From fields to bytes: orchestrating digital ecosystems in rural areas

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Giovanna Terrizzi - Alba Marino - Maria Cristina Cinici
Daniela Baglieri

Abstract

Framing of the research. *In recent years, agri-food companies have started to build digital platform ecosystems to implement complex value propositions. Typically orchestrated by a focal actor, these digital platform ecosystems have been seen as collaborative arrangements through which companies combine their individual offerings into a coherent customer-facing solution, the core of which is a technology platform. In contexts hostile to change, the role of orchestrators becomes even more critical for initiating and managing their construction.*

Purpose of the paper. *This study focuses on the emergence of digital platform ecosystems in rural areas and the key role of the orchestrator. Specifically, it aims to investigate how focal actors initiate their emergence in peripheral areas.*

Methodology*. We adopt a single case study design with a focus on an experimental initiative to create an integrated multichain digital traceability platform. To conduct the exploratory study, we draw on a series of primary and secondary data.*

Results*. Our results identify the set of activities through which a focal actor pursuing collective interests initiates the emergence of a digital platform ecosystem. By distinguishing between the ecosystem design and launch phases, we shed light on how the orchestrator plans not only the ecosystem but also the actions implemented to motivate participation and govern it.*

Research limitations. *This study is limited to companies operating against the backdrop of a shared project to create a digital platform ecosystem.*

Managerial implications. *Our study highlights how firms can manage the adoption of digital technologies by exploiting external collaborations. Moreover, we offer a multiplayer perspective of the mechanisms behind traditional sectors' innovative efforts in rural areas.*

Originality of the paper. *Although digital platform ecosystems have been the subject of numerous studies in the agri-food sector, to the best of our knowledge, there is no comprehensive and exhaustive exploration of the phenomenon within a rural area where ecosystem participants combine efforts to create value in an innovation-hostile environment.*

Key words: *digital platform ecosystems; rural areas; blockchain; agri-food*

1. Introduction

In recent years, agri-food companies have started to build digital platform ecosystems to implement complex value propositions (Gawer and

Cusumano, 2014; Jha *et al.*, 2016; Calabrese *et al.*, 2021). Along with this orientation, they have been regarded as collaborative arrangements through which companies combine their individual offerings into a coherent, customer-facing solution, the core of which is a technology platform and/or a set of shared resources, standards, and interfaces (Ceccagnoli *et al.*, 2012; Gawer, 2014). Value creation depends on complementary inputs from interconnected but hierarchically independent heterogeneous stakeholders, typically orchestrated by a focal actor capable of coordinating all participants and introducing a series of actions to shape the context in which they collaborate and compete (Thomas and Ritala, 2022).

While there is an increasing amount of research focused on established agri-food platform ecosystems (e.g., Tsolakis *et al.*, 2021), much less work addresses the creation of a de novo ecosystem within a rural area and the development of a shared structure of interactions. Moreover, establishing platform ecosystems-not an easy feat in itself-is particularly difficult in rural areas where geographical, cultural, and socioeconomic barriers can inhibit the adoption of emerging technologies (Rijswijk *et al.*, 2021; Schreieck *et al.*, 2021). In a context so hostile to change, the role of orchestrators becomes even more critical for initiating and managing the construction and collaboration of innovation networks, which represent valuable tools for connecting the countryside to the digital economy and achieving a more modern and sustainable future for the agri-food industry (Trendov *et al.*, 2019).

In response to the growing demand for contextualized studies on digital platform ecosystems (Gulati *et al.*, 2012; Jacobides *et al.*, 2018), this article directs its attention to their manifestation in rural areas, underscoring the critical role played by the orchestrator. The significance of exploring ecosystems' orchestration in rural settings lies in their unique dynamics, which offer valuable insights into the transformative impact of digital platforms on traditionally underserved regions. Specifically, adopting a single case study design (Eisenhardt, 1989) with a focus on a project that started in the Sicilian hinterland and drawing on a series of primary interviews and extensive secondary data, we address the following question: "*How do orchestrators initiate the emergence of digital platform ecosystems in rural areas?*". Our results identify the set of activities through which a focal actor defines strategies, mobilizes, and aligns with other actors and their resources while orchestrating the digital transformation of areas hostile to change. By distinguishing between the ecosystem *design* and *launch* phases, we shed light on how the orchestrator plans not only the ecosystem but also the actions implemented to motivate participation and govern it.

The remainder of this paper is organized as follows. Section 2 draws upon a conceptual framework on digital platform ecosystems, orchestrators, and their technology adoption process. Section 3 presents the methodology and research design. Section 4 briefly introduces the project's reference context and the characteristics of the companies involved. Section 5 presents the findings obtained by analysing orchestrator activity from a two-layered perspective. Section 6 provides theoretical and practical implications of the results. Finally, Section 7 highlights some limitations of the study.

2. Theoretical framework

2.1 Digital platform ecosystem

Digital platform ecosystems have quickly emerged as a promising stream of research in the entrepreneurship and innovation literature (Jacobides *et al.*, 2018). They have been broadly conceived as forms of endogenous strategic action where autonomous agents contribute to the digital platform's value proposition (Teece, 2018). Whereas traditional firms create value within the boundaries of a company or a supply chain, digital platform ecosystems drive coproduction, cocreation, and value capture (Hein *et al.*, 2020). They are built on collaborative arrangements between firms that combine individual offerings to create a coherent solution aimed at a defined audience and share a set of technical standards (Adner, 2006; Thomas and Autio, 2020). As the participants in the ecosystem depend on each other, offering a digital platform ecosystem requires careful orchestration of actors and resources. Even if most digital platforms act as private regulators of their ecosystems (Gawer, 2021), they facilitate transactions and innovation under the coordination and direction of the platform orchestrator (Wareham *et al.*, 2014, p. 1211). Orchestrators establish the rules through which their various actors interact, decide what behaviours to encourage or discourage on the platform, and choose how to enforce them (Autio, 2021).

In recent years, the digital platform phenomenon has attracted interest in the agri-food activities that have been reorganized around platform-based ecosystems for value creation and appropriation (Annosi *et al.*, 2020). Digital technologies, such as the Internet of Things (IoT) and blockchain, have been exploited to collect and record data to create efficient, transparent, and sustainable supply chains; more often, digital platform ecosystems have proven necessary for firms operating in the agri-food sector (Tsolakis *et al.*, 2021).

For example, adopting blockchain technology to record, store, validate, and secure data can solve various agricultural problems, such as business financing. Previous research has demonstrated that if banking and insurance industries are connected in real time to activity data in the farming industry, better credit ratings and profile models can be created (Rijanto, 2021). Additionally, in a context where consumers have become more educated at the bottom of supply chains and demand real-time updated information on foods they consume, digitalization has allowed the agri-food industry to be highly connected, efficient, and responsive to customer needs and regulatory requirements. The COVID-19 pandemic has also increased the reliance of individuals, businesses, and governments on online platforms. As a result, food product traceability, safety, and sustainability issues have become crucial concerns for food retailers, distributors, processors, and farmers. This situation has forced actors to accelerate the adoption of digital agriculture technologies to support emergency responses, making the issue especially topical and increasing institutional pressures that demand that actors participate in a traceability system (Hew, Wong, Tai, Ooi, and Lin, 2020). However, the rise and deployment of digital platform ecosystems

in the agricultural and food industries are challenging and resource demanding; they can prove particularly difficult within rural areas, where factors related to geographical, social, institutional, and market access conditions can act as barriers to environmental change and innovation (Baumber *et al.*, 2018, Miles and Morrison, 2020).

Despite the orchestrator's intervention, more conservative firms may not perceive this strategy favourably, holding them back from participating in the ecosystem and adopting digital technologies (Hew *et al.*, 2020). In this context, ecosystem leaders must persuade others to make voluntary inputs consistent with the ecosystem's overarching value offering. As such, in line with institutional theory (DiMaggio and Powell, 1983), which posits the influence of external institutions in driving isomorphism between firms (Yigitbasioglu, 2015), the orchestrator could exert pressure (coercive, mimetic, and regulatory) on firms, influencing their perceptions of digital systems (Hu *et al.*, 2016; Yigitbasioglu, 2015) and motivating their intentions to adopt (Teo *et al.*, 2003).

2.2 Orchestrating the emergence of a digital platform ecosystem

Research on the emergence of digital platform ecosystems has often focused on their structure, examining the actors involved and their linkages to establish a common value proposition (e.g., Özalp *et al.*, 2018; Rong *et al.*, 2015; Pan Fang *et al.*, 2021). Specifically, some studies have shed light on the role of the orchestrator, namely, the entity that provides key resources and infrastructure and regulates linkages between complementary actors to initiate the ecosystem and give it momentum (e.g., Autio, 2021; Mann *et al.*, 2022; Das and Dey, 2021).

Most of them identify as orchestrators with a focal firm operating in a highly innovative industrial setting, namely, a large, powerful, and established organization with the knowledge, resources, and key technologies to stimulate the emergence of an ecosystem and profit from it (e.g., Lingens *et al.*, 2022; Das and Dey, 2021; Hou *et al.*, 2020). In large rural settings, micro- and small enterprises attached to traditional values are often geographically isolated due to low entrepreneurial density and lack of infrastructure, and they lack the ability to stimulate the emergence of an ecosystem (Ferrari *et al.*, 2022; Hammer and Frimanslund, 2022). In these contexts, the ecosystem may be triggered by an external catalyst, namely, a third party with a strong relational position.

In contrast to focal firms, external orchestrators pursue collective interests-for example, social, environmental, or industry interests-and aim for network vitality to foster the diffusion of innovative ideas in highly uncertain environments (Hurmelinna-Laukkanen and Nätti, 2018). Moreover, in wide rural areas, these orchestrators may leverage public and private actors who are firmly rooted in the local microenvironment to legitimize the ecosystem and introduce it to potential complements, building a shared understanding of its purpose within the broader economic and social context (Thomas and Ritala, 2022; Lingens *et al.*, 2022; Rogers, 1961).

2.3 Orchestrating the participation in a digital platform ecosystem

The emergence of studies on digital platform ecosystems has encouraged researchers to scrutinize the decision-making processes that drive complementary autonomous agents to join a platform (Boudreau, 2010; Church and Gandal, 1992; Gawer and Henderson, 2007; Zhu and Iansiti, 2012). Most of the existing studies on how platforms attract complements often assume that they possess detailed information on the participants, the technologies involved in regulatory issues related to data governance, or the ecosystem's value proposition.

While this assumption may hold in regard to some established platform ecosystems, in emerging ecosystems, neither the set of platform actors nor the information regarding platform functioning or long-term sustainability may not be clear (Dattée *et al.*, 2018; Hannah and Eisenhardt, 2018; Pan Fang *et al.*, 2021). Moreover, in rural contexts, where average levels of education and skills are generally lower, fear of change and mistrust of technology disincentivize the adoption of emerging technologies and participation in a digital platform ecosystem (Ferrari *et al.*, 2022; Malecki, 2003; Salemink *et al.*, 2017). In scenarios of high uncertainty, the orchestrator plays a key role (Thomas and Ritala, 2022).

In fact, the orchestrator must have a clear "proto-vision" of the ecosystem and must convey this to potential complements to convince them to take part in overcoming critical mass and generating the indirect network effects typical of ecosystems (Datteé *et al.*, 2018; Katz and Shapiro, 1985; Rogers, 2003). Previous research has shown the importance of conferences and workshops being organized in an in-person format to attract possible users, introduce them to the platform and reduce perceived uncertainty about new technology (Dattée *et al.*, 2018; Garud, 2008; Özalp *et al.*, 2018; Pan Fang *et al.*, 2021). Specifically, the platform is proactively publicized in these meetings to stimulate awareness among potential users (Cusumano and Gawer, 2002; Rogers, 2003).

In this context, participants may influence each other, and early adopters may motivate adoption by sharing their experiences and taking a significant role in the education and training of potential users (Attewell, 1992; Bandura, 1986; Pan Fang *et al.*, 2021). Even in rural communities, in-person workshops appear to support the dissemination and adoption of digital technologies, contributing to peripheral areas' social and economic progress (Raisänen and Tuovinen, 2020). In this context, the orchestrator may leverage ecosystem partners that motivate entrepreneurs to attend conferences and training workshops through incentives (Pan Fang *et al.*, 2021). However, deploying a digital platform in contexts of high uncertainty is not immediate. Nevertheless, it recognizes time as a critical element of innovation. It requires iterative and recursive feedback loops-positive and negative-concerning the use of emerging technologies, which may lead to more or less homogeneous intersubjective convergence (Vargo, Archpru Akaka, and Wieland, 2020).

3. Methodology

We chose to employ a single case study design following the approach outlined by Eisenhardt (1989) to illuminate a digital platform ecosystem's emergence process in a rural context. The decision to utilize a single case study was grounded in the inherent advantages of the approach, which allows for a meticulous and comprehensive exploration of the phenomenon at hand. This design is suitable for testing theories within a specific context, dissecting an unusual situation worthy of detailed documentation, and conducting a longitudinal examination where conditions and underlying processes evolve (Yin, 2018). Therefore, the single case study design afforded us the depth and specificity necessary to uncover nuanced insights into the intricate dynamics of digital platform ecosystems in rural settings.

The present study was conducted on an experimental initiative sponsored by public and private actors to promote the territorial development of peripheral areas. The project aimed to create an integrated multichain traceability digital platform, enhance the UNI EN ISO 22005[1] certified Sicilian agri-food supply and promote the development of local economies. The designed system was based on the integration of various digital technologies-such as blockchain technology and the IoT-capable of recording information from the entire production process and ultimately making it accessible to the end consumer. The project involved a total of 194 enterprises-who voluntarily adhere to the initiative-located in the rural areas of Sicily (Figure 1). The participants included farms, processing firms, and packagers operating in eleven different supply chains, as detailed in Table 1.

Data collection began in February 2022 and ended in February 2023. To ensure the triangulation of the data and the robustness of our research results, the data collected were obtained from both primary (semistructured interviews) and secondary (desk analysis and information from the project kick-off meeting) sources (Benbasat *et al.*, 1987; Dubé and Paré, 2003; Eisenhardt, 1989; Yin, 2018).

Building on theoretical sampling (Glaser and Strauss, 1967), we conducted twenty-two semistructured interviews. We selected companies that produce differentiated agri-food products and operate at different supply chain stages among the available companies. In addition, we considered farms of various sizes. These choices lie in the possibility of highlighting variations between trials and identifying categories in terms of properties and dimensions (Strauss and Corbin, 1998). Thus, we involved nineteen company representatives. Furthermore, we interviewed the certification agency's project manager and two project promoters, namely, the project leader and a spokesperson, to help regional policy-makers better understand the initiative's goals and expected impact on local environmental development.

All the interviews were conducted in Italian, some on an online videoconferencing platform (MS Teams) and others over the phone. The

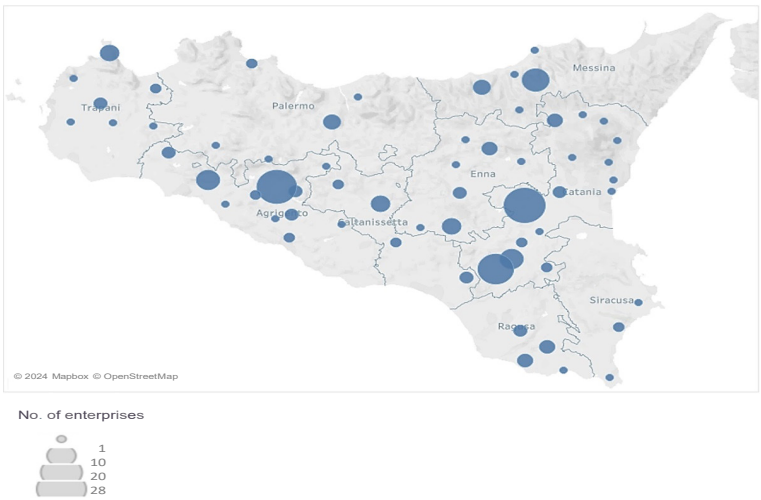
1 UNI EN ISO 22005:2008 is an international standard for the certification of agri-food traceability systems. Its objective is to support companies in documenting the history of the product, enabling its origin to be traced.

interviews lasted between 20 and 90 minutes each and were recorded, transcribed, and subsequently translated into English. At the beginning of each interview, we explained the study's objectives and ethical issues. We designed an interview outline consisting of eleven open-ended questions. The interview guide had two main sections of questions. The first section allowed informants to provide general considerations about their participation in the project and the role of the organizers. The second section explored how managers in the agri-food sector perceive digital transformation, highlighting the challenges and opportunities. Table 2 presents the twenty-two key informants, their job position, and the duration of the interviews. In addition, for the key informants of the nineteen companies, we indicated the type of company they work with and the supply chain in which the company operates.

We collected secondary data from archive documents (e.g., executive plan of project activities) and the official project website. In addition, we gathered information from the kick-off meeting held in February 2022. Table 3 shows a summary of the secondary data sources.

The data analysis used familiar approaches for inductive studies, and we had no a priori hypotheses. We read the cases independently to form our views of each actor's role in participating in the ecosystem. We began with detailed written accounts and schematic representations. We triangulated the primary data with secondary data, enriching the thematic analysis to the point of saturation (Strauss and Corbin, 1998). After constructing each profile, we conducted within-case analyses, which were the basis for developing early constructs surrounding ecosystem emergence as experienced by each actor. Cross-case analysis produced our working framework for ecosystem emergence and orchestration. The blended approach allowed us to remain open to surprises in the data while ensuring theoretical consistency from the outset. The results of the data analysis are presented and discussed in the following sections.

Fig. 1: Places and operators involved in the project



Source: Authors' elaboration on data from the executive plan of the project

Tab. 1. Number of companies operating in eleven different sectors

Supply chain	No. of companies
Extra Virgin Olive oil supply chain	62
Wheat and derivatives supply chain	55
Dried fruit and derivates products supply chain	28
Pulses, hemp, aromatic-officinal plants and their products and honey supply chain	23
Citrus fruit and citrus fruit products supply chain	19
Vegetables and their products supply chain	19
Livestock supply chain	12
Grape and grape products supply chain	10
Cheese supply chain	7
Prickly pear and prickly pear products supply chain	7
Exotic fruit and derivates products supply chain	5

Source: Authors' elaboration on data from the executive plan of the project

Tab. 2: Key informants

Key informant ID	Job position	Type of company and Supply chain	Interview duration (in minutes)
KI-1	Project Leader	/	90''
KI-2	Spokesperson for the regional policymakers	/	60''
KI-3	Certification agency's Project Manager	/	30''
KI-4	Sales Manager	Farm and Processor - Pulses, hemp, aromatic-officinal plants and their products and honey supply chain Livestock farms, processors, and packers - Livestock supply chain	20''
KI-5	Founder and Legal Representative	Farm and Processor - Cheese supply chain	25''
KI-6	Founder and Company Partner	Farm and Processor - Citrus fruit and citrus fruit products supply chain Processor and Packager - Wheat and derivates supply chain Farm - Extra virgin olive oil supply chain	40''
KI-7	Quality Manager	Processors and Packagers - Vegetables and their products supply chain	30''
KI-8	Quality Manager	Mill and Processor -Wheat and derivates supply chain	20''
KI-9	Founder	Farm - Citrus fruit and citrus fruit products supply chain Farm - Extra virgin olive oil supply chain	50''
KI-10	Owner and Legal Representative	Farm - Prickly pear and prickly pear products supply chain, Dried fruit and derivates products supply chain, Pulses, hemp, aromatic-officinal plants and their products and honey supply chain, Extra virgin olive oil supply chain, Vegetables and their products supply chain, Grape and grape products supply chain	60''
KI-11	Administrator	Mill and Processor -Wheat and derivates supply chain	20''
KI-12	Owner	Processor and packager - Citrus fruit and citrus fruit products supply chain, Cheese supply chain, Dried fruit and derivates products supply chain, Wheat and derivates supply chain	20''
KI-13	Administrator	Oil mill and packer - Extra virgin olive oil supply chain	40''
KI-14	Owner	Farm - Dried fruit and derivates products supply chain, Extra virgin olive oil supply chain, Wheat and derivates supply chain	35''
KI-15	Owner	Farm - Extra virgin olive oil supply chain	25''
KI-16	Owner	Farm - Wheat and derivates supply chain	30''
KI-17	Administrator	Farm, Processor and Packer - Vegetables and their products supply chain	40''
KI-18	Owner	Farm - Dried fruit and derivates products supply chain	55''
KI-19	Owner	Farm - Exotic fruit and derivates products supply chain	30''
KI-20	Owner	Farm - Extra virgin olive oil supply chain Farm and Processor - Grape and grape products supply chain	40''
KI-21	Owner	Processor and Packer - Wheat and derivates supply chain	40''
KI-22	Owner	Farm - Wheat and derivates supply chain	20''

Source: Authors' elaboration

Tab. 3: Summary of secondary data sources

Source	Type
Archive documents	Renewal of UNI EN ISO 22005:2008 certificate and start of digitization project Executive plan of project activities
Project kick-off meeting	Transcript of the kick-off meeting held on 14 February 2022
Official project website	Web Page

Source: Authors' elaboration

4. Reference context and general features of the project member enterprises

The project initiative is set in the rural areas of Sicily's nine provinces, comprising 96% of its 25,711 km2 surface area (ISTAT, 2010).

The richness of these territories in terms of biodiversity and quality of native crops clashes with the poverty of infrastructure and services that affects, above all, the region's innermost areas. In fact, they have a tangible and intangible infrastructure network-road and rail networks, broadband, telematic networks and logistics networks-that is extremely deficient. The absence of an extensive highway network forces the use of rural, often rutted roads, which affects the travel time of agri-food goods, particularly penalizing products meant for fresh consumption. In addition, due to their land morphology and low population density, many inland areas have low connectivity or no broadband at all. In these difficult contexts, the lack of essential services severely affects the quality of life of rural communities, fostering depopulation in hard-to-reach areas and hampering the potential for business creation and development.

The enterprises participating in the pilot project operate in eleven different supply chains, as detailed in Table 1. The distribution of participating enterprises shows a prevalence in the extra virgin olive oil and wheat sectors, which are traditional quality crops of the Sicilian hinterland. Finally, in terms of numbers, we find operators in the supply chain of exotic fruits and their derivative products. This is a booming market, especially in the Tyrrhenian strip of Messina (ME), which offers favourable environmental conditions for tropical fruit production.

General information on the participating firms, which is provided in Tables 4, 5 and 6, was acquired through the Orbis Bureau Van Dick database. Since 44 of the 194 participating enterprises are sole proprietorships-a type of enterprise not found in the database-the tables contain general information for 150 enterprises and financial and governance information for a variable and further reduced number of organizations. In more detail, Table 4 contains descriptive statistics for each supply chain and the entire group, while Table 5 details some information by sector. Finally, Table 6 provides some information on the management and supervisory bodies of the enterprises where available.

The enterprises participating in the initiative are micro- and small enterprises. In general, the size of these types of enterprises-which characterize the rural areas of inland Sicily-is responsible for excessive

fragmentation of the production fabric and poor vertical integration between production phases. Due to their small size, only 23 out of 150 enterprises-that is, 15.3%-have branches, and only 6 out of 150 enterprises-4%-have more than one branch. Excessive fragmentation of production makes it impossible to achieve economies of scale and reduce and optimize operating costs, causing many sectors to be unprofitable. Despite the presence of well-established enterprises-with an average age of 14 years-profits are limited, and in some cases, such as in the vegetable and prickly pear and derived products sectors, there are large losses.

Approximately 43% of the member enterprises-that is, 84 out of 194 companies-operate in two or more certified supply chains. The existence of multiproduct enterprises transcends the verticality of the supply chain and creates a complex cross-system-the so-called ecosystem-in which each organization must interact with operators in other supply chains.

Participating micro- and small businesses have a low rate of digitization; only 30% of them have already invested in digital technologies, i.e., by setting up a website. This figure suggests that digital transformation is proceeding very slowly and confirms the existence of a digital divide severely limiting peripheral areas' development. The highest percentage of businesses on the web belong to the supply chain of legumes, hemp, aromatic-officinal plants and derivatives, honey, and wheat and its derivatives.

A male presence at the top of the boards prevails over a female presence, but the latter seems to be gaining ground despite the cultural backwardness of the Sicilian hinterland. In fact, Table 6 shows that 70% of CEOs are men and 30% are women. There is also a female presence on other board roles and on the boards of auditors. Most of the governing and supervisory body members are between 25 and 49 years old, but there are numerous members who are older than 50 years. The presence of young people is still too limited, reflecting the reduced generational turnover that characterizes the Sicilian agribusiness sector, which is why the digitization process is not taking off.

The business strategy of the companies participating in the pilot project focuses on the high quality of niche regional agri-food products, which include raw materials and semifinished and finished products. In their efforts to bring down prices and be competitive in a market dominated by multinationals, their policy is to optimize production costs, particularly harvesting, which is normally done by mechanical means.

Tab. 4: Descriptive statistics

		Obs.	Mean	Std. Dev.	Min	Max
All companies	Web Presence	150	.333	.473	0	1
	Firm age	150	13.673	10.312	1	57
	Multi-chain	150	.407	.493	0	1
	Branches	150	.153	.362	0	1
	Multi-branches	150	.04	.197	0	1
	Sales and Services Revenues*	56	2.940.754	10.919.739	0	78.185.688
	Total Production*	73	2.515.856	10.582.472	0	86.870.563
	Net income*	56	37.041	187.26	-181.719	1.319.054
Extra Virgin Olive oil supply chain	Web Presence	62	.306	.465	0	1
	Firm age	62	10.742	7.769	1	29
	Multi-chain	62	.694	.465	0	1
	Branches	62	.177	.385	0	1
	Multi-branches	62	.065	.248	0	1
	Sales and Services Revenues*	28	1299.62	2847.59	.75	14.493.748
	Total Production*	32	1.295.399	2.581.682	12.95	13.398.802
	Net income*	28	64.245	254.199	-110.98	1.319.054
Wheat and derivates supply chain	Web Presence	55	.455	.503	0	1
	Firm age	55	14.764	9.821	2	47
	Multi-chain	55	.545	.503	0	1
	Branches	55	.109	.315	0	1
	Multi-branches	55	.036	.189	0	1
	Sales and Services Revenues*	19	1040.25	1680.72	0	5.665.908
	Total Production*	26	863.146	1.522.392	0	5.947.829
	Net income*	19	19.779	68.228	-61.511	248.847
Dried fruit and derivates products supply chain	Web Presence	28	.214	.418	0	1
	Firm age	28	9.143	6.895	1	25
	Multi-chain	28	.714	.46	0	1
	Branches	28	.107	.315	0	1
	Multi-branches	28	.036	.189	0	1
	Sales and Services Revenues*	14	7.091.454	20.807.255	13.708	78.185.688
	Total Production*	16	6.733.011	21.618.777	13.708	86.870.563
	Net income*	14	33.583	91.585	-110.98	279.955
Pulses, hemp, aromatic-officinal plants and their products and honey supply chain	Web Presence	23	.478	.511	0	1
	Firm age	23	14.913	9.811	3	39
	Multi-chain	23	.913	.288	0	1
	Branches	23	.217	.422	0	1
	Multi-branches	23	.043	.209	0	1
	Sales and Services Revenues*	9	1.072.818	1.798.284	6.328	5.665.908
	Total Production*	12	900.849	1657.08	8.896	5.947.829
	Net income*	9	16.236	47.987	-61.511	102.632
Citrus fruit and citrus fruit products supply chain	Web Presence	19	.316	.478	0	1
	Firm age	19	17.684	13.901	3	57
	Multi-chain	19	.737	.452	0	1
	Branches	19	.211	.419	0	1
	Multi-branches	19	.053	.229	0	1
	Sales and Services Revenues*	6	988.915	2.293.298	0	5.665.908
	Total Production*	9	760.974	1947.9	0	5.947.829
	Net income*	6	14.026	27.824	-3.201	67.043
Vegetables and their products supply chain	Web Presence	19	.421	.507	0	1
	Firm age	19	14.895	8.987	5	36
	Multi-chain	19	.526	.513	0	1
	Branches	19	.316	.478	0	1
	Multi-branches	19	.105	.315	0	1
	Sales and Services Revenues*	4	5.783.265	11.298.316	12.517	22.729.248
	Total Production*	7	3.548.613	8.883.736	83.066	23693.98
	Net income*	4	-44.462	93.313	-181.71	24.391
Livestock supply chain	Web Presence	12	.167	.389	0	1
	Firm age	12	17.083	11.658	3	39
	Multi-chain	12	.25	.452	0	1
	Branches	12	.167	.389	0	1
	Multi-branches	12	.083	.289	0	1
	Sales and Services Revenues*	3	5.188.657	8.061.642	309.088	14.493.748
	Total Production*	4	3676.56	6.487.324	175.667	13.398.802
	Net income*	3	103.794	154.032	-5.526	279.955
Grape and grape products supply chain	Web Presence	10	.4	.516	0	1
	Firm age	10	12.9	7.724	5	28
	Multi-chain	10	.8	.422	0	1
	Branches	10	.3	.483	0	1
	Multi-branches	10	0	0	0	0
	Sales and Services Revenues*	4	502.829	535.256	12.517	1.143.938
	Total Production*	4	565.099	531.018	113.222	1.173.705
	Net income*	4	16.164	12.907	3.042	29.746
Cheese supply chain	Web Presence	7	.429	.535	0	1
	Firm age	7	15.286	9.725	3	26
	Multi-chain	7	.429	.535	0	1
	Branches	7	.286	.488	0	1
	Multi-branches	7	.286	.488	0	1
	Sales and Services Revenues*	3	999.792	913.014	1.826	1.793.124
	Total Production*	4	843.743	860.461	3.529	1.820.117
	Net income*	3	31.565	60.916	-6.922	101.798
Prickly pear and prickly pear products supply chain	Web Presence	7	.286	.488	0	1
	Firm age	7	10.571	6.554	3	20
	Multi-chain	7	.429	.535	0	1
	Branches	7	0	0	0	0
	Multi-branches	7	0	0	0	0
	Sales and Services Revenues*	4	3068.46	4.864.798	.246	10.223.107
	Total Production*	4	3166	5.019.901	.264	10.548.795
	Net income*	4	-6.958	64.215	-90.866	65.583
Exotic fruit and derivates products supply chain	Web Presence	5	.2	.447	0	1
	Firm age	5	20	21.272	4	57
	Multi-chain	5	.6	.548	0	1
	Branches	5	.2	.447	0	1
	Multi-branches	5	0	0	0	0
	Sales and Services Revenues*	1	278.662	.	278.662	278.662
	Total Production*	3	245.105	66.867	206	322.314
	Net income*	1	21.16	.	21.16	21.16

Notes. *Average value computed between 2017 and 2020.
Source: Authors' elaboration on data from Orbis Bureau Van Dick database

Tab. 5: Characteristics of supply chains

	Firm age			Firm size*			Multi-chain		With branches			Total
Supply chain	0-5	6-24	25+	0-9	10-49	50+	No	Yes	No	Yes	Multi-branch	
Extra Virgin Olive oil supply chain	27	32	3	54	8	0	19	43	51	11	4	62
Wheat and derivates supply chain	14	33	8	49	6	0	25	30	49	6	2	55
Dried fruit and derivates products supply chain	15	13	0	24	4	0	8	20	25	3	1	28
Pulses, hemp, aromatic-officinal plants and their products and honey supply chain	5	14	4	19	4	0	2	21	18	5	1	23
Citrus fruit and citrus fruit products supply chain	4	12	3	18	1	0	5	14	15	4	1	19
Vegetables and their products supply chain	5	12	2	18	1	0	9	10	13	6	2	19
Livestock supply chain	3	5	4	11	1	0	9	3	10	2	1	12
Grape and grape products supply chain	3	6	1	9	1	0	2	8	7	3	0	10
Cheese supply chain	2	3	2	7	0	0	4	3	5	2	2	7
Prickly pear and prickly pear products supply chain	2	5	0	5	2	0	4	3	7	0	0	7
Exotic fruit and derivates products supply chain	1	3	1	5	0	0	2	3	4	1	0	5

Notes. *Average value computed between 2017 and 2020.
Only for those companies for which information could be found through Orbis.

Source: Authors' elaboration on data from Orbis Bureau Van Dick database

Tab. 6. Current management and control bodies

	Sex		Age			Total
	Women	Men	18-25	26-50	50+	
CEO	48	112	9	90	61	160
Board of Directors	14	47	5	32	24	61
Board of Auditors	4	9	0	6	7	13
Judicial Administrator	0	1	0	0	1	1
Partner	6	2	1	2	5	8
Other	0	3	0	0	3	3

Source: Authors' elaboration on data from Orbis Bureau Van Dick database

5. Findings

In this study, we describe the emergence of a digital platform ecosystem to enhance and integrate the distinctive features of rural areas. We structure our findings through the design and launch phases of the platform, highlighting the activities carried out at each stage to bring the ecosystem to life and populate it and the feelings of its actors. Specifically, we identify the role of the orchestrator as the project leader-designed as an external actor with no direct interest in supply chains-and its contribution to maximizing the ecosystem's value codiscovery potential.

5.1 Designing the digital platform ecosystem

The design phase describes the orchestrator's motivations for triggering the ecosystem creation process, followed by the design idea and the construction of the platform.

5.1.1 Development of a future vision for the rural arena

The project originated with an independent entity with a strong relational position in response to the need to enhance the rural areas of Sicily. In a context characterized by the poor capacity for aggregation on the part of the production system-due to the small size of enterprises and the low propensity for cooperation-the initiative was conceived as an opportunity to foster local collaboration aimed at enhancing the territory and its resources according to a participatory approach. In fact, KI-1 revealed, "[...] the project aims to network small businesses and foster a system approach between disadvantaged territories, from which to generate a common return. [...]. This is a very ambitious project aimed at making attractive inland areas dominated by feelings of distrust and abandonment".

Although embarking on a digital transformation journey was expected to be very difficult in such a change-hostile environment, the initiative was seen as an opportunity for a mindset change. KI-1 revealed, "Cultural resilience takes time, consistent messages, and the ability to convince businesses to change. Through the help of partners, we raise awareness of the digital transition among agricultural producers and provide them with all the assistance they need to persuade them to join a potentially revolutionary project for the area".

The complexity and ambition of the project justify its conception and management by an independent entity without economic interests, which takes on the role of orchestrator. KI-3 said, "You understand well that such a project would be neither thinkable nor feasible by individual companies".

5.1.2 Development of the project idea

The core of the project is the creation of a digital platform integrated with an international traceability standard to prove the Sicilian origin of agri-food products, to which targeted commercial interventions are added to promote an image of the products related to the specificities of the area. KI-2 explained, "[The project] intends to ferry rural communities into the world of digital technologies at the service of quality Sicilian food, certified according to the UNI EN ISO 22005 standard". To complement this, it envisages the creation of a direct sales circuit to market products and link the network of businesses with promotional and commercial initiatives carried out by regional, national, and international organizations and operators. KI-1 stated, "[Through these interventions] we would like to make very small local businesses visible in national and international markets [...] that alone could not make it". In addition, KI-3 stated, "The project provides an innovative solution that could in time also be integrated with other projects, such as food and wine tourism".

5.1.3 Designing the technological infrastructure

The project leader relied on an external agency to define the technical and organizational architecture of the digital platform, which was implemented

through public funds. Regarding its features, during the kick-off meeting, the certification agency stated, "We designed an Azure blockchain platform for digital traceability, in compliance with UNI EN ISO 22005, accessible to all companies that will join. It is a modular multichain architecture that allows each operator to record and share information about each agri-food product. Each adhering company will only have access to its own data, which will be immutable. In contrast, the project leader will have an overview and be able to access all the data". He added, "We defined smart contracts to regulate transactions within the platform and implemented a traceability system that may involve many digital technologies. In the future, it will be the basis for building innovative forms of communication, so-called smart labels, through which the end consumer, after framing a digital label on the foodstuff packaging with his smartphone, will be able to trace the product's origin".

As designed, the platform connects all participating companies, enabling them to create complementary offerings. Again, the certification agency said, "It [the platform] generates a complex network of linkages between multiproduct supply chains, which overcomes the traditional vertical view of each supply chain in favour of the rise of a cross-sector ecosystem, in which each actor will take on a defined role based on its position along the supply chain, i.e., farm and/or processor and packer".

5.2 Launching the digital platform ecosystem

The launch phase of the project required the orchestrator to find ways to "open" the platform to potential complements. Thus, the orchestrator shifted from an inwards focus in the conception phase to an outwards focus to attract users.

5.2.1 Development of consensus

The strategies implemented by the focal actor to develop consensus among potential complements focused on the promotion of the ecosystem as a certification system to enhance the economic and social potential of local products and the entire territory. Often, the project leader leveraged public and private partners with strong local roots to present the platform and its objectives to potential users. KI-10, KI-13, KI-14, KI-15, and KI-22 stated that they got to know about the project thanks to their trade associations during meetings where the focal actor was present. KI-10 explained, "[During one meeting] he described the project in broad outline, convincing me to look into it further in the following days". On the other hand, KI-20 stated, "I got to know [the initiative] thanks to a discussion with a project partner company that operates in the same supply chain as us".

In addition, the orchestrator organized informational meetings on the project and again used partners to encourage the participation of member companies. For example, the professional associations-partners in the initiative-entered into advantageous agreements with the orchestrator, awarding training credits to members.

However, a few companies that were interviewed judged the promotional efforts made by the orchestrator to attract more traditional companies to the platform as still too weak due to cultural resistance typical of the rural world. For this reason, KI-2 hoped for more publicity efforts. He stated, "The orchestrator must facilitate early participation, emphasizing the urgency of the ecosystem to overcome the digital divide that characterizes peripheral territories". According to KI-9, some companies may join the project in the future. He stated, "Currently, more traditional companies do not understand the advantage that digital traceability certification offers. Despite these promotional efforts, many local companies have chosen not to join the project. To convince reluctant companies, showing them a definite advantage, such as returns from the market, will probably be necessary".

5.2.2 Empowering ecosystem actors

The orchestrator promotes free training courses on the use of digital technologies and leverages partners to incentivize the participation of their member companies. Once again, the professional associations-partners in the initiative-enter into advantageous agreements with the orchestrator, awarding training credits to members. In this regard, KI-1, KI-2, KI-3, KI-10, KI-12, and KI-19 agreed on the usefulness of training activities to assist companies in introducing and maintaining digital innovation. Specifically, KI-7 recognized the value of training courses in less structured, family-run businesses where "often the owner is elderly and not very familiar with technology". In particular, KI-3 stated that, given the complexity of the project and the number of technologies involved, training activities are essential to moving companies towards cultural change and making them autonomous in the management of digital tools. In fact, without such actions, digital tools risk becoming just an expensive frill for the participating companies. According to KI-7, "those who do not have these skills will slow down all the others. Ad hoc training courses allow us all to start from the same level".

However, some companies' representatives negatively evaluate the communication strategy implemented by the orchestrator and call for its improvement. For example, KI-8 said, "There is a need for better communication of what the project envisages in practice. Some of our suppliers do not want to participate because they do not understand what they have to do (i.e., keeping formal records). Not being able to include them in the traceability system will be detrimental to us". Similarly, KI-6, KI-10 and KI-11 recognized the value of effective communication, through which a growing number of companies will be able to understand the project and its potential benefits. As a result, companies will be able to organize themselves to welcome change.

5.2.3 Governing the ecosystem

The orchestrator is responsible for defining the game's rules, codified within a regulatory framework and providing confidentiality agreements

for sensitive data. Additionally, the project leader will monitor the correct application of the established procedures through periodic checks and appropriate tools, such as traceability tests and mass balances. On this matter, KI-3 stated, "The orchestrator is the data owner. He keeps an eye on all the information at the dashboard level, which individual companies are not able to access for privacy reasons". Furthermore, KI-8 recognized the orchestrator as "the entity that dictates the guidelines and periodically checks that all the companies-and there are many of them-are doing things correctly". Many interviewees evaluated the role of the orchestrator positively. In this vein, KI-4 and KI-6 agreed to define the orchestrator as "a point of reference" to whom they can discuss internal rules. Instead, KI-3, KI-10 and KI-17 defined the orchestrator as key intermediary entity that coordinates all project-related activities in a constant, structured, and precise way. Specifically, KI-3 stated, "It would be impossible to imagine a project of this tenor, of this innovative scope, without the presence of the orchestrator, without his coordination and, above all, without his intermediary activity".

However, some interviewees complained about the absence of an adequate number of consultants to support the orchestrator, on the one hand, in control activities and, on the other hand, in handling requests for clarifications from companies. Once participation in the platform grows and extends to smaller and less structured companies, it will become almost impossible to meet everyone's needs. For this reason, KI-7 said, "There needs to be more consultants placed alongside the orchestrator so that they can talk to the individual companies in depth and accompany them step by step through the digital transformation process".

6. Discussion

In an innovation-hostile environment, digital platform ecosystem emergence may occur when an independent entity with a strong relational position, assisted by public and private partners rooted in the territory, engages in a range of activities tailored to rural communities framed in the ecosystem design and launch phases. In the first stage, the orchestrator conceives of the ecosystem; in the second stage, he brings together and leverages the resources and capabilities of third parties to attract potential users, initiate the ecosystem and manage the digital transformation process.

6.1 Theoretical implications

Responding to the call for more contextualized studies (Gulati, Puranam, and Thusman, 2012; Jacobides, Cennamo, and Gawer, 2018), this paper contributes to the recent literature on ecosystems through an in-depth longitudinal study on the emergence of a digital platform ecosystem in rural areas as a tool for local development. The empirical context of our case study complements the predominant focus of previous literature; we analyse ecosystem emergence in a low-tech rather than a high-tech sector (Gawer & Phillips, 2013), driven by an independent actor rather

than an established enterprise (Stonig, Schmid and Müller-Stewens, 2022), operating for collective interests rather than personal ends (Shih, Pisano, and King, 2008), and in peripheral areas hostile to innovations rather than lively (Dittrich, Duysters, de Man, 2007). Moreover, our study extends the research on ecosystem emergence stages (e.g., Jha *et al.*, 2016; Cinici, 2018), focusing on the ignition phase. Specifically, we identify two key moments, namely, ecosystem design and launch, i.e., when the focal actor plans the ecosystem and develops a set of strategies to initiate it. While the prevalent perspective (e.g., Addo, 2022; Hammer and Frimanslund, 2022; Cinici *et al.*, 2019) describes ecosystem emergence as a bottom-up process of collective discovery and negotiation, our results reveal a top-down, imposed value blueprint (Adner, 2017). We show that, in a rural environment, the ecosystem is successfully initiated when a focal actor, after assessing systemic and contextual conditions, develops a value proposition related to the actual development needs of potential users and when he or she implements a set of activities necessary for its realization (Ansari, Garud and Kumaraswamy, 2016; Batterink, Wubben, Klerkx and Omta, 2010; Boon, Moors, Kuhlmann, Smits, 2008). First, he or she designs a multiactor, modular and scalable platform that enables the coordination of users and their resources and the cocreation of value within the ecosystem. Second, a set of strategies is developed to stimulate membership and foster innovation in dispersed areas. By leveraging public and private partners, the focal actor publicizes digital platforms and promotes training activities (Rogers, 1961; Pan Fang *et al.*, 2021). To attract participation in events, an incentive-based persuasion strategy is implemented. The focal actor reduces the risk of nonmembership in the ecosystem or later defection, facilitating its ignition and allowing it to overcome the chicken-and-egg-type problems that are typical of multisided platforms (Addo, 2022; Evans, 2009; Evans and Schmalensee, 2016). Third, the focal actor takes the lead in the ecosystem and manages the innovation process, setting the rules of the game and performing periodic checks (Autio, 2021).

6.2 Practical implications

The empirical findings of this study underscore the pervasive influence of marginality in rural contexts on local communities' economic conditions and quality of life, consequently impeding the developmental potential of micro- and small enterprises. Conventional, centralized policies that focus solely on funding and promoting digital infrastructure often prove inadequate at addressing the nuanced challenges faced by these communities (Salemink *et al.*, 2017).

A novel approach emerges from the examination of successful interventions, namely, targeted local digitalization projects that address both connectivity and inclusion issues. In contrast to the prevailing discourse that tends to overlook the role of local governance, our study accentuates the pivotal position of local government. Often the unrecognized orchestrator in managing rural development, local government stands as the level of governance closest to everyday life. Acting in collaboration with civil society organizations and the private sector (Douglas, 2005)

catalyses change. Our research posits that the ignition of rural territories and community development should emanate from strategic local and regional policies. When championed by stakeholders intimately acquainted with the terrain, these policies can give rise to projects that amplify the unique strengths of these peripheral areas. As a result, our paper offers valuable insights to policy-makers, guiding them in formulating policies that empower regional administrations to nurture similar projects in marginalized territories.

Simultaneously, this study serves as a handbook for local administrators, imparting crucial lessons on how to champion the cause of marginal territories. It emphasizes the imperative of recognizing rural areas' specificities and needs, advocating for collaborative partnerships between public and private entities. Through joint efforts, these partnerships can spearhead development by implementing shared digitization projects and fostering a range of actions that actively engage and support local businesses.

Moreover, our research illuminates the journey of rural micro- and small enterprises towards technology adoption. Despite initial resistance to change, these enterprises exhibit a remarkable willingness to embrace technology when provided with guidance and support in the digital transformation process. In this context, technology is a pivotal driver of the emergence of these ecosystems, acting as a catalyst for innovation and collaboration. The integration of digital tools and platforms not only facilitates streamlined communication and knowledge sharing but also accelerates the coevolution of interconnected entities towards common territorial development goals. Embracing technology, as a core element of ecosystem development, ensures that these initiatives are sustainable and capable of adapting to the dynamic landscape of the digital era. Top-down digitalization projects emerge as facilitators, enabling access to specialized skills and knowledge, expediting the learning curve, and mitigating perceived risks through shared experiences. Central to this process is the ecosystem created by collaboration with other organizations. This ecosystem acts as a platform for interaction and cooperation, fostering a coevolving vision aligned with common territorial development goals. Strategic decisions to reengineer intra- and intercompany processes become more informed and adaptive, reflecting broader technological adoption. However, organizations aiming to cultivate such ecosystems must embody traits of receptivity, flexibility and take a proactive stance towards organizational and operational changes. This adaptability is vital for facilitating the development and evolution of ecosystems, creating an environment where innovation thrives and permeates the entire community.

Our study advocates for a paradigm shift towards localized, inclusive digital initiatives guided by responsive policies. By recognizing the potential of local actors and fostering collaborative ecosystems, these initiatives can usher in a transformative era for rural development, unlocking the latent capabilities of marginalized territories and empowering local businesses to thrive in the digital age.

7. Conclusion

As part of a broader research project, the present study explores the mechanisms underlying the innovative efforts of traditional sectors operating in rural areas. In particular, we explore the opportunities and threats specific to rural contexts, focusing on how complex interrelated organizations can thrive and develop rather than fail to scale up. Despite being in an exploratory stage, the project will allow us to observe and closely monitor the evolution of such a digital ecosystem, shedding light on the role of external orchestrators and the relationships among the other actors. Although digital platform ecosystems have been the subject of several studies in the agri-food sector, there is no comprehensive and exhaustive exploration of the phenomenon within a rural area where ecosystem participants join efforts to create value in an innovation-hostile environment.

This study is limited to companies operating against the backdrop of a shared project to create a digital platform ecosystem. The youthfulness of the project forced us to limit our study to only the initiation stage of the digital platform ecosystem for value codiscovery. In the future, the study could be extended to the momentum stage of the ecosystem to provide additional consistency with our results. Finally, for the time being, the project's uniqueness makes it impossible to compare it with other similar cases in the national context.

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Academic or professional positions and contacts

Giovanna Terrizzi
Ph.D Student of Economics, Management and Statistics
University of Messina - Italy
e-mail: terrizzig@unime.it

Alba Marino
Assistant Professor of Management
University of Messina - Italy
e-mail: alba.marino@unime.it

Maria Cristina Cinici
Associate Professor of Management
University of Messina - Italy
e-mail: mariacristina.cinici@unime.it

Daniela Baglieri
Full professor of Management
University of Messina - Italy
e-mail: daniela.baglieri@unime.it

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