

## DIGITALIZATION AS A DRIVER OF SUSTAINABLE REGIONAL ENTREPRENEURSHIP: A QUALITATIVE CASE STUDY OF EUROPEAN IT COMPANIES

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**Introduction.** The rapid expansion of digital technologies has fundamentally reconfigured the structural foundations of regional economic development. Digitalization is no longer limited to the automation of individual business processes; it has evolved into a systemic factor shaping entrepreneurial ecosystems, innovation capacity, and territorial competitiveness. Regions characterized by a high level of digital integration demonstrate stronger productivity growth, enhanced innovation diffusion, and greater resilience to global economic volatility. In this context, digitalization becomes a strategic determinant of sustainable regional entrepreneurship rather than merely a technological upgrade.

Within the European economic space, IT companies play a pivotal role in this transformation. Acting as technological leaders and ecosystem orchestrators, they generate knowledge spillovers, foster collaboration with universities and SMEs, and stimulate cluster-based innovation dynamics. Their activities extend beyond firm-level performance, influencing employment structures, skill formation, infrastructure modernization, and long-term regional efficiency. Consequently, the interaction between digitalization and regional entrepreneurship requires deeper analytical consideration, particularly through the lens of sustainability and ecosystem efficiency.

Recent research highlights the positive relationship between digital capabilities and entrepreneurial performance, as well as the growing importance of innovation ecosystems in enhancing organizational efficiency. However, most existing studies focus on quantitative assessments at the SME or national level, leaving insufficient attention to qualitative, comparative analyses of leading European IT corporations as



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drivers of sustainable regional development. The mechanisms through which digital integration within large IT firms translates into broader entrepreneurial and territorial efficiency remain underexplored.

Addressing this gap is both scientifically and practically relevant. For policymakers, understanding ecosystem-based digital transformation provides guidance for designing cluster-oriented regional strategies. For scholars, it enables the conceptual integration of digitalization, entrepreneurial efficiency, and sustainable development within a unified analytical framework.

This study aims to analyse how digitalization implemented by selected European IT companies contributes to sustainable regional entrepreneurship and long-term efficiency. Using a qualitative comparative case study approach and a structured evaluation framework, the article examines the ecosystem effects of leading firms and develops a conceptual model linking digital integration, innovation ecosystems, entrepreneurial efficiency, and sustainable regional development.

**Analysis of recent research and publications.** Contemporary academic discourse increasingly conceptualizes digitalization as a structural determinant of entrepreneurial efficiency and sustainable regional development. In this context, J. Cheng, M. Wu, B. Liu, W. Luo, and H. Wang interpret high-quality economic development as a multidimensional process in which innovation intensity, institutional coordination, and technological upgrading jointly enhance entrepreneurial productivity and systemic adaptability [1]. Empirical evidence provided by V. Kulyk, D. Škodová Parmová, and M. Jílek confirms that the development of e-business models contributes to improved organizational efficiency and supports structural modernization at both firm and regional levels [2]. At the same time, V. A. Kulyk emphasizes the importance of integrating digital risk management into Sustainable Development Goals frameworks, substantiating the need to mitigate digital threats in business environments to ensure long-term sustainability and governance stability [3].

Digital transformation is also examined as a catalyst for entrepreneurial capacity building through competence development and educational modernization. Á. Tóth-Pajor, Z. Bedő, and V. Csapi demonstrate that the integration of digital tools into entrepreneurship education significantly enhances entrepreneurial skills and strengthens regional absorptive capacity [4]. Complementary findings by M. Hasan, M. Jannah, T. Supatminingsih, M. I. S. Ahmad, M. Sangkala, M. Najib, and Elpisah indicate that financial, entrepreneurial, and digital economic literacy collectively foster creativity and improve SME performance within knowledge-based economic systems [5]. These contributions confirm that digitalization extends beyond technological adoption and contributes to human capital development and institutional readiness.

Another strand of research highlights the role of entrepreneurial marketing and digital marketing capabilities in strengthening digital-enabled competitiveness, Z. Zahara, I. Ikhsan, I. N. Santi, and F. Farid substantiate that the integration of entrepreneurial marketing with digital marketing instruments enhances SME performance and supports post-crisis recovery trajectories [6]. Also, N. Chooset and S. Sukhabot further conceptualize entrepreneurial marketing dimensions in digitally mediated environments, demonstrating how strategic adaptability and customer-oriented innovation generate sustainable competitive advantage [7].

Financial technology diffusion represents an additional mechanism through which digitalization expands entrepreneurial opportunities and modernizes financial infrastructures. Further, I. J. Ismail and F. U. Rashidi show that FinTech adoption depends on dynamic entrepreneurial capabilities and digital financial innovation processes that enhance SME efficiency [8], while S. Peter, G. Elangovan, and A. Gupta empirically confirm that digital engagement contributes to financial inclusion and reduces gender-based entrepreneurial disparities, reflecting broader socio-economic spillovers [9]. Alsharah H. [10] demonstrates that artificial intelligence integration into entrepreneurial processes strengthens innovation performance and strategic decision-making, while P. M. Rahman, S. Akhtar, S. Babar Khan, M. Khan, M. M., and M. Afjal [11] link efficiency improvements in manufacturing SMEs to innovation-oriented managerial practices and dynamic capabilities within digitally enabled production systems.

At the regional level, entrepreneurial ecosystem theory provides an integrative explanatory framework. K. N. Mai and V. T. Nguyen argue that mature ecosystems stimulate organizational learning, creativity, and long-term business success through coordinated institutional support and network externalities [12]. Sustainability-oriented digital transformation is further examined by E. Astuty, I. D. Sudirman, and R. Aryanto, who demonstrate its contribution to micro-business resilience and adaptive capacity in volatile economic environments [13].

Spatial and territorial perspectives broaden this analytical scope. P. Artelaris and G. Mavrommatis highlight, from a capabilities-based approach to spatial justice, the necessity of integrating technological modernization

with inclusive territorial and social investment strategies [14]. Breau S. and Marchand Y. empirically map regional disparities in exposure to automation, demonstrating that digital transformation produces differentiated territorial effects requiring targeted governance responses [15]. Tantoh H. B., McKay T. J. K., and Leonard L. emphasize the importance of community-led development and locally embedded governance mechanisms in promoting sustainable resource management and inclusive regional growth [16].

Despite the breadth of these contributions, the existing literature remains predominantly focused on quantitative modelling or sector-specific investigations. Limited attention has been paid to qualitative comparative analyses of leading European IT corporations and their systemic role in shaping sustainable regional entrepreneurship. By integrating insights from digitalization theory, entrepreneurial ecosystem research, sustainability studies, and territorial development frameworks, the present study addresses this research gap and develops a structured analytical approach for examining how digitally advanced firms contribute to long-term regional efficiency, resilience, and structural transformation.

**The objective of this study** is to investigate the extent to which digital transformation processes implemented by leading European IT companies influence the development of sustainable regional entrepreneurship and strengthen entrepreneurial efficiency within regional innovation ecosystems. The research focuses on identifying and systematizing the mechanisms through which corporate-level digital integration produces spillover effects that affect regional competitiveness, structural modernization, sustainability orientation, and long-term value creation. Particular attention is paid to the interconnection between digital capabilities, ecosystem coordination, and the resilience of regional entrepreneurial systems.

To accomplish this objective, the research design is based on a qualitative comparative case study approach that enables an in-depth examination of complex, multilevel interactions between corporate strategies and regional economic environments. Five European IT companies were selected according to criteria of technological leadership, measurable regional influence, and the integration of sustainability principles into corporate governance and operational models. The empirical base of the study includes corporate annual reports, sustainability and ESG disclosures, strategic documents, and materials related to regional clusters and innovation partnerships.

The methodological framework combines systemic and structural analysis with a structured evaluation procedure designed to assess key dimensions of digital and ecosystem development. A conceptual five-point scale is applied to evaluate the level of digital integration, the strength of innovation ecosystem engagement, the degree of sustainability orientation, the contribution to entrepreneurial ecosystem development, and the impact on long-term regional efficiency. Each evaluation level is defined through observable qualitative indicators, ensuring analytical consistency and comparability across cases. Such an approach provides methodological rigor and procedural transparency, allowing qualitative evidence to be systematically linked to corporate practices and regional development outcomes. It also facilitates the identification of typological patterns in digital transformation models and their differentiated influence on sustainable regional entrepreneurship.

**The main material of the study.** The empirical analysis is structured around the proposed conceptual model: Digitalization → Innovation Ecosystem → Entrepreneurial Efficiency → Sustainable Regional Development.

The section presents the results of a qualitative comparative assessment of five European IT companies and substantiates the identified relationships through structured analytical evaluation.

**1. Digital Integration as a Structural Foundation of Regional Entrepreneurship.** Digital integration within leading European IT companies extends beyond technological adoption and reflects systemic transformation of business models, value chains, and stakeholder interaction. In this study, digital integration is assessed in terms of platform architecture, AI deployment, cloud infrastructure, data analytics, and ecosystem connectivity.

SAP, Dassault Systèmes, and Adyen demonstrate very high platform integration combined with advanced AI-driven analytics, enabling scalable interaction with SMEs and strengthening digital ecosystems at the regional level. ASML and Ericsson, while technologically sophisticated, primarily operate through industrial and infrastructure-based digital models, generating more indirect spillover effects.

These findings support previous research emphasizing that advanced digital capabilities increase operational and innovation efficiency [10; 11]. This analysis extends the perspective to regional spillovers, linking corporate digitalization to ecosystem-level outcomes.

**2. Contribution to Regional Innovation Ecosystems.** All examined firms function as anchor institutions within regional clusters, stimulating university-industry cooperation, startup formation, and knowledge diffusion.

Table 1

Key dimensions of digital integration in selected European IT companies

Company	Core Digital Specialization	Level of Platform Integration	AI/Data Utilization	SME Digital Enablement
SAP	Enterprise software (ERP, cloud)	Very High	Advanced	Extensive
ASML	Semiconductor lithography systems	High	Advanced	Moderate
Ericsson	Telecom infrastructure (5G)	High	Moderate	Indirect
Dassault Systèmes	Digital twins, smart manufacturing	Very High	Advanced	High
Adyen	FinTech payment platform	Very High	Advanced	Extensive

Source: compiled by the authors based on publicly available corporate reports, sustainability disclosures, and open-source analytical materials

Table 2

Regional innovation ecosystem contribution

Company	Regional Cluster	University Cooperation	Startup Support	Knowledge Spillovers	Ecosystem Strength
SAP	Baden-Württemberg (Germany)	Strong	Extensive	High	Very Strong
ASML	Eindhoven (Netherlands)	Strong	High-tech focus	Very High	Very Strong
Ericsson	Stockholm (Sweden)	Moderate	Moderate	High	Strong
Dassault	Île-de-France (France)	Strong	Industrial focus	High	Strong
Adyen	Amsterdam (Netherlands)	Moderate	FinTech ecosystem	Moderate	Strong

Source: developed by the authors based on qualitative synthesis of publicly available regional, corporate, and cluster-level data.

SAP and ASML exhibit particularly strong ecosystem coordination, reinforcing regional specialization and long-term innovation capacity. Industrial IT firms primarily strengthen manufacturing modernization, while platform-based companies (Adyen) accelerate SME financial digitalization, highlighting complementary ecosystem models.

**3. Sustainability Integration and Long-Term Efficiency.** Sustainability is a core dimension linking digitalization with regional development. All companies embed environmental, social, and governance (ESG) principles within strategic frameworks.

Table 3

Sustainability integration and regional impact

Company	Environmental Initiatives	Social Contribution	ESG Strategy Integration	Regional Resilience Impact
SAP	Carbon reduction programs	Digital skill training	Integrated	High
ASML	Energy-efficient production	High-skilled employment	Integrated	High
Ericsson	Energy-efficient networks	Digital inclusion	Integrated	Moderate-High
Dassault	Lifecycle optimization tools	Engineering education	Integrated	High
Adyen	Green operations initiatives	SME empowerment	Partial	Moderate

Source: authors' elaboration based on analysis of publicly available ESG reports and corporate sustainability disclosures.

Integration of ESG principles is most comprehensive in SAP, ASML, and Dassault. Adyen shows moderate integration, primarily through SME empowerment. This aligns with resilience-oriented digitalization research [13] and digital risk frameworks [3]. Sustainability integration correlates with stronger regional resilience and long-term efficiency.

**4. Comparative Analytical Evaluation.** Structured five-point conceptual scale was applied across five evaluation factors. We used a five-point scale (1 = very low, 5 = very high) to comparatively assess each company across five dimensions: digital integration, innovation ecosystem, sustainability support, entrepreneurial ecosystem development, and long-term efficiency. The scores were assigned based on qualitative and secondary data analysis, reflecting the relative strength and maturity of each dimension within the company's strategic and operational practices. The scale enables cross-company comparison rather than absolute performance measurement.

Table 4 serves as a generalizing analytical instrument. It demonstrates that companies with very high digital integration tend to exhibit stronger ecosystem coordination and higher long-term efficiency. This

Comparative evaluation of digitalization and regional entrepreneurial efficiency (1–5 scale)

Company	Digital Integration	Innovation Ecosystem	Sustainability Support	Entrepreneurial Ecosystem Development	Long-term Efficiency
SAP	5	5	4	5	5
ASML	5	5	4	4	5
Ericsson	4	4	4	4	4
Dassault	5	4	4	4	5
Adyen	5	4	3	5	4

Source: authors' evaluation based on qualitative comparative analysis of publicly available corporate and ecosystem data

confirms the theoretical linkage between digital capacity and entrepreneurial performance identified in previous studies [1].

The results reveal three key patterns:

1. Strong digital integration → High ecosystem efficiency;
2. Ecosystem maturity → Enhanced entrepreneurial efficiency;
3. Embedded sustainability → Greater regional resilience.

Furthermore, the analysis distinguishes two structural models:

1. Industrial-technology model (SAP, ASML, Dassault): deep specialization, strong R&D clustering, manufacturing modernization;

2. Platform-based model (Adyen): scalable SME empowerment and financial digital infrastructure.

Ericsson represents an infrastructure-cantered hybrid model enabling digital connectivity.

**5. Conceptual Interpretation of Results.** The results confirm the internal logic of the proposed conceptual framework by empirically validating the sequential relationship between digitalization, ecosystem strengthening, entrepreneurial efficiency, and sustainable regional development. Digitalization emerges not merely as a technological upgrade but as a structural mechanism that reduces transaction and coordination costs, accelerates knowledge diffusion, and expands the scalability of inter-organizational interaction. Through these channels, it reinforces innovation ecosystems and improves the functional alignment of regional actors.

The strengthening of innovation and entrepreneurial ecosystems translates into higher entrepreneurial efficiency, reflected in more effective resource allocation, increased innovation capacity, and enhanced digital readiness of small and medium-sized enterprises. This efficiency effect extends beyond firm-level outcomes and contributes to broader regional dynamics, including productivity growth, adaptive resilience, and structural modernization.

Conceptually, the findings demonstrate that large digital corporations operate as ecosystem orchestrators, shaping institutional configurations, innovation networks, and sustainability trajectories at the regional level. Thus, digitalization, when embedded within coordinated ecosystem and sustainability frameworks, functions as a systemic driver of sustainable regional entrepreneurship rather than an isolated technological factor.

**Conclusions.** The results of the study confirm that digitalization acts as a structural driver of sustainable regional entrepreneurship by strengthening innovation ecosystems and enhancing entrepreneurial efficiency. Based on a qualitative comparative analysis of leading European IT companies, the research demonstrates that deep digital integration, when combined with ecosystem coordination and sustainability-oriented strategies, generates significant regional spillover effects. These effects manifest in increased innovation intensity, SME digital enablement, cluster-based development, and long-term regional resilience.

The scientific novelty of the study lies in the development of an integrated analytical framework linking digital integration, innovation ecosystem maturity, entrepreneurial efficiency, and sustainable regional development within a structured qualitative evaluation model. Unlike predominantly quantitative approaches in existing literature, this research provides a comparative ecosystem-level perspective, highlighting the role of large IT corporations as regional orchestrators rather than isolated economic actors. The differentiation between industrial-technology, infrastructure-cantered, and platform-based digital models further refines the conceptual understanding of how various IT business architectures influence regional entrepreneurial dynamics.

The scientific significance of the findings consists in expanding theoretical discourse on digitalization and regional development by empirically substantiating the interdependence between digital capabilities and sustainable entrepreneurship. The practical significance is reflected in the implications for regional economic policy, particularly regarding cluster-based digital strategies, support for SME digital ecosystems, and integration of sustainability principles into digital transformation policies.

Future research may focus on quantitative validation of the proposed five-factor evaluation scale, comparative analysis across additional European and emerging regions, and deeper examination of SME-level spillover mechanisms. Further investigation of digital risk management and cybersecurity dimensions within regional entrepreneurial ecosystems would also enhance theoretical and applied insights.

Overall, long-term regional competitiveness depends on the synchronized integration of digitalization, sustainability, and entrepreneurial ecosystem development, confirming the strategic importance of IT-driven innovation management in the European digital economy.

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The article examines digitalization as a structural driver of sustainable regional entrepreneurship. It identifies the strategic role of large IT companies in strengthening innovation ecosystems and enhancing entrepreneurial efficiency. The study analyses the depth of digital integration, ecosystem coordination, sustainability orientation, and long-term regional effects based on a qualitative comparative case study of leading European technology firms. It reveals that advanced digital infrastructures stimulate innovation diffusion and regional resilience. Particular attention is paid to ecosystem orchestration models and their contribution to sustainable competitiveness. The research substantiates the interdependence between digital transformation and balanced regional development.

**Key words:** digitalization, sustainable development, regional entrepreneurship, entrepreneurial efficiency, innovation management, European digital economy.

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У статті досліджено цифровізацію як структурний чинник формування сталого регіонального підприємництва в умовах трансформації європейської економіки. Визначено, що цифрова інтеграція виступає не лише технологічним інструментом модернізації бізнесу, а й системним драйвером розвитку інноваційного середовища, підвищення підприємницької ефективності та зміцнення регіональної конкурентоспроможності. Проаналізовано вплив цифрових платформ, інфраструктурних рішень та індустріально-технологічних моделей на формування сучасного підприємницького середовища. Досліджено роль провідних європейських ІТ-компаній як ключових учасників, які формують умови взаємодії між бізнесом, інноваційними структурами та регіональними інституціями, стимулюючи розвиток малого і середнього підприємництва та поширення цифрових компетенцій. Встановлено, що поєднання глибокої цифрової інтеграції, розвитку інноваційних мереж та орієнтації на принципи сталого розвитку забезпечує довгострокові регіональні ефекти, зокрема зростання продуктивності, підвищення адаптивності економічних систем і посилення їх інституційної стійкості. Проведено якісний порівняльний аналіз діяльності провідних європейських ІТ-компаній за критеріями рівня цифрової інтеграції, зрілості інноваційного середовища, підтримки сталих практик і довгострокової ефективності. Обґрунтовано взаємозв'язок між цифровою трансформацією, розвитком підприємницької активності та структурною модернізацією регіонів. Доведено, що забезпечення сталого розвитку регіонального підприємництва потребує узгодженої інтеграції цифрових стратегій, ефективного управління інноваційними процесами та інституційної підтримки бізнесу. Сформульовано практичні орієнтири для регіональної політики у сфері цифрової трансформації з урахуванням кластерного підходу, розвитку цифрової інфраструктури та підвищення довгострокової конкурентоспроможності європейського економічного простору.

**Ключові слова:** цифровізація, сталий розвиток, регіональне підприємництво, підприємницька ефективність, управління інноваціями, європейська цифрова економіка.