Implementing the Sustainable Development Goals with a digital platform: experiences from the vitivinicultural sector

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***Abstract*—Emerging technologies, such as Digital Platforms, Internet of Things, remote sensing and Big Data, are going to significantly influence the achievement of the 17 Sustainable Development Goals (SDGs) targets, pursued by all United Nations Member States starting from 2015. As the whole agricultural sector is transforming in a more knowledge-intensive system, precision agriculture could play a significant role to achieve the SDGs, by reducing environmental impacts of agriculture and farming practices, increasing the profitability of the farm and thus improving the quality of life for farmers Based on these premises, the aim of this article is to present VITIS, a digital platform, for the management of vineyard water and nitrogen stress, developed by the Operational Group SMART VITIS and tested in 4 pilots located in Marche Region. All the functions and modules of the platform were built by following a Design Thinking approach. This approach started from the analysis of the needs of the winegrowers, the end-user of the solution. While a focus group, made of agri-experts was conducted to receive feedback from the test phase of the platform. This study illustrates how this approach can be a useful tool to develop targeted digital solutions for farmers with low digital skills.**

***Keywords: Digital Platform; vineyards; Design Thinking Approach; Focus Group, Sustainable Development* Goals**

I. Introduction

The 2030 Agenda for Sustainable Development is a plan of action, signed in 2015 by all countries of the United Nations, with the aim to eradicate poverty in all its forms. The Agenda includes the 17 Sustainable Development Goals (SDGs) seek to address issues relating to hunger, poverty alleviation, democratic governance and peace building, climate change and disaster risk, and economic inequality [1]. Considering the fact that the global population is growing at a fast rate and natural resources are finite, Precision Agriculture and digital technologies could help farmers to maximise yields, improve the efficiency and sustainability of agriculture, thus contributing to the implementation of the United Nations [2-3]. In fact, the adoption of Precision Agriculture Technologies could directly affect the following SDGs:

- ***Goal 2: Zero hunger*** which aims to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture;
- ***Goal 13: Climate Action*** which aims to take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy;
- ***Goal 15: Life on land*** which aims to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

The 2030 Agenda for Sustainable Development leaves just ten more years to provide effective solutions to these issues. Therefore, all actors involved must simultaneously step up their efforts to develop new Agricultural Knowledge and Innovative Solutions (AKIS). Nowadays, technologies, such as Digital platform, based on the collection of Big Data from several sources, producing useful information to farmers, can contribute to the achievement of a sustainable farm management. In fact, digital platforms for data management are revolutionizing the way to manage agriculture [4-5]. Some of the platforms and software are multi-purpose focusing on whole-farm management in the fields, for precision agriculture applications and inventories. Some others are dedicated to specific applications, such as for forecasting specific diseases or pests, for irrigation [6-7].

Almost all the platform on the markets have the capability to collect information from different data sources:

- External data sources (i.e. weather station data networks, historical satellite data archive, water supply managers' networks);

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- Data acquired in real time from distributed smart sensors (drones, smart electronic leaf, …) through intelligent networks (battery-powered smart networks wireless);
- Precision farming tools and agricultural smart vehicles.

The fact that large amounts of data are collected from a variety of sources makes the gathering of all these data sets together in one place very important for any farmers wanting to improve the whole farm's sustainability. Available Platforms are focused on agricultural tasks but most of them do not have a strong real-time module to manage IoT devices and information. For high-income crops such as grapevine, it is important to monitor all the environmental parameters which allow obtaining high-quality productions. High-quality grape production requires the adoption of innovative systems that assist the optimization of wine quality and yield [8-9]. For this reason, Precision viticulture has established itself as a specialized field of smart agriculture aiming at maximizing the oenological potential of wine grape yield. [10-11]. In addition, in order to compete in international markets, it becomes of utmost importance to achieve higher quality standards in the vineyard. This has led to a radical renewal of viticulture and a review of agricultural techniques, with the aim of maximizing quality and sustainability through the reduction and more efficient use of production inputs such as energy, fertilizers and chemicals, and minimizing input costs while ensuring the preservation of the environment. [12-13].

Wine has become a global high-value commodity such us strategic productions for European Union (EU). Related to the grape production, the EU represented around 45 % of the world's total area under vines, with 3.2 million hectares cultivated in 2015 and 2,4 Million of holders. In 2019 the production raised up to 25.763 thousand tonnes. In 2019, Italy, Spain and France and Greece are the largest EU producers of wine and table grape, accounting for more than 80 % of production [14] (Figure 1).

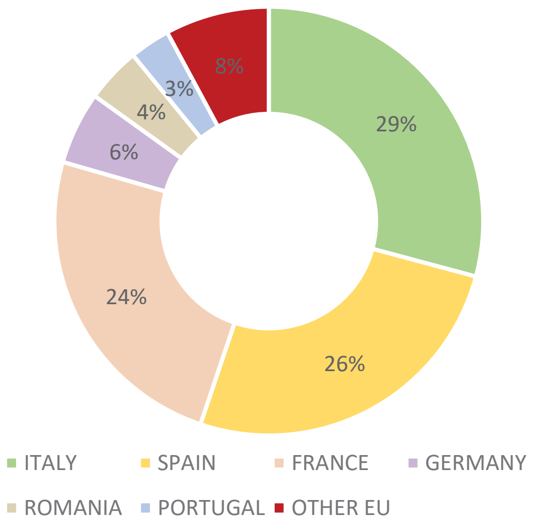

Figure 1: European wine grape production in 2019

In Italy the 5 top producers of grape are Puglia, Veneto, Emilia Romagna, Sicilia and Abruzzo Region [15] (Figure 2).

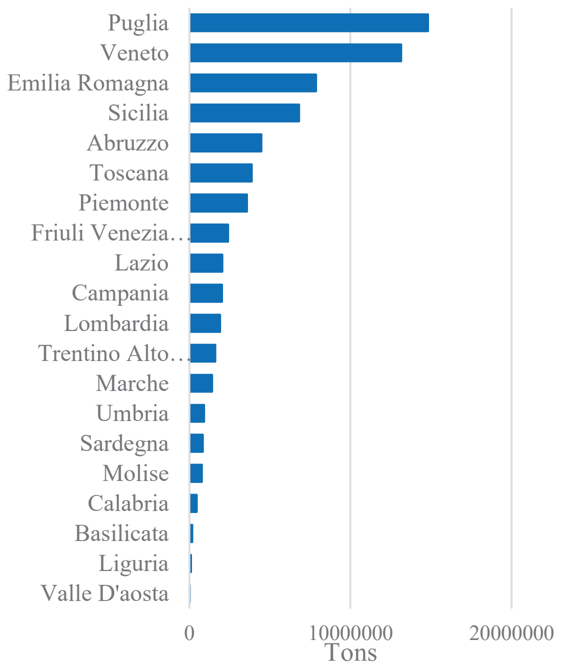

Figure 2: Wine grape production by Italian Region in 2019

Despite its limited grape production (930 tons in 2019), Marche Region is found to have the potential for high quality standards wine considering the availability of several terroirs suitable for the wine grape cultivation. For this reason, the Region, with its local varieties, produces wines labelled with Controlled Designation of Origin (DOC) and Denomination of Controlled and Guaranteed Origin (DOCG) schemes. While the DOC label recognizes the quality and typicality of wines produced in limited small- and medium-sized areas, DOCG, follow the highest production standards to obtain an excellent quality product. At present, Marche has 18 (DOC) wines and 5 (DOCG) wines [16] (Table1).

TABLE 1: Grape Varieties and Wine Denomination in Marche Region

	Marche Region
Varieties	Biancame, Lacrima, Maceratino, Malvasia, Montepulciano, Montonico Bianco, Passerina, Pecorino, Sangiovese, Tai Rosso, Trebbiano, Verdicchio, Vernaccia Nera
DOCG wines	Castelli di Jesi Verdicchio Riserva, Conero, Offida, Verdicchio di Matelica Riserva, Vernaccia di Serrapetrona
DOC wines	Bianchello del Metauro, Colli Pesaresi, Colli Pesaresi- Sottozona Focara, Colli Pesaresi-Sottozona Roncaglia, Colli Pesaresi- Sottozona Parco Naturale Monte San Bartolo, Pergola, Lacrima di Morro d'Alba, Rosso Conero, San Ginesio, Esino, Verdicchio dei Castelli di Jesi, Colli Maceratesi, Serrapetrona, Verdicchio di Matelica, I Terreni di San Severino, Rosso Piceno, Falerio, Terre di Offida

The need to maintain high quality standards of wine production could justify the adoption of site-specific management practices to simultaneously increase both quality and yield. Digital platform and the related Decision Support Systems (DSS) are already available on the market to support the growers in making their decisions. However, the use of these platforms is still very low. [17-21] Therefore, it is crucial to develop an easy to use system and convince farmers to adopt them. The aim of the article is to highlight how the use of the Design Thinking approach is a useful flexible tool for developing a digital platform that can both satisfy the needs of the end user and provide feedback from other stakeholders. The rest of the paper is structured as follows. Section 2 provides an overview of the main characteristics of the VITIS platform. Material and Methods are explained in Section 3. Section 4 shows the main results of the analysis and conclusions are drawn in Section 5.

II. THE DIGITAL PLATFORM SYSTEM

Digital platforms are characterized by specific architectures that define them. Each product distinguishes by a specific architecture that outlines modalities through which its parts and functions are composed.

The main structure of the VITIS platform developed by Gruppo Filippetti, consists of the integration of the platform environment with specific data management and modeling components for agriculture, as well as with sensor data input systems (Figure 3). The platform is a set of application modules and infrastructural technologies conceived and developed to provide advanced cloud services in the field of smart technologies and the Internet of Things. The data measured by the sensors distributed on a large scale are by their very nature highly variable and can quickly and for each individual use case constitute significant volumes that cannot be managed with common database engines. IoT Smart Platform uses Big-Data technologies and a robust and performing architecture for data collection, persistence and recovery. The innovative character of the platform is that it can be used to collect data in the field and subsequently it is possible to use that same data to train an Artificial Intelligence or Machine Learning model. These data streams can be generated by field sensors (temperature, pressure, soil temperature, soil humidity, moisture, etc.), the robot itself, and other sources like i.e. satellite photographic data ad 3D mapping. VITIS platform allows the integration of all these sources data, gathered daily and seasonally, to generate new aggregated information to implement advance analysis and prescription activities on the field.

Figure 3: Vitis platform structure

The sustainable wine production involves the precise use of water and N inputs in the vineyard. Improved knowledge on grapevine ecophysiology, the use of sensors for soil and canopy monitoring, plant phenotyping and improved crop management can help save water and N inputs [22-23]. To achieve these goals, the VITIS platform developed specific algorithms for the management of vineyard water and nitrogen stress.

III. MATHERIALS AND METHODS

The modular nature of the platform implies that its development can be achieved through a Design Thinking approach, a systematic method to create solutions in the form of products or services based on the needs of the end-users. Several authors [24- 27] agree that this approach is common in organizations of all sizes across all industry sectors, including technology companies. For this reason, we found it useful to apply this approach in the development of a platform for the management of the vineyard, considering that agricultural operators usually have low digital skills and therefore it is not easy to immediately implement ready-to-use solutions. The design thinking process uses five fluid steps that result in a solution built around the needs of "users" and "stakeholders." The "user(s)" (farmer) experiences the problem and the stakeholders (technology company, consultants, contractors, university) are those who have experience around the perceived problem. The process begins with an open-minded assessment and continues through five steps until the appropriate solution is produced, often in a nonlinear pattern. The goal of this process is to identify an optimal solution informed by feedback obtained through discussions with, or observations of, users and stakeholders in the context of the perceived problem.

As reported in Figure 4, the Design Thinking Process follows 5 different steps:

1. **Empathise**: Innovation always starts with a in-depth diagnosis of the needs and expectations of users and potential users of the product, and understanding the technical conditions and market conditions of the product. The empathize step is primarily done through interviews and observing the actions of the users in the context of the problem. Stakeholders will be looking to answer questions such as "Who is the user?" and "What is it important for the users?"
2. ***Define***: This steps provides the definition of the issue and the needs of the user. Stakeholders now will be seeking to answer this question :"What is the audience's point of view and what are the needs of the end user?
3. ***Ideate***: Ideating is the brainstorming period to generate a wide range of potential solutions. The more ideas, the more likely the optimal solutions will be identified. Creative solutions should evolve from the defined problem statements. Solutions should speak to the different aspects of the problem investigated.
4. ***Prototype***: This stage involves creating or building a rough representation of one or more ideas to show to the end user.
5. ***Test***: In the last stage, the prototype should be presented as a solution to the original user in order to obtain its opinion on the generated product. In this

way, users can test its functioning. The scope of this step is to check the functioning of the designed solution in a real environment in which the product will be used.

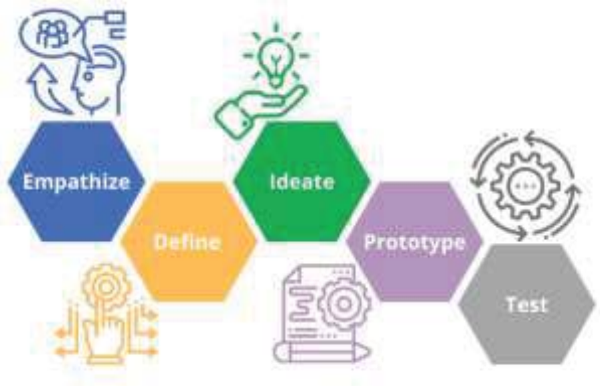

Figure 4: Design Thinking process

Then, the iterative process would continue with reworking and adjusting the product as the design team receives feedback from end users. Finally, in our analysis, the main results from the Design Thinking approach process are synthetized in a SWOT analysis which stands for Strengths, Weaknesses, Opportunities, and Threats, a strategic planning technique used to assess these aspects related to business competition or project planning. [28- 29].

IV. Results

The first step implies to gain a deep understanding of the customer or end user for which the product is designed for. In our study, 4 winegrowers were selected for testing the platform and 4 pilot sites with different characteristics (cultivated variety, plot extension) were chosen. To know the characteristics of the company and the characteristics that the platform should have had, a survey was built. The survey had 4 sections. The first section explores the characteristics of the pilots. The second section queried respondents on their current wine yard management practices. In the third section, a series of questions asked landowners about their knowledge, understanding and current use of precision farming technologies. In the last section winegrowers were asked to indicate what functionalities were desired in the platform. Table 2 synthetize the main characteristic of the pilots.

TABLE 2: Characteristics of the pilots

	Variety	Hectars	Management
Farm 1	Verdicchio	3,27	No emergency irrigation and manual harvesting
Farm 2	Verdicchio	1,37	No emergency irrigation and manual harvesting
Farm 3	Montepulciano	4,41	Emergency irrigation and mechanized harvesting
Farm 4	Montepulciano	2,39	Emergency irrigation and both manual and mechanized harvesting

However, in the absence of feedback from the winegrowers as the platform is still being tested, we decided to conduct the test of the platform with a team of Agriexperts in order to know their feedback on the platform. Considering that agricultural knowledge from experienced experts is needed for the purpose of validating the feasibility of generated strategies and correcting the mistakes in provided decision supports, we found useful to consider the team of agri expert as the users of the platform, and test the platform with them [30]. In order to accomplish the test, a focus group of 5 agriexperts was performed and a SWOT analysis synthetized the main results emerged.

Strengths: The VITIS platform provides real-time data on the quantity of nitrogen present in the soil and the level of humidity thanks to the humidity probes present in the pilot sites.

Weaknesses: According to agriexperts, some functions of the platform are still not very intuitive and for this reason one is needed more user-friendly interface.

Opportunities: Insert in the platform the possibility to customize the level of information request (from general to more specific); possibility of automatically processing weekly bulletins that summarize the main information order to facilitate winegrowers to reading and understand the data. According to [31] for farmers is usefull to visualize data in formats of map, table, list, line chart, pie chart, and flowchart, so that they can easily understand data collected from sensors.

Threats: Consider the possibility of a scarce usage of the platform by winegrowers. To solve this problem, the agriexperts recommended organizing training meetings and drawing up guidelines for the use of the platform.

These results provide an in-depth presentation of the feedback from agriexperts related to the VITIS platform. The team of agriexperts provides useful recommendations to implement the phase of platform adoption among the end-users.

V. Conclusion

In order to enhance the sustainable impact of digital technologies on food and agriculture production, it is necessary to achieve a broad social consensus. This paper has presented the Design Thinking approach as a helpful tool for technological companies developing digital solutions. Results showed how this process could have a positive impact on the user's acceptance by carrying out a user-centred designed process, based on the continuous and active involvement of the user representatives with the entire development of the platform. The decision to test the solution first on agriexperts helped the technology provider to build a specific solution in order to minimize the resistance of farmers to digital platforms. The platform will offer to farmers a sustainable smart farming open data network. This allows the winegrowers to provide an added value to their productions in the form of better decision making or more efficient input management. This, of course, remains a work in progress for our research team, in the sense that among our future goals is the extension of the current platform.

Acknowledgment

The authors wish to thank all the members of the Operational Group SMART VITIS - Intelligent and Sustainable Viticulture (ID N° 290089 - financed by RDP Marche 2014/2020, Submeasure 16.1 – Support for the establishment and management of EIP operational groups on agricultural productivity and sustainability

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