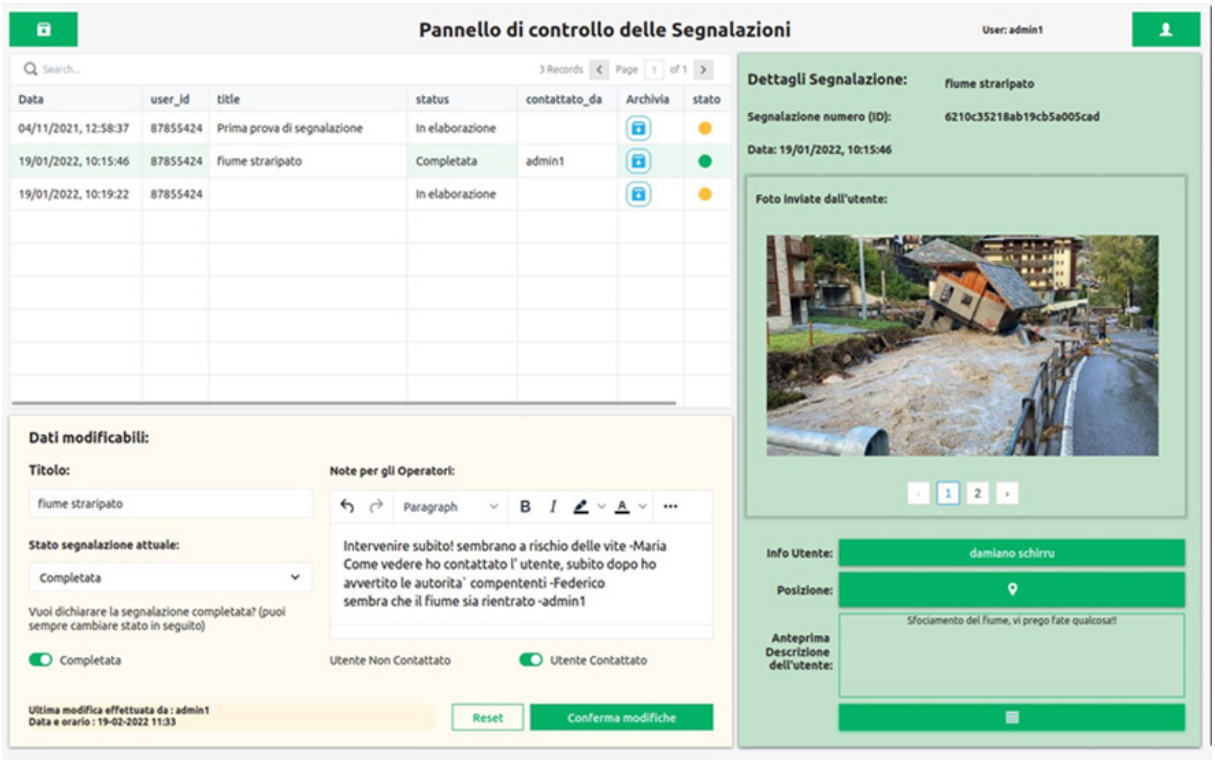
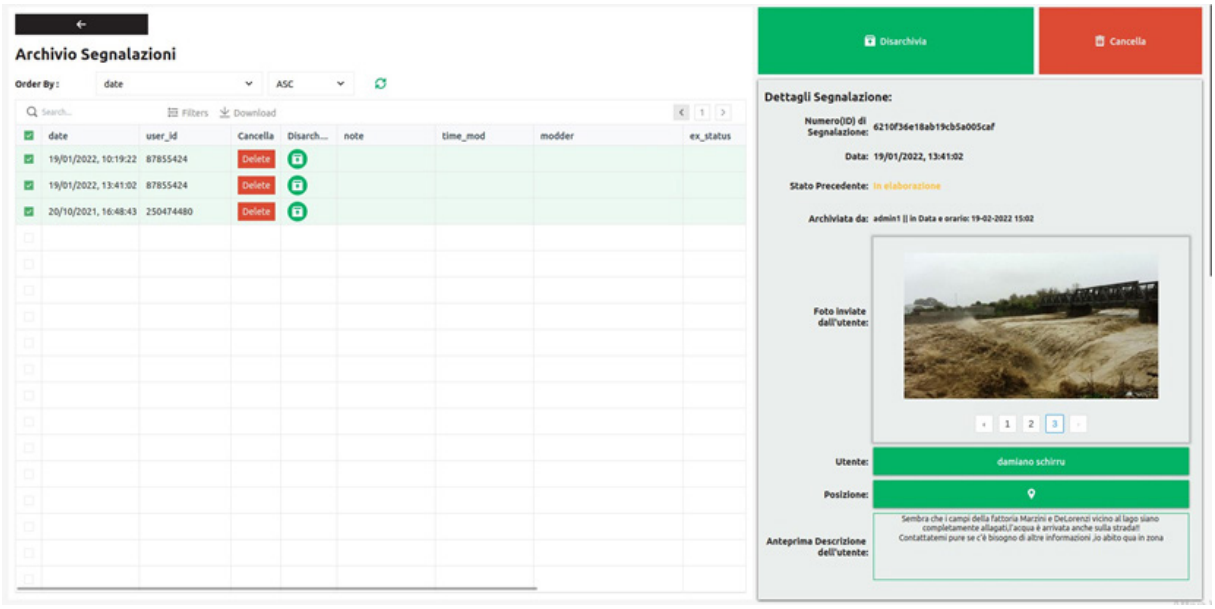


Fig. 6: Wild animals and wind turbine in the simulated DigiForest environment



2.1.5 Chatbot's framework

The leading aspect that influenced the design of the Chatbot was the need to exploit a framework for creating simple and programmable interfaces, also for non-programmers.

After comparing various frameworks, the Appsmith platform has been selected. It is a low-code and open-source platform for the graphic development of web applications, especially for the creation of management panels with graphics, forms, and other features. It is particularly powerful and fast for creating simple and practical interactive interfaces. What seems to be a limiting aspect at first glance leads to advantages in terms of the complexity of installation and maintenance of the Chatobot. In fact, it is possible to easily install the Appsmith tool by its integration with the Docker framework, which allows a fast deploy of an Appsmith instance on Linux systems. Then, after importing a configuration file describing the entire application, the Chatobot can be accessed by connecting to the Docker instance. The latter runs on a dedicated virtual machine set up in CNR site in Pisa, which can be duplicated and relocated if needed.

2.1.6 Chatbot's potential impacts

As anticipated above, the tool has been designed and implemented as a result of the activities carried out in the Tuscany Living Lab. This tool has been also utilised as a use case via which activities that involved the LL's stakeholders, and thus potential future users, have been carried out from the pre-lauch stages of the tool.

The overall goal was the improvement of efficiency of maintenance works carried out by CTN, which revealed a multitude of potential impacts according to the co-creation activities and feedback received from the LL stakeholders. The impacts that have been identified and discussed during the use case activities showcase the Chatbot as a fast and efficient tool that can furtherly involve citizens in the area in the management of the land has the potential to optimise resource allocation by CTN, resulting in a reduction of the number of extraordinary land management activities (typically more costly and urgent than ordinary activities), thus freeing both time and financial resources. Extending on optimising the resource allocation, CTN commits part of its annual budget to liaise with external actors (specialized companies, farm associations, citizens) to carry out certain operational activities, therefore achieving a more efficient resource management can lead to increased income for such actors, pushed by their interest in living in a secure area that is supported by inclusive monitoring mechanisms and improved, at least to a certain degree, resource management routines. Chatbot facilitates the participation of local communities in the process of land management, despite the uncertainty for perceived the risk of a reduced number of inspections conducted by technicians that may be partially replaced due to the adoption of an efficient remote and digital reporting tool. To conclude, a tool that can support activities aimed at reducing hydrogeological risks was welcomed by the local actors and potential future beneficiaries.

The expectations and needs of the included actors have allowed to articulate and reflect on potential intended and unintended impacts of the Chatbot. More than just early involvement, the tool has been designed and developed in accordance with the actual needs in the area (i.e., the need for resilience

given the risks due to floods in the mountainous region) and incorporates in its design the objectives for resilience and environmental sustainability that CTN has set within its work in the region. The choice of Chatbot as has been made to maximise the usability of the tool, since farmers and citizens are accustomed with routines that report incidents and request for interventions through an existing Whatsapp channel, managed directly by the CTN staff. The use of a messaging system, such as Telegram, very similar to Whatsapp's core functionalities, has allowed to use a familiar interface that receives immediate automated answers. In addition to that, users can consult the status of the requests they opened, so to have information about potential planned actions. In that way, accountability on both sides can be ensured, meaning that users requesting interventions are known and their actions can be traced, as well as answers and actions from the operators of the Chatbot (CTN) will be transparent and traced. Overall, the Chatbot may be simple from a technological standpoint, though its potential positive community and wider regional impacts are to be considered for the further development of the area.

2.2 'DigiCroft' a tool to create virtual farm environments

2.2.1 General description of DigiCroft

The virtual farm concept was first used in the H2020 project PLAID (Peer-to-peer Learning: Accessing Innovation through Demonstration). It is well understood that farmers learn from farmers and engage with new technologies and practices through demonstration activities. These activities also contribute to the development of networks in agricultural and isolated rural communities, leading to longer term sustainability and economic development. Little research however has focused on agricultural demonstration activities in EU countries. PLAID explored the use of demonstration farms to allow farmers to access information, however it was reported that visiting demonstration farms is often time and location dependent. Farmers, who are often time poor and can be located many miles from a demonstration farm or proposed event, found that accessing a demonstration farms is a costly exercise often leading to fruitless engagement. The concept of widening access using virtual engagement was developed.

The DESIRA project has taken this concept further. Gaming technology was used to create a simulated gaming environment based on a generic crofting township. This simulated environment has been developed as a training platform to allow viewers to find information on training opportunities. The environment is fully interactive and can be navigated via several different modes, and is used as a signpost to direct players to resources and training opportunities, at the same time as being entertaining. It has been found that people engage more fully whilst being entertained.

Due to the unique nature of the crofts, where they are located and in general the land being used, the training needs to be bespoke. Crofting is often commercially challenging resulting in a large number of crofters being pluriactive. It would be wrong to consider that any of their occupations are part time, crofting is a lifestyle and often traditional production methods are employed. Some of these skills are dying out and the crofters access courses to either learn or refresh knowledge. In addition, they employ new techniques that are adapted to their unique lifestyle. For example, fencing is an important skill,

but in the context of crofting stock fencing is required and certain techniques to sink posts in boggy or rocky ground are needed.

These training requirements are fulfilled by many organisations, they tend to be offered on-site in remote locations which require registration to prevent over or under subscription. Finding opportunities in a timely fashion can be challenging, especially as web browser searches are only successful if the correct keyword searches are undertaken. Many searches may be required to attempt to find these unique opportunities: a time consuming; frustrating and often unrewarding task. Alternatively events can be advertised in the local communities, but the audiences reached are limited.

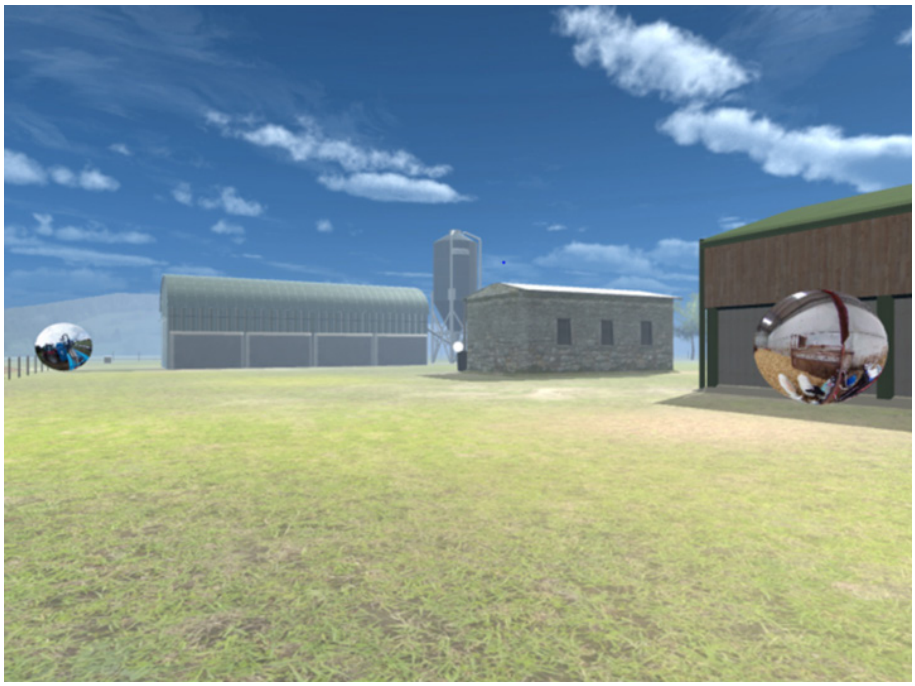
DigiCroft is a tool that was developed in collaboration with DESIRA and takes advantage of the project's Living Lab methodology to help crofters and training providers by linking opportunities with potential attendees. DigiCroft targets crofters, smallholders, large crofting organisations (including the Scottish Crofting Federation and the Crofting Commission) and introduces new training capabilities. Likewise, DigiCroft extends the training development potential to officers and other key relevant organisations including Farm Advisory Scotland (FAS), Scottish Government policy officers and knowledge exchange administrators. Finally, the tool provides a valuable resource to rural SMEs, NFUS and local colleges including the University of the Highlands and Islands (UHI).

2.2.2 History of the DigiCroft's development

The EU-funded PLAID project (Peer-to-peer Learning: Accessing Innovation through Demonstration), coordinated by The James Hutton Institute, worked with 12 EU partners from 2017-1019. The issue of isolation for rural communities was addressed by encouraging farmers to embrace the sharing of their innovations virtually and the concept of a virtual farm was explored to widen access to demonstration farms and the associated innovation being demonstrated. These activities helped rural communities, that are isolated, whose members would normally have to travel many miles to visit an on-farm demonstration by providing the means to view the farm and its innovations virtually. 'Virtual demonstrations' give stakeholders the chance to engage at their leisure (24/7), on demand and create unique viewing experiences each time. The interactive content encourages people to be in control of their experience and allows them to interact with the content. This creates a better, in terms of retention of material, learning experience.

To help the project a group of students from Abertay University, studying a course of Professional master's in games development, developed the concept platform for the virtual farm. Starting from a brief provided by the PLAID project the students pitched their interpretation of the brief from which the winning team went on to design the pilot, virtual farm (Fig. 7). The pilot was used to gather feedback when launched at the Royal Highland Show 2018 and develop the proof-of-concept version.

Fig. 7: PLAID virtual farm proof of concept



The Macaulay Development Trust (MDT) provided funding to develop this proof of concept further. The MDT funding enabled the production of the DigiForest in a professional level. The simulated environment was based on an Agroforestry environment and visualized various plots of deciduous and coniferous trees. Other resources included were: a wind turbine; farm animals; wild animals and a quad for navigating quickly from various areas (Fig. 8 and 9).

Fig. 8: Domesticated farm animals in the open grazing area in the DigiForest

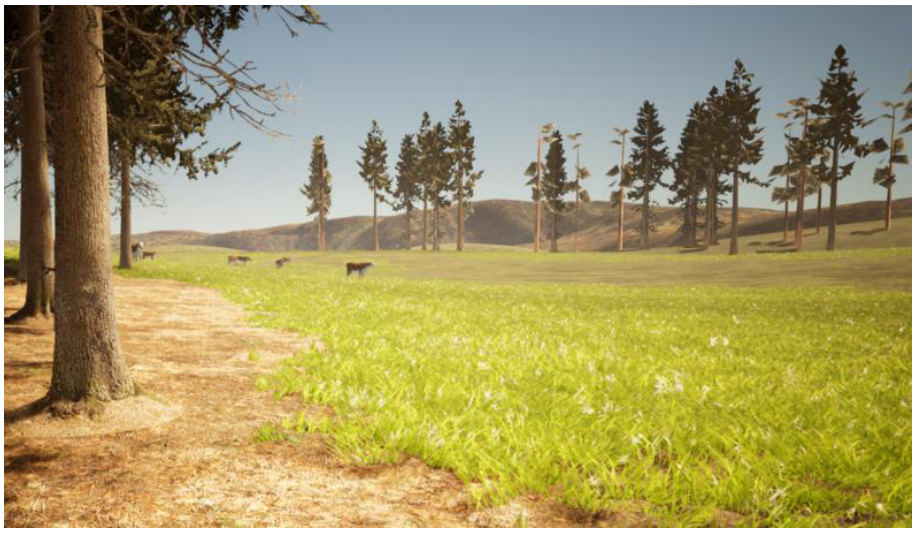


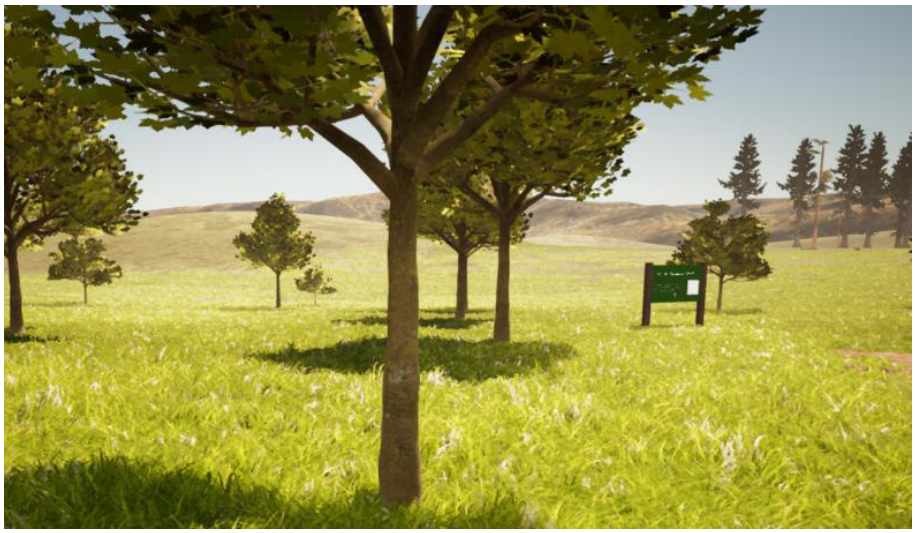
Fig. 9: Wild animals and wind turbine in the simulated DigiForest environment

In addition this simulated environment contained spheres (Fig. 10) hosting 360 degree videos to show further forest innovations.

Fig. 10: DigiForest spheres hosting 360 degree footage

This digital platform has now been taken by the DESIRA project and further developed again to produce a training platform. Working with the Scottish LL a simulated crofting environment has been produced with signposts providing a description of training providers and a URL link embedded to help navigation to external sites hosting training opportunities (Fig. 11).

Fig. 11: DigiForest showing signposts to guide players to external sites



2.2.3 DigiCroft's development

The DigiCroft was initially developed having the crofting communities as a model for the primary target audience, although during the development of the tool the development team worked also closely with the DESIRA'a Scottish Living Lab. This Living Lab is focused on a small crofting area in the Northwest of Scotland called Coigach, a peninsula north of Ullapool, in Wester Ross. The area consists of a traditional crofting and fishing community of a couple of hundred houses located between mountain and shore overlooking the Summer Isles and the sea. Coigach has mountains which rise sharply from, lochan and moorland landscape, and a highly indented rocky coast with many islands, bays and headlands. The highest summit is Ben Mor at 743 metres; the distinctive profile of Stac Pollaidh is the other main peak within Coigach. The scenic nature has led to many visitors especially those following the famous NC500. The main settlement is Achiltibuie.

In this area in Scotland, small-scale 'crofts' are the prevalent form of agricultural land holdings, these are registered land holdings with associated regulations on their use and maintenance, there are also people that own their own land but are not registered crofters they are smallholders without the need to comply but also without access to crofting organisations, and thus restricted access to opportunities. The crofting areas are concentrated in remote, upland locations which typically impacts on production and commercial viability. More than just agricultural holdings, crofts are typically pluriactive and play an important role in rural economic development, maintaining the population in remote rural areas, providing a secure base for the development of small businesses, and maintaining and supporting a range of unique wildlife habitats.

The remote nature of the crofts makes it difficult to access inputs and market products, training or employment options. Digital developments offer many opportunities for digital training (e.g. through 'virtual demonstration'), and increasing land access, thus enabling new entrants to the sector. However, crofts are relatively small farms, and are not likely to adopt innovative agricultural technologies unlike larger farms in less remote geographical locations.

Co-development with the crofting communities has helped identify barriers to training that the tool will overcome. Namely these barriers include:

- Difficulty finding information.
- Knowledge of the available options
- Targeted and directed web searches.
- Lack of clarity on the processes to access the options offered.
- Limited access to some of those options

2.2.4 DigiCroft's technical features

The simulated environment shows a croft setting (Fig. 12) and individual assets that are introduced in it such as the Community hall; individual crofts; common grazing; in-bye grazing; community-owned wind turbines; peat bog; pond; planted mixed deciduous/coniferous woodlands.

The simulated environment was created in Unreal Engine. For the better understanding of the technical specificities that describe the DigiCrofts operation, brief explanations of the technical terminologies will be explained below:

- **Unreal Engine:** A powerful game engine developed by Epic Games, used for creating high-quality interactive experiences, including simulations and virtual environments.
- **Simulated Environment:** A digital representation of a real or fictional environment, created using computer graphics and physics simulations to provide an immersive experience.
- **Scene:** A collection of objects, assets, lighting, and other components that make up a specific location or setting within the simulated environment.
- **Level:** A defined area or stage within the simulated environment where gameplay or interaction takes place. It typically includes terrain, objects, and other elements that define the environment.
- **Asset:** Any individual item or object within the simulated environment, such as 3D models, textures, animations, sound effects, or scripts.
- **Blueprint:** A visual scripting system in Unreal Engine used for creating interactive behavior and functionality within the simulated environment. It allows designers and developers to create and modify game logic without writing code.
- **Lighting:** The process of simulating realistic lighting conditions within the simulated environment, including dynamic lights, shadows, global illumination, and other effects that enhance visual fidelity.
- **Physics Simulation:** The computation of realistic physical interactions between objects within the simulated environment, including gravity, collision detection, rigid body dynamics, and other forces.
- **Particle System:** A component in Unreal Engine used for creating and controlling dynamic visual effects, such as fire, smoke, water splashes, and explosions, to add realism and atmosphere to the simulated environment.

- **Post-processing Effects:** A set of visual effects applied after the rendering process to enhance the final image, including color grading, depth of field, motion blur, bloom, and other effects that improve the overall look and feel of the simulated environment.
- **Optimization:** The process of improving performance and efficiency in the simulated environment by reducing computational overhead, optimizing asset usage, and implementing techniques like level of detail (LOD) or occlusion culling.
- **Multiplayer Networking:** The implementation of networked gameplay functionality, allowing multiple users to interact and experience the simulated environment together, either cooperatively or competitively.

Fig. 12: DigiCroft simulated environment with quad for navigation and the community hall

Navigation

The mouse allows you to look around and change the direction of view using a combination of the mouse, and standard direction (arrow) keys offers the possibility to travel at a slow speed around the enviroment. The standard direction keys used are ; W- to move forwards; S- to move backwards; A-to travel horizontally left; D –to travel hoziontally right. A combination of the mouse and keys allows a more dynamic path of travel. To take a faster trip the quad can be assessed and driven at speed around the environment: approach the quad and text saying ‘Press “use” to enter’ appears, press the E key and you will take control of the quad, press E again and you will exit the quad. Whilst using the quad use the navigation keys and the mouse to handle.

Functionality

Technical features include a day/night visualisation. Depending on the actual time of day depends on the light levels seen in the simulated enviroment. Sunrise and sunset are depicted by increasing and decreasing light levels. As dusk approaches the light diminishes and light effects can be seen. This feature can be switched off for demonstration purposes. Short days and limited light levels that are experienced in northern regions of Scotland can cause problems with viewing some features.

A menu can be brought up by clicking M (Fig. 13), this menu gives direct access to all the resources and allows the player to drop directly onto a point in the simulated enviroment. The point to be visited needs to be clicked on the map by positioning the cursor, clicking 'M' a second time and the site is accessed.

Fig. 13: DigiCroft menu

2.2.5 DigiCroft's potential impact

The DigiCroft was already in an early stage of development when it was introduced to the DESIRA project, as described in the sections above. When reimagining the tool for DESIRA and introducing it to the crofters and stakeholders of the DESIRA's Living Lab, the development team worked together with the involved stakeholders to understand the core user needs related to the tool, from the perspectives of all relevant users and audience members. The DigiCroft was first developed as a Use Case conducted through dedicated online workshops, that took part throughout the project. The tool has been designed in a way to be accessible and usable on a rangé of devices, in order to include interested individuals across the whole digital skills range and hardware capacity. Having that in mind multiple dimensions of expected impacts have been emerged and identified throughout the developmental process of the tool, accounting from its founding PLAID project stages until the latter DESIRA project 'quasi-pilot' stages that included more hands-on activities and a more practical developmental approach.

Social impact: The tool will enhance the crofters access to training resulting in much needed opportunities for upskilling of the remotely located crofters. These opportunitities have been available but accessing the information has been a problem for the crofters. Equally providing equal access to the training has been problematic for the training providers. The crofters are often time restrained, due to the pluriactivity of most if not all the people in the crofting communities. Having access to a time saving and efficient digital tool will enhance access to training and reduce stress and frustration. Upskilling of residents will build resilience of the communities encouraging new people to settle in the area.

Economic impact: The tool allows crofters to save time in searching out training opportunities of relevance to them, as these are signposted and available in one location. The fragmented nature of training resources online (as well as information for in-person training events etc.) has often meant that it is costly to crofters in terms of time to access this information. Reducing time spent searching for these resources can allow crofters to spend more time developing and maintaining the croft, caring for the animals and so on. Furthermore, accessing more relevant training opportunities and resources can have economic impacts by increasing the effectiveness and financial viability of the croft.

Environmental impact: The tool allows crofters to access online training resources and opportunities without the usual extended travel to in-person training events. This environmental impact could be significant, given that crofters are typically located in very remote regions, at great distance from other rural areas. The tool gives crofters access to training on environmental issues and will encourage the use of sustainable resources in livestock production. It can positively impact on biodiversity, and encourage practices such as peatland restoration, good water management, and the restoring of/ rewilding woodland areas in this part of Scotland.

3 Adoption strategy considerations

In order to realize the full potential of the DigiCroft virtual farm and Chatbot technologies, it is crucial to increase resources and explore potential sustainability pathways. By doing so, we can ensure that these tools are adopted and integrated into the daily practices of crofters, small-scale farmers, and other relevant stakeholders, leading to a more resilient and sustainable rural economy. The scenario development potential of these tools can play an important role in this process, as it can contribute to the development of a shared vision of the future that takes into account the needs and perspectives of all stakeholders. Through scenario building and related activities, these technologies can be used to stimulate conversations and co-create sustainable pathways that meet the needs of both current and future generations.

As the DigiCroft virtual farm and Chatbot have been described in detail, it is important to consider their potential for adoption and sustainability.

Regarding the scenario development potential for the technologies, while the DigiCroft was not initially developed with scenario building in mind, it could be used to envision future versions of the environment and stimulate conversations and activities related to scenario development with relevant groups such as crofters and small-scale farmers. The Chatbot was developed as a response to a use case developed in the Tuscany Living Lab and represents an important technological piece that can be customized and upgraded over time to tailor it to varying conditions and needs. It can support future activities meant to further develop the future scenario that has been developed and showcase the potential of digital technologies in improving the resilience of rural areas. However, it is important to note that the Chatbot relies on internet connectivity, which cannot be guaranteed in remote areas such as the one under consideration.

For the DigitCroft, despite the limitations imposed by the Covid pandemic the tool has been presented to crofters in the Living Lab and at the Scottish Government-led Cross Party Group for Crofting with

positive and enthusiastic feedback. The aim is to launch the tool soon and roll it out to all the crofting townships via organizations that have a vested interest in its promotion.

Sustainability considerations are also important for the adoption of these technologies. Additional financial resources should be allocated for the final phases of the commissioning of the tools to address this limitation. The provision of more resources is critical to ensure the successful adoption and sustainable use of the DigiCroft virtual farm and Chatbot technologies. With adequate resources, we can address several challenges that currently hinder the wider adoption of these tools, such as the lack of awareness and knowledge among potential users, as well as the limited technical skills and resources needed for customization and maintenance. In particular, resources are needed to develop and implement effective training and capacity-building programs that enable crofters, small-scale farmers, and other stakeholders to effectively use these tools in their daily practices. This includes not only technical training, but also training in areas such as data management, communication, and collaboration, which are essential for the effective use of digital technologies in agriculture and rural development. Moreover, additional resources are needed to support the ongoing development and customization of these tools to meet the evolving needs and expectations of users. In summary, the provision of more resources is crucial to ensure that these tools are adopted and integrated into the daily practices of crofters, small-scale farmers, and other stakeholders, leading to a more resilient and sustainable rural economy. By investing in these technologies and the resources needed for their successful adoption, we can support the development of a more sustainable and equitable future pathways.