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italian journal of management

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Vol. 43
Issue 3

SEP-DEC
2025

Italian Society of MANAGEMENT

FONDAZIONE CUEIM

Official Journal of Italian Society of Management

Vol. 43, Issue 3, 2025 ISSN 0393-5108 ISSN 2785-549X

sinergie

italian journal of management

Official journal of Italian Society of Management

VOL. 43 ISSUE 3 N. 128	**Sinergie IJM's Essays**	SEP-DEC 2025

Sinergie Italian Journal of Management is a peer-reviewed scholarly publication focusing on the principal trends in management studies.

Formerly *Sinergie rivista di studi e ricerche*

Published quarterly

Founded in 1983

ISSN 0393-5108 - ISSN 2785-549X

Open access at *www.sijm.it*

Indexed in Scopus (as from 2021), Google Scholar, ACNP, ESSPER

Sinergie Italian journal of management is published by Fondazione CUEIM, a foundation aiming to carry out and to promote scientific research, especially in the fields of business administration and of organizations management, both profit and non profit.

Sinergie Italian journal of management is the official journal of SIMA, the Scientific Society of Italian Professors of Management, whose aim is to contribute to the development and dissemination of management knowledge in the academic, economic and social fields, on an excellence basis.

The editing activity is sponsored by Consorzio Universitario di Economia Industriale e Manageriale - CUEIM - www.cueim.it

Peer reviewed journal

Journal accredited by AIDEA

Questa testata è associata a USPI Unione Stampa Periodica Italiana

Sinergie Italian Journal of Management
Via Interrato dell'Acqua Morta, 26
37129 Verona (VR), Italy
Tel. +39 045 597655
www.sijm.it

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Vol. 43, Issue 3, 2025

Sinergie IJM's Essays

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Aphorism

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italian journal of management
Vol. 43, Issue 3, 2025

The words of the past year
Belong to the language of the past year
And the words of the year to come await another voice.
(Thomas Stearns Eliot)

sinergie
italian journal of management

ISSN print 0393-5108
ISSN online 2785-549X
p. 9

FONDAZIONE CUEIM

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A Manifesto for the Future of Management Studies[1]

Francesco Ciampi - Arabella Mocciaro Li Destri -
Alberto Pastore

The project of a Manifesto for Management Studies stems from the need to foster a deep and shared reflection, both within and beyond our scholarly community, on the current and future challenges of our discipline. The goal is to identify new trajectories and perspectives of evolution of management thought and research (whether thematic, methodological, or of a different nature), in line with the emerging demands of business practice and, more broadly, of society.

Today, businesses and policymakers are confronted with a "new normal", characterized by increasing instability, rapidly changing contexts, and the multidimensional (economic, social, technological, environmental, geopolitical, etc.) nature of ongoing transformations. This new normal of uncertainty exponentially amplifies the complexity of the phenomena we investigate, and challenges management scholars to question established theoretical and methodological paradigms, and develop new approaches capable of capturing the inherently multidisciplinary nature of such transformations (Reinecke *et al.*, 2024), and supporting the design of sustainable, equitable solutions oriented toward the common good, as well as the creation of economic value (Dencker *et al.*, 2023). For instance, the advent of artificial intelligence calls for new paradigms that can effectively interpret the challenges posed by the integration of the immense potential of these emerging technologies into business processes (Bliese *et al.*, 2024; Grégoire *et al.*, 2024). Similarly, the growing emphasis on purpose-driven business and the societal demand for sustainability and inclusion (Becchetti *et al.*, 2023; Caselli *et al.*, 2023) require frameworks that acknowledge and enhance the relations of mutual support between economic value, individual well-being, and collective welfare (Strategic Management Society, 2023). The complexity of contemporary contexts makes it urgent to overcome the persistent divide between academia and practice, thereby enhancing our capacity to generate "real impact", i.e., practically relevant results for firms, policymakers, and society at large (Tourish, 2020).

The activities leading to the Manifesto published in this issue of the journal unfolded in four main stages. First, we conducted a review of the most recent literature (from 2020 onwards) addressing the prospective directions of our discipline. This review focused on articles published in journals ranked 4 and 4* by in the ABS list, as well as on position papers issued by leading national and international academic associations in the field of management. In the second stage, we developed an initial draft of

the Manifesto, as the outcome of a shared and in-depth reflection within the proposing group. The third stage consisted of a series of exploratory interviews with a selected group of practitioners holding top management positions in large corporations operating in different sectors. The aim was to collect assessments, comments, and proposals from one of the key external stakeholder groups of our scholarly community. This step reflects our conviction that only through a systematic dialogue between theory and practice is it possible to develop research that is both scientifically rigorous and socially meaningful. Finally, the proposing group drafted and validated the final version of the document, which was officially presented on 13 June 2025 at the annual SIMA conference in Genoa.

The proposals set out in the Manifesto stem from of a collective reflection within the group and are grounded in the conviction that our community is now called to focus on the real-world challenges confronting businesses, institutions, and policymakers, and to contribute to the development of timely and effective solutions for the future (Langley *et al.*, 2023; Muñoz & Dimov, 2023; van Gelderen *et al.*, 2021). In other words, we believe that our studies, while methodologically rigorous, must also be relevant, accessible, and timely (Chen *et al.*, 2023; Haenlein *et al.*, 2025; Houston, 2024; Pastore & Ugolini, 2023; Schmitt *et al.*, 2022).

The document outlines three major directions of development. The first concerns the need to enhance the impact of our studies on firms, institutions, and society by increasingly engaging in co-designed research with managers and policymakers, adopting more future-oriented and transformative approaches, and ensuring effective dissemination of results. The second highlights the need to evolve our methodological approaches toward greater interdisciplinarity, the integration of multi-method and multi-level perspectives, and the full exploitation of the potential of technology and artificial intelligence. The third proposes a renewed research agenda aimed at overcoming the trade-off between profit and purpose, promoting a new humanism in management, and making a significant contribution to defending and strengthening the competitiveness of the Italian entrepreneurial system.

The document concludes with a call to responsibility: in a world increasingly shaped by interconnected and complex crises, our scholarly community must commit to acting as an agent of change. The Manifesto we present is not a final destination, but the beginning of a journey, an open platform, a living document designed to foster ongoing dialogue within and beyond our community. Its ambition is to strengthen our capacity to interpret the current and future challenges of our discipline, to recognize their evolution, and to respond with rigor, responsibility, and effectiveness. The intention is to periodically review and update its contents, thereby constantly projecting it into the future and ensuring its responsiveness to the emerging challenges and opportunities emerging time from time in our field.

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sinergie
italian journal of management

ISSN 0393-5108
ISSN 2785-549X
DOI 10.7433/s128.2025.01
pp. 11-14

Italian Society of
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THE MANIFESTO OF MANAGEMENT STUDIES

The future of management studies

Over the past two decades, the expectations and development trajectories of firms and markets have been repeatedly challenged by shocks that have generated systemic and global impacts on the economy and society. These events have confronted entrepreneurs, managers, and policy makers with a new normal-one characterized by volatility and uncertainty. The changes we are experiencing are marked by their rapid emergence and evolution, their epochal and disruptive nature, and their influence on multiple, interconnected dimensions: the economy, society, the environment, and even the international political order.

Management scholars have historically made significant contributions to understanding organizational phenomena and to the progress of both the economy and society as a whole. However, in light of the ongoing transformations, we feel a strong responsibility to reflect on the need to open new paths, with the aim of providing entrepreneurs, managers, and policy makers with new frameworks and tools to interpret and manage these changes.

We believe that this challenge can be addressed by pursuing three fundamental, closely interrelated and complementary directions: a greater impact on businesses, institutions, and society; methodological approaches capable of interpreting and exploring the complexity of emerging contexts; a renewed research agenda.

WHAT WE WANT

1) **GREATER IMPACT ON BUSINESSES, INSTITUTIONS, AND SOCIETY**
   - ✓ Research co-designed with entrepreneurs, managers, and policy makers
   - ✓ Forward-looking approaches
   - ✓ Effective dissemination of results

2) **ENHANCED CAPACITY TO ADDRESS COMPLEXITY**
   - ✓ Intra- and inter-disciplinary integration
   - ✓ Leveraging the potential of AI, ML, and big data
   - ✓ Multi-method and multi-level approaches

3) **A RENEWED RESEARCH AGENDA**
   - ✓ Moving beyond the trade-off between profit and purpose
   - ✓ A "new humanism in management" in the age of AI
   - ✓ A focus on the competitiveness of the Italian "country system"

4) **AN ASSUMPTION OF RESPONSIBILITY FOR THE COMMON GOOD**

1. Generating greater impact on businesses, institutions, and society

We must commit to generating a stronger impact on the world of business, policy making, and society at large. To achieve this goal, we consider it essential to strengthen the connections between academic research, enterprises, and policy makers.

1.1 Co-designing research projects

We advocate for greater collaboration between scholars and practitioners in the design phase of research projects. Co-designing research with teams composed of academics and practitioners (entrepreneurs, managers, and policy makers) enables the formulation of research questions not solely derived from existing literature (an "inward to the literature" approach), but also inspired by real-world challenges faced by managers, firms, and policy makers (an "outward to practice" approach). At the same time, we emphasize the importance of preserving spaces for basic research that maintain autonomy and independence from operational contingencies, which are essential for generating valuable foundational knowledge.

1.2 Integrating the analysis of past phenomena with the search for future solutions

To increase the relevance of our research, we support the adoption of more future-oriented approaches. Beyond understanding past and current phenomena ("how the world has worked and works"), we encourage a stronger commitment to envisioning and designing solutions for the future ("how the world should or could work"), with particular attention to those capable of shaping long-term transformations. Achieving this goal requires evolving how we formulate research questions, moving from gap-spotting approaches, which focus on filling gaps in the existing state of the art and often assume the validity of dominant theoretical paradigms, to path-setting approaches, which aim to develop new perspectives by challenging existing paradigms and offering novel visions.

1.3 Effective dissemination of research findings

We believe it is essential to improve the effectiveness of how research findings are disseminated. To be relevant to society, it is crucial to communicate our research outcomes promptly and effectively, also beyond academic audiences, using diverse and complementary channels to traditional scholarly journals. We encourage management scholars to communicate their findings in an accessible and timely manner, using clear and direct language and leveraging channels (social media, digital platforms, etc.), formats (books, general-audience articles, podcasts, case studies, multimedia content, etc.), and dissemination methods that can reach relevant stakeholders (e.g., entrepreneurs, managers, policy makers, students) effectively. In this context, we support stronger engagement in organizing and participating in direct exchanges (e.g., conferences,

roundtables, seminars) between academics and practitioners. These occasions represent valuable opportunities for sharing and interpreting research findings, as well as identifying future research trajectories. Equally important is enhancing the effectiveness of technology transfer processes through academic spin-offs and other structured forms of collaboration between universities, practitioners, and policy makers, which allow us to transform research results into practical applications and valuable solutions for businesses, public administrations, or other actors within the economic and social system. From this perspective, focusing on the diverse characteristics of our territories may gain renewed interest and relevance.

2. Advanced methodological approaches to understand the complexity of emerging contexts

We argue that the complexity of the ongoing transformations necessitates the expansion and evolution of the methodological approaches used to design, implement, and validate management research.

2.1 Intra- and interdisciplinary approaches

Given that the complexity of emerging contexts largely stems from the highly interdisciplinary nature of the problems and challenges we face, we believe it is valuable to encourage studies that transcend traditional disciplinary boundaries and integrate approaches and methods typical of the various domains of management studies (from marketing to finance, from strategy to organization, from operations to R&D). Looking ahead, we also advocate for a greater cross-fertilization between business disciplines and other scientific fields, such as economics, sociology, philosophy, psychology, and data science. The absence of a shared language, epistemological differences across disciplines, the lack of adequate integration of theories developed in distinct scientific domains, and the resulting increased complexity in evaluating scientific outputs are critical issues that must be addressed to enable a deeper and more realistic understanding of phenomena. At the same time, collaboration among scholars from diverse disciplines and the integration of heterogeneous perspectives and methodologies are enabling conditions for effectively managing the multidimensionality of the challenges at hand, bridging the gap between theory and practice, and enhancing the relevance of academic research.

2.2 The potential of AI and ML

The potential of machine learning (ML), artificial intelligence (AI), blockchain technologies, big data analytics, and computational simulation techniques has exponentially expanded our ability to analyze vast amounts of data in extremely short timeframes, identify unifying themes and complex relationships, measure constructs that are difficult to observe with traditional methods, address issues of reverse causality, examine an

extraordinary number of heterogeneous variables, and simulate contexts and solutions. We encourage greater efforts to understand and incorporate these technologies into our research methodologies while maintaining strong awareness of potential biases, such as algorithmic opacity, distortions in outcomes caused by prejudices in data, and the risk of displacing the researcher in the generation of research hypotheses.

2.3 The value of multi-method and multi-level approaches for studying highly dynamic contexts

The study of contexts and phenomena characterized by high levels of variability and complexity requires the development of theoretical paradigms that focus on becoming rather than being, enabling us to understand how changes unfold over time, the conditions that make them possible, and the mechanisms that sustain or hinder them. This also calls for the adoption of multi-method research approaches capable of integrating different analytical perspectives, interpreting multiple dimensions of the same phenomenon, and developing multi-level theoretical paradigms. To this end, we consider it essential to employ methodological approaches that combine the analytical and generalizing power of quantitative methods with the interpretive and exploratory potential of qualitative methods, such as case studies, micro-ethnography, and action research. The latter, despite risks and limitations related to the potential loss of professional distance between the researcher and the phenomenon under investigation (the so-called "engagement paradox"), allow for the construction of meaning through direct interaction with the field of study and foster co-creation processes capable of generating significant impact.

3. A renewed research agenda: purpose, technology, the new humanism of management, and national competitiveness

The increasing complexity of the environments we face compels us to reflect on the areas that should be prioritized in our research agenda. On one hand, there is a growing need to address the challenge of integrating economic sustainability, social sustainability, and the transformative capacity of enterprises. On the other hand, we must also confront the challenges posed by digital transformation, including its new forms related to artificial intelligence (AI). Lastly, as Italian scholars of management, we consider it essential to refocus attention on the distinctive features of our national economic and business contexts, in order to enhance their dynamics and contribute to their evolution.

3.1 Moving beyond the profit–purpose trade-off

The view of the firm as an organization whose sole purpose is to maximize shareholder value (the shareholder view) has long been surpassed. We have embraced an alternative perspective that identifies value creation for all stakeholders (the stakeholder view) as a key condition for the survival and

development of firms. A more recent evolution of the stakeholder approach is the purpose-driven perspective, where purpose is conceived as a higher cause, a mission that transcends the interests of individual stakeholders and embodies the cultural identity and values of the organization. This shift has led us to reflect more deeply on the fundamental raison d'être of the firm and its role in advancing the common good and addressing the complex and urgent challenges faced by society at large.

A growing body of empirical evidence suggests that firms which integrate ESG criteria into their business models and adopt corporate practices that promote diversity, equity, and inclusion (DEI) tend to be more resilient and innovative, more effective in attracting and retaining talent, and better equipped to safeguard their reputation over the long term. Given the growing importance of issues such as environmental degradation (climate change, pollution, biodiversity loss, etc.), resource scarcity, and increasing social and economic inequalities, along with the corresponding demands for equity, business ethics, respect for diversity, and inclusion, we argue that the research agenda should place the purpose-driven perspective at its core. In this regard, we see the need to develop a theory of the firm grounded in the idea that economic sustainability and social sustainability are not mutually exclusive goals, but rather interdependent dimensions of corporate success, linked by a relationship of mutual reinforcement. We therefore consider it fundamental to contribute to the development of a theoretical framework that recognizes and values the interrelations among corporate performance, individual well-being, and collective well-being, within a systemic and long-term vision.

The search for integration between profit-driven and purpose-driven logics is also closely connected to the dynamics of deglobalization. On the one hand, the need to safeguard economic sustainability pushes firms to reduce their dependence on global value chains. On the other hand, the shortening of supply chains encourages investment in building trust-based relationships with local communities, economies, and institutions. These dynamics promote more sustainable production practices (e.g., investments in renewable energy, waste reduction, adoption of circular economy principles), thus facilitating the implementation of low environmental impact business models.

3.2 Technological acceleration and the new humanism of management

AI and ML technologies are now capable of performing complex tasks that have traditionally been considered the exclusive domain of human intelligence. These new technologies offer substantial opportunities in terms of operational efficiency, predictive capabilities, and the ability to detect hidden patterns. As a result, organizations gain greater agility, improved adaptability to contextual changes, enhanced capacity for rapid and informed decision-making, and a progressive integration of managerial competencies with collaborative models based on interaction between humans and intelligent systems.

At the same time, these tools pose significant risks related to cognitive delegation, algorithmic transparency, and the marginalization of the

human element. Without a critical reflection on the centrality of the human person, such technologies risk depriving work of its meaning, thereby undermining its ethical and existential dimensions. First, they tend to weaken individuals' engagement, professional identity, and sense of belonging within organizations. Second, they threaten to marginalize the distinctive value of the human dimension of management, which will continue to be essential for corporate survival, growth, and value creation. In a world where AI increasingly surpasses human abilities in solving well-defined problems, there remains a cognitive domain in which management will continue to hold a comparative advantage: the ability to question and reformulate worldviews, reinterpret existing problems, identify new and different issues to be addressed, and discover novel connections and interdependencies between distant and diverse realities.

In this context, our discipline is called upon to renew its epistemological foundations by embracing a paradigm that integrates technological efficiency with creativity, empathy, social responsibility, and individual well-being. We believe that the dialogue between technology and a new humanism constitutes a foundational pillar for rethinking the study and practice of management in the twenty-first century.

3.3 The competitiveness of the national economic and business system

In today's "new normal" characterized by volatility and uncertainty, the Italian management research community is committed to contributing meaningfully to strengthening the competitiveness of the Italian "country system". We must refocus our agenda on the distinctive traits of Italian business models and explore pathways to defend and enhance their competitive strength.

There is a need to redirect attention to those economic sectors that form the identity and competitiveness of the Italian system: from traditional "Made in Italy" industries (such as fashion, agri-food, furniture, jewellery, luxury boating, and luxury automotive) to advanced manufacturing sectors (such as industrial machinery, automation, aerospace, and electronics), as well as industries linked to culture, tourism, and the arts. Italian firms in these sectors operate within ecosystems where traditional knowledge and contemporary creativity converge in business models marked by exclusive design, sustainable innovation, and a high identity and artisanal value. We should bring these models back to the centre of our reflections, valuing their originality and wide variety (in terms of entrepreneurial culture, ownership structures, managerial approaches, firm size, etc.), with the aim of developing new paradigms capable of interpreting and guiding the ways in which Italian entrepreneurs integrate traditional know-how with emerging technologies; cultural and identity-based values with globalization; intrinsic sustainability (natural materials, local production, product longevity) with competitive advantage.

At the same time, the industrial scalability potential of the business models of most of our small and medium-sized enterprises remains largely untapped. Italian "fourth capitalism" firms and the champions of "made in Italy" stand out for their ability to combine deep roots in specific territorial

and cultural contexts with medium-to-large scale and excellent global competitiveness. Revisiting the models that led these firms to success could help us identify developmental trajectories that smaller firms might follow to evolve their managerial structures, grow in scale, and enhance their competitive capacity in the international arena.

4. A shared responsibility for the common good

The complexity and urgency of the challenges facing businesses and the broader community demand that all positive forces within society work together actively to ensure a sustainable and equitable future for our world. As management scholars, we bear the responsibility of offering our best possible contribution to understanding the problems that managers and policymakers are currently facing to developing timely and effective solutions, and more broadly, to building the common good and shaping a desirable future for our society.

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sinergie
italian journal of management

ISSN print 0393-5108
ISSN online 2785-549X
pp. 15-21

Original Research Papers

What matters for innovative startup growth? A study on local, firm-specific, and founder-specific factors[1]

Received
11th March 2024
Revised
27th April 2025
Accepted
7th May 2025

Barbara Del Bosco - Roberto Chierici - Alice Mazzucchelli

Abstract

Frame of the research: *While several studies have focused on the creation of innovative startups, less attention has been devoted to the drivers of growth for these startups.*

Purpose of the paper: *This study investigates the drivers of growth in innovative startups by jointly considering factors at different levels: local, firm-specific, and founder-specific.*

Methodology*: The study analyzes 701 innovative Italian startups and tests the research hypotheses using multiple regression analysis.*

Findings: *The findings reveal a positive association between the number of incubators in a province and the growth of innovative startups. Additionally, a highly educated workforce is positively related to startup growth. Furthermore, the prevalence of young individuals in the entrepreneurial team is associated with higher growth, while entrepreneurs' gender does not lead to significantly different growth rates, suggesting that the slower growth observed in women-led startups in previous studies does not characterize women-led innovative startups.*

Research limits: *The research has limitations, as it analyzes growth over a relatively short period and focuses solely on the Italian context. Further research is encouraged to examine drivers of long-term growth and to investigate the growth of innovative startups in different national contexts.*

Practical implications: *The study highlights the importance of supporting the establishment of incubators, as they contribute to the development of an entrepreneurial ecosystem that fosters the growth of new ventures. Additionally, findings suggest that policymakers should support young entrepreneurship, as firms created by this group tend to grow faster than others.*

Originality of the paper: *The study adopts a multilevel perspective by jointly analyzing factors at three levels - local, firm-specific, and individual - to respond to the call for research on startup growth drivers that considers factors of diverse natures.*

Key words: *growth; innovative startup; entrepreneurship; new venture*

1. Introduction

The aim of this study is to investigate the drivers of innovative startup growth. Growth is a relevant dimension of firm success (Davidsson *et al.*, 2006; Miroshnychenko *et al.*, 2021), particularly important for innovative new firms as it may represent a condition for their competitiveness and survival (Lomi and Lorenzoni, 2000). Moreover, various studies have highlighted that entrepreneurship in a geographic area plays a crucial role in enhancing economic development and employment (Audretsch and Keilbach, 2004; Fritsch and Schindele, 2011; Gambardella, 2014); the impact that new entrepreneurial initiatives have on local employment and growth depends not only on the startup rates of an area but also on new ventures' ability to survive, be competitive, and grow. Hence, consideration of both the creation of new ventures and the subsequent evolution of startups within local contexts is important. However, previous literature on high-tech and innovative startups has devoted limited attention to these firms' growth (Innocenti and Zampi, 2019), focusing mainly on the drivers that favor their creation (Acosta *et al.*, 2011; Cavallo *et al.*, 2020; Colombelli, 2016; Giudici *et al.*, 2019; Venkataraman, 2004).

This study addresses this gap and aims to answer the following research question: *What are the drivers of innovative startup growth?* In doing so, we respond to the call for studies that investigate the drivers of startup growth, examining factors of different natures (Innocenti and Zampi, 2019). Previous literature on growth has highlighted enablers of firm growth, including both internal and external factors (Almus and Nerlinger, 1999; Horne and Fichter, 2022), although these factors have frequently been analyzed separately. We adopt a multilevel perspective, jointly examining external factors - which characterize the local entrepreneurial ecosystem (Acs *et al.*, 2017; Cavallo *et al.*, 2019; Jacobides *et al.*, 2018; Stam, 2015) - and internal factors, corresponding to key internal resources of the new venture (including both intangible assets and characteristics of the entrepreneur). Specifically, we investigate factors at three levels: the *local context,* the fi*rm level,* and the *individual/entrepreneur level.*

Regarding the role of the local context, our starting point has been studies that identify local factors affecting the creation of high-tech and innovative startups. These studies have shown the relevance of local knowledge and related opportunities for knowledge spillovers in explaining innovation and new venture creation in particular areas (Audretsch and Lehmann, 2005; Audretsch and Link, 2019; Giudici *et al.*, 2019; Woodward *et al.*, 2006) as well as the role played by forms of support, such as incubators, that enable nascent entrepreneurs to obtain resources, competencies, and access to networks of relationships needed to launch a new venture (Del Bosco *et al.*, 2021; Cavallo *et al.*, 2020; Colombelli, 2016). In this study, we aim to investigate whether these specific local factors (regarding knowledge availability and the presence of incubators), besides affecting innovative startup creation, also influence subsequent growth.

We also include internal factors in the analysis, as the growth of each entrepreneurial initiative, besides being influenced by the local context, may be affected by its specific resources and decisions made by the entrepreneur

(Almus and Nerlinger, 1999; Horne and Fichter, 2022). At the firm level, we focus on analyzing the role of research and development (R&D) activity, as well as human and intangible resources, which are critical factors for the performance of innovative startups (Colombelli *et al.*, 2016; Pérez *et al.*, 2004; Innocenti and Zampi, 2019). Once a firm has been established, indeed, its activity and competitiveness depend not only on opportunities to access external knowledge within the local context but also on the availability of internal knowledge and capabilities for its development and exploitation (Belitski *et al.*, 2021). Moreover, entrepreneurs play a critical role in influencing the future of startups, as their motivation and desire for success propel the development trajectory of the new ventures (Huggins *et al.*, 2017), while their skills contribute to the firms' resources. In particular, the growth ambitions of the founding entrepreneurs appear to be important determinants of startup growth (Stam and Wennberg, 2009), and approaches to firm growth may vary among different categories of entrepreneurs. Our analysis, therefore, includes factors at the individual/entrepreneurial level to account for this aspect.

A distinctive trait of this study is the effort to jointly investigate factors of different natures and at various levels. Indeed, some of the factors included in the analysis have been examined in previous studies, but extant literature has frequently focused on only one level of analysis, for example, investigating individual factors in some studies or focusing solely on the macro-level study of local factors in others. Given that these factors together determine the growth performance of innovative startups, it is important to jointly investigate their roles.

Thus, we study the relationship between the growth of innovative startups and three kinds of factors: local, firm-specific, and founder-specific. Accordingly, we investigated a sample of innovative Italian startups using a dataset we created by combining data from various sources, namely the Innovative Startups database of the Italian Chambers of Commerce, the Bureau Van Dijk AIDA database, and the Italian National Institute of Statistics (ISTAT). The use of multiple sources allowed for coverage of different kinds of potential explanatory factors.

This paper provides both a theoretical and practical contribution by offering a better understanding of how different categories of factors may influence the growth path of innovative startups. First, it contributes to the literature on innovative startups, extending the focus beyond creation to encompass growth. Second, by jointly studying drivers of innovative startup growth at different levels, the study provides a better understanding of how local, firm-specific, and founder-specific factors interact and contribute to startup growth. Finally, by identifying factors that affect innovative startups' growth, it offers practical guidance and insights for entrepreneurs and policymakers.

The paper is structured as follows: the next section presents a literature review supporting the development of the study's hypotheses, followed by the presentation of the methodology applied, the investigated sample, and the data sources. The study's main findings are then presented and discussed, highlighting practical and theoretical implications, and in the final section, we offer concluding remarks, identifying limitations and opportunities for future research.

2. Literature review and hypotheses development

The extant literature on entrepreneurship, one of the most dynamic research fields (Audretsch, 2012; Ferreira *et al.*, 2019), has mainly investigated factors affecting innovation and new venture creation in specific geographic areas (Audretsch and Keilbach, 2004; Fritsch and Schindele, 2011; Gambardella, 2014), while the impact of various factors on startup growth has received less attention and remains an under-explored research field (Innocenti and Zampi, 2019).

Given the central role founders play in decision-making and business shaping, human capital may help predict startup growth (Colombo and Grilli, 2010). As noted in previous studies, opportunity identification and exploitation phases are influenced by founders' sociodemographic and personal traits (Block *et al.*, 2017), yet further insights are needed to understand these effects in the later stages of entrepreneurship (Lee and Lee, 2016). Although founders' traits seem to be key elements in startups' growth, the current context, characterized by several initiatives aimed at stimulating entrepreneurial activities and promoting development, requires investigation not only into founders' traits but also into the entrepreneurial ecosystem (Reynolds and Uygun, 2018). This is especially relevant in Italy, where forming innovative startups is more challenging than in other countries (Cavallo *et al.*, 2021). The strong interdependencies among economic actors within a local context suggest that the entrepreneurial ecosystem plays an important role in the successful development of the innovative startups of the area (Tripathi *et al.*, 2019).

2.1 Local factors and startup growth

The literature on entrepreneurship has revealed the importance of local contexts as sources of knowledge and expertise that can facilitate (or inhibit) the creation and development of innovative, high-tech startups (Collinson and Gregson, 2003). Local contextual characteristics can offer new entrepreneurial opportunities, helping startups meet new market demands by effectively exploiting their knowledge and technological advances (Wang *et al.*, 2013). Thus, external knowledge sources help explain the influence of local contexts on new ventures' growth paths.

Previous studies have explored the relationship between education and entrepreneurship, considering both entrepreneurs' education and local schooling levels. Studies focusing on education within specific populations indicate that a qualified workforce is crucial for innovative startups (Woodward *et al.*, 2006). A well-educated labor force can better support startups, as employees are equipped to quickly grasp and adopt new technologies and production techniques (Doms *et al.*, 2010; Lin, 2011; Skinner and Staiger, 2005). In areas with a significant proportion of educated individuals, entrepreneurs are more likely to find and hire employees with higher-order skills (Piva *et al.*, 2011). Consequently, startups operating in labor markets with abundant highly educated workers incur lower search costs for specialized skills (Doms *et al.*, 2010).

Therefore, we propose the following hypothesis:

H1: The level of education within a local population is positively related to innovative startup growth.

Individuals' willingness to create new firms, along with their survival and growth, is influenced by the opportunities and constraints within their localities (Bergmann *et al.*, 2016). According to the knowledge spillover theory, the extent of knowledge accessible within a particular area influences economic growth by enabling individuals to perceive and exploit entrepreneurial opportunities. Several studies have suggested that knowledge spillovers can benefit startups in contexts involving spatial proximity to universities and research facilities (Mueller, 2006), which are conducive to forming formal and informal networks that facilitate knowledge exchange (MacGregor and Madsen, 2013). Through interaction with these networks, entrepreneurs can acquire diverse resources that contribute to enhancing their innovative startups' performance (Gao *et al.*, 2023). Universities have been identified as potential enablers of local development since they can positively influence the entrepreneurial pipeline, especially in innovative, high-tech, and knowledge-intensive industries (Modina *et al.*, 2023). Furthermore, Audretsch and Lehmann (2005) found that university knowledge spillovers may affect firm growth. Collaborating with universities and research centers allows startups to access the knowledge and expertise of researchers without requiring substantial investments during the initial phases of their development and growth (Galvão *et al.*, 2019). Universities and research institutions can support firms by increasing the available knowledge capital in a given region (Nicotra *et al.*, 2018) and sharing technical resources (Chan and Lau, 2005). Additionally, the presence of universities and research institutions encourages the transfer of knowledge and technology (Calcagnini *et al.*, 2016), which may contribute to the growth of innovative startups.

Therefore, we propose the following hypothesis:

H2: The density of universities and research centers within a local area is positively related to innovative startup growth.

Previous studies have also emphasized the role of support organizations, such as incubators, in fostering entrepreneurship, particularly in creating and developing innovative and high-tech ventures (Aernoudt, 2004; Cavallo *et al.*, 2020). Incubators provide a supportive environment through various services, including shared workspaces, administrative assistance, and value-added services like technical and managerial advice, fundraising support, and networking opportunities (Fukugawa, 2018). Specifically, networking opportunities offered by incubators can provide access to diverse knowledge, thereby promoting the success of new ventures (Mas-Verdú *et al.*, 2015). By offering support facilities and networking services, incubators help entrepreneurs establish and grow their venture ideas (Ahmed *et al.*, 2022). Incubators act as catalysts, connecting entrepreneurs with other actors who can facilitate the launch, survival, and expansion of entrepreneurial initiatives (Theodoraki *et al.*, 2018).

The support available to incubated firms can assist entrepreneurs in addressing typical challenges, such as identifying and mobilizing

resources necessary for launching and growing a new venture. This business-friendly environment allows new entrepreneurs to mobilize resources they might otherwise lack and provides opportunities to form networks that enable access to valuable information, advice, and resources essential for market competition (Galvão *et al.*, 2019). Moreover, the presence of incubators in a local area contributes to the transmission of entrepreneurial and community logics and favors the generation and exploitation of opportunities for interactions and collaboration among local firms (Roundy, 2017). They often attract startups with complementary characteristics, fostering a high degree of synergy among firms (Chan and Lau, 2005; Monsson and Jørgensen, 2016; Shih and Aaboen, 2019). This context facilitates the development of an entrepreneurial ecosystem that promotes entrepreneurship by enabling the identification and exploitation of opportunities and supporting the scaling of new ventures (Cavallo *et al.*, 2019; Stam, 2015).

The presence of incubators in a local area, which provides services and fosters networks among local firms, is thus expected to stimulate the growth of innovative startups. Therefore, we propose the following hypothesis:

H3: The number of incubators in a local area is positively related to innovative startup growth.

2.2 Firm-specific factors and startup growth

Given the importance of knowledge in innovation and entrepreneurial processes, analyses of the drivers of innovative startups' growth should consider both external knowledge sources and internal knowledge available at the firm level. Accordingly, previous studies have investigated the relationship between innovation activities and the ability of startups to survive and grow. Engagement in innovation and investment in R&D activities have been found to help new ventures survive longer (Colombelli *et al.*, 2016; Pérez *et al.*, 2004). However, the relationship between R&D investments and firm growth is complex, as evidenced by mixed findings in the literature. While some studies found no significant impact of R&D investments on growth (Lamperti *et al.*, 2017), others focusing on innovative and high-tech startups found that R&D investments support growth in these specific ventures (Innocenti and Zampi, 2019; Stam and Wennberg, 2009).

The competitiveness and growth of new ventures may also be influenced by available resources, particularly human resources and intangible assets. Specifically, human capital has been widely studied in the entrepreneurship literature, as launching and developing successful, innovative, high-tech ventures requires advanced qualifications and technical skills (Lasch *et al.*, 2007). Human capital has been recognized as an important driver of startup success (Kaiser and Muller, 2015), as highly educated employees with technical skills can contribute to valuable innovation, reduce firm failure, and drive firm growth (Ouimet and Zarutskie, 2014). Employees' talent, skills, and competencies are essential assets for new ventures and their growth (Zhao *et al.*, 2021). According to Stam and Wennberg (2009), highly educated entrepreneurs are more likely

to establish innovative ventures reliant on product development and R&D investments. Additionally, studies suggest that firm survival and growth are influenced by education levels combined with previous experience (Bates, 1995; Peña, 2002). Thus, entrepreneurs' and employees' human capital are crucial resources for new ventures' creation and growth (Gimmon and Levie, 2010).

Similarly, the availability of patents can offer startups incremental economic benefits, impacting their growth and success (Farre-Mensa *et al.*, 2019). Studies examining patents' role indicate several positive effects on new ventures' development and productivity (Kogan *et al.*, 2017; Mann and Sager, 2007). Patents act as catalysts, enabling startups to grow and succeed by increasing sales, creating jobs, and fostering innovation (Farre-Mensa *et al.*, 2016).

Therefore, we propose the following hypotheses:

H4a: R&D investments are positively related to the growth of innovative startups.

H4b: A highly educated workforce is positively related to the growth of innovative startups.

H4c: The availability of patents is positively related to the growth of innovative startups.

2.3 Founder-specific factors and startup growth

At the individual level, literature has explored the influence of entrepreneurs' traits not only on startup creation (Shane, 2003) but also on their development (Rauch and Frese, 2007). Studies have investigated the relationship between startup success and entrepreneur-specific characteristics, including age, gender, nationality, motivation, work experience, and pre-founding activities (Cuervo, 2005; Lasch *et al.*, 2007). Regarding gender, previous studies on startups indicate that women face more challenges than men when establishing new ventures (Chatterjee *et al.*, 2018), and they tend to start and manage high-performance firms less frequently than men (Cliff *et al.*, 2005; Dahlqvist *et al.*, 2000). The survival of women-owned firms is often shorter than that of firms owned by men (Arribas and Vila, 2007). Women-led startups generally underperform, appearing smaller, with less initial capital and external financing, lower sales revenues, slower growth, and lower profitability compared to those created by men (Albort-Morant and Oghazi, 2016; Aragon-Mendoza *et al.*, 2016). Even women's approaches to entrepreneurial activity appear to differ in some ways from those of male entrepreneurs. Women are primarily motivated by autonomy, change, challenge, determination, self-realization, and work-life balance, while men tend to be driven by business opportunities, wealth, status, and financial success (BarNir, 2012; Buttner and Moore, 1997; Carter *et al.*, 2003). Women's sociodemographic characteristics, personality traits, and motivations may impact their willingness to engage in entrepreneurship and their ability to successfully manage startup growth (Audretsch, 2012; Laudano *et al.*, 2019; Mari *et al.*, 2016).

Other studies have examined young entrepreneurs, who are often considered more ambitious, motivated, enthusiastic, and energetic than older individuals (Blanchflower and Meyer, 1994). Notably, research indicates that entrepreneurs' age at the startup phase is significantly associated with success, with younger entrepreneurs more likely to capitalize on market opportunities and achieve superior performance (Ughetto, 2016).

Therefore, we propose the following hypotheses:

H5a: The prevalence of women in entrepreneurial teams is negatively related to innovative startup growth.

H5b: The prevalence of young individuals in entrepreneurial teams is positively related to innovative startup growth.

3. Methodology

3.1 Sample and data sources

This empirical analysis is based on a dataset of innovative Italian startups. Law Decree 221/2012, known as the Italian Startup Act, defines an innovative startup as an enterprise that produces, develops, and commercializes innovative goods or services of high technological value. New ventures must meet specific criteria to qualify as innovative startups: they must operate in Italy, have a turnover of less than 5 million euros, have been incorporated for no more than 60 months, not be listed, not distribute profits, and not result from a merger or transfer of a business or a part thereof (Law Decree 221/2012). Additionally, an innovative startup must meet at least one of the following three criteria: (1) R&D expenditures account for at least 15% of the higher value between turnover and annual costs; (2) at least one-third of its workforce consists of individuals with a Ph.D., Ph.D. students, or researchers, or at least two-thirds of the team holds a master's degree; (3) the startup owns a registered patent, is a licensee, or has applied for an industrial property right; alternatively, it owns an original registered software program (Law Decree 221/2012).

The study's dataset includes various information collected from multiple data sources. Using the database on innovative startups maintained by the Italian Chambers of Commerce, which registers Italian firms, we gathered data on 1,199 innovative startups founded in 2014. We decided to analyze data from innovative Italian startups founded in 2014 and 2015-2017 revenue growth rates to completely avoid the possibility that the data could be biased based on the COVID-19 situation.

The data collected included information on each firm's geographical location, R&D costs, presence of a highly educated workforce, patents, and details about the gender, ages, and nationalities of the startups' capital owners and board members. We also collected economic and financial data on the startups for the three-year period (2015-2017) and details on their fields of activity from the AIDA database at Bureau van Dijk. Additionally, we obtained provincial data on the number of incubators from the certified incubators database maintained by the Italian Chambers of Commerce,

the number of universities and research centers from the Ministry of Education, University and Research database, as well as education levels, population densities, and growth rates from the ISTAT database. Finally, we acquired data on the number of existing firms from the Movimprese database of the Italian Chambers of Commerce.

Since the study aimed to explore the effects of local, firm-specific, and founder-specific factors on growth in innovative startups' sales, startups with zero revenue in 2015 (the year following their establishment) or those missing sales revenue data for 2015 and 2017 were excluded. Our final sample included 701 innovative Italian startups that met the study's criteria and had complete data for the analysis.

3.2 Method and variables

We conducted a multiple regression analysis to test our hypotheses, estimating the growth of innovative startups. There is no consensus on the most effective measures for assessing the performance of recently established firms (Söderblom *et al.*, 2015), as sales are easier to compare across sectors but tend to be more volatile than employee numbers. Our analysis used the growth rate of sales revenue as the dependent variable since sales reflect customers' commitment to adopting the startups' products or services (Autio and Rannikko, 2016). Specifically, following Ferguson and Olofsson (2004), we measured the growth rate of sales revenue as the ratio of the difference in sales revenue between 2015 (the year after the startups' establishment) and 2017 to the sales revenue in 2015, expressed as a percentage.

The main independent variables in the analysis pertained to local factors, firm-specific factors, and founder-specific factors.

Regarding local factors, we measured the presence of universities and research centers in each province as the density of universities and research centers in 2015, calculated as the ratio of the number of universities and research centers to the total population of the province. Education level was measured as the percentage of graduates among the population over 14 years in each province in 2011. Another local factor was the number of certified incubators in each province in 2015.

Among firm-specific factors, R&D investments were measured as a dummy variable, with a value of 1 if the startup's R&D costs were at least 15% of the higher value between turnover and annual costs; otherwise, 0. The presence of a highly educated workforce was also a dummy variable, with a value of 1 assigned if at least one-third of a startup's workforce had a Ph.D., were Ph.D. students or researchers, or if at least two-thirds held a master's degree; otherwise, 0. Internal availability of patents was a dummy variable as well, with a value of 1 if a startup was the owner or licensee of a registered patent (or had applied for an industrial property right) or owned an original registered software; otherwise, 0. Information on firm-specific factors was verified by the Italian Chambers of Commerce before including firms in the innovative startups dataset.

For founder-specific factors, we measured the prevalence of particular entrepreneur categories (women or young individuals) as contributors

of startup capital and board members as a dummy variable. A value of 1 was assigned if the mean of the percentage of startup capital owned by a particular category and the percentage of board members in that category exceeded 50%; otherwise, 0.

To avoid bias, several control variables associated with the local context, startups, and entrepreneurial teams were included in the analysis. For contextual factors, we controlled for population density in 2015, population growth rate during 2015-2017, and the density of existing firms in each province in 2015. We also controlled for firm-specific factors, such as the industry, social orientation, employee count in 2015, debt/equity ratio, and independence/ownership structure. Lastly, we controlled for the prevalence of immigrants in the entrepreneurial team. Tab. 1 shows the description of the study's variables.

In the correlation analysis, pairwise correlations among variables ranged from -0.457 to 0.774. Since some correlation values were relatively high, we assessed the variance inflation factor (VIF) to check for potential multicollinearity. VIF values were below 3 (Hair *et al.*, 2021), except for the number of incubators, which is still under 5 and thus, according to the extant literature, under an acceptable threshold (Hair *et al.*, 2010), indicating that multicollinearity among the studied variables was not a significant issue (Tab. 2).

4. Results

Tab. 2 presents the results of the analysis, which reveal that among local factors, the number of certified incubators had a positive and significant association with innovative startup growth ($\beta = 1.615$, $t = 2.990$, $p < 0.01$), supporting H3. Additionally, there was a significant relationship between education level and innovative startup growth, but the association was negative, contrary to H1 ($\beta = -127.548$, $t = -3.066$, $p < 0.01$). The coefficient for the density of universities and research centers was not significant ($\beta = 8.630$, $t = 0.716$, $p > 0.05$), thus H2 was rejected.

Among firm-specific factors, there was a positive and significant relationship between the presence of a highly educated workforce and innovative startup growth ($\beta = 3.357$, $t = 2.097$, $p < 0.05$), supporting H4b. However, the coefficients for R&D investments ($\beta = 2.098$, $t = 1.288$, $p > 0.05$) and patent availability ($\beta = 1.133$, $t = 0.683$, $p > 0.05$) were not significant; therefore, H4a and H4c were not supported.

Lastly, among founder-specific factors, there was a positive and significant association between the prevalence of young individuals on entrepreneurial teams and innovative startup growth ($\beta = 4.145$, $t = 2.420$, $p < 0.05$), supporting H5b. However, the coefficient for the prevalence of women in entrepreneurial teams was not significant ($\beta = -1.930$, $t = -1.149$, $p > 0.05$), leading to the rejection of H5a.

Tab. 1: Description of the study variables

Variables	Description	Mean	Std. deviation
Dependent variable			
Innovative startup growth	Ratio of the difference in sales revenue between 2015 and 2017 and the sales revenue in 2015 (%)	4.270	15.867
Independent variables			
Density of universities and research centers	Number of universities and research centers located in the province per 10,000 inhabitants (2015)	.052	.052
Education level	Percentage of graduates out of the total provincial population above the age of 14 years (2011)	.108	.023
Number of incubators	Number of certified incubators in the province (2015)	1.69	2.300
Internal R&D investments	Dummy variable assigned a value of 1 if a startup's R&D costs are equal to or higher than 15% of the higher value between turnover and annual costs; otherwise 0	.56	.496
Internal presence of a highly educated workforce	Dummy variable assigned a value of 1 if at least one-third of a startup workforce comprises individuals with a PhD, PhD students, researchers, or if at least two-thirds of the team hold a master's degree; otherwise 0	.33	.470
Internal availability of patents	Dummy variable assigned a value of 1 if a startup is the owner or licensee of a registered patent (or it has submitted an application for an industrial property right) or it owns an original registered software program; otherwise 0	.26	.441
Prevalence of women in the entrepreneurial team	Percentage of startup capital owned by women plus the percentage of board members who are women, divided by 2. Dummy variable assigned a value of 1 if the value of the ratio exceeds 50%; otherwise 0	.15	.359
Prevalence of young individuals in the entrepreneurial team	Percentage of startup capital owned by young individuals plus the percentage of board members who are young individuals, divided by 2. Dummy variable assigned a value of 1 if the ratio value exceeds 50%; otherwise 0.	.15	.356
Control variables			
Population density	Number of inhabitants per square kilometer in the province (2015)	730.470	804.097
Population growth rate	Ratio of the difference in the population of the province between 2015 and 2017 and the population in 2015 (%)	-.275%	4,211%
Density of firms	Number of existing firms located in the province per 1,000 inhabitants (2015)	75.997	13.434
Number of employees	Number of employees in 2015	2.24	4.379
Startup industry	Dummy variables for each startup industry (based on the NACE code): manufacturing, agriculture, commercial services, information science and software, R&D, and other services (as the baseline)		
Startup social orientation	Dummy variable assigned a value of 1 if a startup has a social orientation; otherwise 0	.03	.171
Startup debt-to-equity ratio	Ratio of the total debt and equity of the startup in 2015 (%)	17,679	258.559
Startup independence/ ownership structure	Ordinal variable with four levels describing a firm's ownership structure based on the independence indicator provided by the Bureau van Dijk. The levels range from "independent startups" (level 1) to "concentrated startups" (level 4)	2.91	1.141
Prevalence of immigrants in the entrepreneurial team	Percentage of startup capital owned by immigrants plus the percentage of board members who are immigrants, divided by 2. Dummy variable assigned a value of to 1 if the ratio exceeds 50%; otherwise 0	.02	.135

Source: Authors' own elaboration

Tab. 2: Regression analysis (Y = Innovative Startup Growth)

Variables	B Coefficient	t test	VIF
Constant	12.733*	2.098	
Education level	-127.548**	-3.066	2.719
Density of universities and research centers	8.630	0.716	1.144
Number of incubators	1.615**	2.990	4.409
Internal R&D investments	2.098	1.288	1.869
Internal presence of highly educated workforce	3.357*	2.097	1.622
Internal availability of patents	1.133	0.683	1.532
Prevalence of women in the entrepreneurial team	-1.930	-1.149	1.037
Prevalence of young people in the entrepreneurial team	4.145*	2.420	1.061
Population density (2015)	-0.001	-1.052	2.013
Population growth rate (2015-2017)	-0.050	-0.341	1.186
Density of firms (2015)	0.015	0.257	1.858
Number of employees (2015)	-0.103	-0.752	1.031
Startup industry manufacturing	3.359	1.726	1.445
Startup industry agriculture	0.294	0.075	1.117
Startup industry commercial services	8.232*	2.402	1.112
Startup industry information science and software	2.412	1.571	1.582
Startup industry R&D	-0.201	-0.102	1.419
Startup social orientation	2.879	0.816	1.037
Startup debt-to-equity ratio	-0.001	-0.291	1.030
Startup independence/ownership structure	-0.918	-1.707	1.077
Prevalence of immigrants in the entrepreneurial team	-1.820	-0.411	1.023
R^2	0.057		
Adjusted R^2	0.028		
F statistics (Sig.)	1.947 (0.007)		

N = 701; *p < 0.05, **p < 0.01

Source: Authors' own elaboration

5. Discussion

This study aimed to enhance understanding of the factors influencing innovative startup growth through an empirical analysis encompassing three categories of growth determinants: local, firm-specific, and founder-specific.

Regarding local factors, the analysis focused on certain local characteristics that previous studies have shown relevant to startup creation, exploring whether these factors may also promote the subsequent growth of new innovative firms. Of the three external factors analyzed (density of universities and research centers, education level of local populations, and number of incubators), only the number of incubators demonstrated the expected positive relationship with innovative startup growth, supporting Hypothesis 3. This finding suggests that the availability of support organizations such as incubators contributes to an environment conducive to startup growth. New ventures may benefit from the facilities,

services, and networking opportunities provided by incubators, which can assist them in their developmental path (Fukugawa, 2018). Additionally, incubators may foster an entrepreneurial ecosystem (Roundy, 2021; Theodoraki *et al.*, 2018), offering opportunities for collaboration and knowledge spillover that can benefit all firms in the area. Incubators, indeed, support the formation of internal and external networks, facilitating information, knowledge, and resource exchange (Galvão *et al.*, 2019).

The density of universities and research centers was not significantly related to the growth of innovative startups. Thus, the results from our sample do not support Hypothesis 2, suggesting that a relatively high concentration of research institutions in an area is not a decisive factor for the growth of innovative startups. A possible interpretation of this result relates to the heterogeneity of universities and research centers. Indeed, previous studies have shown that the impact these research institutions have on the development of innovative startups may depend on their characteristics, attitudes toward collaboration and knowledge transfer, and the specific nature of their activities (Calcagnini *et al.*, 2016; Guerrero *et al.*, 2019).

The local education level (percentage of graduates in the population above 14 years old) was found to be negatively associated with revenue growth, which does not support Hypothesis 1, as we initially hypothesized a positive relationship. Further research is needed to understand the reasons behind this counterintuitive result. One possible explanation is that more intense competition may impact innovative, knowledge-based entrepreneurial initiatives in areas with a large proportion of highly educated people. Such contexts favor new venture creation (Andersson and Koster, 2011; Audretsch and Fritsch, 1994; Bull and Winter, 1991), making it easier for competitors to create knowledge-based ventures and hire skilled individuals who could contribute to their competitiveness (Doms *et al.*, 2010; Piva *et al.*, 2011).

When interpreting this result, it is also helpful to consider that evidence concerning firm-specific factors shows a positive association between a highly educated workforce within a startup and the rate of its sales growth. This finding highlights the importance of human capital and suggests that, after the creation of an innovative firm, the presence of a qualified workforce within the firm itself matters more than the broader availability of qualified people in the population. The multilevel approach adopted in this study enables testing the role of knowledge at different levels, underscoring that internal knowledge, stemming from a highly educated team, is more significant for innovative startup growth than external knowledge tied to the presence of universities or a highly educated local population.

Thus, it is essential for innovative startups to manage hiring processes effectively to build teams with highly educated members. Human capital is a central component of the bundle of resources and competencies that determines a firm's competitive advantage (Hatch and Dyer, 2004), especially for high-tech and innovative ventures. A qualified workforce can facilitate a new venture's development, as individuals' prior knowledge enables them to identify and exploit business opportunities (Shane, 2000). A highly educated workforce may also enhance access to external knowledge,

as skilled employees can foster dialogue and collaboration with external interlocutors with similar educational backgrounds.

This significant, positive relationship between workforce education level and innovative startup growth supports Hypothesis 4b. However, our findings did not support Hypotheses 4a (on internal R&D investments) and 4c (on patent availability). The growth of innovative startups during the early stages of their lifecycle appears to be influenced more by the quality of internal human capital than by patents held or R&D efforts. Notably, patents and R&D investments may have different impacts depending on the time horizon. Some studies indicate that R&D does not necessarily improve the short-term performance and survival of new ventures (Hyytinen *et al.*, 2015; Stam and Wennberg, 2009).

Our results suggest that human capital plays a crucial role in the early years after the establishment of innovative startups. One possible explanation is that, in the early lifecycle stages, a startup needs flexibility to receive feedback, refine its products and services, or adjust its business model. In this context, a highly educated team may be more beneficial than other intangible assets (such as patents), as it fosters learning and flexibility.

Lastly, we hypothesized that certain characteristics of entrepreneurs could influence the growth trajectories of their startups. Our findings supported Hypothesis 5b, highlighting the specific influence of young entrepreneurs, but not Hypothesis 5a regarding female entrepreneurs. These findings suggest that, even among innovative startups, ventures founded by young entrepreneurs have a higher propensity to grow than those founded by older entrepreneurs. One reason may be that, despite lacking the experience of their older counterparts, young entrepreneurs often possess traits such as motivation and ambition (Lasch *et al.*, 2007), which enable them to pursue and achieve better growth outcomes for their startups.

In contrast, the nonsignificant influence of the prevalence of women in entrepreneurial teams suggests that gender is not a critical factor in determining growth orientation and capability in this type of venture. This finding is interesting, as it indicates that although women's reasons for launching innovative startups may differ from men's (BarNir, 2012), and despite frequently facing more difficulties than men (Gatewood *et al.*, 2009), their entrepreneurial initiatives do not underperform compared to those founded by men. This result contrasts with other studies showing lower performance in firms created by female entrepreneurs (Klapper and Parker, 2011). A possible explanation for this finding is that innovation-oriented entrepreneurs, in general, tend to be more inclined to seek growth because they are more willing to embrace change and invest in uncertain projects. The literature suggests that R&D-oriented behaviors among nascent entrepreneurs make them more prepared to pursue firm growth, even in teams that might have a conservative approach (e.g., teams with family ties) (Muñoz-Bullón *et al.*, 2020). Similarly, our findings on innovative startups with a prevalence of women in their entrepreneurial teams indicate that innovation-oriented entrepreneurs seek growth, irrespective of gender differences.

6. Implications

This study, by allowing a better understanding of the drivers of innovative startup growth, provides a contribution from both the theoretical and practical point of view.

6.1 Theoretical implications

From a theoretical perspective, our study enriches the literature on high-tech and innovative startups by advancing insights into the drivers of their growth. This is a relatively under-researched topic, as previous literature on these startups has devoted limited attention to growth, focusing mainly on factors that favor their creation (Acosta *et al.*, 2011; Cavallo *et al.*, 2020; Giudici *et al.*, 2019; Venkataraman, 2004). Specifically, our study responds to calls for research into the relationship between local characteristics and innovative startup growth, as well as calls for studies considering firm-specific factors and characteristics of founding team members (Almus and Nerlinger, 1999; Innocenti and Zampi, 2019).

By investigating the influence of various determinants (belonging to different categories), the study demonstrates how growth is affected by different kinds of factors (local, firm-specific, and founder-specific) and clarifies which are most relevant. A multilevel study enables testing the importance of various factors while accounting for the presence of other potential influences at different levels, which enhances our understanding of growth drivers' overall framework. From this perspective, the study makes an empirical contribution by jointly testing the relevance of internal and external growth factors (Horne and Fichter, 2022).

Additionally, the study contributes to literature on the role of specific traits of entrepreneurs. In particular, it adds to research on female entrepreneurship by highlighting the unique aspects of innovation-oriented entrepreneurs. Our findings indicate that women who found innovative startups possess the intent and ability to achieve growth performance comparable to that of male entrepreneurs, contrasting with results obtained by previous studies on female entrepreneurship (e.g., Klapper and Parker, 2011).

Finally, from a resource-based perspective (Barney, 1991), the paper provides a contribution highlighting how, among internal resources, human capital, specifically a highly educated workforce, plays a central role in explaining the initial growth of innovative startups.

6.2 Practical implications

Identifying specific factors related to startup growth also has practical implications, providing guidance on potential strategies to foster growth, which is valuable for both entrepreneurs and policymakers.

Regarding local factors, our results emphasize the importance of policies promoting incubator creation, as incubators help build an entrepreneurial ecosystem that not only supports the creation of new ventures but also facilitates their growth. These findings also suggest that entrepreneurs

may benefit from establishing their ventures in areas with incubators, which offer support services and create opportunities for interaction and collaboration among local firms, thus promoting an environment conducive to innovative startup growth.

Moreover, our findings on founder-specific factors indicate that encouraging the creation of innovative startups by young entrepreneurs may be especially beneficial, as firms established by this group tend to grow faster. This finding implies that policymakers should pay particular attention to initiatives targeting young people when formulating policies to foster entrepreneurship and enhance its impact on economic development.

From the perspective of entrepreneurs, an interesting finding from the analysis is the positive association between the presence of a highly educated internal workforce and startup growth. This result has significant implications for hiring policies, emphasizing the value of a highly educated workforce in positively contributing to firm growth. Our study highlights that, once a firm has been established, the educational level of its internal workforce is critical in explaining growth, whereas the local level of education does not appear to be beneficial. This finding also has policy implications, suggesting the importance of fostering conditions that encourage the creation of innovative startups that employ highly educated individuals.

7. Conclusions

Given the important role that the growth capability of innovative startups plays in economic development, our study aimed to investigate the factors influencing their growth. In response to calls for studies examining drivers of startup growth across factors of different natures (Innocenti and Zampi, 2019), we adopted a multilevel perspective, jointly analyzing factors at three levels: the local context, the firm level, and the individual/entrepreneur level. Our findings supported the hypothesis of a positive association between the number of incubators in the local area and the growth rate of innovative startups, highlighting the importance of these organizations in promoting entrepreneurial activity. The findings also showed a positive relationship between the presence of a highly educated workforce within a startup and its growth rate, underscoring the central role that this intangible asset plays in the early developmental stages of an innovative startup, while other factors, such as patents and R&D investments, did not significantly explain growth within the studied time frame. Moreover, the results supported the hypothesis that innovative startups led by young entrepreneurs demonstrate a greater capacity for growth. They also indicated that the growth performance of firms with a prevalence of women in entrepreneurial teams does not differ significantly from those founded by men, suggesting that the tendency to underperform, which is often attributed to women-led startups, is substantially mitigated in the context of this type of startup.

Although our findings contribute to the understanding of drivers of innovative startup growth, the study has some limitations, which suggest

the need for further research. We analyzed growth over a relatively short period. Therefore, future studies could investigate drivers of long-term growth, which may differ somewhat from those identified within this timeframe, as certain factors, such as R&D investments, may impact firm development over a longer period. Moreover, in this study, we analyzed a sample of firms created before the COVID emergency and investigated the growth path in a period of time that precedes this emergency, in order to have data not affected by this specific event. Future studies may investigate the peculiarities and growth processes of innovative startups created during the pandemic crisis, as well as those created in the post-pandemic period. In this study, we focused on a sample of Italian startups. Future studies could examine the growth of innovative startups in other national contexts or conduct cross-country analyses. They could also expand the set of variables used to explore local, firm-specific, and founder-specific factors simultaneously or employ different research approaches (e.g., qualitative studies) to gain a deeper understanding of the drivers of growth in innovative startups and the mechanisms through which these factors exert their influence.

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ISSN print 0393-5108
ISSN online 2785-549X
DOI 10.7433/s128.2025.02
pp. 25-47

The dilemma of connectivity to work: investigating the impact of constant connectivity to work on psychological well-being of employees[1]

Received
31st July 2024
Revised
17th February 2025
Accepted
19th March 2025

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Abstract

Frame of the research: *Existing studies highlight the benefits and drawbacks of digital connectivity for work flexibility and efficiency. However, the literature largely overlooks how constant connectivity during non-work hours undermines employees' psychological well-being by intensifying work-life conflict. Moreover, prior research has not sufficiently addressed how individual boundary management strategies-segmentation versus integration-moderate these effects.*

Purpose of the paper: *This study examines the effects of constant connectivity to work through digital devices on employees' psychological well-being and work-life conflict. It investigates how boundary management practices moderate these relationships, providing insights into their impact on employee well-being.*

Methodology*: This study is grounded in boundary management theory and digital work-life conflict frameworks. We hypothesize that constant connectivity to work negatively impacts psychological well-being through work-life conflict and that boundary enactment moderates these effects. The study tests these relationships using structural equation modeling (SEM) with data from IT professionals in India. Additionally, a multi-group analysis is conducted to explore the moderating effect of boundary management practices (segmentation vs. integration).*

Findings*: Results indicate that employees who remain constantly connected to work during non-work hours experience heightened work-life conflict, leading to a significant decline in psychological well-being. Furthermore, segmentation-oriented employees report lower levels of work-life conflict and better psychological detachment than integration-oriented employees, emphasizing the role of boundary management strategies in mitigating digital stress.*

Research limits: *The study does not consider different connectivity and boundary behavior with respect to different mobile applications. In addition, different sectors might report varied levels of connectivity, suggesting a need to explore the underlying variables in different organizational contexts.*

Practical implications: *Organizations should implement structured digital disconnection policies to regulate after-hours connectivity and promote healthier work-life boundaries. Employees should be encouraged to adopt segmentation strategies to minimize work-life conflict. Training programs on digital boundary management can enhance well-being by fostering autonomy and psychological detachment from work.*

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italian journal of management
Vol. 43, Issue 3, 2025

Originality of the paper: *This study expands current knowledge by empirically demonstrating the impact of constant connectivity on employee well-being and work-life conflict. It uniquely examines how boundary management preferences moderate these relationships, offering new insights into managing digital stress in modern workplaces.*

Keywords: *constant connectivity; work-life conflict; psychological well-being; employee well-being; digital devices; boundary management theory.*

1. Introduction

The modern digital landscape is transforming significantly, with digital devices becoming essential daily (Kushlev *et al.*, 2019). The widespread availability of these technologies keeps employees connected to work beyond regular hours (Boswell and Olson-Buchanan, 2007; Farveh Farivar *et al.*, 2024), preventing detachment even during non-work hours (Baek *et al.*, 2023). Interconnectivity, facilitated by mobile devices and high-speed internet, alters job dynamics and enables seamless transitions between work and personal life (Waizenegger, 2015; Tennakoon, 2018). This trend has intensified post-pandemic, with remote and hybrid working models changing organizational dynamics (Farveh Farivar *et al.*, 2024).

Unremitting internet access via digital devices has led to porous work-life boundaries, resulting in work-related device usage during non-work hours and vice versa (Farveh Farivar *et al.*, 2022, 2024). "Anytime anywhere" connectivity offers benefits like flexibility and multitasking (Piszczek, 2017; Loeschner, 2018; Dagnino, 2020; Yang *et al.*, 2022) but also leads to burnout, technostress, and reduced well-being (Büchler *et al.*, 2020), as well as work-life conflict (Diaz *et al.*, 2012; Tennakoon, 2018; Zoonen *et al.*, 2020) and decreased psychological detachment from work (Büchler *et al.*, 2020).

The digitally transforming workplace culture has established new norms for a hybrid lifestyle, where employees are expected to be available around the clock, even if it is not part of their official job profile. Organizations often assume constant availability as part of employee services (Hoeven, 2021; Mazmanian and Erickson, 2014). This leads to competitive pressure and fear of missing out (Barneclo, 2021; Mazmanian and Erickson, 2014), making it challenging for employees to disconnect and maintain personal boundaries. Continuous digital engagement, fueled by push notifications, creates permeable boundaries and cross-domain interruptions, contributing to work-life conflict and psychological fatigue (Zoonen *et al.*, 2020). Constant connectivity during non-work hours is detrimental to psychological well-being (Vorderer *et al.*, 2018; Kondrysova *et al.*, 2022), highlighting the need for digital disconnection to manage inter-domain conflict (Neuhofer and Ladkin, 2017).

This study aims to understand employees' perceptions of constant connectivity to work during non-work hours and its impact on work-life conflict and psychological well-being. The relationship between continuous connectivity and psychological well-being remains unclear

(Vorderer *et al.*, 2018), and this study seeks to examine this connection empirically. Understanding this relationship can help address current challenges and aid organizations and employees in mitigating future issues. Additionally, the study explores how individual boundary management preferences influence the relationship between constant connectivity, work-life conflict, and psychological well-being. Limited literature exists on the mediation effect of work-life conflict between constant connectivity and psychological well-being, and this study aims to address this gap by examining this relationship.

2. Conceptual background

2.1 Constant Connectivity and Psychological Well-Being

Over the past few decades, mobile devices' rapid advancement and adoption have transformed global interactions, making them integral to daily life and significantly increasing interconnectivity (Baek *et al.*, 2023). This widespread presence of digital devices reshapes connectivity perceptions, altering work culture, job nature, and communication modes (Wajcman and Rose, 2011; Baek *et al.*, 2023). Mobile devices now enable employees to access work from anywhere, fostering constant connectivity (Büchler *et al.*, 2020; Dong *et al.*, 2022; Gonçalves and Santos, 2022). Employees face expectations of after-hours availability, feeling obliged to remain accessible during non-work hours (Kondrysova *et al.*, 2022).

Constant connectivity, defined as the perpetual availability of employees for work via digital devices (Büchler *et al.*, 2020; Wajcman and Rose, 2011), involves being connected during both work and non-work hours (Büchler *et al.*, 2020). Baek *et al.* (2023) describe it as a state where employees remain connected beyond assigned work hours, leading to a lack of detachment from work. This connectivity offers benefits like work-life flexibility and multitasking (Waizenegger, 2015; Piszczek, 2017; Dagnino, 2020; Gonçalves and Santos, 2022; Yang *et al.*, 2022) but also places demands on employees' psychological detachment and well-being, causing stress, anxiety, and burnout (Büchler *et al.*, 2020; Dong *et al.*, 2022; Gonçalves and Santos, 2022).

Psychological well-being, a complex and multidimensional concept, has been extensively researched. Ryff's framework (1989) includes six dimensions of wellness. Kubzansky *et al.* (2023) view psychological well-being as feelings, cognitions, and strategies associated with positive functioning. Literature suggests that constant connectivity impacts various psychological facets. Studies show it affects psychological detachment (Kondrysova *et al.*, 2022; Mellner, 2016), psychological capital (Tao *et al.*, 2023), well-being (Kushlev *et al.*, 2019; Truța *et al.*, 2023), psychological disengagement (Sonnentag and Bayer, 2005), psychological distress (Dong *et al.*, 2022; Li *et al.*, 2023), and overall well-being (Büchler *et al.*, 2020; Liu *et al.*, 2024; O'Driscoll *et al.*, 2010; Reinke and Gerlach, 2021; Vorderer *et al.*, 2018).

Connectedness to the organization reduces psychological detachment, decreasing psychological well-being (Kondrysova *et al.*, 2022). Psychological detachment, the ability to "switch off" from work during non-work hours (Sonnentag and Bayer, 2005), correlates with higher well-being (Büchler *et al.*, 2020). Conversely, those constantly connected during non-work hours struggle to disengage, reducing their well-being. Digital device usage is crucial in altering psychological well-being, with the "always on" culture posing various risks (Vorderer *et al.*, 2018). This behavior necessitates exploring connectedness's role in employees' well-being. Researchers have found that constant connectivity reduces well-being (Büchler, ter Hoeven, *et al.*, 2020; O'Driscoll *et al.*, 2010; Reinecke *et al.*, 2017, 2018; Vorderer *et al.*, 2018).

Maintaining well-being in a constantly connected environment depends on autonomy over digital device usage (D. Liu *et al.*, 2019; Reinecke *et al.*, 2018; Vorderer *et al.*, 2018). The effect of constant connectivity on well-being remains unclear (Vorderer *et al.*, 2018). The increasing integration of mobile devices into daily life necessitates confirming the relationship between constant connectivity during non-work hours and well-being. Constant connectivity reduces psychological detachment, blurring work and non-work boundaries and leading to feelings of alienation. Thus, the following hypothesis is formed:

H1: Constant connectivity to work during non-work hours significantly leads to reduced psychological well-being.

2.2 Work-Life Conflict as a Mediator

In recent years, the advancement of digital technologies has profoundly impacted organizational operations, policies, and practices, altering how employees manage their work-life demands. The significant increase in mobile device use has enabled constant connectivity with work, resulting in workplace hyperconnectivity (Boswell and Olson-Buchanan, 2007; Yang *et al.*, 2022). Scholars note that this hyperconnectivity affects work and life domains (Wright *et al.*, 2014; Yang *et al.*, 2022). While constant connectivity via digital devices offers benefits like autonomy (van Zoonen *et al.*, 2022), many employees feel it intrudes on personal time, creating a sense of obligation to remain available (Sarker *et al.*, 2021).

Constant connectivity reshapes traditional work-life domains, presenting challenges in maintaining boundaries and managing roles, leading to work-life conflict. Work-life conflict is an inter-role conflict wherein performing one domain role complicates another (Netemeyer *et al.*, 1996). Technology enables employees to perform duties across domains, generating inter-role conflicts.

Since the COVID-19 pandemic, organizational policies have shifted, with employees remaining connected around the clock. The "Bring Your Own Device" lifestyle has blurred boundaries between work and life, leading to cross-domain interruptions. Constant connectivity via digital devices is a double-edged sword, offering flexibility, autonomy, and mobility (van Zoonen *et al.*, 2022) but also increasing work-life conflict

(Dong *et al.*, 2022; Li *et al.*, 2023; Santos *et al.*, 2023; Seedoyal Doargajudhur and Hosanoo, 2022; Yang *et al.*, 2022).

Digital practices like remote working and flexible schedules have given employees more autonomy over when and where they work. However, this has increased the potential for work to encroach on non-work domains, causing inter-domain conflict (Feery and Conway, 2023). Changing organizational practices are reshaping traditional work-life domains, with employees feeling obligated to be responsive during non-work hours. Mobile devices and communication technology ease have led employees to handle work-related tasks during their free time (Wright *et al.*, 2014; Yang *et al.*, 2022). Studies report that employees who frequently use communication technology outside work hours significantly increase work-life conflict (Wright *et al.*, 2014; Dong *et al.*, 2022; Yang *et al.*, 2022; Santos *et al.*, 2023). Sarker *et al.* (2021) found that constant connectivity via mobile devices increases work-life conflict, with employees perpetually available beyond dedicated hours, leading to higher conflict levels (Boswell and Olson-Buchanan, 2007; Diaz *et al.*, 2012).

Technology allows employees to traverse seamlessly between work and leisure, blurring boundaries and increasing work-life conflict (Tennakoon, 2018). Organizations are increasingly adopting hybrid workplace models, with more individuals working remotely. Researchers have found that inter-domain availability for work results in increased work-life conflict, which can decline psychological well-being and increase psychological distress (Badri and Yunus, 2022; Dong *et al.*, 2022; Rizwan and Sivasubramanian, 2022). Psychological well-being encompasses environmental mastery, autonomy, personal growth, positive relations with others, purpose in life, and self-acceptance (Ryff and Keyes, 1995). The work-from-home culture has led to prolonged connectivity, blurring work-life boundaries and increasing inter-domain conflicts, negatively impacting psychological well-being (Dong *et al.*, 2022; Hipolito, 2023).

Researchers highlight that long work hours generate role conflicts in work and life domains, with increased work-life conflict leading to reduced psychological well-being (Badri and Yunus, 2022; Dong *et al.*, 2022; Hipolito, 2023; Hogan and Victoria, 2013; Taufik *et al.*, 2021). Studies have explored the mediating role of work-life conflict in altering the effects of after-hours work connectivity on employee psychological distress (Dong *et al.*, 2022). However, there is a paucity of studies examining the mediating role of work-life conflict between constant connectivity during after-work hours and psychological well-being. Understanding this mediating role is timely and imperative given the current organizational shift. From the above information, we can conclude that constant connectivity to work via mobile devices during non-work hours increases work-life conflict, reducing employees' ability to maintain psychological well-being. Thus, the following hypotheses are proposed:

H2: Constant connectivity to work in the non-work hours significantly lead to increased work-life conflict.

H3: Work-life conflict significantly leads to reduced psychological well-being.

H4: Work-life conflict mediates the relationship between constant connectivity to work in non-work hours and psychological well-being.

2.3 Boundary Enactment

Boundary theory explores the dynamics of work-life boundaries and their influence on individuals and society. Boundaries are physical, temporal, emotional, cognitive, mental, and relational dividing lines separating one social domain from another (Ashforth *et al.*, 2000). Ashforth *et al.* (2000) proposed that individuals psychologically transition between work and non-work domains, with these transitions termed boundary-crossing activities. One domain of role transition involves work-home transitions. Individuals tend to segment or integrate their domain roles, focusing on minimizing the difficulty of transitions or the frequency of undesired interruptions. Preferences for segmentation or integration practices vary, leading to inflexible, impermeable or flexible, permeable boundaries that allow cross-domain interruptions. Boundary enactment is an individual's adoption of segmentation or integration practices to satisfy their domain roles, considering their environmental conditions and preferences (Martineau and Trottier, 2022; Wepfer *et al.*, 2018).

In the current phase of organizational transition, employees remain constantly connected to the organization, even during post-work hours. The post-pandemic period has led to more blurred boundaries and altered work behaviors (Farveh Farivar *et al.*, 2024). This constant connectivity behavior influences employee boundary management behavior (Farveh Farivar *et al.*, 2024). Employees now have more temporal and spatial flexibility, allowing them to work from any place and at any time (Chen and Casterella, 2019; Kossek *et al.*, 2006). There is a scarcity of studies exploring the moderating role of boundary enactment. Studies have shown that perceived boundary control is associated with levels of work-life conflict. Employees perceiving low boundary control tend to face high work-life conflict, while those perceiving high control and preferring segmentation practices tend to have better work-life balance (Kossek *et al.*, 2012; Mellner, 2016). Constant connectivity leads to various stressors resulting in work-life conflict, depending on an individual's boundary preference (Feery and Conway, 2023). Segmentation behavior impacts work connectivity behavior after hours, regulating psychological detachment (Wang *et al.*, 2023).

Boundary behavior in a constantly connected environment can act as a resource requiring self-control, self-regulation, and self-policing, or it can be a challenge resulting in constant connectivity compulsion (Feery and Conway, 2023). Employees must maintain and adjust their connectivity boundaries (Waizenegger *et al.*, 2024). The role of boundary management preferences is complex and may result in different outcomes for employees and employers (Farveh Farivar *et al.*, 2024). The impact of constant connectivity to work during non-work hours on employees' psychological well-being varies based on individual and organizational contexts, suggesting a need to explore the moderating role of boundary enactment.

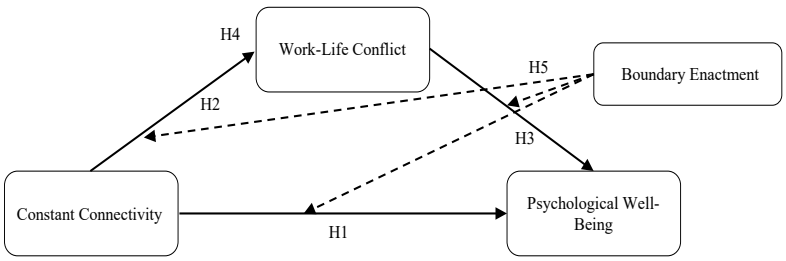
H5: Boundary enactment moderated the relationship between constant connectivity to work in non-work hours and psychological well-being through work-life conflict.

H5a: Constant connectivity to work in non-work hours and work-life conflict are less positively associated in segmentation than integration.

H5b: Work-life conflict and psychological well-being are less negatively associated in segmentation the integration.

H5c: Constant connectivity to work in non-work hours and psychological well-being are less negatively associated in segmentation than integration.

Fig. 1: Research Theoretical Model



Source: Authors' elaboration

2.4 Rationale of Industry

The IT industry in India has experienced significant growth over the past few years. As a developing country, India has established itself as a major player on the global stage. With a large employment pool of 5.1 million in FY 21-22 and 5.4 million in FY 22-23 (Ministry of Electronics and Information Technology, 2023) and a highly skilled workforce, India has become a preferred destination for global IT sector investment. In FY 23-24, over 0.65 million professionals were trained in Gen-AI, with re-skilling efforts predicted to boost the Indian IT sector by FY 2025. Government initiatives, such as 100% automatic FDI in the IT-BPM industry, have increased foreign investment in this sector (Make in India, 2023).

The IT industry is characterized by the widespread use of digital devices, which are essential in various job roles. This extensive use makes the IT sector more susceptible to the effects of digital device utilization. According to NASSCOM (2023), there are seven major IT hubs in India. Data has been collected from two of these hubs, Delhi-NCR and Bengaluru, representing the northern and southern regions.

3. Methodology

3.1 Participants and Procedures

The data has been collected from the employees of IT industry in India. The questionnaire was administered and data was collected in two ways. Firstly, the HR department of the IT organizations contacted their

employees to participate in our research by filling up the questionnaire. Secondly, the employees were contacted through LinkedIn to fill the questionnaire and share it among their colleagues. The sample consist of junior level employees (258=58.28%), senior level employees (158=33.12%) and executive rank employees (41=8.6%). The final sample consisted of 477 employees out of which majority of employees were males, where 306 (64.15%) are male and 171(35.85%) are female.

3.2 Study Measures

Psychological well-being is measured using an 18-item instrument developed by Ryff and Keyes (1995). This instrument assesses various indicators such as autonomy, self-acceptance, personal growth, environmental mastery, positive relationships with others, and purpose in life. Work-life conflict is measured with a 15-item scale assessing work-family and family-work conflict (Kossek *et al.*, 2012). Constant connectivity to work during non-work hours examines how individuals perceive their availability for work during these times, their sense of obligation to be available for the organization, and their need to disconnect from work. A nine-item scale, adapted from Büchler *et al.* (2020), Thomas *et al.* (2016), and Zoonen *et al.* (2023), was used to assess employees' constant connectivity to their organization during non-work hours. The scale consisted of two components: six items measuring perceptions of mobile device connectivity, based on Büchler *et al.* (2020) and Zoonen *et al.* (2023), followed by three items assessing employees' connection habits, as suggested by Thomas *et al.* (2016). To ensure contextual relevance in the study of IT employees in India, the scale was adapted to reflect contemporary digital communication tools commonly used in the industry, such as instant messaging applications and project management platforms. Additionally, modifications were made to capture the effects of remote and hybrid work models. The revised scale was validated through exploratory and confirmatory factor analyses, demonstrating strong internal consistency (Cronbach's $\alpha = 0.938$) and construct validity.

Responses are recorded on a 5-point Likert scale (1 = Strongly agree; 5 = Strongly disagree). Additionally, two items measure employees' digital device usage and their feelings toward technology utilization. All items, after reliability and validity testing, are reported in Annexure 1. To measure boundary enactment, a two-item scale from Wepfer *et al.* (2018) and Martineau and Trottier (2022) is used. This scale includes two polarized statements measuring employees' preferences for segmentation and integration on a continuum (e.g., "I often work after hours or on weekends" vs. "I never work after hours or on weekends"). Individuals are asked to respond by selecting one of the two categories.

4. Results

4.1 Descriptive Statistics

Table I reports the mean, standard deviation and correlations of constant connectivity, psychological well-being and work-life conflict. The feelings of employees were accessed if they were forced to go without accessing technology. The question measures the continuum of feelings from anxious to relaxed. The results reveal that 29.77% of respondents feel bored for not assessing digital devices for more than 24 hours followed by 22.64% respondents feel relaxed and 18.23% feel anxious (Table II). Furthermore, the results for individual digital device usage highlights that 67.92% of respondents cannot go over one to three hours without assessing their instant messaging application (e.g., Whatsapp etc.). On the other hand, 31.45 % individuals responded that they can go over more than a week without assessing video calls (Table III). It is revealed that the highest utilization is of instant messaging applications, wherein the highest number of employees cannot access instant messaging services for longer than 1 to 3 hours. The lowest utilization is video calls, where employees can go without accessing it for a day or longer (N=171) or even more than a week (N=150).

Tab. 1: Descriptive Statistics and the Bivariate Correlations

	M	SD	CC	PWB	WLC
Constant Connectivity	3.455	.965	-		
Psychological well-being	2.414	.927	-.649**	-	
Work-Life Conflict	3.659	.984	.676**	-.753**	-

** Correlation is significant at p<0.01.

Source: our elaboration

Tab. 2: Employee perception towards digital dysconnectivity

Statement: It forced to go without technology, I would feel:		
Feelings	Number of users	Percentage
Anxious	87	18.23
Bored	142	29.77
Indifferent	59	12.37
Free	81	16.98
Relaxed	108	22.64

Source: our elaboration

Tab. 3: Employee perception towards digital dysconnectivity

Statement: I would typically go without accessing the following (a-d) for:								
Time Period without accessing digital Media	Email		Instant Messages		Social media		Video Calls	
	N	Percentage	N	Percentage	N	Percentage	N	Percentage
1-3 hr	138	28.9%	324	67.9%	164	34.4%	55	11.5%
3-6 hr	152	31.8%	100	20.9%	181	37.9%	27	5.7%
6-12 hr	108	22.6%	49	10.4%	88	18.4%	74	15.5%
A day or longer	58	12.1%	3	0.62%	32	6.7%	171	35.8%
More than a week	21	4.4%	1	0.2%	12	2.5%	150	31.4%

Source: our elaboration

4.2 Preliminary analysis

The initial item pool of 42 items has been generated to measure the relationships between constant connectivity, psychological well-being and work-life conflict. The item generation process was based on the review of literature, theoretical conceptions and the examination of qualitative data. The scale's content validity has been assessed in two stages a suggested by (Hardesty and Bearden, 2004). Firstly, three judges were provided with the explanation along with the definitions of all the three dimensions. The judges were asked to evaluate which items of a particular dimension is applicable, which item is repetitive and which item is not applicable. After elimination of items which failed to describe the dimensions under the study only 32 items were retained. This pool of 32 items was further submitted to two other judges. The judges were asked to categorize the items pertaining to the dimensions as their clear representative or non-representative. Only the items that were categorized as clear representative were retained for further analysis. After completion of this process 28 items remained. Furthermore, items were measured on 5-point Likert scale.

A pilot test was conducted with the help of 100 respondents. The data set was tested for its factor structure with the help of exploratory factor analysis (EFA). All the items loaded in their respective factors with loadings more than 0.5. Therefore, all the items were retained in this step. The instrument was then administered for main survey, including response from 477 respondents. The data set was subjected to confirmatory factor analysis measurement model to confirm the factor structure that emerged in EFA. Lastly, two items in the instrument were included to measure the moderating relationship of boundary enactment. These two items were categorical in nature.

4.3 The Measurement Model

The reliability analysis was analyzed with the help of Cronbach's α, and structural equational modelling (SEM) based tests of composite reliability (CR) and average variance extracted (AVE). The acceptable range for Cronbach's α is more than 0.7 (Hair *et al.*, 2010; Malhotra *et al.*, 2017). Further the acceptable values for CR and AVE are 0.7 and 0.5 respectively

(Malhotra *et al.*, 2017) (Table IV). The validity was analyzed in terms of convergent and divergent validity. Fornell and Larcker (1981) suggested the methods of measuring convergent and divergent validity. The acceptable values for convergent validity are AVE greater than 0.5, standardized factor loadings greater than 0.5 and CR greater than 0.7 (Fornell and Larcker, 1981; Hair *et al.*, 2010, Cheung and Wang, 2017) (Table IV). For discriminant validity the square root of AVE should be greater than the correlations between the two variables (Cheung and Wang, 2017; Fornell and Larcker, 1981) (Table V). Additionally, the discriminant validity can be proven if the AVE is higher than the maximum squared variance (MSV) and average squared variance (ASV) (Almén *et al.*, 2018). Furthermore, the measurement model generated the good model fit indices with: CMIN/df= 1.638, GFI=.926, CFI=.986, TLI=.984 and RMSEA=0.037. Hence, the data set produced all the measures within acceptable range, confirming reliability and validity of the scale.

Tab. 4: Reliability and Convergent Validity

Construct	Cronbach's α	CR	AVE	Indicators	Standardised factor loadings
CC	.938	0.934	0.669	CC1	.807
				CC2	.778
				CC3	.775
				CC4	.820
				CC5	.836
				CC6	.838
				CC7	.867
PWB	.971	0.971	0.703	PWB1	.824
				PWB2	.828
				PWB3	.818
				PWB4	.810
				PWB5	.818
				PWB6	.812
				PWB7	.882
				PWB8	.875
				PWB9	.861
				PWB10	.872
				PWB11	.850
				PWB12	.855
				PWB13	.811
				PWB14	.821
WLC	.950	0.949	0.787	WLC1	.904
				WLC2	.889
				WLC3	.852
				WLC4	.905
				WLC5	.908

Note: CC- Constant Connectivity, PWB- Psychological Well-Being, WLC- Work-Life Conflict; CR-Composite Reliability, AVE- Average Variance Extracted

Source: our elaboration

Tab. 5: Discriminant Validity

Variable	CR	AVE	MSV	ASV	CC	WLC	PWB
CC	0.934	0.669	0.516	0.492	0.818	-	-
WLC	0.949	0.787	0.629	0.572	0.718	0.887	-
PWB	0.971	0.703	0.629	0.548	-0.684	-0.793	0.839

Source: our elaboration

4.4 The Structural Model

We tested direct relationships between all the underlaying variables with the help of structural model. Overall, all the direct relationships are found to be statistically significant. Hypothesis1 proposes that constant connectivity to work even after work hours reduces psychological well-being. The regression model demonstrated a good model fit with $\chi 2/df=1.738$, GFI=.937, AGFI=.921, CFI=.987, TLI=.985 and RMSEA= 0.039. The path coefficient between constant connectivity and psychological well-being was significant with $\beta=-.68$ ($p<0.001$). Thus, findings support the assumption that constant connectivity reduces psychological well-being. Path coefficient for direct relationship between constant connectivity to work and work-life conflict is statistically significant ($\beta=.71$, $p<0.001$). Thus, supporting hypothesis 2, that constant connectivity increases work-life conflict. Lastly, path coefficient for direct relationship between work-life conflict and psychological well-being is statistically significant ($\beta=-.78$, $p<0.001$). Thus, this supports hypothesis 3 that work-life conflict results in reduced psychological well-being.

4.5 Mediation Analysis

Hypothesis 4 assumes that work-life conflict mediates the relationship between constant connectivity and psychological well-being. The mediating relationship has been tested based on Baron and Kenny's (1986) and Hayes (2018) suggestions. To test the mediation, the direct relationship between constant connectivity to work after working hours and psychological well-being is examined for its significance. These results were supported by hypothesis 1. Further, the direct relationship is found to be statistically significant between constant connectivity and work-life conflict ($\beta=.71$, $p<0.001$); and between work-life conflict and psychological well-being ($\beta=-.78$, $p<0.001$). Thus, the results were supported for hypothesis 2 and hypothesis 3. In mediation model, bootstrapping has been used to test the indirect effect of constant connectivity on psychological well-being via work-life conflict. The mediation model (Figure 2) explained the significant indirect effect of -.433 with $p<0.001$ at 5000 bootstrap sample on 95% significance level. In addition, the constant connectivity is found as the predictor of work-life conflict with $\beta=.72$ at $p<0.001$, and work-life conflict is found to predict psychological well-being with $\beta=-.61$ at $p<0.001$. The introduction of mediating variable resulted in the reduction of direct effect between constant connectivity and psychological well-being from $\beta=-.68$ to $\beta=-.25$ while still being significant ($p<0.001$), with regression model

demonstrated a good model fit with χ2/df=1.638, GFI=.926, AGFI=.911, CFI=.986, TLI=.984 and RMSEA= 0.037. Thus, work-life conflict is found to mediate the relationship between constant connectivity and psychological well-being (Table VI, Figure 2), thus supporting hypothesis 4.

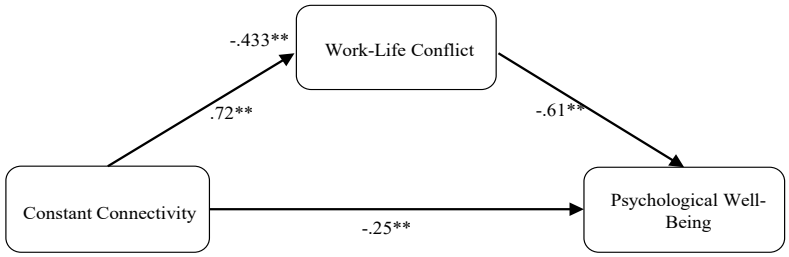
Tab. 6: Standardized Path coefficients using Bootstrapping

Hypothesis	Direct Effect without mediator	Bootstrapping*					Result
		Direct effect with mediator	Indirect effect	Lower Bounds	Upper Bounds	p	
H1: Constant Connectivity →Psychological Well-Being	-.684	-	-	-.739	-.671	<0.001	Supported
H2: Constant Connectivity →Work-life Conflict	.71	-	-	.671	.873	<0.001	Supported
H3: Work-life Conflict → Psychological Well-Being	-.78	-	-	-.761	-.625	<0.001	Supported
H4: Constant Connectivity →Work-Life conflict → Psychological Well-Being	-.68	-.25	-.433	-.508	-.358	<0.001	Supported-Partial Mediation

Note: 5000 bootstrap sample on 95% level of significance

Source: our elaboration

Fig. 2: Model Path Diagram



Source: our elaboration

4.6 Multi-group Analysis

The study aims to explore the moderating role of boundary enactment. A multi-group analysis has been performed to examine any changes in the path coefficient of the proposed structural model. The study utilizes two nested models for each group of moderating variable (Alrawad *et al.*, 2023; Collier, 2020). Where one model is unconstrained i.e. built without any constraints, and other model is restricted with factor loadings to be similar across every group of nested models. Further, chi-square difference was calculated to test the differences between constrained and unconstrained model across the two groups (H5). Lastly, all the model paths were tested to analyze the differences across the two groups on the path level (H5a, H5b, H5c). Table 7 presents the results for model comparison in terms of chi-square difference, where two groups of boundary enactment (segmentation and integration) were found significantly different ($\Delta\chi^2$= 40.577, p<0.05).

Tab. 7: Multi group Analysis

Results of Structural Measurement Analysis for Segmentation and Integration preference						
Group- Boundary Enactment				df	CMIN	p-Value
Unconstrained v/s Structural Weights				26	40.577	0.034
Model	CMIN/df	NFI	CFI	TLI	AGFI	RMSEA
Goodness of fit indices for the nested structural model of segmentation (N=197) and integration (N=250)						
Unconstrained Model	1.279	.941	.987	.985	.862	0.025

Source: our elaboration

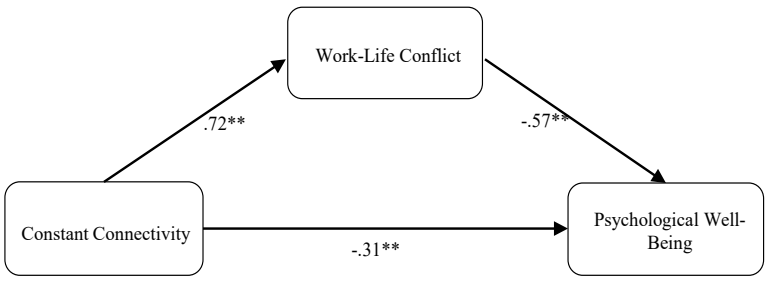
The results reveal that for both the groups i.e. integration and segmentation, the path from constant connectivity to psychological well-being is found to mediate through work-life conflict partially. Further, to analyze the level of moderation between the variables across integration and segmentation type of boundary enactment, path differences between the two groups were calculated as shown in table 8. These results suggest that the relationship between constant connectivity of employees to work in non-work hours and psychological well-being through work-life conflict is significantly different based on employee boundary enactment behavior. Further, the path coefficients for both the models reveal that relationship between constant connectivity to work in non-work hours vis-à-vis work-life conflict and psychological well-being is statistically higher for employees with integration behavior (Figure 3, Figure 4). However, the path from work-life conflict to psychological well-being was not found to be significantly different across the two groups.

Tab. 8: Path Coefficients for Multi-Group Analysis

Path Coefficients	Segmentation		Integration		Hypothesis
	Path Coef.	p-Value	Path Coef.	p-Value	
CC→WLC	.66	0.001	.72	0.001	H5a→Supported
WLC→PWB	-.57	0.001	-.57	0.001	H5b→Not Supported
CC→PWB	-.29	0.001	-.31	0.001	H5c→Supported

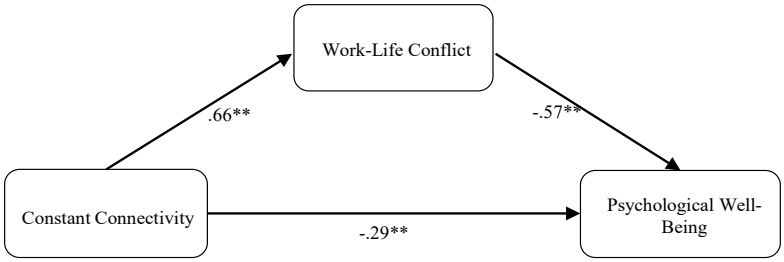
Source: our elaboration

Fig. 3: Integration Behavior



Source: our elaboration

Fig. 4: Segmentation Behavior



Source: our elaboration

5. Discussion and conclusion

The first aim of this study was to investigate how constant connectivity to work in the non-work hours affects employee's psychological well-being and further influence their work-life conflict. The results of the structural equational modelling established a strong and significantly negative relationship between constant connectivity to work in non-work hours and employee's psychological well-being. Further, the second aim of this study was to explore the mediating role of work-life conflict. The study's results demonstrated that with the introduction of work-life conflict the strength of the direct relationship between constant connectivity and employee psychological well-being lessens while resulting in significant and negative indirect relationship between constant connectivity and psychological well-being through work-life conflict. Therefore, the results support the partial mediation. It suggests that work-life conflict negatively mediates the relationship between constant connectivity and employee psychological well-being. The constant connectivity increases work-life conflict, while work-life conflict reduces psychological well-being. Lastly, the study examines how these relationships vary based on an individual's segmentation and integration preferences. The results reveal that constant connectivity to work non-work hours results in lower work-life conflict levels for employees following segmentation behavior. Further, no significant difference was found in the levels of psychological well-being based on work-life conflict with respect to employee's integration or segmentation practices. Lastly, the employees following segmentation behavior found higher levels of psychological well-being based on their constant connectivity to work in the non-work hours compared to those following integration practices.

Constant connectivity to work after work hours leads to increased levels of conflict between the work and life domain of employees. The study advances on previous research (Ashforth *et al.*, 2000; Kossek *et al.*, 2006). The results reveal that employees following segmentation practices establish clear boundaries between work and non-work domains and experience lower levels of work-life conflict and improved psychological well-being. The study reinforces the idea that employees face more work-life conflict due to their constant connectivity to work based on increased flexibility

and permeability of boundaries (integration behavior). Further, the study's findings enhance existing knowledge base by providing empirical evidence by establishing a relationship between constant connectivity to work in non-work hours and psychological well-being. Furthermore, this study found that on the one end of the connectivity continuum, employees usually are on their digital devices due to boredom or anxiety arising from fear of missing out.

On the other hand, on the other end of the continuum, some employees would like to stay away from technology for at least 24 hours to feel relaxed. In addition, the employees' digital device usage is high as they cannot go without assessing instant messages, emails and social media for an average time of 1 to 6 hours. Digital device usage acts as a primal individual-level antecedent for constant connectivity. Employees can regulate their digital device usage to reduce work-life conflict and maintain better psychological well-being.

5.1 Theoretical Implications

This study advances the theoretical understanding of digital connectivity, boundary management, and employee well-being by presenting a structured model that highlights the mediating role of work-life conflict. While prior research has largely focused on the general effects of digital connectivity on stress and work engagement (e.g., Vorderer *et al.*, 2018; Zoonen *et al.*, 2020), our findings provide robust empirical evidence that constant digital engagement-especially during non-work hours-intensifies work-life conflict and consequently undermines psychological well-being.

Our analysis reveals that employees who perceive themselves as constantly connected to the workplace, primarily through instant messaging and emails, experience heightened role conflict between their work and non-work domains. This is particularly evident in scenarios where employees rarely disconnect for periods exceeding one to six hours, suggesting that the very tools designed to offer work flexibility may inadvertently contribute to adverse psychological outcomes. In contrast to the abundant literature emphasizing the benefits of digital connectivity for work-life balance, our study uniquely demonstrates that excessive connectivity can diminish psychological well-being by fostering continuous role conflict.

Furthermore, this study contributes to the emerging discourse on boundary enactment by demonstrating that proactive, segmentation-oriented boundary strategies significantly moderate these adverse effects. Building on Ashforth *et al.*'s (2000) boundary theory and extending the foundational perspectives of Kossek *et al.* (2012) and Mellner (2016), our findings indicate that employees who clearly delineate between work and personal life experience lower levels of work-life conflict and greater psychological detachment compared to their integration-focused counterparts. This evidence resonates with recent work (Wang *et al.*, 2023) on the benefits of segmentation in mitigating digital stress, while also highlighting that adaptive boundary strategies-not rigid segmentation

practices-empower employees to effectively manage their work-life interfaces. Further, in the scenario of obligatory technology use, employees go through competitive pressure and anxiety about being away from work while their colleagues are available for work (Hoeven, 2021; Mazmanian and Erickson, 2014). On the other hand, from the perspective of digital dysconnectivity, employees report a need to be away from technology for a sense of relaxation.

Additionally, our research underscores the cumulative nature of digital stress, a phenomenon documented by Reinecke *et al.* (2017) and Vorderer *et al.* (2018), and highlights the competitive pressure and anxiety associated with obligatory connectivity (Hoeven, 2021; Mazmanian and Erickson, 2014). These findings emphasize the critical need for effective boundary regulation mechanisms, particularly within hybrid work models, and suggest that organizations must proactively implement policies and interventions that promote healthier connectivity practices (Piszczek, 2017).

5.2 Practical Implications

Our study provides significant practical implications for employees, organizations, managers, and policymakers by elucidating strategies to mitigate the negative impacts of constant connectivity on psychological well-being. At the individual level, our findings indicate that employees should actively regulate their digital device usage after work hours to foster psychological detachment and reduce work-life conflict. In today's work environment-characterized by a surge in mobile device usage and evolving work dynamics-blurred boundaries between professional and personal domains necessitate proactive digital boundary management. Employees who adopt segmentation-oriented strategies, thereby clearly delineating work from personal time, experience lower levels of stress, burnout, and overall work-life conflict compared to those with integration-based approaches.

From an organizational standpoint, our research underscores the critical need for clear IT policies that govern employee connectivity. Organizations must support and monitor technology use to ensure that employees do not feel compelled to remain perpetually available. The implementation of structured digital disconnection policies, such as 'right to disconnect' protocols, is recommended to establish explicit guidelines for after-hours communication. Such measures can alleviate undue pressure on employees, thereby reducing stress, burnout, and the erosion of work-life balance.

Moreover, our findings advocate for the development of tailored training programs on digital boundary management. By equipping employees with adaptive boundary-setting strategies, organizations can move beyond rigid segmentation practices and empower individuals to autonomously manage their schedules and technological engagement. HR policies should be refined to promote flexible work arrangements that accommodate varying needs across the workforce, acknowledging that managerial interventions may need to be tailored according to employee seniority. Notably, junior employees-who often face higher expectations

for constant availability-may benefit from targeted support to mitigate the adverse effects of incessant connectivity.

At the policy level, our study highlights the necessity of regulatory frameworks that address the mental health consequences of pervasive work connectivity, particularly in high-intensity sectors such as IT. The implementation of digital wellness programs and enhanced employer accountability for maintaining work-life balance are imperative steps. These initiatives are not only relevant for individual organizations but also carry significant implications for management and entrepreneurship communities at both national and international levels.

In summary, our study offers actionable insights into how employees and organizations can collectively foster healthier digital engagement practices. By balancing connectivity during work hours with structured disconnection after work, stakeholders can safeguard psychological well-being, reduce work-life conflict, and ultimately enhance overall organizational performance.

5.3 Limitations and future research

Our study has certain limitations. Primarily, it examines the impact of employees' constant connectivity during non-work hours on their psychological well-being, focusing on overall mobile device connectivity. However, the study reveals that connectivity levels vary across different mobile applications. Future research should explore connectivity and boundary behaviors specific to various mobile applications. Additionally, other sectors may exhibit varied connectivity levels, indicating a need to investigate underlying variables within different organizational contexts. Connectivity perceptions may also differ across generations, as individuals from different age groups may adopt varied behaviors related to work-life boundaries and inter-domain roles. Therefore, studying these underlying concepts concerning different age groups is essential.

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italian journal of management
Vol. 43, Issue 3, 2025

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sinergie
italian journal of management

ISSN 0393-5108
ISSN 2785-549X
DOI 10.7433/s128.2025.03
pp. 49-72

FONDAZIONE CUEIM

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A literature review of systemic risk management and the role of stakeholders[1]

Received
5th December 2024
Revised
15th April 2025
Accepted
18th July 2025

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Abstract

Frame of the research: *This study examines the relationship between non-financial risk governance, stakeholders, and management controls, employing a literature review and fuzzy-set qualitative comparative analysis (fsQCA). The findings indicate which configurations of controls and stakeholder involvement are necessary or sufficient for effective risk management, highlighting the pivotal role of stakeholders.*

Purpose of the paper: *This paper explores the relationship between non-financial risk governance, the role of stakeholders, and management control objects. It aims to fill a gap in the literature by investigating how specific configurations of controls and stakeholder engagement contribute to systemic risk governance.*

Methodology*: This study conducted a literature review combined with a fuzzy set qualitative comparative analysis (fsQCA) to examine and identify which management controls should be adopted to address various aspects of systemic risk management. This study also investigated stakeholder engagement in risk management processes. The fsQCA method was chosen for its ability to detect complex and non-linear relationships. A detailed calibration and validation process was followed to ensure methodological robustness.*

Findings*: The findings indicate that certain risk components are discussed more frequently in the literature than others. Management controls are highlighted as essential tools for intervening in and mitigating risks, and stakeholders are shown to play a critical role in all stages of risk management. Analysis revealed which combinations of controls are sufficient or necessary across the different phases of the risk management process.*

Research limitations: *This study is based on a theoretical framework suggesting that future research should include empirical investigations to explore the role of stakeholders in non-financial risk management. Moreover, the context-specific nature of fsQCA and the reliance on theoretical calibration introduce some limitations regarding generalisability.*

Practical implications: *This study identifies the relationships between management controls and risk management phases, emphasising the critical role of stakeholders in non-financial risk management. The proposed framework can help companies identify the necessary actions to manage all stages of risk management and determine the most strategically important stakeholders, who require greater*

involvement in this process. Organisations can use the configurational insights provided by this study to design more resilient and inclusive risk governance systems.

Originality of the paper: *This paper is original in its approach, as it synthesizes literature on non-financial risk governance and stakeholder engagement, and subsequently applies fsQCA to determine the necessary and sufficient elements that shape systemic risk management. To the best of our knowledge, this is one of the first studies to apply fsQCA to a literature-based dataset in the context of non-financial systemic risk, thereby offering a novel methodological contribution.*

Key words: *Systemic view of risk; stakeholder engagement; literature review; fsQCA*

1. Introduction

Managing risk means taking responsibility for one's choices by developing effective strategies to prevent, control, and mitigate risks and their effects (Miller *et al.*, 2008). Managing risks also means having tools or technologies available that allow for the intervention in and reduction of risks (Miller *et al.*, 2008) when unexpected events occur (Chenhall, 2003). The COVID-19 pandemic is just one example of an extraordinary event that affected organisations around the world. Unexpected events like the COVID-19 pandemic highlight the importance of considering risk analysis, management, and control-that is, governance, from a systemic (Martins *et al.*, 2022) and multidimensional perspective-to identify how and with what processes businesses manage and control these risks. The COVID-19 pandemic has altered the world of employment. In 2020, there was an increase of 24.7 million in unemployment (ILO, 2021), a reduction of 4.4% in global GDP, and significant changes in global trade relations and supply chains (Guan *et al.*, 2020; Linton and Vakil, 2020). Risks affect organisations and represent significant sources of crisis (Bundy *et al.*, 2017; Lampel *et al.*, 2009). Risks include climate change (Pinkse and Gasbarro, 2019; Weinhofer and Hoffmann, 2008) and related natural disasters (Baker, 2014; Battaglia *et al.*, 2019; Sargiacomo, 2014), as well as the social risks of human rights violations and occupational safety (EU-OHSA, 2010; Graetz and Franks, 2013; Passetti *et al.*, 2020). For instance, regarding the phenomenon of climate change, in 2017, the concentration of CO2 in the atmosphere reached 146%, the highest since the preindustrial era (UNEP, 2020). All of these events can have an impact on companies in terms of business interruption, administrative sanctions, and conflicts with stakeholders, producing negative repercussions on competitiveness and a reduced ability to create value (Bundy *et al.*, 2017). To respond to these issues, risk management and control systems (RMCS) can act as facilitating factors capable of preventing and reducing these negative effects (Chenhall, 2003; Mouritsen *et al.*, 2022; Passetti *et al.*, 2021; Sargiacomo *et al.*, 2014).

Based on the foregoing, this study undertook a literature review (Arshed and Danson, 2015; Huff, 2009) and fuzzy set qualitative comparative analysis (fsQCA) (Ragin, 2000, 2008, 2009) to deepen our understanding of relevant management and control systems (MCS) and

how they emerge in risk management, prevention, and control; that is, this study sought to identify what types of internal business controls, if any, influence the configurations of risk management practices to enable a systemic approach to risk governance. The concept of risk governance adopted in this study refers to a holistic and systemic perspective on risk (Miller *et al.*, 2008; Tryhuba *et al.*, 2022) in which the role of stakeholders cannot be ignored; thus, organisations should continually identify, manage, and communicate risks to key stakeholders during the different phases of crisis management (Ndlela, 2018; Xia *et al.*, 2018). In particular, this study focuses on systemic risk governance by considering the four components of the risk management process (Institute of Risk Management [IRM], 2002): risk assessment, risk reporting, risk treatment, and risk monitoring. Regarding controls, the objects of control adopted are those identified by Merchant and Van der Stede (2012): action controls, result controls, personnel controls, and cultural controls. The objects of control describe the contribution of a proactive management control system to the likelihood that the organisation's objectives will be achieved, given that the primary function of management control is to influence behaviour in desirable ways. These objects of control are used to analyse each risk management process component. From a methodological point of view, a two-step research approach was developed.

First, we carried out an updated review of the literature (Arshed and Danson, 2015; Huff, 2009) on risk governance and stakeholder engagement. This review process involved selecting papers that considered stakeholders relevant subjects in risk management and control so that we could outline a profile of a systemic business risk process. Second, we analysed the selected papers based on the object-of-control framework proposed by Merchant and Van der Stede (2012), classifying them based on both risk management phases and the types of control that were adopted. Finally, we carried out an fsQCA (Ragin, 2000, 2008, 2009) of the literature review to define the necessary and sufficient elements that shape the configurations of systemic risk management based on the responses of businesses in terms of controls adopted for non-financial risks. The decision to use fsQCA in this study is justified by the complexity and configurational nature of systemic risk governance. Specifically, fsQCA enables the identification of conditions that are minimally necessary and/or sufficient to achieve desired outcomes (Ragin, 2008; Ragin, 2009). Unlike traditional linear methodologies, fsQCA is particularly effective in capturing asymmetric and non-linear causal relationships, which are common in complex managerial environments such as systemic risk management (Meyer *et al.*, 1993; Fiss, 2011). Applying fsQCA allowed this study to explore multiple simultaneous conditions that influence effective risk governance, thereby overcoming the limitations of methods that assume uniformity or linearity in causal processes.

Results show that the literature tends to concentrate resources on specific risk mitigation phases (Leopoulos *et al.*, 2004). Through fsQCA, we observed that, according to the literature, the risk mitigation and assessment phases have the greatest impact on the control dimension (Gond *et al.*, 2012), thus influencing risk management, although the academic impact is often indirect and mediated by other mechanisms. Furthermore, the results

show that stakeholders are taken into consideration in different phases of risk governance, although often superficially and marginally. Nonetheless, stakeholders play an important role because they influence business activities and contribute to identifying, managing, and communicating risk.

The remainder of this paper is organised as follows: Section 2 discusses the theoretical framework and the research methods; Section 3 reports the results of the literature review and the fsQCA; Section 4 discusses the results and implications; and Section 5 presents the conclusions, limitations, and future research directions.

2. Reference framework and research method

Managerial, organisational, and accounting studies use the concept of risk to denote the 'uncertainties and threats' to which the system is exposed (e.g., Nyberg and Wright, 2016). Starting from the work of Knight (1921), this literature conceptualises risks as choices and situations that affect the organisational system itself. Risk governance involves a set of models, practices, and tools that allow the identification of any future situations and their severity, frequency, and probability of occurrence, making them visible, calculable, controllable, and, consequently, manageable (Miller *et al.*, 2008). In the context of business and organisations, risk analysis and management have grown in relevance in the last 15 years due to an increase in the number of factors that influence the choices and methods of the organisation of business and society (Gephart *et al.*, 2009). Initially, the concept of risk largely focused on the financial dimension (De Goede, 2004). Subsequently, the need emerged to move beyond the financial perspective and embrace a broader vision to guide business and organisational choices (Whiteman and Williams, 2019). In recent years, different types of risks have emerged, such as environmental (Keverne and Binder, 2020), social, technological, and industrial risks (Hardy and Maguire, 2016). Many companies suffer from environmental pollution caused, for example, by organisational operations (Maguire and Hardy, 2013) or catastrophic events (Matilal and Höpfl, 2009). Furthermore, the scale of environmental risks has shifted from specific local threats to those that have a global impact (Rockström *et al.*, 2009; Whiteman *et al.*, 2013).

As Gephart *et al.* (2009) have stressed, we live in a risk-based society, and the organisational risk calculation processes previously used in modern society do not work anymore because the risks are no longer localised and are long-term. The close interconnection and growing interdependence between social, technological, economic, and environmental dynamics stimulate an integrated approach to risk governance. To respond to systemic risks, it is necessary to promote integrated solutions. As Bebbington and Larrinaga (2014) and Markard *et al.* (2012) have argued, effective risk analysis and management require adopting a systemic perspective that captures the interconnections among various issues to promote more sustainable business practices and societal outcomes. Embracing a systemic view enables the development of more resilient and sustainable

solutions. Crucially, achieving such a perspective involves recognising the role of stakeholders in the risk assessment process (Tryhuba *et al.*, 2022). The increasing complexity of modern risks presents a significant challenge that demands a comprehensive, integrated response-one that actively engages stakeholders throughout all phases of the risk management cycle. Traditionally, literature on risk governance primarily focused on technical aspects (Miller *et al.*, 2008; Bundy *et al.*, 2017). However, scholars such as Kujala *et al.* (2022), in line with Freeman's stakeholder theory (Freeman, 1984; Donaldson and Preston, 1995), have highlighted that stakeholders are not merely passive recipients of risk information but active participants in shaping the risk management process.

In this study, we explore this perspective by examining how the role of stakeholders is framed across the various stages of risk, including management, analysis, communication, and measurement. This approach fosters a more comprehensive understanding of risk, acknowledging the interconnectedness between a company's operational strategies and the broader social, economic, and environmental systems in which it operates. Stakeholders play a fundamental role in the company as they can influence the achievement of the organisation's objectives (Freeman, 1984, p. 46; Noland and Phillips, 2010). Therefore, the task of management is to co-ordinate the expectations and needs of the various interest groups (Eesley and Lenox, 2006; Harrison *et al.*, 2010). This information, in turn, can stimulate innovation and enable the company to better cope with changes in the environment (Harrison *et al.*, 2010) and possible risks. Girard and Sobczak (2012) defined stakeholder engagement as a set of learning activities involving 'the creation and dissemination of trust, knowledge, and values, to build a base of social capital' (p. 217). While acknowledging that various definitions of stakeholder engagement exist in the literature, the proposed definition is intended to represent a useful extension of the previous definitions by making explicit the importance of the link between stakeholder engagement (Mitchell *et al.*, 2020) and risk management and control from a systemic point of view. Integrated risk and stakeholder engagement can promote the effectiveness of both risk management and stakeholder engagement (Xia *et al.*, 2018).

Based on the foregoing, this study aimed to identify what types of internal business controls, if any, influence the configurations of risk management practices to enable a systemic approach to risk management, that is, an approach that already includes and can foster virtuous and inclusive processes of stakeholder engagement (Zoritza *et al.*, 2022).

Therefore, our research question is:

What types of internal business controls influence the configurations of risk management practices to foster a systemic approach that integrates virtuous and inclusive stakeholder engagement processes?

Internal MCS can prevent, measure, and reduce the negative effects of risks, as widely stressed in the existing literature (Chenhall, 2003; Mouritsen *et al.*, 2022; Passetti *et al.*, 2021; Sargiacomo *et al.*, 2014). Nevertheless, the literature has not focused on the outlined systemic perspective of risks, in which stakeholders have a role, and has yet to assess the types of controls that play as enablers in risk management and control. To fill this gap, we

adopted Merchant and Van der Stede's (2012) object-of-control framework. This framework considers four types of controls (i.e. action, results, personnel, and cultural) and enables a comprehensive understanding of the management controls that an organisation can mobilise in response to organisational risks (Passetti *et al.*, 2020, 2021; Van der Kolk *et al.*, 2020).

We used the literature review method (Arshed and Danson, 2015; Huff, 2009). We selected papers from Scopus and Web of Science, which are considered the two most prestigious academic databases (Wang and Waltman, 2015) to search for scientific articles (Buzzao and Rizzi, 2020). We only considered articles written in English (Ansari and Kant, 2017; Daddi *et al.*, 2018) and published in the last 25 years, that is, from 2000 to 2025. Furthermore, we considered the 'business', 'management', and 'accounting' research areas in Scopus and the 'management' area in Web of Science. We used the results from the literature review for an fsQCA (Ragin, 2000, 2008, 2009) to investigate which elements of controls could be considered the main drivers explaining systemic risk management and the role of stakeholders.

Reading the literature is essential to define a complete and extensive picture of the influence of stakeholders in the risk treatment phases. The review was non-systematic (Arshed and Danson, 2015), and the choice of keywords to include in the algorithm did not follow a standard process, such as that required by systematic literature reviews (Xiao and Watson, 2017). Operatively, we reviewed the literature through the components of the risk management process described by the IRM (2002), integrated with the role covered by stakeholders. We then adopted the object-of-control framework (Merchant and Van der Stede, 2012) to interpret the four components of the risk management process and identify how these controls act over risk governance. In this way, we analysed risk management from a systemic perspective while considering the role of stakeholders.

The components of the risk management process (IRM, 2002) are risk assessment (risk analysis and evaluation), risk reporting, risk treatment, and risk monitoring (IRM, 2002, p. 4; Palermo, 2017).

Risk assessment aims at identifying, describing, and estimating risks. Risk reporting is concerned with communication at different organisational levels (i.e. board, business units, individuals, external stakeholders) of information about the risk management process. Risk treatment is the process of selecting and implementing measures to address risks (e.g. risk transfer, avoidance). Finally, the monitoring process should provide assurance that there are appropriate controls in place and that procedures are understood and respected (Palermo, 2017).

The systematic management of risk requires companies to implement proactive control over all desired choices and to anticipate overcoming and reducing the negative effects of unexpected events. The Merchant and Van der Stede (2012) model refers to management control within the company. It consists of four types of controls: action controls, result controls, personnel controls, and cultural controls. Action controls are the most direct form of management control because they involve steps to ensure that one is acting in the best interest of the organisation. Examples of actional control techniques include the operational and managerial

procedures and manuals adopted by the organisation (formalised knowledge) and the definition of managerial roles and responsibilities within the organisation. Result controls are an indirect form of control because they do not explicitly focus on actions but on the results obtained. Examples include performance monitoring systems about budget or internal non-financial measures, such as the number of accidents at work, product quality levels, and customer satisfaction levels. Personnel controls are indirect controls based on the fulfilment of job requirements and alignment with organisational requisites. Examples include training programmes, job design and worker selection procedures, and motivational systems and systems that provide recognition of personnel. Finally, cultural controls refer to indirect controls based on internal shared values, social norms, and beliefs. Examples include codes of conduct, ethics, and value principles. This framework enables a comprehensive understanding of the management controls that an organisation can mobilise to understand how to manage risk from a systemic view. Merchant and Van der Stede's (2012) model has been widely used in the literature as it has provided important theoretical and empirical insights into the various organisational dynamics and management controls (Passetti *et al.*, 2021; Passetti *et al.*, 2020; Van der Kolk *et al.*, 2020; Velez *et al.*, 2008).

Based on the components of the risk management process (IRM, 2002), we analysed the phases of risk management from a systemic perspective (Table 1).

Tab. 1: Matrix of risk categories and control actions considering the 'stakeholder dimension'

Stakeholder engagement (Ref. Freeman, 1984; Noland and Phillips, 2010)		Objects of control (Ref. Merchant and Van der Stede, 2012)			
		Action controls	Result controls	Personnel controls	Cultural controls
Systemic risk management components (Ref. IRM, 2002; Palermo, 2007)	Risk assessment (risk analysis and evaluation)				
	Risk reporting				
	Risk treatment (risk management and control)				
	Risk monitoring				

Source: Authors' elaboration

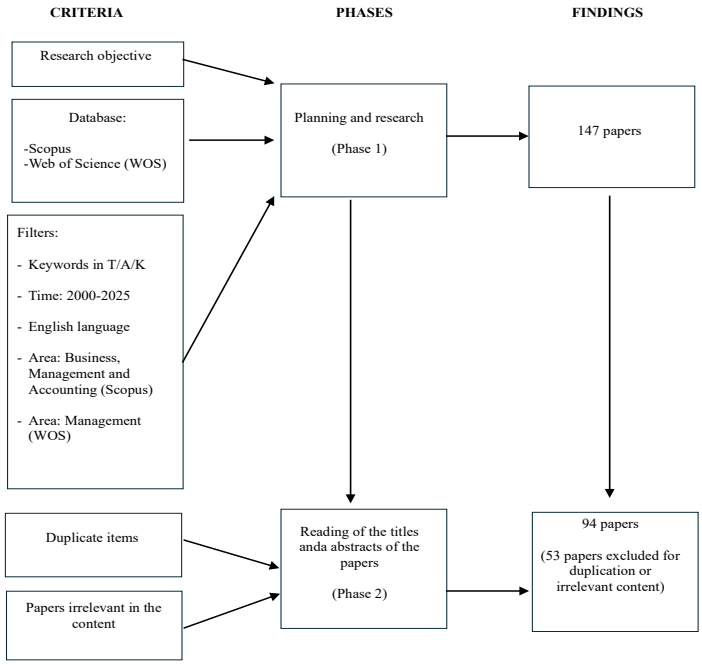
The matrix incorporates the components of the risk management process (IRM, 2002) along with stakeholder engagement (Freeman, 1984) on the one side, and the objects of control (Merchant and Van der Stede, 2012) on the other. This approach allows us to systematically assess risk by considering all control actions throughout the phases of risk management.

To carry out our analysis, we used the keywords derived from the intersection of the risk management process components, integrated with stakeholder engagement, and the objects of control. Consequently, the keywords identified in the title, abstract, or papers' keywords were risk

management AND compan* AND stakeholder and the combination of the categories described in the matrix (Table 1), risk analysis and evaluation AND action control, risk analysis and evaluation AND result control, risk analysis and evaluation AND personnel control, risk analysis and evaluation AND cultural control, risk reporting AND action control, risk reporting AND result control, risk reporting AND personnel control, risk reporting AND cultural control, risk treatment AND action control, risk treatment AND result control, risk treatment AND personnel control, risk treatment AND cultural control, risk monitoring AND action control, risk monitoring AND result control, risk monitoring AND personnel control, and risk monitoring AND cultural control.

This keyword search generated an initial pool of 147 articles. After reviewing the titles and abstracts, we excluded 53 articles that were deemed irrelevant. We then analysed the remaining 94 articles and entered them into the matrix. The process of collecting and analysing the papers began in September 2022 and ended in March 2025. The research methodology is depicted in Figure 1.

Fig. 1: Stages of the literature review



Source: Authors' elaboration

This study utilised fsQCA to investigate the various simultaneous conditions that affect effective risk governance. This approach addresses the shortcomings of methods that rely on uniformity or linearity in causal processes (Ragin, 2000, 2008, 2009). The analysis aimed to determine whether the configurations identified in the literature indicate specific relationships between management controls and risk management.

FsQCA is a configurational comparative method grounded in set theory and fuzzy logic, enabling the nuanced examination of how various configurations of conditions lead to specific outcomes (Ragin, 2008, 2009). By simultaneously employing qualitative and quantitative approaches (Ragin, 2009), fsQCA uncovers which combinations of factors are minimally necessary or sufficient to achieve desired results, facilitating the classification of case groups sharing particular condition sets (Meyer *et al.*, 1993; Skarmeas *et al.*, 2014).

Configurations in fsQCA consist of multiple conditions or factors, which can be positively present, negatively present, or entirely absent. A condition is necessary if a particular outcome cannot occur without it, and it is sufficient if it alone can produce the outcome without additional conditions (Ragin, 2008). This method is particularly suited to investigating complex causal relationships, including causal asymmetry and combined effects, that traditional methodologies may overlook (Fiss, 2011; Gligor and Bozkurt, 2020; Kumar *et al.*, 2022; Llopis-Albert *et al.*, 2018; Rihoux, 2006). Furthermore, fsQCA can handle conjunctive causality, where the necessity or sufficiency of conditions depends on their combination with others, and equifinal causality, where different configurations yield the same outcome (Fiss, 2011).

FsQCA bridges quantitative and qualitative analysis by clarifying complexities at the individual case level and identifying overarching patterns across cases (Aguilera-Caracuel *et al.*, 2014; Crilly, 2011). This approach enhances comprehension by identifying pertinent factors influencing desired outcomes and outlining how factors synergistically integrate, thereby illuminating causal complexities (Chang and Cheng, 2014; Fiss, 2011).

The operationalisation of variable values begins with calibration, assigning fuzzy membership scores that quantify the conformity of cases to predefined sets (Ragin, 2008). These fuzzy membership scores range from 0 (full non-membership) to 1 (full membership), with anchor points for full membership, full non-membership, and a crossover point of maximum ambiguity clearly defined (Kent, 2005; Ragin, 2008).

Following calibration, fsQCA generates a truth table-a matrix of 2^k rows (where k is the number of conditions)-depicting all logically possible configurations of causal conditions and their complements. Each case is categorised according to these configurations (Ragin, 2008; Woodside and Baxter, 2013). Subsequently, the Quine-McCluskey algorithm reduces the truth table into simplified configurations minimally sufficient for achieving outcomes based on the frequency and consistency thresholds (Chang and Cheng, 2014; Quine, 1952; Ragin, 2008, 2009).

Consistency and coverage measure solution quality (Ragin, 2008). Consistency quantifies how reliably instances with similar conditions yield the same outcome, while coverage measures the empirical relevance of solutions. Specifically, conditions are deemed necessary if their consistency is ≥ 0.9 and sufficient if their consistency is ≥ 0.75 (Schneider and Wagemann, 2010). Raw coverage indicates the proportion of outcomes explained by a specific configuration, whereas unique coverage shows the proportion explained exclusively by that configuration (Ragin, 2008).

In our analysis of different risk management components, we identified conditions under which specific management controls contributed to process phases, distinguishing between strictly necessary and sufficient control types.

3. Findings

3.1 Results of the literature review

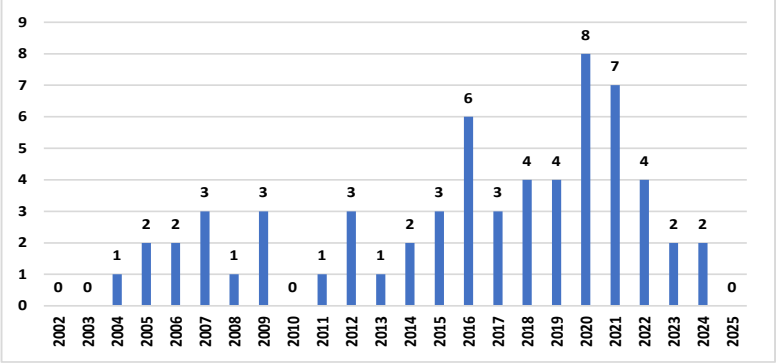
We inserted the articles resulting from the review process into the matrix (Table 2). The matrix revealed the phases of the risk process that were considered in the literature. A total of 33% of the articles were focused on risk treatment, 27% on reporting, 22% on risk assessment, and 18% on monitoring. We report the distribution per year of publications in Figure 2, which shows an oscillating trend, with the highest peaks in 2020 and 2021. Analysis revealed that 33% of the articles were published in the last three years. The synthetic content of the articles is reported in Annex 1.

Tab. 2: Matrix of articles that consider risk categories and stakeholders

Stakeholder engagement (Ref. Freeman, 1984; Noland and Phillips, 2010)		Objects of control (Ref. Merchant and Van der Stede, 2012)			
		Action controls	Result controls	Personnel controls	Cultural controls
Systemic risk management components (Ref. IRM, 2002; Palermo, 2007)	Risk assessment (risk analysis and evaluation)	1	6	8	5
	Risk reporting	7	13	3	3
	Risk treatment (risk management and control)	5	22	2	3
	Risk monitoring	5	10	1	0

Source: Authors' elaboration

Fig. 2: Number of relevant documents published annually from 2000 to 2025



Source: Authors' elaboration

Risk assessment (risk analysis and evaluation)

Articles described risk assessment and analysis through indices or platforms (Testorelli and Verbano, 2020) to identify and qualify risks (Gogan, 2014; Lo *et al.*, 2021). Above all else, the articles described risk assessment in corporate projects (Popescu and Petruş, 2012; Testorelli and Verbano, 2020; Zafar *et al.*, 2019), the assessment of risks related to the supply chain (Hernandez and Haddud, 2018), credit risk (Lo *et al.*, 2020), and intellectual capital (Gogan, 2014).

Regarding the stakeholders, the articles in the risk assessment phase considered the employees and their level of qualifications because this can influence the success of a project. Poor employee skills can be a risk factor for a company, making it important to evaluate and manage necessary skills (Popescu and Petruş, 2012). Companies also consider the expectations and priorities of dominant stakeholders in an assessment of risks (Hernandez and Haddud 2018; Hsiao and Ploughman, 2009; Zafar *et al.*, 2019). This is essential to identify the critical areas to which attention should be paid, which can influence decision-making (Kapiriri and Razavi, 2021).

Taking into consideration the four types of controls (Merchant and Van der Stede, 2012), personnel controls play an important role. This aspect confirms the importance of the 'dependent' stakeholder in the risk analysis and assessment phase, their perception, and their training regarding the possibility of responding to the risks identified as most relevant. Indeed, the articles described the checks carried out on the innovation and production capacity (Lo *et al.*, 2021) of workers (Zafar *et al.*, 2019), their perceptions and expectations (Testorelli and Verbano, 2020), and their training based on the performance of their work activities (Hsiao and Ploughman, 2009). Moreover, the indicators and platforms (Gogan, 2014) adopted for risk assessment have a certain degree of importance. In this respect, six articles highlighted the importance of result controls as systems that allow support for the risk assessment process and verify the effectiveness of companies' management response tools (Hernandez and Haddud, 2018; Lo *et al.*, 2021). Therefore, the selection of adequate performance indicators associated with the possible risks emerges as relevant from the initial assessment phase. Furthermore, it guides the risk management, control, and measurement process even in the subsequent phases (see Table 2 and the following details).

Only one article described action controls. These checks have an 'operational' nature and thus have less significant weight in the initial assessment phase. The article described the controls implemented to avoid exceeding established deadlines for the implementation of specific projects for which the risk assessment was conducted (Zafar *et al.*, 2019).

Finally, cultural controls concern the establishment of shared values that influence workers' mentality and behaviour. These controls are based on the communication of values and the motivation of staff. They emerge in this risk assessment phase as a connection between the evaluation process and company management systems (Zafar *et al.*, 2019) through the measurement of the value created (Testorelli and Verbano, 2020) to prevent possible risks (Fotr *et al.*, 2015).

Risk reporting

These articles described risk reporting through the publication of voluntary reports (Al-Shaer *et al.*, 2022; Callaghan and Nehmer, 2009). Such reports disclose information regarding the risks borne by a company (Lakshan *et al.*, 2021). External disclosure is crucial to improve stakeholder satisfaction (Callaghan and Nehmer, 2009) and enable stakeholders to make more informed decisions (Baig *et al.*, 2024; Lakshan *et al.*, 2021; Xiaoxia and Minghui, 2023). In some cases, the same stakeholders ask companies to provide information on how they manage social and environmental issues and integrate sustainability considerations into their operations (Ahmed *et al.*, 2019).

Compared to objects of control, result controls have a significant role. Result controls concern the monitoring of management results and risk-related performances based on the adoption of adequate sustainability performance indicators (Ahmed *et al.*, 2019; Buniamin, 2020), which are communicated to the various stakeholders through reports (Al-Shaer *et al.*, 2022; Callaghan and Nehmer, 2009).

Action controls also have a certain degree of relevance, emerging in seven of the investigated reports. Companies aim to provide indications of their risk management methods as well as the procedures and practices (Bager and Lambin, 2020; Karwowski *et al.*, 2021) they adopted to prevent harmful events and reduce the probability of the unexpected occurring.

Few articles described personnel controls, although the issue of personnel involvement and training represents a crucial step for the correct implementation of risk management procedures (Buniamin, 2020). Similarly, few articles referred to cultural controls, although the identification of values and principles that guide business activity is considered important for directing the approach to corporate risk governance (Lakshan *et al.*, 2021). However, the communication of these issues did not emerge as a priority, and this type of control does not appear to have a significant influence on the risk reporting phase.

Risk treatment (risk management and control)

A large number of articles dealt with the topic of risk treatment. Some articles described how enterprises manage global risks along the value chain (Liu *et al.*, 2020; Wu *et al.*, 2021), while others described risk management in projects (Leopoulos *et al.*, 2004; Liu *et al.*, 2023; Wang *et al.*, 2022; Zhu *et al.*, 2020) and how risk management plays a fundamental role in achieving project success (Wang *et al.*, 2022). Several articles considered risk management in business performance (Abiodun Eniola, 2020; Mateescu *et al.*, 2017). Finally, some articles focused on the management of risks arising from sustainability issues, such as climate change, resource depletion, and natural disasters (Guimarães *et al.*, 2018; Kuruppu *et al.*, 2024; Manab and Aziz, 2019; Osland and Osland, 2007; Schaltegger *et al.*, 2015).

Different categories of stakeholders were reported, but suppliers, consumers, and workers emerged as the most relevant. By sharing risk with stakeholders, companies obtain both image and prevention advantages (Wang *et al.*, 2022). Firms that manage risks by considering stakeholder expectations increase stakeholder satisfaction (Prioteasa *et al.*, 2021) and

decrease negative impacts that can affect stakeholder relationships (Manab and Aziz, 2019; Pham, 2016).

Considering the four objects of control, the articles frequently considered result controls, while action controls were considered less frequently than expected. Performance controls concern the monitoring of the results achieved to manage risks, and are the main evidence of the effectiveness of management practices and actions that have been implemented. In particular, the articles described the checks carried out on the implementation status of the completed projects (Wang *et al.*, 2022; Zhu *et al.*, 2020), checks on their quality and the level of customer satisfaction (Wu *et al.*, 2021), and the controls carried out on management performance with specific indices (Guimarães *et al.*, 2018; Abiodun Eniola, 2020; Schaltegger, 2016; Arnold, 2015; Mateescu *et al.*, 2017).

Five articles described action controls. Action controls concern practices and procedures used for risk prevention and to identify the actions that should be taken to reduce the effects of events associated with critical occurrences (Bostan *et al.*, 2012; Guserl, 2016; Osland and Osland, 2007). These are central activities in the field of risk prevention and minimisation, which allow risk management to be concretely and operationally integrated into a company's business practices. However, the number of papers explicitly dealing with this topic was rather low, demonstrating an even greater tendency of research to focus on the measurement and control of results rather than on the tools and practices that can support those results.

As previously noted, few papers dealt with cultural controls, and even fewer described personnel controls as determinants of the risk treatment phase. Cultural controls concern codes and principles that guide corporate action and have the objective of influencing the behaviour of corporate employees in terms of risk prevention and management. The papers in this case concerned the reputational effects of value systems (Hirsch, 2017) and the existing relationships between cultural controls and the adoption of a company's integrated management system (Zeng *et al.*, 2007). Personnel controls concern the actions companies take to valorise and qualify human resources to achieve company objectives and manage risks (Borggraefe, 2016; Popescu and Petruş, 2012).

Risk monitoring

Only 16 papers in our review considered risk monitoring. Some of these articles described the monitoring of risks related to sustainability issues (Lueg *et al.*, 2015; Naidoo and Gasparatos, 2018; Schaltegger *et al.*, 2015), while others dealt with monitoring systems for risks related to intellectual capital (Parshakov, 2017). Although there were few papers related to this risk management phase, collaboration with stakeholders remains an element that can support companies in measuring the impact that potential risks can generate over time (Wu *et al.*, 2021).

Finally, in respect to the four objects of control, most articles considered controls on results while only a few articles addressed controls on actions. Once again, controls over results emerged as the main driver. The definition of structured performance indicators allows for the monitoring of actions and projects aimed at preventing critical events (Jin *et al.*, 2022;

Schaltegger *et al.*, 2015) and the maintenance of certain quality standards (Wu *et al.*, 2021). Five papers described the action controls that outline the operational methods with which the monitoring activity is developed as a function of risk reduction (Bostan *et al.*, 2012; f.i. Guserl, 2016), and one paper connected the training and qualification of staff to risk monitoring activities (Borggraefe, 2016). None of the articles considered cultural controls.

3.2 FsQCA results

The fsQCA methodology was chosen because it enables the identification of the sufficient and necessary conditions (i.e. types of controls) in the literature that are pertinent to the four components of the risk management process (IRM, 2002). FsQCA facilitates an understanding of which control components are relevant within each specific phase of risk management. This analysis supplemented what has been previously highlighted and aimed to uncover additional information. Based on findings from the literature, this analysis allowed for:

- Identifying the phases of risk management that are generally influenced by controls.
- Delineating the control objects most pertinent to each phase in which they are influential.

Our fsQCA was conducted in three steps (Ragin, 2008). Initially, we examined and defined the outcome measures and conditions. We then codified the cases and calibrated the membership set using the direct method (Kraus *et al.*, 2018; Woodside, 2013), resulting in three calibration anchors representing full membership (0.95), full non-membership (0.05), and the crossover point (0.5). Ultimately, we constructed the truth tables.

We utilised fsQCA 3.0 software (Ragin and Davey, 2016), with the objective of understanding the level of dependence of the outcomes (O1, O2, O3, O4) on the four input conditions, either necessarily or sufficiently (C1.1, C1.2, C1.3, C1.4-C2.1, C2.2, C2.3, C2.4-C3.1, C3.2, C3.3, C3.4-C4.1, C4.2, C4.3, C4.4). Table 3 summarises the outcomes and conditions considered in the fsQCA.

Tab. 3: Definition of outcomes and conditions for the fsQCA

Outcomes	Conditions
Risk assessment (O1)	Action controls (C1.1) Result controls (C1.2) Personnel controls (C1.3) Cultural controls (C1.4)
Risk reporting (O2)	Action controls (C2.1) Result controls (C2.2) Personnel controls (C2.3) Cultural controls (C2.4)
Risk treatment (O3)	Action controls (C3.1) Result controls (C3.2) Personnel controls (C3.3) Cultural controls (C3.4)
Risk monitoring (O4)	Action controls (C4.1) Result controls (C4.2) Personnel controls (C4.3) Cultural controls (C4.4)

Source: Authors' elaboration

We analysed each condition in terms of consistency and coverage. The results are presented in detail. Table 4 summarises the configurations analysed. Necessary conditions are indicated by a black circle (•); sufficient conditions are indicated by an open circle (°).

Tab. 4: Summary of the configurations of the literature

	Risk assessment (Outcome 1)	Risk reporting (Outcome 2)	Risk treatment (Outcome 3)	Risk monitoring (Outcome 4)
Action controls (IN 1.1)	°		°	
Result controls (IN 2.1)	°		°	
Personnel controls (IN 3.1)	°		°	
Cultural controls (IN 4.1)	°		°	
Raw coverage	0.526316	0.407895	0.526316	0.407895
Unique coverage	0.526316	0.407895	0.526316	0.407895
Consistency	1	1	1	1

Legend:
• Necessary condition
° Sufficient condition
Blank space: none of the previous

Source: Authors' elaboration

The results show that all of the controls examined are sufficient conditions for risk management in the assessment and treatment phases. These are the two phases in which the technical (Schaltegger and Burritt, 2005), organisational (Ahrens and Chapman, 2007; Brown and Duguid, 1991), and cognitive (Hoffman and Bazerman, 2007) aspects act more on the control dimension (Gond *et al.*, 2012), ultimately influencing risk management as well. Thus, it is not surprising that these phases play an important role in literature. Therefore, the risk assessment and risk treatment phases for the management of non-financial risks are well supported by the totality of controls that can be adopted within the company. Although not strictly necessary, the presence of all such controls seems to allow a dynamic approach to the analysis and treatment of risks. All controls were found to be important, and it is precisely from their integrated adoption that adequate systems of identification, prevention, and response to possible crises can be obtained.

The monitoring and reporting aspects have a dominant technical component in business management and risk management as well. Through them, indicators are defined that allow performance to be monitored over time and stakeholders to be informed through adequate reporting processes. Nevertheless, these actions come after the phases of assessment and treatment, and do not present a direct connection with controls adopted by the organisation. From this point of view, the contribution of internal controls is not directly necessary or sufficient for reporting and monitoring initiatives, but emerges as a consequence of the importance of these controls in the assessment and treatment phases.

4. Discussion and implications

Through this literature review, we have illustrated the important role and influence of stakeholders in risk management, the integrated management of all risk phases, and the implementation of harmonised controls over the different phases.

Regarding the role of stakeholders, the articles highlighted the attention paid to stakeholders in the assessment, treatment, monitoring, and reporting of risk (Bostan *et al.*, 2012; Abiodun Eniola *et al.*, 2020; Guserl, 2016). This attention seems to improve the relationship an organisation has with stakeholders (Prioteasa *et al.*, 2020; Pham, 2016; Leopoulos *et al.*, 2004). Stakeholders considered by the articles primarily included customers, employees, investors, and suppliers, who can help the company identify and manage risks. There is a mutual influence between risk management and stakeholders. Managing risk improves an organisation's relationship with stakeholders (Prioteasa *et al.*, 2020; Pham, 2016; Leopoulos *et al.*, 2004) and collaboration with stakeholders can lead to learning, innovation, and business transformations (Sloan, 2009), reducing the occurrence of unexpected events. As stakeholder support makes an important contribution to organisational outcomes (Mateescu *et al.*, 2017), it is crucial to consider them in all risk management processes. Companies should consider stakeholders in the risk analysis process to respond to their expectations (Bager and Lambin, 2020). Stakeholders should be considered in the risk reporting phase to provide them with useful information (Lakshan *et al.*, 2021) and to improve relationships with them. Finally, they should be considered in risk management and monitoring because of the need to respond to stakeholder pressure and requests for risk reduction (Ahmed *et al.*, 2019). However, the articles showed that companies currently consider stakeholders in some phases of risk management but not in others. Companies should make an effort to integrate stakeholders across all phases in order to learn from stakeholders and improve risk management.

Based on the results of our research, many articles in the literature described the importance of each phase of risk management. What is missing is the company's use of all components of risk management in a systemic way, as well as consideration of the role of stakeholders and the controls on the risk phases. Regarding the risk identification and assessment phase, many articles in the literature have described its value and importance (e.g., Walker *et al.*, 2001). Others have pointed out that organisations use the risk assessment phase to provide sufficient means to reduce risks (Lo and Chen, 2012). Regarding the risk treatment and risk reporting phase, the literature describes the importance of developing one's culture and organisational processes to guarantee the reliability of risk reporting information (Oliveira *et al.*, 2013) and minimise the negative effects (Gander *et al.*, 2011) of unexpected events. Finally, in terms of the risk monitoring and control phases, the literature shows that they are often poorly implemented due to the lack of ability to monitor and manage the identified risks, causing significant losses (Obondi, 2022). Therefore, based on our review, all risk phases are fundamental, and companies cannot

underestimate them because risk management can significantly contribute to the survival of the company. Risk management can have an impact on the social status of all stakeholders involved (Fotr *et al.*, 2015). At the same time, stakeholders can influence risk management (Liu *et al.*, 2020) and thus the survival of the businesses (e.g., Barnett and Solomon, 2006).

Regarding controls, our study shows that companies do not systematically consider risk and risk management phase controls because they place more importance on specific risk phases. Companies can only effectively manage non-financial risks through the adoption of harmonised control systems.

The fsQCA results show the parsimonious relationships between conditions and outcomes. The results of the fsQCA, derived from the literature review, show that action controls, result controls, personnel controls, and cultural controls are sufficient for risk assessment and treatment. This interesting result shows that, according to fsQCA, controls are not necessary and sufficient for risk reporting and monitoring results, but it is sufficient that conditions exist for the assessment and treatment of risk. This result is linked to the nature of the risk management phases considered: risk assessment and treatment have a technical (Schaltegger and Burritt, 2005), organisational (Ahrens and Chapman, 2007; Brown and Duguid, 1991) and cognitive nature (Hoffman and Bazerman, 2007) and tend to act more on the control dimension (Gond *et al.*, 2012); whereas risk reporting and risk monitoring are technical in nature and are the effects of the correct implementation of controls over the other phases of risk management (Battaglia *et al.*, 2016; Lai *et al.*, 2014; Porac and Thomas, 2002).

Based on our analysis, management controls have a relevant role in supporting an organisation's response to risks. At the organisational level, management controls facilitate close internal co-ordination among staff members regarding the different risk management phases, and support the definition of the various operational practices capable of facilitating the response to emergencies. In the external dimension, control mechanisms can foster dialogue, trust, and opportunities to mitigate the impacts that may emerge from these risks.

From this perspective, the harmonious management of control systems gives visibility to the greater complexity generated from a crisis at all levels of controls-a result that is in line with previous literature highlighting the concomitant use of multiple control mechanisms to deal with unplanned situations (Bedford and Malmi, 2015; Passetti *et al.*, 2021; Rikhardsson *et al.*, 2021; Van der Kolk *et al.*, 2015). Indeed, the action controls allow rigorous and extraordinary operational co-ordination of health, safety, and prevention practices to minimise the occurrence of emergencies. However, this technical dimension should be integrated with the active participation of staff (skilled and empowered) who can manage critical situations with a sensitivity of governance and a set of values (cultural controls) aimed at guiding processes, detecting the needs of stakeholders, and responding to their expectations. Finally, the result controls enable the measurement of the effectiveness of what has been implemented, facilitating the correct identification of actions that can be implemented.

In short, companies should holistically manage risk to avoid unexpected adverse events under a system of controls based on organic rather than mechanistic approaches. They should also consider stakeholders at all stages of the risk management process, not sporadically or superficially.

This study provides significant contributions from both theoretical and managerial perspectives. Theoretically, it enhances the ongoing discussion on integrated risk governance by emphasising the importance of adopting a strategic agility perspective (McGrath, 2013)-highlighting the organisation's ability to rapidly adapt to changing conditions and emerging risks-while actively involving stakeholders throughout all phases of the risk management process. In this view, stakeholders are not only affected parties, but strategic allies whose engagement is crucial to ensure responsiveness, relevance, and resilience in an increasingly uncertain environment. Our updated literature review addresses a critical gap: while many studies focus on individual phases of risk management, a comprehensive approach that integrates the entire risk management cycle while considering the role of stakeholders is largely missing. By applying the object of control framework (Merchant and Van der Stede, 2012), this study identified theoretical configurations that link stakeholder engagement and the adoption of specific control mechanisms to corporate practices in managing non-financial risks.

The results revealed that the existing literature focuses on the risk management and control phase. Significantly, many contributions concentrate on a single phase of the risk management process, overlooking the integrated perspective across all phases to achieve truly effective and proactive risk management. Furthermore, stakeholders are recognised as essential actors whose engagement must evolve from operational involvement to a strategic partnership role, contributing actively to organisational learning, adaptability and risk anticipation. This theoretical fragmentation points to the need for more integrated approaches that recognise the interdependence of various phases of risk management and the evolving nature of stakeholder relationships.

From a managerial perspective, the results offer concrete implications for organisations. Companies are encouraged to adopt a holistic and cross-functional view of risk by integrating stakeholder contributions throughout the entire management cycle-from risk analysis and evaluation to treatment, communication, and monitoring. Customers, suppliers, employees, and investors can serve as valuable sources of knowledge, helping anticipate unforeseen events, thereby enhancing organisational resilience and improving adaptability to changing environments. Moreover, structured stakeholder engagement can promote organisational learning, innovation, and transformation, thereby supporting the long-term sustainability of business decisions. Companies are encouraged to adopt a holistic and agile view of risk, integrating stakeholder contributions throughout the entire management cycle as strategic resources capable of detecting weak signals, triggering innovation, and supporting long-term adaptability.

Another important managerial implication is the need to implement coherent and harmonised control systems across all stages of the risk management process. The lack of structured controls in critical phases, such

as monitoring and reporting, can undermine the overall effectiveness of risk governance. Therefore, companies need to establish integrated control mechanisms that support not only risk identification and assessment but also ongoing risk management and continuous stakeholder dialogue. Our analysis suggests that while companies may apply certain controls at specific points, they often fail to implement them consistently throughout the entire process. However, a harmonised and proactive control system is crucial for increasing the likelihood of achieving organisational objectives and aligning internal behaviours with those objectives.

Each type of control impacts specific aspects of risk management, but only an integrated approach-one that combines multiple control mechanisms-can produce truly effective responses. This finding aligns with existing literature, which emphasises that managing non-financial risks requires a systemic perspective and coherence between strategy, control, and stakeholder engagement.

5. Conclusions, limitations, and future research

In conclusion, adopting an integrated approach to risk management that combines strategy, control systems, and active stakeholder engagement represents not only a theoretical challenge but also a practical means to enhance organisational resilience and sustainability.

While this study makes a significant contribution to the field, it also has its limitations. The findings primarily rely on a review of existing literature, which may not fully capture the diverse range of risk management experiences and practices found in different business contexts.

Moreover, fsQCA provides significant insights into complex causal structures, but it comes with its own set of challenges. A major issue is the calibration process, which transforms raw data into fuzzy sets. This process requires researchers to make critical decisions based on theoretical reasoning and assumptions (Ragin, 2008). As a result, even small changes in calibration thresholds can lead to different configurations and interpretations, highlighting the method's sensitivity and the inherent subjectivity involved. Moreover, although fsQCA excels at examining the interplay among conditions within causal configurations, it does not quantify the causal power of individual conditions or uncover the underlying causal mechanisms. Therefore, employing complementary analytical approaches-whether qualitative or statistical-could deepen the understanding of these complex relationships.

Additionally, the findings from fsQCA are often context dependent, necessitating caution when attempting to generalise results beyond the specific cases studied (Jiang *et al.*, 2018). Conducting replication studies across various settings can enhance the external validity and robustness of the conclusions.

Even though efforts were made to calibrate variables based on objective benchmarks, some degree of subjectivity was unavoidable. As Ragin (2009) has pointed out, defining thresholds inevitably involves the researchers' theoretical and empirical judgement. Thus, while fsQCA can

identify necessary conditions within a given configuration, Dul (2016) has suggested that Necessary Condition Analysis (NCA) provides a valuable extension by identifying additional necessary conditions and quantifying the minimum levels required to achieve a specific outcome. In this context, applying NCA in future quantitative studies could offer greater clarity regarding the role and relevance of necessary conditions.

As a priority for future research, we advocate for the need to analyse how controls act, specifically in the management of non-financial risks. Controls are essential to prevent, manage, and trigger a proactive and doubtful attitude within the company regarding unexpected events, which can help identify risks. The active participation of the staff enables the correct management of critical situations. Furthermore, a high governance sensitivity and the presence of corporate values aimed at orienting risk management processes facilitate a reduction in the occurrence of risks and the effective management of unexpected events when they occur. Future research should analyse, above all, the role of value and organisational controls, which are currently underestimated in risk management processes. Along with other controls, they have a fundamental role to play in facilitating emergency responses.

Additionally, our study identifies the importance of managing all risk management phases and the relationships between controls and the risk management phases. Future research should thoroughly investigate the nature of the relationship between controls and risk management phases to understand whether it is possible to start with this relationship and provide a profile of the risks that might be faced by companies. This would allow companies to systematically manage all stages of risk management and act on non-financial risks through a harmonised system of controls to address unplanned situations (Bedford and Malmi, 2015; Passetti *et al.*, 2021; Rikhardsson *et al.*, 2021; Van der Kolk *et al.*, 2015).

This study also highlights the fundamental role of stakeholders in risk management. Future research could analyse the degree of engagement among each category of stakeholder and propose suggestions for increasing this engagement. Furthermore, it would be very useful for companies to identify the most strategic categories of stakeholders that need to be more involved to effectively manage risks. This involvement is useful for companies to identify risks and effectively manage them and respond to the needs and requests of stakeholders. Furthermore, it is important to improve the relationship between the company and its stakeholders, who play a fundamental role in the survival of companies.

Future research could also benefit from replicating this fsQCA-based approach in different companies, regions, and institutional contexts to improve generalisability. Combining fsQCA with longitudinal or mixed-method designs may provide a more comprehensive understanding of causal pathways and the dynamics of systemic risk governance over time. Additionally, integrating stakeholder interviews or using hybrid approaches such as NCA or structural equation modelling may provide more detailed insights into the strength, direction, and conditionality of specific risk management configurations. Furthermore, our findings highlight the importance of examining corporate strategies for integrating

non-financial risk management frameworks, particularly through the explicit or implicit involvement of stakeholders in risk management practices. Future research could undertake an empirical analysis of a sample of companies to explore the role of stakeholders, their level of engagement in non-financial risk management phases, the categories of stakeholders prioritised by companies, and the challenges they encounter in involving these stakeholders. Such an empirical analysis could generate valuable practical evidence that can be compared with existing literature. The proposed research may also serve as a guide in identifying the risk management phases that should be considered in empirical studies.

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Annex 1. Literature Review

Authors	Year	Title of the article	Object of control	Research object	Stakeholder
Risk assessment					
Zafar I., Wuni I.Y., Shen G.Q.P., Ahmed S., Yousaf T.	2019	A fuzzy synthetic evaluation analysis of time overrun risk factors in highway projects of terrorism-affected countries: the case of Pakistan	Action - how to act in order not to exceed the project times	Highway projects, risk and stakeholder management	General reference to stakeholders, without specification
Lo F.Y., Wong W.K., Geovani J.	2021	Optimal combinations of factors influencing the sustainability of Taiwanese firms	Result - control over the results of financial performance	Optimal combinations of factors from institutional environment adaptation mechanisms and internal resources or capabilities that influence the sustainability of a firm.	General reference to stakeholders, without specification
Testorelli R., Verbano C.	2020	Value creation with project risk management: a systematic literature review	Result - identify, analyse, evaluate and address the risks inherent in the project	Project risk management as a process of creating value for companies.	General reference to stakeholders, without specification
Liu W., Wei W., Yan X., Dong D., Chen Z.	2020	Sustainability risk management in a smart logistics ecological chain: An evaluation framework based on social network analysis	Result - check results to reduce risk	Risk management in the smart logistics eco-chain	General reference to stakeholders, without specification
Hernandez D.F., Haddud A.	2018	Value creation via supply chain risk management in global fashion organizations outsourcing production to China	Result - control over operational performance	Complexity of global supply chains and its intrinsic risk	Customers
Gogan L.M.	2014	A new Platform to Evaluate Intellectual Capital	Result - platform to control the results of intellectual capital	It evaluates intellectual capital	Employees
Popescu S.G., Petruş A.A.	2012	Risk analysis methods in project management. Critical analysis	Result - identify risks in the assessment and control phases	Project management	Employees
Lo F.Y., Wong W.K., Geovani J.	2021	Optimal combinations of factors influencing the sustainability of Taiwanese firms	Personnel - checks on innovation capacity and production capacity and human capital	Optimal combinations of factors from institutional environment adaptation mechanisms and internal resources or capabilities that influence the sustainability of a firm	General reference to stakeholders, without specification
Testorelli R., Verbano C.	2020	Value creation with project risk management: a systematic literature review	Personnel - checks on perceptions and expectations	Project risk management as a process of creating value for companies.	General reference to stakeholders, without specification
Zafar I., Wuni I.Y., Shen G.Q.P., Ahmed S., Yousaf T.	2019	A fuzzy synthetic evaluation analysis of time overrun risk factors in highway projects of terrorism-affected countries: the case of Pakistan	Personnel - checks on the workforce	Highway projects, risk and stakeholder management	General reference to stakeholders, without specification
Hernandez D.F., Haddud A.	2018	Value creation via supply chain risk management in global fashion organizations outsourcing production to China	Personnel - checks on the risk elements that have proved to be the most influential	Complexity of global supply chains and its intrinsic risk	Customers
Fotr J., Spacek M., Soucek I., Vacik E.	2015	Scenarios, their concept, elaboration and application	Personnel - work with risks and give organizational support of the results in the company	It explains the risk mitigation approach	Social stakeholders
Gogan L.M.	2014	A new Platform to Evaluate Intellectual Capital	Personnel - control over intellectual capital	Evaluate intellectual capital	Employees
Popescu S.G.	2012	Risk analysis methods in project management. Critical analysis	Personnel - personnel checks	Project management	Employees
Hsiao A., Ploughman M.	2009	Strategic Risk Management in New Product Development	Personnel - checks on project execution	How SMEs manage the risks associated with innovation	General reference to stakeholders, without specification
Lo F.Y., Wong W.K., Geovani J.	2021	Optimal combinations of factors influencing the sustainability of Taiwanese firms	Cultural - checks on the corporate sustainability index	Optimal combinations of factors from institutional environment adaptation mechanisms and internal resources or capabilities that influence the sustainability of a firm	General reference to stakeholders, without specification
Testorelli R., Verbano C.	2020	Value creation with project risk management: a systematic literature review	Cultural - control over the measurement of value	Project risk management as a process of creating value for companies.	General reference to stakeholders, without specification
Zafar I., Wuni I.Y., Shen G.Q.P., Ahmed S., Yousaf T.	2019	A fuzzy synthetic evaluation analysis of time overrun risk factors in highway projects of terrorism-affected countries: the case of Pakistan	Cultural - Decision support system for risk management	Highway projects, risk and stakeholder management	General reference to stakeholders, without specification
Hernandez D.F., Haddud A.	2018	Value creation via supply chain risk management in global fashion organizations outsourcing production to China	Cultural - controls to measure the risk associated with global outsourcing	Complexity of global supply chains and its intrinsic risk	Customers
Fotr J., Spacek M., Soucek I., Vacik E.	2015	Scenarios, their concept, elaboration and application	Cultural - controls to mitigate risk	It explains the risk mitigation approach	Social stakeholders

Authors	Year	Title of the article	Object of control	Research object	Stakeholder
Risk reporting					
Karwowski M., Raulinajtys-Grzybek M.	2021	The application of corporate social responsibility (CSR) actions for mitigation of environmental, social, corporate governance (ESG) and reputational risk in integrated reports	Action - analyze the role of CSR in risk mitigation	CSR to prevent the risks borne by companies	Stakeholders involved in CSR
Lakshan A.M.I., Low M., de Villiers C.	2021	Management of risks associated with the disclosure of future-oriented information in integrated reports	Action - information disclosure controls	PurposeIntegrated reporting (IR) promotes the disclosure of future-oriented information to enable financial stakeholders to make better-informed decisions	Disclosure of information to enable stakeholders to make more informed decisions
Reimsbach, D., Schiemann F., Hahn R., Schmiedchen E.	2020	In the Eyes of the Beholder: Experimental Evidence on the Contested Nature of Materiality in Sustainability Reporting	Action - risk assessment controls	Information from sustainability reports	General reference to stakeholders, without specification
Bager S.L., Lambin E.F.	2020	Sustainability strategies by companies in the global coffee sector	Action - checks on sustainable action efforts	Sustainability challenges in the coffee sector	General reference to stakeholders, without specification
Buniamin S.	2020	Managers' perceptions on stakeholder power in relation to esg reporting	Action - checks on the perceptions of managers	It investigates managers' perceptions of stakeholder power among different stakeholder groups in relation to ESG reporting	Employees, shareholders, communities, customers
Baditoiu B.R.	2019	The integrated reporting "stakeholder relationships" principle in the ccount financial sector	Action - information disclosure controls	Analysis of the quality and complexity of the content found in the integrated reports	The relationship with stakeholders reduces corporate risk. Shareholders and investors, employees, customers and suppliers, the community and the environment
Guserl R.	2016	Unprofessionalism in finance leads to destructive effects on corporate governance	Action - control system design and implementation	How corporate governance is the system that directs and controls the operations of the firm	Suppliers, customers and shareholders
Al-Shaer H., Albitar K., Hussainey K.	2022	Creating sustainability reports that matter: an investigation of factors behind the narratives	Result - controls on risk communication in sustainability reports	It examines sustainability reports	General reference to stakeholders, without specification
Koc K., Gurgun A.P.	2021	Stakeholder-Associated Life Cycle Risks in Construction Supply Chain	Result - checks on results in construction projects	Risk identification to meet supply chain performance objectives in construction projects	General reference to stakeholders, without specification
Karwowski M., Raulinajtys-Grzybek M.	2021	The application of corporate social responsibility (CSR) actions for mitigation of environmental, social, corporate governance (ESG) and reputational risk in integrated reports	Result - control over the results to prevent risks	CSR to prevent the risks borne by companies	Stakeholders involved in CSR
Lakshan A.M.I., Low M., de Villiers C.	2021	Management of risks associated with the disclosure of future-oriented information in integrated reports	Result - results control	PurposeIntegrated reporting (IR) promotes the disclosure of future-oriented information to enable financial stakeholders to make better-informed decisions	Disclosure of information to enable stakeholders to make more informed decisions
Buniamin S.	2020	Managers' perceptions on stakeholder power in relation to esg reporting	Result - ESG risk controls	It investigates managers' perceptions of stakeholder power among different stakeholder groups in relation to ESG reporting	Employees, shareholders, communities, customers
Ahmed D.A.H., Eliwa Y., Power D.M.	2019	The impact of corporate social and environmental practices on the cost of equity capital: UK evidence	Result - lower level of risk for companies managing social and environmental problems	Integration of social and environmental practices into company operations requested by stakeholders	Companies carry out operations requested by stakeholders
Schaltegger S., Zvezdov D., Etxeberria I.A., Csutora M., Günther E.	2015	Corporate carbon and climate accounting	Result - risk controls	Management accounting approaches for analyzing the business benefits and costs of climate change	Relationship with stakeholders
Henklang P., Boonlua S., Ussahawanitchakit P.	2014	Proactive internal control system and firm success: A conceptual framework	Result - proactive internal control system	It investigates organizational risk reduction and stakeholder satisfaction	Stakeholder satisfaction
Callaghan J., Nehmer R.	2009	Financial and governance characteristics of voluntary XBRL adopters in the United States	Result - reporting control	eXtensible Business Reporting Language (XBRL)	community, investors, analysts, regulators and various other corporate stakeholders
Smythe J.	2007	Employee engagement - Its real essence: … and how it helped to transform a top-four UK bank	Result - control over the power given to employees	It explains how opening up decision making to those who can add value helps to transform organizational performance	Employees power
Stanbury J., Pryer M., Roberts A.	2005	Heroes and villains - Tour operator and media response to crisis: An exploration of press handling strategies by UK adventure tour operators	Result - controls on the influence of the media	Strategies employed to handle press during crisis will have far-reaching implications on the reputations of adventure tour operators, and the industry	Costumers
Lakshan A.M.I., Low M., de Villiers C.	2021	Management of risks associated with the disclosure of future-oriented information in integrated reports	Personnel - ensure individual accountability for achieving goals	PurposeIntegrated reporting (IR) promotes the disclosure of future-oriented information to enable financial stakeholders to make better-informed decisions	Disclosure of information to enable stakeholders to make more informed decisions
Karwowski M., Raulinajtys-Grzybek M.	2021	The application of corporate social responsibility (CSR) actions for mitigation of environmental, social, corporate governance (ESG) and reputational risk in integrated reports	Personnel - work control	CSR to prevent the risks borne by companies	Stakeholders involved in CSR
Buniamin S.	2020	Managers' perceptions on stakeholder power in relation to esg reporting	Personnel - ESG risk controls	It investigates managers' perceptions of stakeholder power among different stakeholder groups in relation to ESG reporting	Employees, shareholders, communities, customers
Lakshan A.M.I., Low M., de Villiers C.	2021	Management of risks associated with the disclosure of future-oriented information in integrated reports	Cultural - link the disclosed objectives to the company's risk management practices	PurposeIntegrated reporting (IR) promotes the disclosure of future-oriented information to enable financial stakeholders to make better-informed decisions	Disclosure of information to enable stakeholders to make more informed decisions
Karwowski M., Raulinajtys-Grzybek M.	2021	The application of corporate social responsibility (CSR) actions for mitigation of environmental, social, corporate governance (ESG) and reputational risk in integrated reports	Cultural - risk cultural control	CSR to prevent the risks borne by companies	Stakeholders involved in CSR
Baig, M.H., Jin, X., Ali, R.	2024	Politically connected business and real earnings management: the moderating role of family control and audit quality	Result - Financial risk	Financial information related to risks	Internal and external stakeholder
Xiaoxia, L., Minghui, L.	2023	Do creditors punish real earnings management behavior? Evidence from the cost of debt	Result - Financial risk	Financial information related to risks	Finanacial information to stakeholder
Buniamin S.	2020	Managers' perceptions on stakeholder power in relation to esg reporting	Cultural - ESG risk controls	It investigates managers' perceptions of stakeholder power among different stakeholder groups in relation to ESG reporting	Employees, shareholders, communities, customers

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Vol. 43, Issue 3, 2025

Authors	Year	Title of the article	Object of control	Research object	Stakeholder
			Risk treatment		
Guserl R.	2016	Unprofessionalism in finance leads to destructive effects on corporate governance	Action - controls on actions to manage risks	How corporate governance is the system that directs and controls the operations of the firm	Suppliers, customers and shareholders
Lueg R., Pedersen M.M., Clemmensen S.N.	2015	The Role of Corporate Sustainability in a Low-Cost Business Model - A Case Study in the Scandinavian Fashion Industry	Action - controls on actions to manage risks	Corporate sustainability contributes to the low-cost business model	General reference to stakeholders, without specification
Bostan I., Tulvinschi M., Mates D., Grosu V., Hlaciuc E., Socoliuc M., Bobar A., Mihalciuc C.	2012	Observations on budgeting and planning under an efficient controlling system on a corporate level	Action - control procedures	How companies must manage the risks that also affect the relationship with stakeholders	Business partners or other categories of stakeholders
Kuruppu, S.C., Milne, M.J., Tilt, C.A.	2024	Sustainability control systems in short-term operational and long-term strategic decision-making	Action - sustainability control systems	Economic, social and environemntal risks	Stakeholder engagement
Leopoulos V., Kirytopoulos K., Malandrakis C.	2004	Addressing the problem of limited resources in managing risks	Action - identification, analysis, practices of mitigation of risks	Project Risk Management	It describes the effort that Risk Managers make to persuade Project Stakeholders about the benefits that Risk Management can bring
Liu, Z.X., Ding, R.G., Wang, L., Song, R., Song, X.Y.	2023	Cooperation in an uncertain environment: The impact of stakeholders' concerted action on collaborative innovation projects risk management	Action - risk management in project	Project Risk Management	Risk management strategies of stakeholders
Osland A., Osland J.S.	2007	Aracruz Celulose: Best practices icon but still at risk	Action - operational control practices	Global risks facing an award-winning company known for best practices in sustainability and HRM that, nevertheless, is challenged by a contentious land dispute with indigenous communities and numerous stakeholders	Human resources management
Wang Z.S., Zhou Y.X., Jin X.H., Zhao N., Sun J.S.	2022	Risk allocation and benefit distribution of PPP projects for construction waste recycling: a case study of China	Result - projects check	Public-private partnership (PPP) projects	Sharing risk and distributing income to achieve a win-win situation for all among the different stakeholders
Wu P.-J., Lin L.-T., Huang C.-C.	2021	Diagnosing the service quality of perishable-food logistics: temperature-sensitive milk delivery	Result - quality control in the cold chain	It investigates the service quality of such logistics, using a real-life case of temperature-sensitive milk delivery	Collaborating with their stakeholders can help mitigate potential risks
Prioteasa A.L., Ciocoiu C.N., Chitimiea A., Vaduva V.R.	2020	An Approach To The Implementation of Risk Management In Operating Activities of Romanian SMEs	Result - risk management controls	SMEs and risk management	Increase in stakeholder satisfaction and their involvement in risk management
Liu W., Wei W., Yan X., Dong D., Chen Z.	2020	Sustainability risk management in a smart logistics ecological chain: An evaluation framework based on social network analysis	Result - checks with social network analysis to analyze risk factors	Risk management in the smart logistics eco-chain	General reference to stakeholders, without specification
Zhu J., Hertogh M., Zhang J., Shi Q., Sheng Z.	2020	Incentive mechanisms in mega project-risk management considering owner and insurance company as principals	Result - risk control in projects	In mega-projects, stakeholders can be exposed to significant construction risks	Stakeholder, especially owners and insurance companies
Abiodun Eniola A.	2020	Internal control procedures and firm's performance	Result - risk control, management and monitoring practices	It analyzes internal control procedures and the performance of the company	General reference to stakeholders, without specification
Manab N.A., Aziz N.A.A.	2019	Integrating knowledge management in sustainability risk management practices for company survival	Result - checks on unknown risks associated with environmental complexity	Sustainability risk management	The negative effects of risks affect the corporate image and relationships with business partners or other categories of stakeholders
Guimarães A.G., Vaz-Fernandes P., Ramos M.R., Martinho A.P.	2018	Co-processing of hazardous waste: The perception of workers regarding sustainability and health issues in a Brazilian cement company	Result - sustainability checks in a cement factory	The practise of co-processing	Perception of workers
ElKelish W.W.	2018	Corporate governance risk and the agency problem	Result - statistical checks	It investigates the relationship between corporate governance risk and agency costs across different countries	Risk management helps different stakeholders make decisions
Matescu R.M., Maftei M., Verjel A.-M., Lange S.	2017	The interrelation between risk management and the organizational context: Influence, support and barriers	Result - risk control	Risk management (RM)	It investigates how external factors such as stakeholders, political or social factors and also how vision, strategy and other internal factors related to the organizational context impact the risk management process. Mutual influence is undisputed: a successful management process is supported by all stakeholders, is in line with the corporate vision and strategies and also makes an important contribution to the results of the organization
[No author name available]	2016	Corporate social responsibility and firm risk: The varying effect of individual dimensions	Result - identifying ways to control risk so as to minimize any negative spillovers	It reviews the latest management developments across the globe and pinpoint practical implications	Consumers are increasingly attentive to information regarding risk
Pham T.T.K.	2016	The Relationship between corporate governance and the performance of the Firm: A literature review with a focus on the vietnamses enterprises	Result - well controlled and oriented business development for the company	Corporate governance	Good governance manages risks better and builds good relationships with stakeholders
Schaltegger S., Zvezdov D., Etxeberria I.A., Csutora M., Günther E.	2015	Corporate carbon and climate accounting	Result - performance measurement	Management accounting approaches for analyzing the business benefits and costs of climate change	Relationship with stakeholders
Arnold V., Benford T., Canada J., Sutton S.G.	2015	Leveraging integrated information systems to enhance strategic flexibility and performance: The enabling role of enterprise risk management	Result - performance check	Enterprise Risk Management (ERM)	General reference to stakeholders, without specification
Aureli S., Salvatori F.	2012	Are performance-dependent rewards a viable tool to assure managers' commitment toward firms' goals about risk management'	Result - risk measures in incentive systems	Risk management is crucial for achieving strategic objectives in a complex and uncertain environment	General reference to stakeholders, without specification
Popescu S.G., Petruş A.A.	2012	Risk analysis methods in project management. Critical analysis	Result - identify risks during assessment and control	Project management	Employees
Clarke B.	2011	The eu takeovers directive: A shareholder or stakeholder model?	Result - increased corporate accountability and greater controls over public companies	Risk taking and broad stakeholder view	It considers the well-being of stakeholders
Hendrikse G., Windsperger J.	2008	Introducing "Strategy and governance of networks	Result - risk control and mitigations	relative efficiency of the strategy and governance of an enterprise	Risk mitigation from opportunistic behavior and stakeholder management
Kneebel W.R., Willekens M.	2006	The role of risk management and governance in determining audit demand	Result - controls are only complementary as long as they are voluntary, as mandated controls act as substitutes for non-mandated controls	Disclosures about risk and risk management and actual decisions about corporate governance	External auditing will increase in situations where there are multiple stakeholders with individual risk profiles who may pass on part of the cost of monitoring to other stakeholders
Stanbury J., Pryer M., Roberts A.	2005	Heroes and villains - Tour operator and media response to crisis: An exploration of press handling strategies by UK adventure tour operators	Result - controls to prevent crises	As news dissemination quickens, and consumer awareness increases, strategies employed to handle press during crisis will have far-reaching implications on the reputations of adventure tour operators, and the industry	Consumers, media and stakeholders
Borggraefe J.	2016	Human resources governance and compliance: Introduction and overview	Personnel - Human resources controls	Corporate social responsibility	Human resources, media, and many other social stakeholders as responsible subjects that are expected not only to act compliant but also to act ethically legitimated
Popescu S.G., Petruş A.A.	2012	Risk analysis methods in project management. Critical analysis	Personnel - risk controls to achieve project objectives	Project management	Employees
Hirsch P.B.	2017	Chained to a rock	Cultural - reputational checks	Reputational challenge for brands in social media in an era of heightened political and cultural polarization	Relationship with costumers
Tse M.C., Kahlon R.S.	2013	How Planguage Measurement Metrics: Shapes System Quality	Cultural - risk control to increase the quality of the relationship between people, processes and technology	Innovative IT projects in the public sector healthcare	Reduce the risk of failure of IT projects, improve the understanding and quality of interrelationship between people, processes and technology and consider the point of view of stakeholders
Zeng S.X., Shi J.J., Lou G.X.	2007	A synergetic model for implementing an integrated management system: an empirical study in China	Cultural - control over the integrated management system	The implementation and certification of quality, environmental and occupational health and safety management systems	Stakeholders, customers and institutional environment

Authors	Year	Title of the article	Object of control	Research object	Stakeholder
Risk monitoring					
Britvic J., Merkas Z., Tenjeri T.	2021	POSSIBILITIES OF ISO 9001: 2015 QMS AND ISO/IEC 27001:2013 ISMS INTEGRATION	Action - checks on the quality of products and processes and suppliers	Environmental management systems	Relationship with suppliers
Naidoo M., Gasparatos A.	2018	Corporate environmental sustainability in the retail sector: Drivers, strategies and performance measurement	Action - controls to reduce environmental impacts	Reduction of the internal and external environmental impacts of operations	Pressure from internal and external stakeholders will increasingly become a dominant factor
Guserl R.	2016	Unprofessionalism in finance leads to destructive effects on corporate governance	Action - controls over the company's operations	How corporate governance is the system that directs and controls the operations of the firm	Suppliers, customers and shareholders
Lueg R., Pedersen M.M., Clemmensen S.N.	2015	The Role of Corporate Sustainability in a Low-Cost Business Model - A Case Study in the Scandinavian Fashion Industry	Action - controls to manage risk	Corporate sustainability contributes to the low-cost business model	General reference to stakeholders, without specification
Bostan I., Tulvinschi M., Mates D., Grosu V., Hlaciuc E., Socoliuc M., Bobar A., Mihalciuc C.	2012	Observations on budgeting and planning under an efficient controlling system on a corporate level	Action - businesses need to monitor and validate control activities and procedures	How companies must manage the risks that also affect the relationship with stakeholders	Business partners or other categories of stakeholders
Jin F., Xiang W.W., Ji Z., Zhang B.C.	2022	Quantifying the evolutionary mechanism of COVID-19 impact on international construction multi-projects: a risk driver perspective	Result - control over projects	It quantifies the evolutionary mechanism of coronavirus disease 2019 (COVID-19) impact on international construction multi-projects.	The simulated results of these models are used to drive effective risk control to meet customer requirements
Fakhfakh I., Jarboui A.	2022	Board of director's effectiveness, audit quality and ownership structure: impact on audit risk-Tunisian evidence	Result - revision controls	It investigates the potential influence of internal and external corporate governance mechanisms on audit risk	Investors and stakeholders
Wu P.-J., Lin L.-T., Huang C.-C.	2021	Diagnosing the service quality of perishable-food logistics: temperature-sensitive milk delivery	Result - quality check	It investigates the service quality of such logistics, using a real-life case of temperature-sensitive milk delivery	Collaborating with their stakeholders can help mitigate potential risks
Abiodun Eniola A.	2020	Internal control procedures and firm's performance	Result - internal control procedures	It analyzes internal control procedures and the performance of the company	General reference to stakeholders, without specification
Ahmed D.A.H., Eliwa Y., Power D.M.	2019	The impact of corporate social and environmental practices on the cost of equity capital: UK evidence	Result - controls of social and environmental practices in company operations	Integration of social and environmental practices into company operations requested by stakeholders	Companies carry out operations requested by stakeholders
Parshakov P.	2017	Observing unobservable: estimating the time-varying efficiency of intellectual capital	Result - monitor the dynamic efficiency of a company's intellectual resources	Company intellectual capital (IC) is nowadays considered as a key resource that can transform a company's value	Human resources
Schaltegger S., Zvezdov D., Etxeberria I.A., Csutora M., Günther E.	2015	Corporate carbon and climate accounting	Result - business performance checks	Management accounting approaches for analyzing the business benefits and costs of climate change	Relationship with stakeholders
Aureli S., Salvatori F.	2012	Are performance-dependent rewards a viable tool to assure managers' commitment toward firms' goals about risk management	Result - risk management controls	Risk management is crucial for achieving strategic objectives in a complex and uncertain environment	General reference to stakeholders, without specification
Callaghan J., Nehmer R.	2009	Financial and governance characteristics of voluntary XBRL adopters in the United States	Result - internal reporting	eXtensible Business Reporting Language (XBRL)	Community, investors, analysts, regulators and various other corporate stakeholders
Knechel W.R., Willekens M.	2006	The role of risk management and governance in determining audit demand	Result - auditor checks	Disclosures about risk and risk management and actual decisions about corporate governance	External auditing will increase in situations where there are multiple stakeholders with individual risk profiles who may pass on part of the cost of monitoring to other stakeholders
Borggraefe J.	2016	Human resources governance and compliance: Introduction and overview	Personnel - human resources controls	Corporate social responsibility	Human resources, media, and many other social stakeholders as responsible subjects that are expected not only to act compliant but also to act ethically legitimated

Source: Authors' elaboration.

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ISSN print 0393-5108
ISSN online 2785-549X
DOI 10.7433/s128.2025.04
pp. 73-107

FONDAZIONE CUEIM

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The role of communication in the digital transformation of SMEs: an analysis in the agrifood sector[1]

Received
31st October 2023
Revised
10th Marc 2025
Accepted
18th June 2025

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Abstract

Frame of the research. *In recent years, the academic literature focused on understanding why small and medium-sized enterprises (SMEs) struggle in revising their business models and adopting digital tools for communication, marketing and operations. A common reason given is that they lack the resources and skills to adapt to change. SMEs in the agrifood industry are vulnerable to these problems, given their positioning in a low-tech, traditional industry.*

Purpose of the paper. *Our research focuses on online communication strategies as a gateway for SMEs' digital transformation. Since contents on brand, quality, and provenance are crucial for agrifood consumers, SMEs adopt communication technologies, but whether digitisation affects other areas is not clear. Our primary research question, thus, is: how do marketing communication strategies influence digital transformation in SMEs in the agrifood industry?*

Methodology*. The study is based on a qualitative multi-case approach. Through an abductive approach, we explored the field and systematized the evidence to produce accounts of the potential influences between digital communication and digital transformation by collecting extensive sets of secondary data on SMEs and interviewing key informants in a group of selected SMEs. We analysed the empirical evidence based on a checklist of categories informed by extant literature, coded it, and obtained themes that shed light on the interactions between digital communication and digital transformation in agrifood SMEs.*

Results*. The findings point to relevant themes that could guide further theoretical development: we find evidence on the interaction between perceived usefulness and easiness of digital tools, on the learning processes made possible by external agencies, and on the downsides of the do-it-yourself approach.*

Research limitations. *The study focuses on the agrifood industry; comparisons with similar depth in other industries could favour the emergence of further themes and help weigh their relative importance.*

Practical implications. *Our findings could contribute to improving the digital transformation process in SMEs; they systematise the different factors that managers can combine to trigger organisational learning and the emergence of consensus.*

Originality of the paper. *The paper explores the role of communication in the digital transformation of Italian agrifood SMEs, an empirical context previously*

unstudied in depth. It specifies constructs from the theory of acceptance (TAM), shedding light on the potential negative effects of perceived easiness. It also contributes to literature on the do-it-yourself behaviour (DIY) applied to businesses by framing the role of agencies.

Key words: *Digital communication; digital transformation; digital marketing; SMEs; agrifood industry*

1. Introduction

Several factors constrain small and medium-sized enterprises' (SMEs henceforward) capacity to pursue strategic innovation and operational change (i.e., De Paoli *et al.*, 2020). Small size and the absence of slack resources make them prone to focus on operational urgencies to the detriment of long-term planning (Hess *et al.*, 2016). Their specialisation in few operations and phases within larger value chains makes them domain specialists, a factor that inhibits the development of complementary capabilities (Li *et al.*, 2018). The previous factors lead to other constraints, as documented in previous literature. Domain specialism and a focus on operations channel SMEs' hiring practices towards specific competence profiles, inhibiting the hybridization of traditional and novel skills (Coco *et al.*, 2023). "Tertiary" functions such as marketing and communication are often under-staffed compared to operations. When marketing and communication are considered, literature shows that communication experts and/or agencies play a vital role in helping SMEs establish and maintain their brand image, reach their target audience, and achieve their marketing goals: they allow SMEs to access professional services without the cost of maintaining an in-house marketing department, but several obstacles often make the matching difficult (Clow and Baack, 2017). Numerous factors make it often difficult for SMEs to resort to external actors for reasons of trust, culture, or uncertainties on budget allocations.

We assume digital channels allow SMEs to adopt practices that resemble those of larger organisations (i.e., Taiminen and Karjaluoto, 2015). They enlarge the reach of firms' communication, allowing them to talk to large and heterogeneous audiences at affordable costs. The ability to better interact with customers at acceptable costs could drive the transformation of processes and SMEs' business models, thus pushing digital tools also in the back end, such as in operations through industry 4.0 technologies (Bettiol *et al.*, 2021), servitization (Paiola, 2018), e-commerce and much more. Scholarly and practitioners' discussions stressed the need to speed up SMEs' digital transformation. Digital transformation is a multidisciplinary process that enhances an organization's performance and encompasses all changes digital technologies can bring to its business model, products, processes, and organizational structures (Hess *et al.*, 2016; Deloitte, 2018; Vial, 2019). It can change every aspect of business, in particular the marketing area (Caliskan *et al.*, 2020). Using digital tools in marketing communication could be conducive to SMEs' digital transformation and to the revision of internal and external processes, affecting the organizational

model and relationships with suppliers and partners (Alnuaimi *et al.*, 2022). Thus, we observe not only the transition from analogue to digital but also the set of socio-technical paths and phenomena of adoption and use of (digital) technologies within organisational contexts.

The emphasis policymakers put on calls to speed up digital transformation increased given the importance of information technologies in allowing firms to meet sustainability targets and, ultimately, embark on a twin transition of their strategies (Muench *et al.*, 2022). Answering to these calls requires approaches that are context sensitive and aimed at capturing the determinants of, and the constraints to, mature adoption of digital solutions. This change is also visible when looking at the evolution of some marketing communication actors, as evidenced by the proliferation of several specialized digital agencies (Ceccotti *et al.*, 2024; Hughes and Vafeas, 2019)

This paper follows suit, adopting a qualitative and sector-focused approach to highlight the potential of digital communication to accelerate SMEs' digital transformation. The agrifood sector is a telling case of the chasm between SMEs and up-to-date devices, management practices, and strategic postures subsumed in the "twin transition" label: agrifood is a low-tech industry, populated by micro and small firms lagging in terms of both management and digital maturity. Many firms in the sector are artisanal, family-owned, and product-centric. Radical challenges sweep the industry and command major strategic and operational revisions: sustainability, climate changes, uncertainty in value chains, and changes in consumer behaviour. In this context, digital technologies can offer valuable solutions. As far as the consumer is concerned, social media and online multimedia communication are important tools for conveying the values of the product, and blockchain technology can enable better traceability, enhancing consumer trust. Through e-commerce platforms, SMEs can expand their market, enabling direct sales to consumers. Precision agriculture, through digital tools like satellite imagery, soil sensors, and weather forecasting systems, allows SMEs to optimize the use of resources and increase productivity. Smart supply chain management gives the possibility to adopt software solutions to better manage inventory, logistics, and demand forecasting.

Given the importance of brand, quality assurance, and narratives of provenance for food consumers, our study considers whether the upgrading of SMEs' marketing communication strategies and practices drives to digital transformation in other areas of the firms' operations to answer these challenges. We also explore the role of agencies and consultants in supporting SMEs to embrace digital transformation, shedding a light on the factors leading to in-house, hybrid or external choices. Thus, we tackle the following primary research question: how do marketing communication strategies influence digital transformation in SMEs in the agrifood industry? Based on data collected from 2020 to 2023, we adopt a multi-case approach to formulate an answer. The findings point to relevant themes for theory and practice, in particular the role of marketing and of the actors in the larger service ecosystem surrounding SMEs, specifically digital agencies. We demonstrate that collaboration between SMEs and external partners

fosters mature approaches and effective digital communication strategies, provided issues of perceived ease of use and perceived benefit are resolved. We show the conditions under which digital communication is conducive to digital transformation.

2. Theoretical background and research questions

2.1 Communication, digitalization and SMEs

Websites, blogs, and social media possess features that transformed business communication and forced companies to adapt to novel approaches to markets. Digital communication connects firms and consumers through a many-to-many approach, vis-à-vis the traditional one-to-many logic, making content creation and distribution a complex process (McCann and Barlow, 2015). In principle, communication through digital media increases efficiency in managing customer information, penetration through various channels, and interactivity. Capitalising on the effectiveness of digital tools to communicate requires a concurrent transformation that invests the entire company for two main reasons: first, with online interactions comes an obligation for transparency (Bacile *et al.*, 2014) that involves the firms' back-end (operations, financials, human resource management); second, companies need to understand how data abundance and dispersion impact their strategies and aim at learning how to use data analytics to maximise results (Checchinato, 2021). The literature thoroughly documents how information and communication technology transforms communication flows and logic. Few studies, though, delved into the interactions between the adoption of digital tools to communicate by SMEs and the digital transformation the same companies might go through (Meiers and Peters, 2023). The current debate highlights differences in and opportunities of the implementation of digital technologies to communicate, without explicit considerations on the implications of digital communication for organisation-wide digital transitions. Some scholars posit digital tools help SMEs to vie with larger organisations due to their costs; others found out that SMEs still struggle to use them and limited resources still are a constraint. Lack of familiarity, technical skills (Michaelidou, Siamagka and Christodoulides, 2011) competencies (Bowen and Morris, 2019), and human capital (Cassetta *et al.*, 2020) are highlighted as factors that prevent SMEs from using social networks to support their brands.

The Theory of Acceptance Model (TAM) (Venkatesh and Morris, 2003) has been used as a lens to shed light on the use of digital technology in communication and on the underlying motivations. Since our paper focuses on managerial perspectives on digital communication, TAM's emphasis on individual perceptions offers direct insights into how managers and/or owners evaluate and adopt IT tools (Clemente-Almendros *et al.*, 2024; Lee *et al.*, 2009; La Torre *et al.*, 2023): technology adoption in organizations is a complex interplay of individual attitudes, shaped in part by education level, and broader organizational, relational and environmental factors. The theory maintains that perceived usefulness and perceived easiness are

attitude predictors of the use of ICT. The first one refers to the degree to which an individual believes that a particular technology-a website, social network or other digital communication tools and channels-will enhance its performance, whether it relates to marketing aims, financial targets or else. Another one refers to the degree to which an individual believes that the use of specific tools will be free of mental effort or not daunting from a cognitive point of view. Davis (1993) claimed that a user's expectations on the amount of effort required to use a system (perceived ease of use) is likely to influence the person's subjective probability that using the system will increase performance (perceived usefulness). TAM received some criticism for not considering other variables such as competitive pressure; nonetheless, it has proven to be a useful theoretical framework for analysing and explaining social media adoption and implementation by firms (Veldeman *et al.*, 2017). We use this theoretical lens to examine the increasing adoption of technologies and to investigate the role of digital communication tools in driving firms' digitalization. Becoming familiar with new technologies could change the perception of both easiness and usefulness and lead to different digitalization paths. Digital transformation is a process that requires a step-by-step strategy. This paper aims to investigate whether the incremental use of digital communication tools influences the digital transformation of the company because of the different perception of easiness and usefulness during the time. In other words, perceived easiness and usefulness of digital communication tools can lead the company to adopt technologies with a wider scope, first for the marketing strategy and then for digital transformation as a whole.

Therefore, to answer the primary research question, we split it into the following research questions:

- *How does the use of technologies in communication impact the digital marketing and digital transformation of a company?*
- *How do the perception of usefulness and perceived easiness of communication technologies interact with each other and affect digital transformation?*

2.2 The role of digital marketing and communication agencies in fostering digital transformation

When SMEs approach digital tools to improve the effectiveness of their communication, they often resort to external partners and agencies. Both practitioners and academics assume businesses outsource some or all of the digital marketing or communication functions (Edelman, 2010) because of the need for expertise and skills they can not find internally. Due to the rapid change caused by the Internet and ICT, SMEs are striving to make sense of the ever-evolving communication scenario and of its possible consequences for their businesses.

Literature on client/agency relationships (Ceccotti *et al.*, 2019; Ceccotti *et al.*, 2024; Keegan *et al.*, 2017) frame them as learning processes based on trust and collaboration. Some scholars argue that using a traditional agency theory approach can be misleading, since agencies serving SMEs are often small and specialised actors that partner with firms in a sort of brand and

operational alliance (Mortimer and Louise, 2019). Recently, there has been a breakdown in trust and collaboration, which has resulted in a decrease in information exchange and negatively impacted relationships. One of the main reasons behind this is the increasing access of clients to behavioural data and insights made possible by the availability of enabled by dominant platforms and their dashboards. This has given clients more power, allowing them to decide without involving agencies. Some studies found that the strength of this relationship positively impacts the performance outcomes of the client firm (Lynch and West, 2017).

Digital communication can function as a possible starting point for a deeper digitisation. Our research aimed at understanding the role of agencies and external partners. Previous studies suggest that SMEs can use data science to improve the effectiveness of social advertising strategies. However, when more sophisticated analyses are required, they often rely on external competencies (Saura *et al.*, 2023). The role of agencies and the impact on their client's strategy depends not only on the agency's competencies and skills but also on the involvement of companies' internal actors. Based on the literature on service-dominant logic, we know that value creation is a collaborative process between the service provider (the agency) and the customer, achieved through resource integration (Vargo and Lusch, 2008).

To understand companies' behaviour in the digitization process and the nature of their engagement with specialised agencies, do-it-yourself (DIY) theory comes as a useful framework in combination with TAM. Originally developed by Wolf and McQuitty (2013) for the consumer context, the DIY model was applied also to the study of SMEs and their digital marketing strategies (Ritz *et al.*, 2019). It suggests three motivations for SMEs owners/managers to perform activities autonomously: the perceived economic benefit, lack of product quality, and lack of product availability. In our context, perceived economic benefit refers to the costs of the agency compared to the cost of hiring internal resources, the lack of product quality refers to the outcomes of the agency's activity, and the lack of product availability can be referred to the chance to find an agency able to understand the value proposition as well as the company's values and convey them to the target. In the agrifood sector, especially in the Italian one, where firms are mainly family-owned and values are connected to their tradition and to the quality of ingredients and production practices, the agencies' competencies should cover the operations.

Therefore, to answer the main research question, we need to understand: *How do digital agencies support (or not) the digital transformation process?*

3. Methods

3.1 The context: the agrifood sector in Italy

The agrifood sector is an important component of the Italian economy. From farms to consumers' tables, activities related to the cultivation and transformation of agricultural products equal 4% of the Italian GDP. The

total turnover of the agriculture sector for 2023 in Italy was 74 billion euros, while the transformation of agricultural products was worth 180 billion euros in turnover. An important share of the Italian export includes high-quality products as those labelled with Geographical Indications (GIs). Their trade in foreign markets reached over 20 billion euros in 2023 (ISMEA, 2023). The authors deemed the agrifood sector and its structure in Italy relevant for a study tackling questions at the intersection between marketing communication and digital transformation. Several reasons underpin this option. First, considering communication, as research in heterogeneous fields show, Italian food has become influential among experts and also in popular culture to the point it is associated automatically to values such as high quality, exquisiteness, uniqueness and much more (Parasecoli, 2014; Grandi, 2018) and to the point it commands a differential positioning in consumers' minds all over the world (Bonaiuto *et al.*, 2012; Bonaiuto *et al.*, 2021). As the international success experimented by Italian GIs shows, certain locales invest the products originating from them of symbolic value (ISMEA, 2023). This symbolic richness enables firms rooted in the locales to design and execute differentiation strategies. Second, the sector and the locale-Italy-trace boundaries that might be rich in evidence of digital transformation. As a previous literature showed, digital transformation is complex and bewildering for small organisations. From this angle, the Italian context promises depth and insights: the industrial population of the country is dominated by micro and small enterprises. More specifically, 94% of them employ less than 10 individuals, 0.8% are large firms (over 250 employees), the rest are SMEs (Istat, 2021). The agrifood sector in Italy is populated eminently by SMEs: indeed 60 thousand food processing firms employ 464 thousand persons (the average number of employees is 7.8) and among the 103 million agricultural SMEs, 94% are individual firms or small family firms (Istat, 2022). Finally, the Italian food sector was selected for its potential contribution to enlightening matters related to the digital transformation given this transition's importance in the current European political agenda and its concerns about sustainability. The agrifood sector, in fact, has been one of the most prominent targets in the European strategy for achieving a competitive and sustainable economy. Continental strategies such as the European Green deal and the Farm to fork strategy moved from the realization that food systems generate almost 30% of greenhouse gas emissions (Tubiello *et al.*, 2021) and pointed to digital technologies as pivotal in enabling novel business models, the elimination of inefficiencies and the restructuring of supply chains in an environmentally sound direction (European Commission, 2020). Italian policymakers followed suit: the agrifood sector and its transition towards digitised and sustainable practices is one pillar of the National Plan for Recovery and Resilience, financed by the continental strategy Next Gen EU. Both the food sector and Italy (European Commission, 2023) are lagging in terms of digital maturity and digital transformation, especially when the digitalisation of business is considered (Checchinato *et al.*, 2024). Thus, considering questions related to digital transformation and the concurrent sustainable transition in the agrifood sector is critical, informative, and impactful, as suggested by several policies. Focusing on the sector in a

peculiar setting like Italy, one that amplifies the struggles agrifood SMEs are facing all over the world, makes it more significant for a study like the one presented.

3.2 Data collection and analysis

We opted for a qualitative research design, a multi-case approach, to capture significant insights on the phenomena through in-depth interviews with 14 informants in SMEs of the agrifood industry between January 2020 and September 2023 (Table 2). Method-wise, our choices were justified by the research design. In particular, as stated in Yin (2009) case studies fit with research designs that investigate: a) "process questions" or "how and why questions"; b) engage with phenomena that are "current" and have not yet established; c) investigate a phenomenon in a context or locale to account for the depth and scope of influencing forces and factors; d) integrate a variety of data sources and evidence to provide depth and multiple perspectives. Our study responds to the enumerated criteria. First, we are considering a not yet established type of relationship among different dimensions and separated spheres of organisational practices and strategies. In fact, our research questions aim at establishing a nexus between the use of digital technologies in communication -and their perceived ease of use and usefulness- and the overall process of digital transformation in SMEs. We aimed at devising the potential relationships between the two spheres, a hitherto unexplored area, and thus were called to privilege depth and nuances to uncover potential relationships. Second, the phenomenon of digital transformation has been unfolding as we researched and wrote, especially in geographical and industrial contexts that are lagging. The case study method allowed to shed light on various aspects of the underlying phenomenon, with the perspective of singling out significant relationships that further studies might then measure and assess with quantitative methods. Then, as stated, we posit that the Italian agrifood sector is significant as a context in terms of the richness it might provide to a study like the present one, given the existence of a multitude of factors playing against the mature use of digital technologies in communication and processes of digital transformation. Finally, to make sense of the perspectives enunciated by informants on the topics framed in our research questions, we relied on several additional sources to triangulate and better grasp the specific process firms were going through, went through or the lack of any process of digital transformation. To produce a holistic view of the phenomena at hand, we opted for a multiple case study. The multiple case design that provides depth and richness of variables and factors (Stake, 2006) considering the various manifestations of firms' configurations, their interactions with the logics of different value chains. Multiple cases under investigation allow to avoid biased insights and subsequent generalizations; they also allow for better transferability of the resulting propositions, frameworks, or theories (Yin, 2009).

Our sample exhibits variety and heterogeneity: SMEs come from different value chains, have different sizes, own their own brands sometimes, and supply brand owners in others. We selected from a list

of 520 food companies extracted for the Bureau Van Dijk's repository Aida (a commercial database with financial information on companies) and classified them according to their presence on social media and the existence of one or more proprietary websites. The sheer number of profiles or pages on social media, the number of websites attributable to the company, and the articulation of such websites in sections (including foreign language versions) were used as proxies for the digital readiness and fluency of the selected firms. Thus, we attempted to equilibrate the group of analysed companies in terms of an equal number of mature and lagging firms. The research protocol comprised a preliminary analysis of secondary data sources, followed by semi-structured interviews. Each company's website and digital form of presence was analysed, as were data and information related to them and gathered on online sources, such as specialized publications. One critical issue emerging from a research design relying on respondent's analysis, especially on emerging topics, is biased perspectives. We thus interviewed 4 informants coming from the agency/consulting sector, to have a specular perspective on the factors plaguing mature approaches to digital communication and transformation or enabling them (45 minutes each on average).

The selection of informants responded to our main preoccupation with obtaining relevant information from decision makers within the firms. Respondents in our case were selected according to the standards in key informant interview methods. We aimed at accessing a heterogeneous and composite set of domain-related contents in a parsimonious way by identifying individuals who oversee complex processes and have decision-making power in their organisations. As in Taylor and Blake (2015), our preoccupation with identifying the key informant was that of selecting individuals who possess expert knowledge. In addition, the individuals we interviewed represent a broader group (the organisation and its teams), as stated in Bogner *et al.* (2009). Thus, independently from their position or role, we requested, and had access to, people in charge of making the final decision on digital transformation investments and investments in digital communication. Although the search might have offered different informants for each company, the size of organizations in the sample revealed those decisions are made by one individual which we had access to in all cases. Informants were company owners. Just in one case (case M), a second interview was necessary to complement the information: we interviewed both the marketing manager and the IT director. When interviewing informants from the consulting/agency world, we asked to have access to the individuals actively engaged in the development of digital communication or transformation projects with clients.

As far as the data collection strategy and the approach to the field are concerned, we proceeded as follows. Based on previous research, we developed a list of open-ended questions in a semi-structured interview guide. We also elaborated a checklist of relevant factors (e.g., technologies, strategies, factors determining the adoption of solutions) deriving from both literature, industry publications, and our knowledge of the field. Respondents were asked to answer the questions and left free to interpret them as they wished. This way, we got additional details related to how they

framed the questions, the problems they referred to, and the underlying technologies or solutions and strategies. The checklist of relevant constructs and factors was then used to guide the conversation when the respondents were digressing in directions that were not significant to the study. The group of selected companies (Table 2) comprises SMEs in Italian northeastern regions (Veneto, Trentino Alto Adige, and Friuli Venezia Giulia). Interviews were recorded, saved and accessed from the authors at different times for coding purposes.

Tab. 1: Data sources

Data Source	Data Type	Analytical Use
Secondary data	Descriptive (demographic and general, marketing and communication activities) data on 14 firms.	Appreciation of differences related to size, and resources. Assessment of digital readiness.
Interviews (2020-2023)	Semi-structured interviews (14) - face-to-face or via zoom - with the owners/CEOs of each firm. Each lasted approx. 45-60 minutes - 14.5 hours (audio).	Understanding the degree of involvement of the firm in the digital transformation process (or lack thereof). Collecting qualitative information about each context and the process. Grasping the digital strategy and the role of the actors involved.
Interviews (2023)	4 interviews with informants coming from agency/ consultancy sector - 3 hours (audio).	Data Triangulation with identified themes.

Source: created by authors

Data interpretation and analyses were performed on the corpus of evidence by the authors in waves, first on an individual basis and then collectively. Two of the authors coded the evidence of all the cases since the beginning, while two others intervened in the refinement of the resulting categories in the subsequent iterations of the analysis to triangulate and ensure the robustness of emerging themes.

Process-wise, the authors proceeded in an abductive fashion. We approached the field after the systematization of the extant literature on the themes we were facing, developed a list of codes that was then used to categorize the contents of the interviews and of the other data collection activities (Blaikie and Priest, 2022). Despite having a predefined list of categories emerging from the literature, the two authors that made the first wave of coding open-coded the excerpts of interviews, without assigning them to theoretical categories. Such a way of proceeding responds to the recommendations of Corley and Gioia (2013): while they refer to inductive research designs, their indication as to code at the first level with a language that is close to that used by the informant was key to synthesize the evidence and to make it intelligible to the other researchers. Those two, then, took part in the higher-level coding of the evidence. These iterations were aimed at two objectives. First, they aimed at validating, or settling around, the first-level categories coded by the researchers working on the corpus. Second, they aimed at starting the triangulation that, after the

validation of a code structure at the first level, allowed to reconcile the evidence with the extant themes that were identified from the analysis of the literature. No new themes were identified thanks to this process. Rather, the relationships between existing themes emerged (e.g.: ease of use and perceived usefulness on the one hand, and the commitment to higher investments in communication on the other). The division of labor among authors allowed for the triangulation and validation of the categories in the different iterations.

Tab. 2: SMEs cases at a glance

Case	Activity	Online presence	Informant's role	Informant gender	Turnover (,000 €) (last year of analysis)	Employees (last year of analysis)
A	Manufacture of grain mill products, starches and starch products	6 social media profiles, website (3 languages) and e-shop	Marketing director	Female	1,986.657	15
B	Dairy products	6 social media channels, website (5 languages), no eshop	Marketing director	Female	117,608	316
C	Manufacture of grain mill products, starches and starch products	4 social media profiles, website (2 languages) and eshop	Sales Manager	Male	7,718.24	13
D	Manufacture of other food products	no social media profiles, website (2 languages) no eshop	Administrative staff - responsible for digital activities	Female	5,875.86	15
E	Bakery and farinaceous products	6 social media profiles (not all updated), website (3 languages), eshop	Owner	Male	9,139.49	52
F	Fruit and vegetables	3 social media profiles, website with some errors (2 languages), eshop	Owner	Male	203.00	4
G	Wine	3 social media profiles, website (2 languages) and eshop	Owner	Female	ND	4
H	Bakery and farinaceous products	2 social media profiles, 2 websites (corporate and for one of the company's brand), no eshop	Marketing and NBD Manager	Male	22,909.86	123
I	Manufacture of other food products	only Facebook, website (2 languages), eshop with another brand	Manager of sales	Male	1,895.23	15
J	Manufacture of grain mill products, starches and starch products	4 social media profiles, website (2 languages) and eshop	Marketing director	Female	24,367.64	36
K	Diary products	website with some errors (2 languages), 6 not updated social media profiles, no eshop	Owner	Female	4,515.66	18
L	Processing and preserving of fish, crustaceans and molluscs	Facebook profile, website (1 language), eshop	Managing Partner (marketing activities delegate)	Male	2,175.14	13
M	Fruit and vegetables	website (2 languages), 3 social media profile, no eshop.	A.Marketing director B. IT director	Male/ Male	75,925.02	209
N	Processing and preserving of fish, crustaceans and molluscs	website (italian language only), 4 social media profiles, no eshop	Managing Partner (sales and marketing activities delegate)	Male	36,011.74	38

Source: created by authors

4. Findings

The triangulation among researchers' notes and codes and the iteration with extant literature determined the emergence of four main themes, elucidated in the following section.

Theme 1: usefulness and ease of use as drivers of the increase in digital communication commitment and investment

A first finding pertains to the two attitude factors evoked by TAM: the intertwining of perceptions of usefulness and ease of use, leading to both positive and negative consequences. First, according to some of our respondents, perceived usefulness can trump the preoccupations related to the reduced easiness of digital solutions. A solution whose perceived usefulness is very high is considered even if it scores low on ease of use.

> «We started in 2013 with our Facebook profile, at a time when very few companies, especially in the organic sector, had a professional Facebook presence. During the first year, we were guided by Agency X - a leading Italian agency -, and from the beginning, we wanted to set things in motion in a certain way» (case F)

Our interviewees suggest that the motivation to learn and explore new solutions can reduce the perception of low perceived easiness, ensuring the benefits of technology. SMEs willing to capitalise on the potential brought about by digital tools and strategies are triggered into learning processes (e.g., training courses, workshops, support by external actors) to lower the perceived barriers to adoption.

> «During my graduation, I was working at the company where I first came across Facebook, which was just emerging in Italy. I realised the potential of the platform for the business, but I didn't want to create a profile for the company by myself. So, I took a course with an agency that taught me how to open and manage company pages without any sponsored content. As a personal challenge, I started working on it during the weekends» (case A).

When a company creates a website or a social media profile, managing activities might seem easy. However, as they explore more complex and costly digital activities such as sponsored posts, Google ads, and other paid activities, the perception of "ease of use" may change to "difficult to use". This is confirmed by the waiting behaviour of some companies that remain at the initial level of a digital communication strategy, related to the development of owned media.

Although, if the results of past activities are good enough, they put innovation in communication, marketing, or business in their agenda.

> «We did not do exclusive contracts (with food bloggers) with anyone yet…this will probably be a step for the next few years» (case A).

Based on our informant's responses, some tools seem to fit with the specificities of SMEs, in particular Google Ads or sponsored posts; others, such as search engine optimization and email marketing, did not surface from our coding. As far as the former are concerned, the respondents pointed to their complexity and technicality that require SMEs to search for external help. Social media is another area that captured the interest of SMEs we interviewed. One shared posture is that after a few experiments, firms realise they are more time-consuming and demanding than a superficial assessment might suggest. There seems to be a parallel recourse to specialised figures (external and internal) when the commitment of the company to social media communication increases:

> «We have a modus operandi: either we do things in the best possible way with maximum quality and maximum service, or we don't. [...] In the last year we hired a social media agency to follow us on the social side because personally I couldn't deal with it» (case H).

The intertwining between perceived usefulness and easiness might also play a role in hindering the development of mature approaches to digital transformation. Some respondents allowed us to appreciate an interesting path when a company invests in digital communication through social media but then does not escalate to more complex forms of digital transition. In these cases, when they do not achieve positive results in the initial phase, they fail to leverage the possibilities of digital transformation, and they underperform.

> «We were supported by an agency, but the results were not brilliant, so we internalised the social media management. [...]. We have an ecommerce, but I do not even consider it because results are negligible» (case N)

Thus, the potential lying even in elementary measures, which are characteristic of digital technologies, is often overlooked such in the case of insights analysis:

> «We did not analyse results, either on social media, or on ecommerce. For the last one, we just look at sales» (case N)

Theme 2: The role of external actors in suggesting new activities and supporting future strategic choices

A second theme that emerges from our analysis is related to the acquisition of skills to manage digital communication. The more SMEs venture into digital communication, the more they gain the skills to recognise the gap between extant competences and those needed to manage digital tools. Firms already possessing a marketing orientation and pointing to digital communication for their strategies recognize the problem and search for the support from external actors from the beginning. There seems to be a scaling up of the competences of the firms that derive from the relationship with agencies that allow them to skillfully buy better services when they upgrade their digital communication objectives:

> «The company has always been supported by a digital agency because it recognized the importance of having an external expert to ensure the job was done right from the very beginning [...]. Over time, the company improved its digital capabilities by partnering with better agencies that kept up with the latest trends. Our brand has been associated with new values by today's agency» (case B).

Even if companies outsource digital communication, agencies can affect the overall marketing strategies. The nature of digital communication and ongoing audience interaction means agencies' services shape the company's marketing decisions. Again, this represents a benefit of the relationship for those companies who already are marketing oriented. Some SMEs posit they need to collaborate with agencies because they are

> «partners allow broader insights and views as they work in various markets and collaborate with large companies. I search for agencies that criticise my brief» (case K).

> «We brought in talented young professionals who had collaborated with major groups, allowing us to add value to our business» (Case F)

> «I met by pure chance a new agency that gave me a breakthrough. Now I am starting to work in earnest the website that is certainly not the site that was intended with the precious consultant» (Case G)

Critical aspects emerged on the relationships between SMEs and agencies. The lack of trust in the agency's commitment represents a factor that might slow down the process of escalating commitment to digital communication. Owners are often uncertain about the results they could achieve and need to be guided into making sense of the available options. This leads to questioning whether outsourcing to an agency is worth it.

One informant stated that:

> «The disadvantage of having an agency is that you never know whether you could have better results with alternative ways of doing» (Case D).

Another maintained that:

> «There is a disadvantage: they do not just serve you, they have other clients. [...] they are not as reactive as one would want, surely not as a direct employee would be» (case E).

The lack of perceived economic benefits seems to motivate companies' scepticism and their switch to internalize digital communication activities, even if the internal competencies are not developed. Nonetheless, in several cases the solution is still outsourcing to agencies: other elements are more important than the economic benefit.

Perceived economic disadvantage may drive SMEs to sever agency ties, particularly with poor service. In these cases, the do-it-yourself prevails. When do-it-yourself is paralleled by the investment in adequate internal competences, the choice might make sense and could avoid the negative loop we illustrated in the previous theme. On the contrary, the lack of skills and specialisation might compromise future investments:

> «The problem is that they cannot be as good as an internal resource. Thus, we hired our own marketing responsible […]. This solves a lot of problems, solves communication and coordination problems. The entrepreneur often does not have time to formulate thoughts, brief somebody: he needs someone who is constantly here and can understand everything in a matter of seconds» (Case F).

> «We invested in people who can do different things rather than hiring an external partner». (Case I).

Respondents highlighted the lack of specialised agencies as a relevant factor. Some players, in fact, serve firms in many industries without entering the specificities and subtleties of one. As informant G emphasized, storytelling related to wine and a correct communication of its attributes requires a collaboration between the company's oenologist and the agency, often leveraging languages and semantics that are very dense and sophisticated.

While many SMEs experiment with digital tools via a "learn by doing" method, trying to manage tools in autonomy and learn technicalities when needed, there seems to be a key transformation in their approaches and maturity when they are supported by a consultant.

> «When developing a communication strategy, it is important to professionally manage the digital tools [...] the consultants forbade me from publishing on social media» (case M).

We recognize that if an agency is perceived to provide a good service quality, it can support the development of employees' knowledge and improve their competencies, making them aware about the challenges of digitisation. Informant A and B provides a rather insightful assessment of the importance of the relationship between internal employees and the agency to educate companies:

> «On those [sponsored ads on social media], I want to be followed by an external agency. [...] my idea is that a consultant also leaves knowledge and information to my workforce and my managers. I chose a consultant based on his/her sharing of this idea» (case A).

> "We have an internal resource that works daily with our social media agency." (case B).

Talking to practitioners to triangulate data, they confirm their role as mentors: "sometimes it is the entrepreneur her/himself who transparently asks for training/transfer of experience and skills internally and to work towards objectives" (Digital PR consultant)

Theme 3: From online communication to digital marketing

In our interviews, most of the respondents discussed online promotion and digital marketing activities as they were part of a continuum. This could explain why digital technology to relate with markets represents a gateway to digital transformation for SMEs. Some firms approach digital tools thanks to a website or a social media profile, then they understand how to exploit them for wider marketing purposes. What our evidence suggests is that there might exist a process wherein SMEs use digital tools for one aim and then realise that the same tools, either stretched or joined with others, could extend their usefulness to other functions/areas.

In answering our questions about the use of digital communication tools, informants switched easily to websites, e-commerce, storytelling, and then came back to influencers and word of mouth. This evidence brings us to conclude that when SMEs are concerned, the investigation on their approaches to digital tools should consider wider scopes rather than focusing on single functions and tasks. SMEs might have their own framing of the usefulness of these tools; they might be in a learning process guided by consultants, a journey that articulates along different stages; tools might be used to experiment and build confidence and competence, and then firms might figure out what device and channel is better for what. In small organisations, the absence of dedicated communication employees and even the absence of a formal marketing function in some cases, make it difficult to classify activities rigidly.

In some of our cases, this emerges clearly. For instance, companies create a website or a profile on social networks to communicate their brand values and their activities, to reach their target audience without filters. The high positioning of some of the interviewed companies makes them rely heavily on storytelling, and so they consider digital technology as the best way to showcase their products and assortment. However, when the presence matures and becomes more structured, and consumers interact with them, they change their vision. Social media becomes an instrument to collect data on consumers and redefine the firm's marketing strategy. One company clearly explains this point

> «We use Facebook and Instagram mainly to collect comments and acquire insight» (case M).

According to the same informant, the firm is testing a non-proprietary e-commerce platform to gather data and redefine the target audience without making huge investments, according to an affordable loss principle.

How digital communication drives to digital channels - and backward - are well explained by two informants. The first one (case J) explained that they created the new website to better communicate their sustainability value and to explain products to bakery addicts. Soon they understood they

wanted to buy products on the digital channel, so they opened an e-shop. The online shop helps the company to better explain their products. The second firm explained intermediaries sell their products through Amazon, so they started selling on Amazon too-with positive results-but it caused communication issues related to the price (because of shipping costs) and the perceived value of their products. they opened a direct e-shop where prices are clear and convey the right positioning.

Theme 4: the interaction between digital communication and digital transformation - triggers, determinants and relations

For SMEs, digital communication can be a trigger for more general transitions to digitally enabled business models and for more efficient reconfigurations of their operations. Literature accentuates the importance of digital technologies as devices that create bridges between the outside environment and the firm, allowing SMEs to interact across their borders with suppliers, distributors, and eventually customers (Singh and Hess, 2020). Our cases suggest that the adoption of more mature approaches to digital communication triggers awareness of the potential transformations of strategies and operations in SMEs. As one entrepreneur in the milling industry stated recollecting their digital transformation journey:

> «Our digital transformation started back in 2010, probably 2008. We were ambitious and we wanted to make further steps in that direction. We first increased our investment in digital communication on web spaces, our website in particular: a new image of the firm, a new look and feel to the corporate website [...] Then, we approached social media, since we saw it was growing since 2008» (case C)

> «At the moment we digitised our communication, to be known by the B2B market and to sell online. Next, we are going to digitise our production process» (case N)

Several responses from informants were on the same tone: the realisation that digital technologies can be a conduit to bidirectional flows (brand and image from the firm, data and insights from consumers) might push SMEs to strategize long term commitments of digital transformation that move from the interface with clients.

One typical "story" is that of firms that strengthened their digital communication by investing in branding on social media and digital channels, then resorting to e-commerce, because of strategy or necessity as with the acceleration of electronic transactions during the peaks of the Covid-19 pandemic. E-commerce per se is not the fundamental trigger: what pushes towards full-fledged digital transformation processes is the logic imposed by underlying software such as customer relationship management suites that go hand in hand with transaction management systems:

«The moment that started our digital transformation is the one in which we bought our CRM solution» (case N).

Similarly:

> «The CRM was already present in our e-commerce systems: in other words, I have an e-commerce system for B2B clients, and I would like to extend its logics to the B2C market: we are currently evaluating different solutions; for sure I will want to work with SAS solutions that integrate with our systems and thus grow from there in the future» (case A)

Where we found a commitment to further expand the digitisation of the firm starting from communication and moving to the back end of operations, we spotted a recurring pattern. First, the company pursues an upgrade in its communication online, especially to be more visible to final customers or B2B clients. Embarking in different digital communication initiatives, firms start a learning process that relates especially to the realisation of how digital tools produce data related to the interactions with customers and their effects. SMEs understand how to deploy these technologies in other functions and processes whenever this learning happens. The visibility of digital activities and the opportunity to measure their effectiveness seem to be the main factor legitimating these devices in small organisations and producing the escalation of commitment by entrepreneurs and managers.

External providers of services-consultants and agencies-are pivotal in channelling the willingness to invest in digital technologies from communication to other activities. One respondent, a mid-sized firm in the milk sector, stated that

> «Besides social media editorial planning agency, we do not have any other external consultants for digital transformation» (case B)

While this quote seems to suggest that firms depend strongly on external competences to upgrade their digital transition, it suggests a more nuanced proposition. It suggests that through the journey of upgrading their fluency in digital communication, firms might accumulate knowledge and skills that make them able to recognize that digital transformation requires other competences and diverse suppliers of services and skills.

The point was made clear by another respondent, that represents a variation on the point made earlier:

> «We are also working on digital transformation. For that, we work with the agencies that are serving us in digital communication plus another one that guides us on Amazon, a sales channel that is performing extraordinarily well» (case E)

Using digital technologies in communication can represent for SMEs of this type a sort of experimentation that produces two types of outcomes:

i) awareness of the measurability of digitally enabled actions, a factor that legitimises novel devices that might have been conceived as difficult to be understood in the past; ii) a more fine-grained comprehension of the various competences needed to wire entire business models and processes with digital tools and strategies. First, SMEs we interview seem to suggest their ability to scope the market for services seeking differentiated skills in agencies and providers of services. Second, such fine-grained understanding can be accompanied by a similar ability to ponder the necessity to differentiate internal human resources and competences, as one firm in the milling industry effectively stated.

> «I am revolutionising the entire organisation of the firm [..]: E-commerce is multiplying the things that need to be taken care of and we cannot afford anymore to have the same people do the same things. We are pushing on digital transformation and thus we are aiming first to digitize our warehouse.» (case A)

5. Discussion

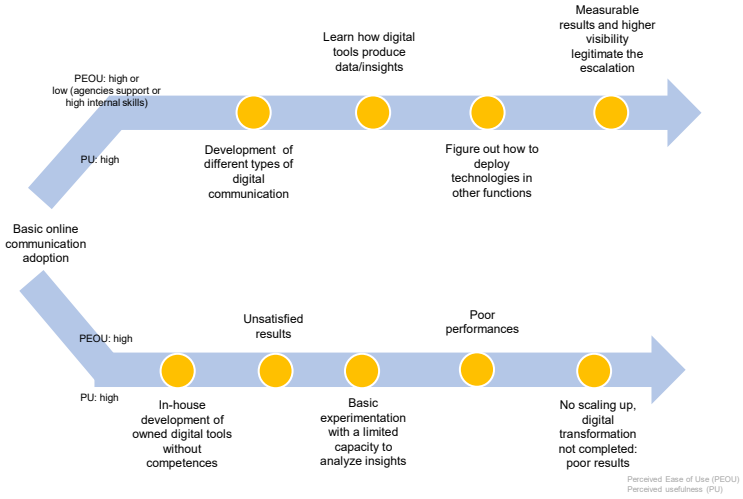
5.1 Theoretical contribution

Our study extends research on digital transformation, shedding light on the role of digital communication. When analysing the social media and digital communication activities, literature mainly refers to the way these tools help to diffuse information and/or reach a wide audience of potential customers (i.e. Kumar *et al.* 2016), instead of analysing how these tools can support consumers' and market knowledge. Just a few studies point to the interaction between digital communication and digital transformation given this bidirectional flow (Klewes, *et al.*, 2017); Meiers and Peters, 2023). As highlighted by Saura *et al.* (2023) digital communication tools such as mobile phones, QR codes, and websites help SMEs adapt their business models to the needs of customers and this is the first step of digitalization, in which marketing and communication sometimes overlap.

Our paper contributes to the theory in three ways. First, this research explores how perceived usefulness and perceived ease of use impact digital technology adoption and escalation, discovering that they do not always impact positively. Second, we could identify different paths based on the dynamic role of these attitudes: how they interact with each other determines the adoption of a higher level of digital transformation. We depict how companies move from a simple digital communication approach to the broader concept of digital transformation, conceived as a process that, thanks to the use of technology, improves the performance of an organization and every aspect of business, in particular the marketing area (Caliskan *et al.*, 2020). Finally, by merging the theory of acceptance models (Davis, 1989; Venkatesh *et al.*, 2003) and the Do-It-Yourself theory (Wolf and McQuitty 2013), we identified the role of the agencies in supporting the path toward digital transformation.

Contrary to the original model and other studies on SMEs (Rokhim *et al.*, 2018), our findings suggest that a high level of perceived ease of use can be negative in exploiting the benefit of technologies initially adopted for communication, slowing down the upgrading. Perceived ease of use leads companies to manage the communication function in-house, but in these cases, results are often poor because of the lack of necessary skills inside the firm. The consequence is a reduced perceived usefulness and a tendency to maintain the status quo, without reaching a more mature level of digital communication (Effing and Spil, 2016; Checchinato *et al.* 2024) or moving on digital transformation (Figure 1) that could reshape their business model. This is consistent with the theory of smallness (Anderson and Ullah, 2014): owners' attitudes and reluctance to grow (Davidsson, 1989) combined with limited finance and managerial expertise (Tocher and Rutherford 2009) limits growth opportunities.

Fig. 1: Proposed main paths



Source: created by authors

Our findings confirm that, in a trial or initial phase (Tuten and Solomon, 2017; Effing and Spil 2016), a firm might experiment with social media without finding them complex to manage: their "consumer" nature and their apparent ease of use might produce a sensation of easiness. Instead, up-to-date and mature exploitation of social media is far from being elementary. The absence of skills in digital communication can bring a user to overlook the more sophisticated aspects of their use and produce a double negative effect: a perception of easiness and a perception of uselessness. This, in turn, might project a sense of uselessness on all categories of digital tools for communication or on digital tools at large (Lacka and Chong, 2016).

The role of agencies can significantly influence the direction of SMEs' digital transformation, both supporting them with low perceived ease

of use and when managers' or owners' motivations and visions require sophisticated approaches from the beginning. When companies recognize an agency's ability to operate effectively in a specific industry, such as the food market, and appreciate the positive outcomes of the agency's activities, they start trusting the agency. This trust allows agencies to co-create growth. Agencies not only provide the necessary expertise when they lack it, but they also help companies enhance their performance. Agencies leverage the knowledge gained from working with various clients to support other firms effectively (Aronson and Liang, 2005). Prior knowledge and the ability to recognise its value are important antecedents of absorptive capacity (Cohen and Levinthal, 1990) and since they are cumulative, agencies must be recognized as valuable.

5.2 Managerial implications

Our findings provide SMEs' managers, owners, and marketing practitioners in firms and agencies, with valuable guidance recommending attention to potential biases that could reduce the success of digital communication strategies and digital transformation paths. Thus, we can advance some indications that could inform the actions and decisions of individuals guiding or supporting SMEs in the industry.

First, managers and entrepreneurs should define how to embrace digital technologies in their communication strategies. If they aim at surviving in the current market landscape, SMEs are required to intervene on their organizations' cultures to avoid the fear of innovation and loss of control. We highlight the importance of balancing internal development with targeted external support. While many SMEs lack the resources and/or skills to fully internalize complex digital functions, relying solely on external partners/agencies can create misalignment with company values. They should match external support and advice with an internal development and internal competences and responsibilities, to compensate for the lack of flexible approaches: typically, digital natives within the organization and in supporting agencies might compensate for the lagging of agrifood SMEs. Thus, inclusion of younger generations in the decision-making process could bring new perspectives and skills in the management decisions. We see in cross-generational collaboration, especially by empowering digital natives within the organization, a way to bridge the gap between tradition and innovation.

Second, our results suggest that starting with small and controlled experiments in the communication activities could help SMEs become acquainted with the specificities of technologies and their marketing uses, to test their limitations and their potential applications. Communication and marketing can serve as crucial gateways for digital transformation, making these functions more important than ever before. Continuing to understaff these areas can have a detrimental impact on the company's long-term strategy-not only in terms of image and narrative, but also because they represent a testing ground for broader transformation initiatives. On the contrary, prior experience can shape how external knowledge is absorbed and applied, compensating SMEs limited absorptive capacity.

Finally, our considerations on how technology changes or can change communication management are similar to what Quinn *et al.* (2016, p, 2125) revealed on marketing transformation: "It is not technology per se that is changing how marketing activities are conducted but how, where and by whom these activities are being carried out". Our findings can help agencies to better define their role in the market, especially when they support SMEs. Because of the technicalities and the always-on requirements by the new media, an entire service industry has been transformed (Ritz *et al.* 2019), agencies should help SMEs not only to apply the new rule of communication but to incorporate digital tools and processes in the entire company's strategy. Agencies should play a more embedded role as long-terms partners who can support the integration of digital tools across different departments.

6. Conclusions, limitations and future research

Combining TAM and DIY we analysed the interviews with key informants (14 SMEs) and 4 practitioners to understand how communication might influence digital marketing and the adoption of digital tools along the whole value chain. Our data show that the agrifood industry has passed through an accelerated wave of digitalisation during the heights of the Covid-19 crisis. We identified how the perception of usefulness and ease of use of digital tools interact in the process of companies' digital transformation. An interesting insight is about the willingness to develop and change when high levels of usefulness are identified as they can lead SMEs (especially in the case of family businesses) to overcome their reluctance to engage in technological collaboration with external partners. External actors can provide learning and enriching experience able to unlock different growth paths.

When time, resources, and competencies lack, the process of self-learning is not the only possible path. Sometimes, the strong technical background of entrepreneurs leads companies to internally focus on product strategies and to be open to collaborations with external actors to manage relationships with customers. On one hand, agencies can help companies introduce new professional specialisations such as search engine optimization (SEO), social media management systems, CRM and so on. Although access to digital marketing media is free and open, an entire service industry has emerged where specialized professionals can perform these activities for other businesses.

Our research suffers from some limitations that open avenues for further research directions. The research primarily focuses on Italian agrifood companies, which might limit the generalizability of the findings. To address this limitation, future research should expand the sample to include a more diverse array of companies. The sample should include companies of different industries but also investigate diverse cultural settings to shed light on how cultural factors might influence digital transformation of SMEs. Indeed, this specificity prompts questions about the wider applicability of our findings beyond Italian SMEs.

We can also identify an opportunity for a longitudinal study, providing a nuanced and profound understanding on the transformation process over time. From a theoretical point of view, TAM and DIY may not capture the full complexity of organizational change, especially in SMEs where informal decision-making, emotional factors, or family dynamics can play a significant role. As a result, integrating organizational learning theories, or dynamic capabilities might provide a more holistic understanding of digital transformation processes.

Finally, as we adopted a qualitative approach, future studies could employ mixed methods or quantitative research methods to test our model and compare our results in the firms with different levels of digital maturity and different levels of digital transformation adaptation (digitization, digitalization, and digital transformation).

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sinergie
italian journal of management

ISSN 0393-5108
ISSN 2785-549X
DOI 10.7433/s128.2025.05
pp. 109-136

FONDAZIONE CUEIM

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Building a customer experience strategy in phygital retail: the role of digital platforms[1]

Received
6th November 2024
Revised
19th March 2025
Accepted
15th July 2025

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Abstract

Frame of the research: *As customer experience becomes increasingly central to brand differentiation and digitalization reshapes retail, brands must engage consumers across both physical and digital channels. This convergence has accelerated the need for 'phygital' strategies-integrated approaches that deliver seamless, contextually relevant experiences across touchpoints.*

Purpose of the paper: *This paper explores how digital platforms are transforming the nature and delivery of customer experience in retail. By focusing on the fashion industry, it investigates how platforms reshape traditional experiential components and purpose-and enable the integration of these elements into a cohesive phygital customer journey.*

Methodology*: The study employs a qualitative approach, combining semi-structured interviews and case analyses based on press and media sources. This methodology highlights the critical elements necessary for effective customer experience in phygital retail.*

Results*: The research identifies five key elements essential to delivering effective customer experiences in phygital retail: (1) a core digital platform, (2) a shared brand purpose, (3) experience customization, (4) strong brand positioning, and (5) a dynamic partnership ecosystem. The digital platform emerges as the central enabler, integrating these elements and allowing brands to mediate relationships and deliver a cohesive, customer-centric phygital journey.*

Research limitations: *This study faced limitations due to the inability to conduct in-store visits and the fact that interviews were conducted online, which limited control over contextual factors. However, triangulation of multiple data sources and interview prompts shared in advance helped enhance the reliability of findings.*

Practical implications: *With expanding digitalization, brands are increasingly omnipresent in customers' lives, requiring coherent phygital strategies. This research offers guidance to managers on developing a consistent customer experience across phygital touchpoints by integrating the five identified elements.*

Originality of the paper: *Despite increasing academic interest in phygital retail, strategies for structuring the customer experience in this domain remain scarce. This*

Authors contributed equally to the conceptualization and writing of the research. They agreed on the research question, methodology and conclusions. Nevertheless, Mogno was responsible for the planning and implementation of the empirical session, while Bellio was responsible for the selection and organization of the relevant literature.

study contributes both theoretically and managerially by presenting a framework of five interrelated elements -with a pivotal role of digital platforms- that can help brands navigate the complexity of hybrid retail and build enduring customer relationships.

Key words: *fashion industry; phygital; omnichannel strategy; brand experience; retail*

1. Introduction

The emergence of contemporary 'omni-customers'-individuals who actively participate in brand content creation and demand seamless control over how, when, and where they engage with brands-has positioned customer experience as a critical factor for generating distinctive engagement (Bellio *et al.*, 2021; Pangarkar *et al.* 2022; Timoumi *et al.*, 2022), while also strengthening customer loyalty (Zou *et al.*, 2022; Tuguinay *et al.*, 2022) and retention (Cambra-Fierro *et al.*, 2021). The "experience room"-the space where customers encounter the brand, whether physical or digital-becomes a key managerial tool whose features can be controlled to assemble a specific customer experience (Edvardsson *et al.*, 2005). When retail is positioned as a strategic driver of memorable customer experiences (Brakus *et al.*, 2009), then the integration of digital and physical touchpoints into a cohesive and contextually relevant 'phygital' journey becomes imperative. Such a phygital approach is essential for fostering social engagement and building customer rapport (Pangarkar *et al.*, 2022), while enabling the delivery of hyper-personalized experiences (Klaus, 2024; Pangarkar *et al.*, 2022) that align with the expectations of "onlife consumers" (Kotler *et al.*, 2021) across both digital and physical channels.

While digital transformation has bridged physical and digital retail environments, existing research has not yet fully clarified how digital technologies reshape key experiential elements such as positioning, purpose-driven engagement, strategic partnerships, and customization. Addressing this gap is crucial, as these elements are foundational to the construction of meaningful and differentiated experiences that drive consumer loyalty and emotional attachment to brands. What strategies do brands pursue to choose and integrate digital technologies with the traditional components of the omnichannel customer experience? This paper seeks to explore the interplay between digital platforms and these core components, offering new insights into how digital platforms reconfigure the experiential value delivered across hybrid retail contexts. The study undertakes an in-depth literature review on customer experience and retail strategies, revealing that, despite the increasing academic interest in both domains, there remains limited clarity regarding which elements of the customer experience are most effectively transferable to phygital retail environments. To gain insights into current managerial practices and derive practical managerial implications, we adopt an exploratory qualitative approach, combining semi-structured interviews with CEOs and industry experts operating within the fashion sector, alongside a case-based analysis of online press coverage and brand-generated content.

Considering the evolving state of phygital retail, this paper adopts an exploratory approach to build theoretical foundations rather than test hypotheses. Our contribution is twofold. Theoretically, we bridge the literature on customer experience and retail strategy by identifying the most pertinent experiential dimensions to a phygital context. From a managerial standpoint, we offer preliminary hypotheses and practical guidelines on how digital platforms can serve as central enablers in aligning traditional customer experience levels - such as branding, purpose, partnerships, and customization - with the demands of hybrid retail environments.

The paper is organized as follows. The first section outlines the theoretical foundations of customer experience and examines how digital transformation has reshaped retail dynamics, as discussed in the marketing and distribution literature. The second section details the research methodology adopted for the study. Section three presents the main findings from the semi-structured interviews and the analysis of press and media content related to fashion brands. In section four, we discuss and synthesize the results of both qualitative approaches, offering an original interpretation of how digital platforms influence traditional customer experience elements. Finally, section five concludes the paper by outlining the theoretical and managerial implications of our findings and by proposing directions for future research.

2. Customer experience and brand in retail: a literature review

The importance of customer experience management in retail is largely recognized in previous marketing and business studies (Chi *et al.*, 2024) with retail social capital depending on different consumer-associated factors: acquiescence, recognition, and integration (Mathur, 2020). Consumers traditionally assess their in-store experience based on their motives for visiting, the time available for shopping, their mood at the time of visit, and their familiarity with the store (Backstrom and Johansson, 2006). Adopting an integrated retail brand equity model, Zhang *et al.* (2023) explain how consumer shopping experience and store performance evaluation should be based not only on visible metrics (e.g., sales) but also information about how customers feel. Investigating the hedonic factors shaping customer experience in retail, Banik and Gao (2023) highlight the significant positive effects of mental imagery, entertainment, and aesthetics on customer experiences, which in turn affect customers' satisfaction and decision-making processes, with all three factors having a greater impact on female customers compared to males. Customer experience fosters excitement and loyalty (Ruiz-Molina *et al.*, 2021) through data-driven personalization (Ansari and Mela, 2003) and by offering "*the right content to the right person at the right time*" (Tam and Ho, 2006, p. 867). Thus, it represents one of the most important factors in the maintenance of a company's competitive advantage in addition to influencing customer preferences (Bascur and Rusu, 2020).

As the creation and establishment of a distinctive brand identity in retail become fundamental for building the customer experience, brands allocate

significant resources to various aspects of in-store experiences including product display, knowledge provision, product trials, store layout, and special store-level activities (Kumar and Polonsky, 2019). However, brands are also increasingly expected to champion social, ethical, or political causes resonating with their target audience (De Swaan Arons *et al.*, 2014; Goodyear, 1996; Iannilli and Spagnoli, 2021). Branding strategies must align with broader societal needs, leading organizations to reshape their values to meet customers' expectations for their positive contributions to society (Gad, 2016). Identifying a core motivation for a brand's existence and the impact it aspires to make in the world (Afdhel and Jones, 2016) is decisive nowadays in driving all stakeholders and making them feel part of something "larger" (Annweiler, 2018). Consumers also increasingly expect organizations to act, choosing brands reflecting their values. Sit *et al.* (2021) stress that both honesty and connection through common values directly affect customers' perceived authenticity of online retailers. Modern customer experience is no longer just about transactions; it is about embodying a lifestyle. This approach, known as lifestyle branding, moves the focus from products to intangible values, aligning a brand with a customer's identity. To achieve this, brands must craft narratives around significant moments in a customer's life, ensuring the message resonates with a diverse audience and tailoring content to reflect their interests, affinities, tastes, and lifestyle choices. Importantly, lifestyle branding should emerge organically from existing communities rather than being imposed on them (Pérez del Castillo *et al.*, 2020). Since strong emotional relationships positively affect customer loyalty, sometimes resulting in brand evangelism (Al Nawas *et al.*, 2021), a purpose-driven customer experience allows brands to meet expectations and enhance recall (Anderson *et al.*, 2018).

Multiple studies also establish that retail partnerships and mergers and acquisitions are set to be vital for growing and reinforcing the customer experience they offer (Atmar *et al.*, 2020) and are fundamental for continuous and relevant value co-creation (Rubio *et al.*, 2021). Partnerships can bring convenience for customers, boost sales, allow organizations to gain access to new capabilities and extend their brand reach to new customers in novel places extending a retailer's brand halo to its partners (Briedis *et al.*, 2020). Due to the digital transformation, retailing is increasingly and extensively driven by innovative technologies (Grewal *et al.*, 2021) that are implemented in many retail-related touchpoints, including in-store services, back-end operations (e.g., warehouses, supply chains), communication (e.g., websites, social media platforms), promotion and display of merchandise. Advanced technology enhances the possibility for organizations to influence purchase decisions, creating delightful experiences, gratitude, or customer satisfaction (Bock *et al.*, 2016; Molinillo *et al.*, 2022) by modifying what is displayed and how based on each customer's purchase behavior and history (Zhang *et al.*, 2011). Since integrating retail channels holds enormous potential in delivering superior customer experience (Hanninen *et al.*, 2019; Iannilli and Spagnoli, 2021) by reinforcing customer empowerment (Mishra *et al.*, 2023), this becomes incredibly critical in omnichannel strategies.

The ecosystem of multiple stakeholders co-creating the customer experience across all digital and physical retail touchpoints requires fast information and data sharing across touchpoints, stakeholders, and dimensions. Engaging, interactive, and immersive technology enables this synergy, conferring all stakeholders a major responsibility in the customer experience design by leveraging on network externalities and use of data (Nuccio and Guerzoni, 2019). Due to escalating digitalization, customers expect to take an active role in their interactions with a brand. Therefore, building a competitive advantage through synergies between channels and technologies in customer experience is critical in the actual scenario (Iannilli and Spagnoli, 2021).

Although the COVID-19 pandemic has turned omnichannel operations by retailers and habitual online shopping behaviors into "*the new normal*" (Bruce *et al.*, 2023), contemporary estimates indicate that 70% of global retail sales still take place in physical stores (Euromonitor, 2024).

This coexistence of complementary online and offline brand-related touchpoints requires adopting a customer-centric approach to deliver a holistic experience that is consistent and customized across digital and physical retail touchpoints and moments (Valdani *et al.* 2016; Banik, 2021). Neuburger *et al.* (2018) study the relationship between physical and digital in tourist spaces providing an overview of how they are changing, which technologies are driving novel developments, and which consequences for the user as well as the tourism supply side are expected. In particular, omnichannel strategies combining digital and physical features can be applied to the retail experience, to make customers feel empowered (Mishra *et al.*, 2023) and deliver a holistic customer experience. However, omnichannel management might be just one possible facet of the customer experience construction and might not deliver anything of novel value to advance managerial practice (Klaus, 2024).

Integrated and consistent rapport-building across digital and physical touchpoints is vital in contemporary retail strategies to enhance customer experience by strengthening commitment and trust (Pangarkar *et al.*, 2022). For example, Jones and Runyan (2013) develop a scale to measure brand experience of multichannel retailers, treating online and offline retail channels separately, while Frasquet-Deltoro *et al.* (2021) define a brand experience scale for omnichannel retail focusing on single-brand retailers.

The integration between physical and digital environments in the phygital era has facilitated both the concentration and dispersion of people across space and time. Thus, the concept of "phygital" must be understood in a more comprehensive and multi-dimensional way to fully grasp the opportunities and challenges it presents, as well as the broader transformation it brings (Batat, 2024). Mele *et al.* (2021) conduct a systematic literature review to gain a comprehensive understanding of the phygital construction. Their findings show that the integration and use of both physical and digital objects and applications within phygital contexts reshape the customer journey, promoting the development of new forms of phygital experiences. Examining the evolution of physical retail space and its impact on customer experience management from a territorial perspective, Alexander and Varley (2025) re-evaluate the concepts of

retail space and place, reimagining the customer experience within the context of phygital retailing. Employing the Experiential Retail Territories (ERT) framework proposed by Alexander (2024), they emphasize how the phygital transcends traditional channel-based logics, requiring retailers to move beyond channel constraints to fully harness its potential in managing customer experiences (Batat, 2024; Klaus, 2024).

The existing literature on both customer experience and retail management shows that building and delivering a strong meaning through an immersive and engaging customer experience is set to be a key for brands to differentiate themselves (Artusi and Bellini, 2021). Nonetheless, there is no clear view on how digital technologies reshape key experiential elements such as branding, purpose-driven engagement, strategic partnerships, and customization in phygital touchpoints and more generally in retail.

In the following sections we empirically explore how the interplay between digital platforms and the experiential dimensions can deliver an effective phygital strategy. This may also offer innovative insights into how technological integration reconfigures the experiential value delivered across phygital retail contexts.

3. Methods

Although delivering relevant customer experiences through phygital retail is becoming increasingly strategic, our in-depth review of the literature on customer experience and retail strategies reveals a gap: the specific elements of customer experience that should be effectively applied to phygital retail remain largely unexplored. To understand current managerial practices that could help to draw a framework, we combine semi-structured interviews with CEOs and experts working within the fashion industry and a case analysis on online press and content from fashion brands. Given the exploratory nature of our study, qualitative methodologies are the most appropriate for developing new grounded theory (Cornelissen, 2017) by understanding processes and factors beneath a phenomenon through the rich accounts of those experiencing it (Gioia *et al.*, 2013). The combination of these two methodologies strengthens our analysis as both approaches complement each other and align with other research in the phygital retail literature (e.g., Bonfanti *et al.*, 2023; Breugelmans *et al.*, 2023; Pusceddu *et al.*, 2025). While semi-structured interviews enabled us to identify which elements are critical to customer experience in phygital retail through rich insights from field experts, the analysis of online press and media (e.g., Breugelmans *et al.*, 2023) revealed how these key elements are successfully implemented in real-world scenarios. This offers practical evidence supporting the theoretical and managerial implications of phygital retail strategies contributing to build validation and enhancing data triangulation (Yin, 2014). Since this paper aims at developing new theory on phygital retail strategies, the triangulation of multiple methodologies allows us to reliably move from a context-specific reality to a generic deeper understanding of the relationships among variables (Massaro *et al.*, 2020), enabling a more conceptual explanation of a phenomenon into a novel theoretical model

through researchers' interpretation (Cornelissen, 2017). Considering the interpretivist nature of qualitative research, this also reinforces the validity and reliability of our proposed model. Given the exploratory nature of the study and the developing nature of the analyzed phenomenon, semi-structured interviews ensured sufficient coverage of the phenomenon by tailoring questions to the interviewee's specific industry and job position, increasing the robustness and reliability of our results. Participants were selected through purposive sampling (Guest *et al.*, 2006) and snowballing technique to ensure that they had sufficient expertise in the topic both in fashion retail and in consultancy companies until theoretical saturation (Glaser and Strauss, 1967; Guest *et al.*, 2006). We conducted five online interviews between April and May 2021 (Table 1) in Italian or Spanish, with each session lasting approximately one hour. This number aligns with qualitative research guidelines when conducting interviews with experts (Creswell, 2007) and existing phygital retail literature (e.g., Bonfanti *et al.*, 2023; Alexander and Varley, 2025). Participants were initially contacted via email and provided with an abstract and general outline of the research. Video recordings were made and overseen by the same researcher to mitigate potential biases and were transcribed verbatim. The same researcher carried out interview coding in two steps. After an initial open coding, codes were collapsed into higher order categories that could describe a phygital customer experience. Based on the initial literature review on customer experience (Bonfanti *et al.*, 2023), this recursive and iterative process between data and extant theory continued until five conceptual themes emerged (Dacin *et al.*, 2010). These codes were validated by all three researchers to ensure reliability until mutual consensus on the following five key elements: shared purpose, brand positioning, customization, digital platform, and partnership.

After identifying key elements of customer experience in phygital retail through interviews, a case analysis was conducted to delineate how organizations may successfully integrate and manage them into their phygital retail strategies.

Cases were selected based on two phygital-related variables: (a) the usage of multiple digital technologies (e.g., apps, web, social media, mixed reality, virtual reality, and augmented reality); (b) the implementation of interfaces linking physical and virtual dimensions (Bartoli *et al.*, 2023). The methodological approach for case identification followed the framework established for phygital events (Piccioni *et al.*, 2021) and the adoption of technologies blending digital and physical elements, consistent with the criteria outlined by Nofal *et al.* (2017). The selection process was guided by Batat's categorization (2019), which defined phygital experiences as those integrating the real into the digital, a central concept of this study. We conducted a thorough review of articles from authoritative sources within the fashion industry, including Vogue Business, Fashion Network, and the Business of Fashion, alongside scrutiny of LinkedIn content from January to April 2021.

Tab. 1: Semi-structured interviews. Summary information about the interviewees

Interview	Company Industry	Short Description	Country	Job Position
1	Consulting	Innovation consultancy supporting organizations in the implementation of innovative processes, business models, and products.	Italy	Innovation Consultant
2	Luxury resale e-commerce	E-commerce for reselling second-hand luxury fashion products and accessories.	Mexico	CEO and Co-founder
3	Consulting	Management Consulting Company assisting luxury brands to develop their retail and communication strategy in APAC.	Singapore	Founder and Managing Director
4	Consulting	Retail management consulting helping luxury and beauty brands enter South Korea.	South Korea	Founder and Managing Director
5	Luxury Jewellery	Jewellery luxury part of a larger multi-brand group with more than 2000 retailers and boutiques worldwide.	Italy	Group Head of Controlling

Source: authors' elaboration

A keyword search on these websites and social media was conducted to select an initial sample of articles about phygital retail, which was then refined through deep reading. Eventually, five brands were selected as representative in terms of phygital strategy: Burberry, Gucci, Nike, Gentle Monster, and Portèlo. We collected further information from the brand's official online sources such as the website and all social media platforms (Table 2).

Tab. 2: Selected brands

Company	Industry	Considered Store	Store Location
Burberry	Luxury apparel and accessories	Burberry Shenzhen Social Store	China
Gucci	Luxury apparel, leather goods, and accessories	Gucci Garden Boutique	Italy
Nike	High-end sports apparel, footwear, equipment, and accessories	Nike Rise Store in Guangzhou	China
Gentle Monster	Luxury eyewear and accessories	Gentle Monster Haus Dosan	South Korea
Portèlo	Luxury resale e-commerce	portelo.shop	Mexico

Source: Authors' elaboration

4. Findings

4.1 Semi-structured interviews

In this section we present the five key elements for delivering a successful customer experience in phygital retail that emerged from the interviews.

Shared Purpose

All interviewees agreed that customer experience is a strategic element in retailing as a purpose shared by both the brand and its customers, becoming a discriminating factor in consumption choices.

"The customer, on buying … buys … shared values" (Interviewee 3)

Participants 2, 3, and 5 provided examples of how phygital retail delivers a brand's sustainability purpose through services like in-store perfume refilling stations, AI, machine learning, and algorithms that optimize delivery routes to reduce environmental impact. Hence, technology heightens potential of purpose as a source of competitive advantage in phygital retail through personalized purpose-driven products, services, or experience that better align with customers who are increasingly conscious of the environmental impact of the fashion industry.

Participants 4 and 5 explained that purpose also constitutes an aggregating element since customers acquire an active role in contributing or talking about it throughout their customer experience. Therefore, the customer experience in phygital retail becomes a cooperative process.

"The consumer is no longer captivated by traditional advertising, but much more by the values of a brand, how the brand communicates and resonates with you… how relevant the brand managed to be during the year with respect to its employees, the environment, and other causes" (Interviewee 5)

Participant 3 added that shared values may guide the atmosphere of online and physical retail touchpoints through arts exhibitions or exclusive customers' events in store. If purpose influences the building of the customer experience in phygital retail, the use of digital technology enables this by enhancing retail design, innovative atmosphere, and the proposal of related customer services.

Customization

While most respondents acknowledge that customers are increasingly conscious about their consumption choices (contributors 2, 3, 4, and 5), they also admit that luxury customers, especially among Gen Z, are omnichannel customers merging online and offline dimensions constantly and effortlessly in their daily routine. In addition to sharing values with a brand, they want to freely choose how and what to consume across various touchpoints in terms of contents, channels, and services. Expecting to be empowered with an active role in building their own customer experience,

they value customization through a hyper-customized service and experience at the point of sale (Interviewees 4 and 5).

"The consumer.… does not want to follow what others do, but looks for novelty, trying to personalize, detaching from standardization" (Interviewee 4)

Participant 5 explained that customization in phygital retail should create a 'wow' effect by leveraging advanced technology to hyper-customize products and services based on aggregated in-store and online behaviors. For interviewees 2 and 5 this may involve the adoption of AI, 3D printing, scanning, and modeling, or smart mirrors, allowing brands to tailor a product or service to each customer's needs, enriching customer experience. Giving the example of a customer who, after trying a product sample in-store via 3D scanning, can have a tailored version automatically delivered from the nearest store to their address, interviewee 5 emphasized how customization in phygital retail also requires a more customer-driven value chain through advanced business intelligence. Consequently, a centralized platform becomes essential, as only aggregating data on consumer behavior and experience across digital and physical touchpoints enables this level of personalization.

Brand Positioning

Positioning is determined by the overall customer experience in and with all online and offline retail touchpoints and the involvement of stakeholders through the implementation of digital platforms. Hence, delivering a consistent and relevant positioning across this multitude of touchpoints and stakeholders is critical to a well-integrated customer experience in phygital retail. Interviewee 3 asserted that positioning of customer experience in phygital retail may involve the development of events and extraordinary customer services, like cafeterias and art exhibitions in stores for customers to get to know the brand while diving into an experience of it. According to participant 5 this also applies to e-commerce through pre-sales and after-sales services and advanced interfaces.

"The store should be a place where you enter not necessarily to buy something, but to spend an hour with friends drinking a glass of wine or a coffee… where you enter into a brand-related context … and live a brand experience… where the brand presents itself in an indirect way, without imposing itself on the customer, and the customer is free to live the experience without strings attached" (Interviewee 3)

Participant 5 claimed that concept stores are increasingly pivotal for positioning, bringing unique experiences to customers and connecting with them more deeply. As customer experience in phygital retail may start in store and end online or vice versa, a customer may get to know a product in store during an exclusive event and buy it online later (participant 3, 4, and 5). A digital platform allows aggregating a customer's behaviors in

both online and physical retail touchpoints, therefore, marketing managers can develop a comprehensive assessment of their customers. Participant 3 revealed that positioning becomes a collaborative process, shaped by the interactions among all involved stakeholders across online and offline retail touchpoints. Digital platforms enable brands to do so effectively by allowing customers to actively contribute to the brand's storytelling through content creation and online sharing, as they engage with the brand in both physical and digital environments.

"A brand should become more digitally consistent from a 360° perspective… propose a phygital experience" (Interviewee 5)

Partnerships

Interviewees stressed that partnerships with local retailers (Interviewees 3, 4, 5) and distributors (Interviewee 5) are more crucial than ever to acquire the necessary knowledge and technology for delivering a relevant and consistent customer experience, through deeper customer knowledge and engagement throughout all phygital retail touchpoints. Respondents argued that building highly integrated ecosystems is strategic in phygital retail, making effective system thinking (respondents 1 and 5) and customer-centric approaches to retail critical.

"[Companies must start] creating networks, ecosystems, reinforcing both financially and economically their value chain to make all operations more fluid, flexible, …. a continuous improvement cycle … of hyper-customization, digitalization, and new role of retail" (Interviewee 5)

Interviewee 1 highlighted that partnerships can successfully solve brands' frictions in implementing innovative technology in retail, supporting the idea that building fully integrated ecosystems is pivotal. Respondent 2 explained that partnerships with distributors may help reduce the impact and time of shipping from store to home, strengthening a brand's sustainability purpose. For interviewees 2, 3, 4, and 5 partnerships help improve customer experience in phygital retail by providing innovative technology in store (e.g., refilling stations and 3D scanning), enhancing store events (e.g., art exhibitions and cafeterias), and supporting e-commerce services (e.g., fast shipping). For interviewee 4, partnerships can add experiential features to phygital retail by ensuring the frictionless connection between online and offline retail touchpoints and promoting content co-creation and engagement, for instance through live streaming. Therefore, partnerships strengthen both brand positioning across the customer experience elements of phygital retail and the importance of a platform as essential for providing innovative technology.

Digital Platform

The platform emerged as a critical aggregating and mediating element of multiple customer experience elements in phygital retail. Interviewees 1, 4, 5 stressed that successfully delivering a seamless and relevant customer experience through online and offline retail touchpoints requires exploiting

platforms making shopping frictionless by integrating digital tools (interviewees 1, 4, 5) and additional store services (i.e., cafeterias and art exhibitions; contributor 3) through interactive and immersive technology, turning stores into locations where customers go not necessarily to buy but to live an experience about the brand with other visitors. Since the exploitation of the potential of digital platforms demands more customer-driven strategies in retail (interviewee 5), the platform constitutes a key factor in building holistic customer experiences in phygital retail.

"Companies…should move… under a more customer-centric approach… exploiting the potential of digital platform" (Interviewee 5)

Participant 2 explained that digital platforms may help businesses transition towards more circular and sustainable solutions, reinforcing the commitment of a brand and its customers towards a shared purpose and enhancing customer trust and perceived brand authenticity, boosting customer experience. Interviewee 2 described how platforms in second-hand fashion retail may improve shipping routes and time through collected data, machine learning and algorithms and more deeply engage customers in the commitment towards sustainability by giving them the possibility to actively do something for the shared cause. Enabling brands and customers to easily connect and talk about the sustainability issue, digital platforms further enrich the customer experience through higher transparency and customer engagement According to participants 2, 4, and 5, interactive technology and platforms make the connection between online and offline retail even more frictionless and enhance the experiential features of retail though virtual reality (VR), virtual fitting, 3D scanning, and live streaming.

"Physical store… turned into a tool to attract everything that happens on social media… live commerce and TV and shopping…which have boosted physical retailing" (Interviewee 4)

Interviewee 5 underlined how platforms make the customer experience frictionless by advancing demand-led production according to store orders and customer behavior in store, making supply chain more efficient as well.

The semi-structured interviews confirm that delivering a successful and relevant customer experience strategy in phygital retail requires brands to move towards a more customer-centric approach, building with each customer an engaging experience through a shared purpose, relevant partnerships, hyper-customization of products, services and experiential features, and a consistent brand positioning across offline and online touchpoints thanks to a centralized platform.

4.2 Press and media case analysis

The analysis of online press and media information about phygital retail strategies was structured around the five identified elements, elucidating

their respective contribution and application to customer experience in the selected brands' phygital retail strategies.

Customization ascribes the customer an active role in designing their customized experience, products or services. Nike Rise's store customers can personalize their shoes through Nike Fit customization services, but also their whole customer experience through the Nike Member App by choosing whether to extend it beyond the store through an augmented reality (AR) game, gym sessions or sports events in the city. Customers can personalize their customer experience in the Gucci Garden Virtual Store by freely moving in the virtual space as they would do in a brick-and-mortar store thanks to virtual reality (VR) technology. Portèlo's customers personalize their experience by choosing their degree of commitment to the sustainability cause, as they can opt for donating part of revenues to local charities in addition to selling their second-hand clothes through their personal account. Gentle Monster Haus Dosan exists as a physical store and a virtual replica, so customers can decide whether to go to the store or stay at home to "visit" it. Since they can also choose whether to go to the store for either shopping or drinking a coffee with friends in the indoor cafeteria, the store turns into a social place. Burberry's Social Store revolves around a currency-collecting game powered by WeChat allowing customers to design their own customer experience by unlocking additional services and products in store and at home (e.g., items in the cafeteria's menu) according to the amount of social currency collected by scanning QR codes around the shop through their mobile devices. Hence, in phygital retail, customization implies the active involvement of customers and other stakeholders, through digital platforms allowing the former to choose which features to include in their experience and the latter to easily communicate across touchpoints.

The brand's *purpose* also emerged as a vital customer experience element in phygital retail, driving retail design, logistics and storytelling. Nike implements special lighting to reduce energy and water consumption in store and reinforces the commitment to its purpose of wellness and an active lifestyle by providing Nike Members access to local gym sessions and sport games through collaborations with local gyms and events, adapting its purpose to local habits. Portèlo provides customers with a convenient platform to contribute to a more sustainable fashion industry by selling second-hand clothes, whereas Burberry uses local social media WeChat fostering superior customer engagement offline and online. Committed to nurturing local talent, Gucci holds in-store exhibitions of local artists, while Gentle Monster collaborates with local brands like Nudake and Tamburins, and artists to enrich its in-store offerings and develop distinctive concepts and architectural design.

Consequently, maintaining consistent *brand positioning* becomes essential through relevant storytelling based on customization and a shared purpose, collectively defined by the brand, its customers, and its partners. While our analysis shows how customers actively contribute to positioning by designing their customer experience in phygital retail, it also indicates how *partners* enable brands to enrich the customer experience

through additional services and experiences inside or outside the store. Tencent provided the WeChat mini-program working as a foundation for Burberry's Social Store, whereas ObsessVR supplied the technology to build the virtual replica of Gucci Garden brick-and-mortar store. Gentle Monster partnered with Nudake to offer fantasy-inspired desserts to store visitors and Tamburins to sell other products (i.e., artisanal cosmetics) in store. Nike collaborated with local gyms and sport events to extend its commitment to wellness outside the store by granting Nike Members convenient access to gym sessions and games, while Portèlo collaborated with no-profit organizations to let customers further commit to their social sustainability purpose.

Digital platforms enable a brand to become omnipresent in a customer's daily routine, extending the customer experience beyond shopping moments and into everyday life - even outside the physical store. They also highlight how stakeholders involved in specific retail touchpoints can influence the brand's positioning in the customer's mind. As such, partnerships are confirmed to be essential for luxury companies - not only to access necessary technologies or offer localized products and services, but also to reinforce the brand's purpose, thereby strengthening its positioning.

As a core contribution of digital transformation, *digital platforms* play a key role in aggregating, managing, and sharing data across all touchpoints. This continuous flow of information among stakeholders enables greater customization of the individual customer experience across both physical and digital retail environments. Portèlo uses the e-commerce platform as a sort of circularity hub to connect people and local charities promoting a more socially and environmentally friendly fashion industry. Nike's Member app and Burberry Shenzhen Social Store's WeChat platform work as a core element aggregating numerous services both in and outside the store. Hosting three distinct brands jointly building the customer experience through additional services across the physical store and its online VR replica, Gentle Monster's store itself works as a platform. Gucci's virtual store offers complementary services with respect to its physical counterpart.

5. Discussion

Findings highlight the pivotal role of digital platforms in phygital retail as both aggregators and mediators of diverse customer experience elements. Figure 1 visualizes the different elements and stresses relevant connections.

Addressing the needs of omnichannel customers immersed in a hyperconnected "onlife" reality (Kotler *et al.*, 2021), these platforms serve as core hubs that seamlessly integrate information and orchestrate interactions across physical and digital touchpoints. First, by connecting all stakeholders around the individual customer, the platform facilitates personalized experiences through ongoing negotiation and co-creation between the brand, the customer, and other actors. This central coordinating

role enhances synergies and reinforces critical complementarities (Gawer and Cusumano, 2014) among the various dimensions of the phygital customer experience, delivering a common purpose-driven narrative jointly developed by both the brand and its customers. Second, by continuously collecting data on customers' behaviors, platforms enable superior and timely *customization* when and where needed. The platform allows customers to choose which retail touchpoints to include in their customer experience, granting them an active role in customizing not only products or services but also their overall experience with a brand. Hence, platform-enabled retail through interactive stores with temporary concepts and formats might keep customers constantly engaged with a brand by leveraging experience novelty and relevance. This is the case of store experiences based on interactive technology revolving around point-collecting video games or interactive avatars in stores. Future phygital retail strategies should envision brick-and-mortar stores as technology-driven platforms delivering elevated and personalized customer experience through game-based retail, city-led retailing, concept, and social store solutions.

As customers are increasingly looking for building a rapport with brands (Pangarkar *et al.*, 2022) based on shared values (*purpose*), the timely and continuous stream of data provided by the digital platform strengthens an organization's ability to convey its purpose in a way that is more tailored and relevant to individual customers in terms of language, time, and retail touchpoint. This reinforces a brand's capacity to offer a coherent and consistent narrative of its identity across phygital retail to each customer, strengthening customers' sense of belonging (Bartoli *et al.*, 2023; Breugelmans *et al.*, 2023) and loyalty (Bonfanti *et al.*, 2023; Alexander and Varley, 2025) through enhanced brand recall, increased exposure, and customers' active engagement (Zou *et al.*, 2022; Tuguinay *et al.*, 2022).

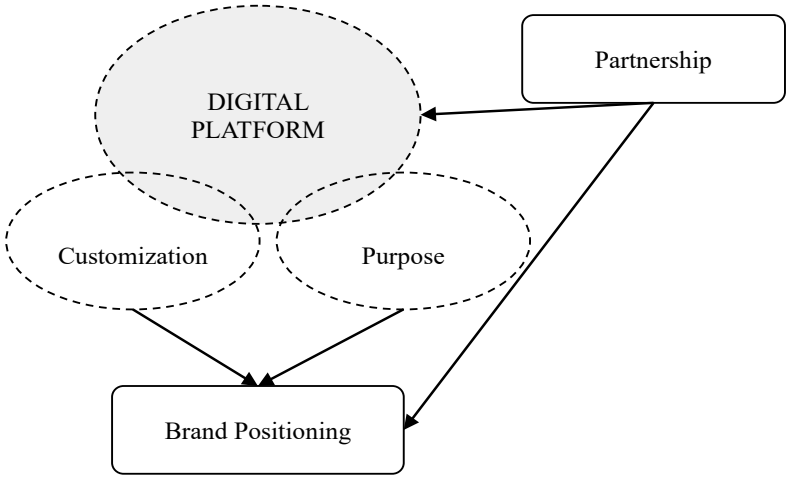
Storytelling and personalized experiences also strengthen *brand positioning* by ensuring consistency across digital and physical touchpoints, connecting stakeholders and channels into a cohesive platform. Moreover, by mediating the negotiation of shared purpose and personalized experiences between brands and consumers across online and offline touchpoints, digital platforms empower phygital retail to better meet evolving customer needs. They facilitate timely and continuous interactions among brands, customers, and other stakeholders, fostering greater engagement and active participation in co-creating personalized brand experiences. Digital platforms overcome traditional storytelling limitations by enabling co-creation through interactive technology, where customers actively shape their brand experience. For instance, social media platform might engage various store and online users in a shared virtual gaming experience, an AR interface could allow individual customers to design his or her own personalized experience outside the store, while an app proposing a point-collecting game inside the store or a two-way live-streaming customized interaction between the brand and the client might strengthen the emotional attachment to a brand (Verhoef *et al.*, 2009). Supporting the transition of retail towards new and more engaging formats (i.e., game-based retailing, AR, VR, social and live commerce), digital

platforms reinforce brand positioning by mediating the negotiation and relationship between each customer and the brand.

Partnerships become a vital experience-enhancing element in designing successful customer experiences in phygital retail. They elevate the in-store experience by introducing innovative technologies (e.g., from the entertainment and media industries) and enriching physical spaces through additional offerings (e.g., food and beverage) or localized collaborations (e.g., with social media, local businesses, or artists). Stores transform from mere shopping venues into experiential, community-centered destinations. Integrating all data and partners in a single place, platforms favour self-reinforcing mechanisms that enhance experience customization in phygital retail through more personalized products or services, higher accountability, faster information sharing and communication both internally, across functions, and externally, among all stakeholders. The effect of partnership is twofold: on the one hand, it further reinforces brand positioning, while on the other it provides innovative technologies to create a platform environment.

A technology-powered digital *platform*, such as a social media account, an app, a video game, or a digitally powered store, works as a mediator and aggregator of core customer experience elements in phygital retail strategies, integrating them across physical and digital elements into a coherent phygital experience. Serving as a central hub, it aggregates all online and offline experiential retail touchpoints around individual customers, enabling the customization of brand offerings and purpose by easing interaction between the brand and the customer, reinforcing brand positioning. Moreover, it mediates negotiation and relationships between all stakeholders (e.g., retailers, suppliers, other brands, distributors, logistics operators, etc.) who are actively engaged in building the customer experience of individual customers throughout and across all its touchpoints. Thus, adopting digital platforms providing interactive and engaging technology in phygital retail not only enables the delivery of a cohesive multisensory customer experience about the brand but also empowers customers (Mishra *et al.*, 2023) so that they can customize their journey and easily hop between physical and digital retail touchpoints, strengthening brand positioning. This further underlines the central role of the platform, which allows for more relevant personalization and deeper customer engagement by integrating valuable customer data across multiple touchpoints. Thus, the phygital customer experience achieves higher integration and customization compared to traditional retail.

Fig. 1: Adding platforms into customer experience elements in phygital retail



Source: authors' elaboration

6. Conclusions

As digital platforms become pervasive, their superior levels of connectivity radically changed the way in which customers experience brands, adding new touchpoints where customers and brands could meet and altering traditional interaction patterns between them. Since existing managerial literature on how non-human elements such as digital platforms affect phygital customer experience is still limited (Mele *et al.*, 2021), this paper makes a theoretical and empirical contribution on customer experience elements and the role of platforms in phygital retail, proposing a framework that could guide managers in devising successful customer experiences through effective phygital retail strategies.

Drawing from qualitative insights and multiple data sources, we propose a framework that reframes traditional customer experience elements-customization, shared purpose, partnerships, and brand positioning-within a phygital logic. Our analysis demonstrates that these elements, while still relevant, must be reconceptualized and cohesively embedded into both online and offline contexts through centralized, data-driven platforms. This study offers a theoretical bridge between the literature on customer experience in retail (e.g., Armstrong and Rutter, 2017; Banik, 2021; Mele *et al.*, 2021) and platform-mediated value creation (e.g., Gawer, 2021), expanding the conceptual boundaries of both fields.

Working as a medium between heterogeneous stakeholders and between digital and physical dimensions, the *digital platform* enables the smooth and timely negotiation of customized products, services, or experiences (*customization*), and shared values (*purpose*) between a brand and its customers across digital and physical retail touchpoints, leading to a superior tailoring of the customer experience to the level of

the single customer. If this reinforces the *brand positioning* through a seamless phygital retail experience that is personalized for each customer (Pangarkar *et al.*, 2022), *partnerships* strengthen brand positioning by providing continuously updated data and innovative technologies that could further enhance the customer experience across digital and physical touchpoints in novel ways, thus further reinforcing the role of the platform in delivering a holistic and relevant customer experience in phygital retail.

Functioning both as an aggregator and mediator of key elements and stakeholders of a brand's customer experience, the platform makes it possible for brands to deliver a coherent, relevant, and personalized customer experience across online and offline touchpoints to each single customer (Banik, 2021) through an engaging relationship and experience (Pangarkar *et al.* 2022).

From a managerial perspective, this study offers actionable insights. As brands must build an ecosystem of synergies among these touchpoints and stakeholders to deliver a consistent phygital experience, managers must carefully consider the most suitable platform for their brand and devise retail strategies accordingly. This paper proposes a theoretical framework that might guide them in designing phygital retail strategies through key customer experience elements. Balancing each element of the proposed framework, managers can gain a better understanding of how to interact with customers in a more relevant and consistent way across phygital retail touchpoints, framing them as a part of a holistic customer experience. The proposed visualization of relationships among customer experience elements in phygital retail may also help them choose which type of technological solution better aligns with customers' needs and behaviors by assessing potential cascade effects in terms of benefits and risks. For instance, using Nike Members app as a central platform aggregating all online and offline retail touchpoints, Nike manages to deliver a personalized experience to each customer, who can choose which services to include in theirs (e.g., shoe personalization in store, participation in a sport-based AR game outside the store or sport events, workshops, and sessions). This also enables Nike to share with customers a joint commitment to sports and wellness both online and offline, enhancing Nike's brand positioning. Nike's partnerships with local gyms and sport events are crucial to strengthening brand positioning and experience even more. Effective partnerships with app developers and technology providers allow Nike to fully exploit the potential of its digital platform (i.e., the app) to enrich and integrate the customer experience across diverse retail touchpoints. As the digital platform collects and aggregates the data of each customer's preferences, choices, and behaviors in every interaction, brands can enhance customer retention and loyalty through feedback loops in experience personalization as well.

This study has limitations, beginning with the methodology. Due to contextual constraints, in-store observations could not be conducted, and interviews were carried out online. This limited direct control over environmental variables. However, the triangulation of multiple data sources and the pre-sharing of an interview guide to participants ensured consistency and reduced variability, preserving methodological rigor.

Given the study's exploratory nature, findings are mainly relevant to the fashion industry and may not generalize to other sectors. Future research could strengthen our findings by expanding the sample, adding case studies, and exploring phygital strategies in other industries. Quantitative approaches - such as large-scale surveys - could also further support and broaden the qualitative insights.

This study focuses solely on the firm's perspective. Future research may also investigate the customer side for additional behavioral insights on how to build a more comprehensive view of phygital customer experiences. Methods like customer interviews, focus groups, ethnography, or neuromarketing could deepen understanding of how consumers navigate technology across touchpoints.

Studies might also unveil how attitudes toward data privacy and platform trust might shape engagement and satisfaction. Examining how platform architecture or governance models influence customer experiences might offer valuable insights, whereas understanding differences in consumer perceptions could enrich the study's framework and help refine phygital platform strategies.

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italian journal of management
Vol. 43, Issue 3, 2025

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sinergie
italian journal of management

ISSN 0393-5108
ISSN 2785-549X
DOI 10.7433/s128.2025.06
pp. 137-160

FONDAZIONE CUEIM

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No easy way out: dissecting firm heterogeneity to enhance default risk prediction[1]

Received
21st March 2025
Revised
29th August 2025
Accepted
13th October 2025

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Abstract

Frame of the research: *Effective risk assessment is central to managerial decision-making in financial institutions, corporate finance, and strategic planning. Drawing from prior studies on default risk, this paper investigates how the predictive ability of financial indicators varies depending on firm characteristics.*

Purpose of the paper: *This study seeks to explore how firm-level heterogeneity is associated with varying levels of predictive strength of financial indicators for default risk, examining how industry, technological levels, size, and age shape the extent to which such indicators are able to predict a firm's likelihood of default.*

Methodology: *The analysis relies on a sample of 121,809 Italian firms sourced from the AIDA database. Logistic regression and random forests are employed to assess the extent to which financial indicators - grouped into liquidity, efficiency, profitability, and growth - predict default risk across firm-specific contingencies.*

Findings: *Results indicate that default risk is more strongly associated with: (a) liquidity indicators in service-oriented firms, (b) efficiency ratios in high-tech firms, (c) profitability measures in smaller firms, and (d) growth indicators in younger firms. These findings support the use of tailored prediction models rather than generalized approaches to default risk prediction.*

Research limits: *The study mainly focuses on incorporated firms and relies primarily on quantitative financial indicators, potentially overlooking qualitative factors and unincorporated micro enterprises.*

Practical implications: *The study points toward the refinement of risk assessment models through the incorporation of firm-level contingencies. This, in turn, has implications for managers, policymakers and institutions involved in SME financing or credit scoring.*

Originality of the paper: *The paper contributes to research on default prediction by combining an integrative theoretical perspective with both statistical and machine learning techniques.*

Key words: *default risk; risk prediction; firm survival; logistic regression; random forests; Italian firms.*

1. Introduction

In times of financial uncertainty, corporate defaults affect firms across industries, organizational scales, and developmental stages (Altman *et al.*, 2017; Bertoni *et al.*, 2023; Ciampi, 2015; He *et al.*, 2023). In this vein, accurate risk assessment informs decisions by financial institutions, policymakers, investors, and managers (Altman *et al.*, 2023b; 2024; Modina *et al.*, 2023). Financial institutions refine lending decisions and stabilize credit markets; policymakers design restructuring policies; investors allocate capital more effectively; managers develop tailored strategies to mitigate risk and sustain growth. Consequently, predictive models of default risk remain a prominent locus of academic and practical interest, spanning from statistical approaches like logistic regression to machine learning methods and big data analytics (Cheraghali and Molnár, 2024).

In spite of the acknowledged relevance of highly accurate default risk models (Cheraghali and Molnár, 2024), exposure to financial distress is not uniform due to the "varying degree of vulnerability" across firms (Igan *et al.*, 2023, p. 102340). For instance, service firms' cash flow constraints, high-tech firms' efficiency requirements, or young firms' growth imperatives suggest that financial signals may carry different predictive weight depending on firm context (Aretz and Pope, 2013; Cathcart *et al.*, 2020).

Yet, empirical evidence remains limited regarding how these differences moderate the predictive power of key financial indicators. Against such a backdrop, this study asks: *How do financial indicators differently predict default risk across various industries, technological levels, firm sizes, and ages?*

To address this research question, we build on an integrative perspective to derive a novel set of hypotheses encompassing the overall assumption that predictive models should reflect firm-specific contingencies. We test our hypotheses on a dataset of 121,809 Italian firms sourced from the Computerized Analysis of Italian Companies (AIDA) database (Bureau van Dijk, 2024) using logistic regression and random forests. The choice of logistic regression is motivated by its longstanding reputation in providing a good balance between flexibility and interpretability in the prediction of firm default (Altman *et al.*, 2023a). Instead, random forests are selected among machine learning methods for their increasing use in the literature of default risk prediction (Li *et al.*, 2020; Perboli and Arabnezhad, 2021; Yıldırım *et al.*, 2021). Compared to logistic regression, random forests have the ability to handle high-dimensional data, non-linear relationships, and complex interactions, which nevertheless comes at the expense of interpretability likewise other machine learning methods (Magrini, 2025).

Building on the gained insights, our paper presents both theoretical and practical contributions. Examining the predictive relationships between key financial indicators and default risk across various firm dimensions, this study seeks to provide a more contingent logic underpinning the predictive value of financial indicators within corporate systems.

2. Theory background and hypotheses development

2.1 Firm heterogeneity in default prediction

Default risk prediction has traditionally focused on financial ratios as key signals of a firm's financial health and likelihood of failure. Early work (e.g., Altman, 1968) established the predictive utility of ratios such as liquidity, profitability, and leverage. Subsequent studies extended this approach, noting that specific indicators capture different dimensions of firm viability under financial stress (e.g., Altman *et al.*, 2023b; Beaver *et al.*, 2019; Bernini *et al.*, 2014; Ciampi, 2015). In particular, liquidity ratios (e.g., current and quick ratios) assess a firm's ability to meet short-term obligations; efficiency indicators (e.g., asset turnover) capture operational effectiveness in converting resources into revenue; profitability ratios reflect the capacity to generate surplus from operations; and growth indicators signal the ability to expand revenue and assets over time, a proxy for market success and future stability (Arbelo *et al.*, 2021; Cheraghali and Molnár, 2024).

The rationale for focusing on these four families of indicators is both theoretical and empirical. Theoretically, they correspond to distinct, complementary dimensions of organizational performance under risk: liquidity aligns with working capital theory, emphasizing short-term solvency; efficiency relates to resource-based and operational perspectives on competitive advantage; profitability reflects sustainability of operations over time; and growth signals the potential for future survival through expansion (Altman *et al.*, 2023a; Ciampi, 2015; Brinckmann *et al.*, 2011; Phelps *et al.*, 2007). Empirically, these indicators are the most widely examined and validated predictors of default risk in both SMEs and large firms (Altman *et al.*, 2023a; Ciampi, 2015; Igan *et al.*, 2023).

At the same time, it is key to acknowledge that firms are highly heterogeneous in both their characteristics (e.g., age and size) and the industries in which they are operating (e.g., services vs. products; high tech vs low tech). In this sense, research increasingly suggests that the appropriateness and predictive power of financial metrics may depend on the specific organizational and environmental context (Aretz and Pope, 2013; Sun and Cui, 2014).

Firm size and age reflect resource access, managerial capability, and stage in the organizational life cycle, which moderate the relevance of profitability and growth indicators (Carreira and Silva, 2010; Cathcart *et al.*, 2020; Coad *et al.*, 2016). For example, smaller enterprises are more likely to exhibit negative shifts in financial indicators such as cash flow ratios or debt levels (e.g., Duarte *et al.*, 2018). This is because these firms may lack the financial resilience to withstand economic downturns (Cathcart *et al.*, 2020), making them more vulnerable to liquidity constraints (Altman and Sabato, 2007).

Industry differences (e.g., services vs. products) shape operational and financial structures, which influence sensitivity to liquidity or profitability. Industry-specific variables, such as demand cycles and regulatory impacts, can significantly influence the risk profiles of firms (Aretz and Pope,

2013). Firms in cyclical industries such as construction or automotive manufacturing may be more exposed to changes in economic conditions compared to those in more stable industries like utilities or healthcare (Drobetz *et al.*, 2016; Öcal *et al.*, 2007; Peric and Vitezic, 2016). Moreover, the rapid pace of innovation and the need to utilize assets efficiently to generate revenue (Dagnino *et al.*, 2021; Yu *et al.*, 2019) make these ratios particularly pertinent for high-tech industries. These firms need to maximize the output from their assets to sustain competitiveness and manage the high costs associated with constant technological upgrades and research and development activities.

Building on such lines of reasoning, this study advances prior research by examining how the predictive ability of liquidity, efficiency, profitability, and growth indicators varies across firm-specific contexts. By grounding variable group selection in established finance and management literature, we test whether the commonly used financial indicators are equally informative across heterogeneous firm characteristics.

2.2 Industry type and liquidity indicators

We propose that the sensitivity of firms to liquidity indicators depends on their industry type. Service-oriented firms, due to their operational characteristics and financial structures, are hypothesized to exhibit greater sensitivity to liquidity indicators than product-oriented firms. This expectation rests on two main arguments.

First, the business model of service firms entails recurring and immediate operational expenses, such as payroll, rent, and utilities (Kumar *et al.*, 2018). These expenses must be met regularly to sustain operations, whereas product firms can partly manage liquidity by liquidating inventory or deferring capital expenditures (Kim, 2021). The constant need to cover frequent expenses makes liquidity management particularly salient for service firms. Liquidity shortfalls often coincide with operational disruptions and elevated default risk, which makes liquidity indicators highly predictive of financial distress in these firms (Safari and Saleh, 2020).

Second, service firms generally possess fewer tangible assets than product firms (Xue *et al.*, 2013). This limited collateral restricts their ability to secure loans or absorb financial shocks, increasing their dependence on operational cash flows to meet short-term obligations. Liquidity indicators, which measure a firm's capacity to cover short-term liabilities with its most liquid assets (Zhang *et al.*, 2020), are therefore especially informative for assessing the financial health and default risk of service firms. Additionally, the revenue model of service firms relies more heavily on operational cash flows than on sales of physical products. Shorter billing cycles and quicker payment terms (Malos and Campion, 2000) further underscore the relevance of liquidity. By contrast, product firms often benefit from longer sales cycles and more flexibility to manage cash flows through inventory and receivables. Hence, liquidity indicators such as the current or quick ratio more effectively signal financial stability and default risk in service firms, reflecting their reliance on timely cash flow generation. Accordingly,

we propose the following hypothesis:

Hypothesis 1: Service industry firms' default risk is more strongly predicted by liquidity indicators than that of product industry firms.

2.3 Technology level and efficiency indicators

We argue that high-tech firms, operating in environments defined by fast-paced innovation and intense competition (e.g., Dagnino *et al.*, 2021; Yu *et al.*, 2019), are more sensitive to efficiency indicators when predicting default risk than low-tech firms.

First, high-tech firms depend heavily on ongoing investments in research and development to remain competitive (Han *et al.*, 2024). In this context, high asset turnover reflects efficient use of resources, supporting stronger revenue streams and financial stability in line with the cost structures of these firms (Ausloos *et al.*, 2018; Florackis and Ozkan, 2009).

Second, the operational models of high-tech firms often involve significant upfront investments in technology, infrastructure, and intellectual property, making efficient asset utilization essential to sustaining financial health (Gedajlovic *et al.*, 2012; Roberts and Grover, 2012). Indicators such as asset turnover ratios capture how effectively these firms convert assets into sales, with lower efficiency typically associated with weaker revenue and higher financial distress (Spitsin *et al.*, 2023; Habib *et al.*, 2020).

Third, competitive pressures and rapid technological obsolescence in high-tech industries intensify the need for operational efficiency to maintain market position (Liu *et al.*, 2014; Pangburn and Sundaresan, 2009). By contrast, low-tech firms operate in more stable environments with slower technological change (Huang *et al.*, 2023), which reduces the urgency to optimize asset utilization and weakens the association between efficiency indicators and default risk. Accordingly, we propose the following hypothesis:

Hypothesis 2: High-tech firms' default risk is more strongly predicted by efficiency indicators, such as asset turnover ratios, compared to low-tech firms.

2.4 Firm size and profitability indicators

In this section we advance that smaller firms, characterized by their constrained capital access and focused market presence, are expected to exhibit greater sensitivity to profitability indicators than larger firms. This is underpinned by various reasons.

First, smaller firms often have more limited access to external financing options as compared to their larger counterparts (Altman and Sabato, 2007; Beck and Demirguc-Kunt, 2006; Beck *et al.*, 2008; Revest and Sapio, 2012). Due to their smaller scale and lesser financial clout, they may face higher borrowing costs and more stringent lending conditions (Altman *et al.*, 2023b; Dieperink *et al.*, 2024). Consequently, maintaining adequate profit

margins is associated with financial sustainability. Profitability indicators measure a small firm's ability to generate income relative to its asset base (Arbelo *et al.*, 2021; Sydler *et al.*, 2014). High profitability reflects efficient use of assets and operational effectiveness, which supports self-financing and is associated with lower observed financial distress. In contrast, larger firms with broader access to financing can rely more on external capital (Carreira and Silva, 2010; Nguyen and Canh, 2021), making profitability indicators relatively less critical in predicting their default risk.

Second, smaller firms often cover relatively small markets with limited customer bases and product diversification (Odlin and Benson-Rea, 2021). This lack of diversification is associated with greater vulnerability to market fluctuations and downturns. In such contexts, profitability serves as an important indicator of resilience. Higher profits are associated with the ability to sustain operations during periods of revenue volatility and economic shocks. Profitability indicators like ROA thus provide insights into the financial health and default risk of small firms (Gharsalli, 2019). Conversely, larger firms, with diversified income streams and broader market presence, can absorb market fluctuations more effectively (Mills and Schumann, 1985), making profitability indicators less predictive of their default risk.

Third, smaller firms generally have less financial resilience and fewer accumulated reserves compared to larger firms (Igan *et al.*, 2023; Lai *et al.*, 2016). This limited financial cushion is associated with greater exposure to liquidity crises and financial distress. Smaller firms with high profitability are better able to manage cash flows and meet short-term liabilities, which is associated with lower observed default risk. In contrast, larger firms, with substantial financial reserves and diversified assets, can rely on their financial strength to weather periods of low profitability, making profitability indicators less central to assessing their default risk.

Taken together, such arguments collectively highlight the heightened relevance of profitability indicators in assessing the default risk of smaller firms compared to larger firms[2]. As a result, we propose the following hypothesis:

Hypothesis 3: Smaller firms' default risk will be more closely related to profitability indicators, such as return on assets (ROA), than larger firms.

2.5 Firm age and growth indicators

In this section, we contend that younger firms' default risk is more closely predicted by growth indicators, such as revenue growth rate, than that of older firms. This relationship rests on two main arguments.

[2] We acknowledge that the adopted database (AIDA) mostly includes incorporated firms, thus our analysis of "small firms" pertains to the subset of small incorporated entities. Many small firms in the broader economy, particularly micro and family-run businesses, are unincorporated and may rely more on owners' personal resources, which are not observable in our data. Accordingly, the findings of Hypothesis 3 should be interpreted within the population of small incorporated firms. This limitation is also discussed in the "Limitations and conclusions" section.

First, younger firms are typically in the growth phase of their organizational life cycle, prioritizing high resource endowments expansion and market penetration (Bruderl and Schussler, 1990; La Rocca *et al.*, 2011; Phelps *et al.*, 2007). During this stage, earnings are reinvested to support marketing, product development, and scaling operations. High growth rates signal successful market entry and customer acquisition, which contribute to stronger cash flows and lower observed financial distress (Brinckmann *et al.*, 2011). In contrast, older firms, with established market positions, rely less on rapid growth, making growth indicators less predictive of their default risk.

Second, younger firms face greater operational and market uncertainty than older counterparts (Bertoni *et al.*, 2023). Limited diversification, fewer customer relationships, and restricted financial resources make their stability more dependent on rapid growth. Growth indicators thus serve as signals of future viability and help attract investors and lenders, who provide the capital needed to sustain operations and mitigate financial distress (Ahmed and Safdar, 2017). Conversely, stagnating or declining growth is often associated with heightened financial constraints and increased default risk among younger firms. Older firms, with more stable revenue streams and financial histories, tend to rely more on profitability and efficiency measures when assessing financial health.

In sum, the strategic emphasis on growth highlights the relevance of growth indicators as predictors of default risk in younger firms, reflecting their need to demonstrate potential and secure external financing. Accordingly, we propose the following hypothesis:

Hypothesis 4: Younger firms' default risk will be more closely associated with growth indicators, such as revenue growth rate, than older firms.

3. Data and Methods

3.1 Setting and sample

The dataset utilized in this study is sourced from the Computerized Analysis of Italian Companies (AIDA) database (Bureau van Dijk, 2024), which comprises detailed financial statements from a large number of Italian firms. We argue that this setting is particularly suitable for testing our hypotheses for several reasons. First, the Italian economic context - characterized by periods of significant financial stress and recovery (Bruzzi *et al.*, 2021) - provides an appropriate setting to examine how economic fluctuations are associated with firm default risk. As a European member state, Italy has consistently been studied by previous research on default prediction (e.g., Ciampi, 2015). This setting provides an ideal environment to test the robustness of models for default risk prediction under varying economic conditions, and enhances the generalizability of the findings to other contexts facing similar economic dynamics. Second, the extensive coverage of the AIDA database allows for a comprehensive analysis across a wide range of firm characteristics including industry type,

size, age, and technological level. The inclusivity of this database ensures that the results of our study are not confined to a narrow segment of the market but are representative of the broader Italian business ecosystem. Third, the diversity within the Italian economy - with a mix of traditional manufacturing, high-technology industries, and robust service industries - provides a unique opportunity to examine the contingencies of default risk across different market conditions and business models. This diversity allows for exploring how financial indicators vary in their predictive power of default risk among firms operating in different economic environments (Broglia and Corsi, 2024). Fourth, the longitudinal aspect of the data, with many firms having multiple years of financial records, allows for dynamic analysis and the ability to track changes in financial health over time. This feature is crucial for investigating how the relationship between financial indicators and default risk evolves as firms grow, adapt, or face economic challenges.

To enhance the representativeness of our sample, we consider all firms present in the database that meet the following three criteria: (i) the legal status is "active" or "failed", (ii) at least three financial statements are available, and (iii) equity is positive for all financial statements. The obtained sample consists of 138,720 firms, of which 127,420 (91.9%) are active and 11,300 (8.1%) are failed. Data cleaning is performed in two steps: (i) companies with anomalous values for any indicator (e.g., when the denominator is very small) are eliminated, and (ii) the set of indicators is pruned until all variance inflation factors indicate no multicollinearity, i.e., they are below the threshold of 5 (O'Brien, 2007). The final sample consists of 121,809 companies, of which 111,612 (91.6%) are active and 10,197 (8.4%) have failed. For most of them (83.8%), the latest available financial statement is for year 2023. The main characteristics of the sample are reported in Table 1.

Tab. 1: Sample characteristics (n = 121,809)

Legal status			*Industry*		
Active	111,612	91.6%	Product-centered	38,588	31.7%
Failed	10,197	8.4%	Service-centered	83,221	68.3%
Firm age			*Firm size*		
≤ 10 years from foundation	9,992	8.2%	Less than 50 employees or total assets < 10 million euros	101,956	83.7%
> 10 years from foundation	111,817	91.8%	More or equal than 50 employees and total assets ≥ 10 million euros	19,853	16.3%
Technological level			*Legal form*		
Low	70,127	57.6%	Capital	117,611	96.6%
High	51,682	42.4%	Consortium	3,703	3.0%
			Other	495	0.4%
Geographical area					
North-West	37,634	30.9%			
North-East	30,807	25.3%			
Center	28,116	23.1%			
South and islands	25,252	20.7%			

Source: our elaboration

3.2 Measures

The dependent variable in this study is the legal status of firms, which is categorized as either "active" or "failed". This binary outcome enables the examination of how various managerial and financial characteristics are associated with default.

Our moderating variables include the industry, firm size, technological level, and firm age. Based on Ettlie and Rosenthal (2011), firms are classified as "product-centered" based on their ATECO 2019 codes if their main activities include manufacturing, agriculture, or retail trade, such as those involved in producing goods or selling products. Examples include manufacturing companies, agricultural businesses, and retail stores. On the other hand, firms are classified as "service-centered" if their activities involve providing services rather than goods, such as healthcare providers, financial services, and IT support companies. To represent the industry, the dummy variable *Industry* is created, coded as 1 if the firm is "service-centered" and 0 otherwise.

Firm size is determined based on the number of employees, revenues and total assets. Firms are classified as "small" if they have fewer than 50 employees or revenues and total assets not exceeding 10 million euros (European Commission, 2024); otherwise, they are considered "medium/large". To represent firm size, the dummy variable *Size* is created, coded as 1 if the firm is "medium/large" and 0 otherwise.

Technological level is determined by the main economic activity similarly to Czarnitzki and Thorwarth (2012) and He *et al.* (2023) , i.e., firms are classified as "high-tech" if their activities are in industries like high-tech manufacturing, IT services, or financial services. Examples include software development firms, biotech companies, and advanced engineering firms. The other firms are considered "low-tech", such as those in traditional manufacturing or basic service industries. To represent the technological level, the dummy variable *Tech* is created, coded as 1 if the firm is "high-tech" and 0 otherwise (Balzano and Marzi, 2023; He *et al.*, 2023).

Firm age is categorized based on the number of years the firm has been in existence. As in Coad *et al.* (2016), a firm is considered "young" if it is 10 years old or less and "established" otherwise. To represent firm age, the dummy variable *Age* is created, coded as 1 if the firm is "established" and 0 otherwise.

Key independent variables include financial indicators, divided into liquidity, efficiency, profitability, and growth. Each indicator is computed two years prior to the date of the latest financial statement in order to predict default risk two years into the future. Liquidity indicators include current ratio (current assets divided by current liabilities) and quick ratio (current assets excluding inventory, divided by current liabilities). Efficiency indicators consist of assets to sales ratio (total assets divided by sales revenue), inventory to sales ratio (inventory divided by sales revenue), and receivables to sales ratio (account receivables divided by sales revenue); these indicators are defined as the reciprocal of turnover ratios to deal with null values of inventory and account receivables. Profitability indicators

comprise return on assets (ROA, calculated as earnings before interest and taxes divided by total assets), return on sales (ROS, calculated as earnings before interest and taxes divided by sales revenue), and return on equity (ROE, calculated as net income divided by equity). Growth indicators are assets change (total assets at time t divided by total assets at time t-1), sales change (sales revenue at time t divided by sales revenue at time t-1), and income change (difference in net income between time t and time t-1, divided by total assets at time t-1).

Control variables include leverage indicators and other firm characteristics. As leverage indicators, we consider the debt to assets ratio (total liabilities divided by total assets), the debt to equity ratio (total liabilities divided by equity), the fixed assets to equity ratio (fixed assets divided by equity), and the interest to debt ratio (interest charges divided by total liabilities). Other firm characteristics encompass legal form and geographical region. Legal form is classified into "capital", "consortium", or "other", with "capital" serving as the reference category, thus two dummy variables are created to represent the categories "consortium" and "other". Geographical region is divided into "north-west", "north-east", "center", and "south and islands", with "north-west" as the reference category, thus three dummy variables are created to represent the categories "north-east", "center", and "south and islands". All the adopted measures are listed and described in Table 2, while their descriptive statistics are reported in Table 3.

Tab. 2: Description of the adopted measures

Dependent variable
Legal status: "active", or "failed"
Moderators
Industry: "product-centered" ($Industry_i$=0), or "service-centered" ($Industry_i$=1)
Firm size: "small" ($Size_i$=0), or "medium/large" ($Size_i$=1)
Technological level: "low-tech" ($Tech_i$=0), or "high-tech" ($Tech_i$=1)
Firm age: "young" (Age_i=0), or "established" (Age_i=1)
Liquidity indicators
Current ratio: current assets / current liabilities
Quick ratio: (current assets - inventory) / current liabilities
Efficiency indicators
Assets to sales ratio: total assets / sales revenue
Inventory to sales ratio: inventory / sales revenue
Receivables to sales ratio: account receivables / sales revenue
Profitability indicators
ROA: earnings before interest and taxes / total assets
ROS: earnings before interest and taxes / sales revenue
ROE: net income / equity
Growth indicators
Assets change: total assets at time t / total assets at time t-1
Sales change: sales revenue at time t / sales revenue at time t-1
Income change: (net income at time t - net income at time t-1) / total assets at time t-1
Control variables
Debt to assets ratio: total liabilities / total assets
Debt to equity ratio: total liabilities / equity
Fixed assets to equity ratio: fixed assets / equity
Interests to debt ratio: interest charges / total liabilities
Legal form: "capital", "consortium", or "other"
Geographical region: "north-west", "north-east", "center", or "south and islands"

Source: our elaboration

Tab. 3: Descriptive statistics: mean, standard deviation, and Pearson's correlations

	Mean	Std. dev.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1)	1.633	1.325	1.000														
(2)	1.152	0.946	0.789	1.000													
(3)	1.519	1.498	0.090	-0.002	1.000												
(4)	0.312	0.581	0.217	-0.150	0.519	1.000											
(5)	0.256	0.336	-0.018	0.045	0.285	0.124	1.000										
(6)	0.053	0.071	0.148	0.250	-0.230	-0.168	-0.118	1.000									
(7)	0.056	0.101	0.182	0.226	-0.010	-0.026	-0.070	0.695	1.000								
(8)	0.076	0.381	0.061	0.112	-0.163	-0.136	-0.101	0.559	0.477	1.000							
(9)	1.519	0.255	-0.043	0.026	-0.077	-0.067	-0.015	0.245	0.176	0.211	1.000						
(10)	1.260	0.598	0.049	0.033	-0.082	-0.053	-0.097	0.192	0.144	0.167	0.257	1.000					
(11)	0.021	0.071	0.050	0.089	-0.072	-0.061	-0.062	0.518	0.362	0.365	0.302	0.287	1.000				
(12)	0.724	0.188	-0.354	-0.407	-0.101	0.088	0.086	-0.301	-0.284	-0.135	0.050	-0.028	-0.083	1.000			
(13)	6.800	11.837	-0.130	-0.171	0.043	0.146	0.098	-0.194	-0.148	-0.305	-0.002	-0.048	-0.076	0.516	1.000		
(14)	1.995	3.594	-0.203	-0.194	0.142	-0.029	-0.007	-0.198	-0.141	-0.283	-0.050	-0.057	-0.067	0.372	0.624	1.000	
(15)	0.014	0.015	-0.018	-0.041	0.001	0.031	0.017	0.041	0.007	-0.110	-0.062	0.005	0.002	0.156	0.111	0.080	1.000

(1) Current ratio; (2) Quick ratio; (3) Assets to sales ratio; (4) Inventory to sales ratio; (5) Receivables to sales ratio; (6) Return on assets (ROA); (7) Return on sales (ROS); (8) Return on equity (ROE); (9) Assets change; (10) Sales change; (11) Income change; (12) Debt to assets ratio; (13) Debt to equity ratio; (14) Fixed assets to equity ratio; (15) Interests to debt ratio.

Source: our elaboration

3.3 Analytical techniques

The proposed hypotheses are tested using logistic regression, which is a statistical model widely known in the literature on default risk prediction for its good balance between flexibility and interpretability (Altman *et al.*, 2023a). All indicators are standardized by subtracting their sample mean and dividing by their sample standard deviation in order to ease interpretation and allow comparisons among parameters (Menard, 2011). We formulate the model as follows:

$$\log\left(\frac{\pi_i}{1-\pi_i}\right) = \boldsymbol{z}_i'\boldsymbol{\alpha} + \boldsymbol{l}_i'\left(\boldsymbol{\beta}^{(l)} + \boldsymbol{\gamma}^{(l)} \cdot Industry_i\right) + \boldsymbol{e}_i'\left(\boldsymbol{\beta}^{(e)} + \boldsymbol{\gamma}^{(e)} \cdot Tech_i\right) + \boldsymbol{p}_i'\left(\boldsymbol{\beta}^{(p)} + \boldsymbol{\gamma}^{(p)} \cdot Size_i\right) + \boldsymbol{g}_i'\left(\boldsymbol{\beta}^{(g)} + \boldsymbol{\gamma}^{(g)} \cdot Age_i\right) \quad (1)$$

where, for a generic firm i:

- π_i is the probability of default, thus $\frac{\pi_i}{1-\pi_i}$ is the odds of the event "failed" versus the event "active", here called default risk;
- $\boldsymbol{z}_i$ is a vector including value 1 followed by the value taken by leverage indicators, dummies for moderating variables (Industry, Tech, Size, and Age), dummies for the legal form, and dummies for the geographical region;
- $\boldsymbol{l}_i$ is a vector including the value of liquidity indicators;
- $\boldsymbol{e}_i$ is a vector including the value of efficiency indicators;
- $\boldsymbol{p}_i$ is a vector including the value of profitability indicators;
- $\boldsymbol{g}_i$ is a vector including the value of growth indicators;
- $\boldsymbol{\alpha}$ is a vector of parameters including the intercept and the main effects of control variables;
- $\boldsymbol{\beta}^{(l)}$, $\boldsymbol{\beta}^{(e)}$, $\boldsymbol{\beta}^{(p)}$, $\boldsymbol{\beta}^{(g)}$ are vector of parameters including, respectively, the main effects of liquidity, efficiency, profitability and growth indicators;
- $\boldsymbol{\gamma}^{(l)}$, $\boldsymbol{\gamma}^{(e)}$, $\boldsymbol{\gamma}^{(p)}$, $\boldsymbol{\gamma}^{(g)}$ are vectors of parameters including the interaction effects.

This model formulation allows the default risk associated with: (i) liquidity indicators to differ across industries, (ii) efficiency indicators to differ across technological levels, (iii) profitability indicators to differ across size classes, and (iv) growth indicators to differ across age categories. For example, the odds ratio per unit standard deviation increase of the first liquidity ratio is given by exp ($\boldsymbol{\beta}_1^{(l)}$) for product-centered industries, and by exp ($\boldsymbol{\beta}_1^{(l)} + \boldsymbol{\gamma}_1^{(l)}$) for service-centered industries, where $\boldsymbol{\beta}_1^{(l)}$ and $\boldsymbol{\gamma}_1^{(l)}$ are the first components of parameter vectors $\boldsymbol{\beta}^{(l)}$ and $\boldsymbol{\gamma}^{(l)}$, respectively. As such, the proposed hypotheses can be tested by performing significance tests on $\boldsymbol{\gamma}^{(l)}$, $\boldsymbol{\gamma}^{(e)}$, $\boldsymbol{\gamma}^{(p)}$ and $\boldsymbol{\gamma}^{(g)}$.

As a robustness check, our hypotheses are tested also based on random forests, which constitute a non-parametric approach to prediction based on decision trees. Originally proposed by Breiman (2001), random forests are increasingly applied to corporate default prediction for their ability to handle high-dimensional data, non-linear relationships, and complex interactions (Li *et al.*, 2020, Perboli and Arabnezhad, 2021; Yıldırım *et al.*, 2021). As such, their feature importance measures can provide a more accurate assessment of the predictive relevance of independent variables

compared to logistic regression. The most advanced feature importance measure in random forests is permutation importance, which consists in the assessment of the loss in predictive accuracy when the dependent variable is predicted based on random permutations of an independent variable. The more the predictive accuracy decreases, the higher is the importance of the variable. Here, we consider the permutation importance measure proposed by Strobl et al (2007), which is robust when independent variables have different scale of measurement or number of categories. In order to test each hypothesis, which considers a set of indicators and two groups of firms, permutation importance is computed for all indicators altogether (by simultaneously permuting their values) separately for each group of firms.

4. Results

4.1 Logistic regression

Parameter estimation and significance tests for the logistic regression model in equation (1) are performed using R for Statistical Software (R Core Team, 2023). The results are shown in Table 4. In order to ease the interpretation of the estimated model, odds ratios per unit standard deviation increase of indicators involved in each research hypothesis are shown in Table 5.

Tab. 4: Summary of parameter estimation for the logistic regression model in equation (1)

Parameter	Estimate	Std. error	p-value
Intercept	-7.8334	0.2720	0.0000 ***
Region: "north-east" vs. "north-west"	0.0181	0.0350	0.6040
Region: "center" vs. "north-west"	-0.1753	0.0355	0.0000 ***
Region: "south and islands" vs. "north-west"	-0.3088	0.0394	0.0000 ***
Legal form: "consortium" vs. "capital"	-0.6178	0.0763	0.0000 ***
Legal form: "other" vs. "capital"	-0.4560	0.1746	0.0090 **
Debt to assets ratio	1.0564	0.0296	0.0000 ***
Debt to equity ratio	0.2615	0.0132	0.0000 ***
Fixed assets to equity ratio	-0.1561	0.0123	0.0000 ***
Interests to debt ratio	0.8939	0.0129	0.0000 ***
Industry	-0.4030	0.0449	0.0000 ***
Tech	0.0844	0.0306	0.0057 **
Size	0.7312	0.0454	0.0000 ***
Age	3.7698	0.2681	0.0000 ***
Current ratio	-0.0032	0.0471	0.9450
Quick ratio	-1.1610	0.0664	0.0000 ***
Assets to sales ratio	-0.4348	0.0396	0.0000 ***
Inventory to sales ratio	-0.1395	0.0249	0.0000 ***
Receivables to sales ratio	-0.1197	0.0157	0.0000 ***
ROA	0.0877	0.0189	0.0000 ***
ROS	0.0801	0.0186	0.0000 ***
ROE	0.3519	0.0153	0.0000 ***
Assets change	-0.0328	0.1581	0.8356
Sales change	-1.4375	0.3116	0.0000 ***
Income change	-1.1145	0.4322	0.0099 **
Current ratio * *Industry*	-0.9406	0.0770	0.0000 ***
Quick ratio * *Industry*	-0.2067	0.0809	0.0106 *
Asset to sales ratio * *Tech*	0.1733	0.0787	0.0278 *
Inventory to sales ratio * *Tech*	0.1065	0.0448	0.0176 *
Receivables to sales ratio * *Tech*	0.0704	0.0291	0.0154 *
ROA * *Size*	0.0690	0.0326	0.0343 *
ROS * *Size*	0.0902	0.0334	0.0070 **
ROE * *Size*	0.0496	0.0244	0.0422 *
Assets change * *Age*	0.0027	0.1589	0.9864
Sales change * *Age*	0.8411	0.3122	0.0071 **
Income change * *Age*	0.9078	0.4324	0.0358 *

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: our elaboration

Tab. 5: Odds ratios per unit standard deviation increase implied by the logistic regression model in equation (1)

	Industry	
	"product-centered"	"service-centered"
Current ratio	0.997 (0.909, 1.093)	0.389 (0.337, 0.449)
Quick ratio	0.313 (0.275, 0.357)	0.255 (0.223, 0.290)
	Technological level	
	"low-tech"	"high-tech"
Assets to sales ratio	1.092 (1.052, 1.133)	1.170 (1.104, 1.239)
Inventory to sales ratio	1.083 (1.045, 1.124)	1.186 (1.111, 1.265)
Receivables to sales ratio	1.422 (1.380, 1.465)	1.494 (1.435, 1.556)
	Firm size	
	"small"	"medium/large"
Return on assets (ROA)	0.647 (0.599, 0.700)	0.770 (0.671, 0.883)
Return on sales (ROS)	0.870 (0.828, 0.913)	0.968 (0.899, 1.041)
Return on equity (ROE)	0.887 (0.860, 0.915)	0.952 (0.905, 1.001)
	Firm age	
	≤ 10 years	> 10 years
Assets change	0.968 (0.710, 1.319)	0.970 (0.939, 1.002)
Sales change	0.238 (0.129, 0.437)	0.551 (0.525, 0.578)
Income change	0.328 (0.141, 0.765)	0.813 (0.779, 0.849)

Note: 95% confidence intervals are shown within brackets.

Source: our elaboration

The estimated main effects of current ratio and quick ratio are negative, indicating that, for product-centered industries, higher liquidity is associated with lower default risk, although only the main effect of quick ratio is statistically significant. The estimated interaction terms, both significant and negative, indicate that higher liquidity is associated with a stronger reduction in default risk for service-centered firms than for product-centered ones. Precisely: the odds ratio per standard deviation increase of current ratio is 0.997 (-0.3%) for product-centered firms and 0.389 (-61.1%) for service-centered ones, meaning that the reduction of the default risk is 60.8% higher for the service-centered industry; the odds ratio per standard deviation increase of quick ratio is 0.313 (-68.7%) for product-centered firms and 0.255 (-74.5%) for service-centered ones, meaning that the reduction of the default risk is 5.8% higher for the service-centered industry. Therefore, Hypothesis 1 is supported.

The estimated main effects of assets to sales, inventory to sales, and receivables to sales ratios are significantly positive, indicating that, for firms with low technological level, greater efficiency-reflected in lower values of these indicators-is associated with lower default risk. The estimated interaction terms, all significant and positive, indicate that an improvement of efficiency is associated with a stronger reduction in the default risk for high-tech firms than for low-tech ones. Precisely: the odds ratio per standard deviation decrease of the assets to sales ratio is 1/1.092=0.916 (-8.4%) for low-tech firms and 1/1.170=0.855 (-14.5%) for high-tech ones,

meaning that the reduction of the default risk is 6.1% higher for high-tech firms; the odds ratio per standard deviation decrease of the inventory to sales ratio is 1/1.083=0.923 (-7.7%) for low-tech firms and 1/1.186=0.843 (-15.7%) for high-tech firms, meaning that the reduction of the default risk is 8.0% higher for high-tech firms; the odds ratio per standard deviation decrease of the receivables to sales ratio is 1/1.422=0.703 (-29.7%) for low-tech firms and 1/1.494=0.669 (-33.1%) for high-tech firms, meaning that the reduction of the default risk is 3.4% higher for high-tech firms. Therefore, Hypothesis 2 is supported.

The estimated main effects of ROA, ROS and ROE are significantly negative, indicating that, for small firms, higher profitability is associated with lower default risk. The estimated interaction terms, all significant and positive, indicate that an improvement of profitability implies a higher decrease of the default risk for small firms than for medium or large ones. Precisely: the odds ratio per standard deviation increase of ROA is 0.647 (-35.3%) for small firms and 0.770 (-23.0%) for medium and large ones, meaning that the reduction of the default risk is 12.3% higher for small firms; the odds ratio per standard deviation increase of ROS is 0.870 (-13.0%) for small firms and 0.968 (-3.2%) for medium and large ones, meaning that the reduction of the default risk is 9.8% higher for small firms; the odds ratio per standard deviation increase of ROE is 0.887 (-11.3%) for small firms and 0.952 (-4.8%) for medium and large ones, meaning that the reduction of the default risk is 6.5% higher for small firms. Therefore, Hypothesis 3 is supported.

The estimated main effects of assets change, sales change and income change are negative, indicating that, for young firms, growth is associated with lower default risk, although only the impact of change in sales and in income result significantly different from zero. The estimated interaction terms, all positive but significant for sales and income change only, indicate that growth implies a higher decrease of the default risk for young firms than for established ones. Precisely: the odds ratio risk per standard deviation increase of sales change is 0.238 (-76.2%) for young firms and 0.551 (-44.9%) for established ones, equating to a 31.3% reduction of the default risk; the odds ratio risk per standard deviation increase of income change is 0.328 (-67.2%) for young firms and 0.813 (-18.7%) for established ones, equating to a 48.5% reduction of the default risk. Therefore, Hypothesis 4 is supported.

4.2 Random forests

The R package 'party' (Hothorn *et al.* 2024) is used to compute the permutation importance measure proposed by Strobl et al (2007). As a first step, a random forest is constructed with the legal status as dependent variable and all other measures shown in Table 2 as independent variables. For this purpose, we set a number of trees equal to 500 and a number of candidates randomly selected at each split equal to 5, corresponding to the rounded squared root of the number of independent variables as suggested by Breiman (2001). In order to test each hypothesis, which considers a set of indicators and two groups of firms, permutation importance is computed

for all indicators altogether (by simultaneously permuting their values) separately for each group of firms. The results are shown in Table 6.

Tab. 6: Hypothesis testing based on permutation importance in random forests. Values are loss in AUC (%) based on 500 random permutations

Hypothesis 1		Loss in AUC (%)
Moderating variable: industry	"product-centered"	2.471 (2.239, 2.698)
Indicators: liquidity	"service-centered"	3.297 (3.139, 3.470)
	(difference)	0.826 (0.506, 1.118)
Hypothesis 2		Loss in AUC (%)
Moderating variable: technological	"low-tech"	1.549 (1.457, 1.709)
level	"high-tech"	1.912 (1.750, 2.077)
Indicators: efficiency	(difference)	0.363 (0.151, 0.574)
Hypothesis 3		Loss in AUC (%)
Moderating variable: firm size	"small"	2.735 (2.639, 2.815)
Indicators: profitability	"medium/large"	2.292 (2.086, 2.483)
	(difference)	-0.443 (-0.678, -0.249)
Hypothesis 4		Loss in AUC (%)
Moderating variable: firm age	<= 10 years	13.236 (7.404, 19.511)
Indicators: growth	> 10 years	2.321 (2.169, 2.490)
	(difference)	-10.915 (-17.291, -5.136)

Note: 95% confidence intervals are shown within brackets.

Source: own elaboration

As shown in Table 6, the loss in AUC after permuting liquidity indicators is higher for service-centered firms than for product-centered firms, with 95% confidence interval for the difference not including value zero and thus indicating significance at 5% level. This finding supports Hypothesis 1. Similarly, the loss in AUC after permuting efficiency indicators is significantly higher for high-tech firms than for low-tech firms, thus supporting Hypothesis 2. The loss in AUC after permuting profitability indicators is significantly higher for small firms than for medium or large firms, therefore Hypothesis 3 is supported. Finally, the permutation importance of growth indicators is significantly higher for young firms than for established firms, providing support to Hypothesis 4.

5. Discussion and implications

This study corroborates the relevance of considering contingent factors-such as industry type, technological level, firm size, and age-when assessing firms' default risk. In this perspective, the study complements prior research, which has highlighted cross-country heterogeneity in vulnerability to financial distress (Igan *et al.*, 2023), by showing that heterogeneity in firm characteristics and the context where the firm is operating, equally shapes the salience of financial indicators. This shift from generalized approaches to default risk to emphasis in firm-level

heterogeneity, underscoring that financial signals are not uniformly informative across firms but rather acquire their meaning in relation to the operational, strategic, and institutional contexts in which firms are embedded.

Accordingly, the findings illuminate how firm characteristics modulate the predictive value of financial metrics. In service-oriented firms, the power of liquidity indicators aligns with their operational immediacy and reliance on cash flow rather than tangible assets (Kumar *et al.*, 2018; Xue *et al.*, 2013). In high-technology settings, the heightened sensitivity to efficiency reflects the imperative to translate R&D investments into market outcomes efficiently, given the volatility and competitive intensity of innovation-driven environments (Dagnino *et al.*, 2021). Smaller firms, constrained in access to external capital (Beck and Demirguc-Kunt, 2006), exhibit a stronger dependence on profitability as an internal buffer, while younger firms rely on sustained growth trajectories to signal legitimacy and attract resources in conditions of uncertainty (Ahmed and Safdar, 2017; Brinckmann *et al.*, 2011).

From a methodological point of view, the study combines logistic regression, a traditional statistical model, with random forests, one of the most popular machine learning methods in bankruptcy risk prediction, to explore and validate heterogeneity in predictive relationships. Logistic regression offers a good balance between flexibility and interpretability, while random forests allow to handle high-dimensional data, non-linear relationships, and complex interactions, although at the expense of interpretability likewise other machine learning methods (Magrini, 2025). This integration addresses the growing demand for predictive models that are both transparent and sensitive to contextual variations (Cheraghali and Molnár, 2024).

For practice, these insights invite managers, investors, and policymakers to move beyond generalized risk assessment tools toward approaches attuned to firm-specific conditions. Accordingly, stakeholders can improve decision-making by weighting financial indicators according to firm profiles-for instance, emphasizing liquidity when evaluating service firms, efficiency for high-tech firms, profitability for smaller enterprises, and growth for younger organizations. Such tailoring can improve the allocation of credit, investment, and policy support while mitigating misclassification errors that arise from one-size-fits-all models.

Furthermore, these differentiated sensitivities suggest that managerial priorities should be aligned with the financial dimensions most salient to the firm's structural and competitive context. For managers, this entails not only optimizing the relevant financial ratios but also communicating these dimensions effectively to external evaluators. For investors, incorporating these insights into portfolio strategies may enhance risk-adjusted returns. Policymakers can design more targeted interventions-such as liquidity facilities for service sectors, operational efficiency programs in high-tech industries, profitability-enhancement initiatives for small businesses, or growth-enabling policies for young firms.

6. Limitations and conclusions

In conclusion, this study makes a contribution to the literature on default risk prediction by advocating for context-specific models that account for the heterogeneity among firms. The findings highlight the need for tailored risk assessment tools that can accurately reflect the diverse characteristics of firms, thereby improving risk management practices and decision-making processes.

However, the study is not without its limitations. First, our findings regarding small firms' heightened sensitivity to profitability indicators must be interpreted in light of two caveats. First, the AIDA database covers only incorporated firms, which excludes the large share of unincorporated micro enterprises that may rely more heavily on personal or informal financial resources. Second, our operationalization groups micro and small firms under the same category, potentially masking heterogeneity in their risk profiles. In particular, micro firms, even when incorporated, may have access to informal or owner-based support that weakens the link between profitability and default risk. Future research should aim to disaggregate micro from small firms and extend the analysis to unincorporated businesses to assess the generalizability of our conclusions. Moreover, while the study leverages a rich dataset, it relies heavily on quantitative financial indicators, potentially overlooking qualitative factors such as management quality or market conditions that could also shape default risk (Altman *et al.*, 2010; Altman *et al.*, 2023a; Ciampi, 2015). Future research could also explore the dynamic aspects of default risk by examining how the relationships between financial indicators and default risk evolve over time. Longitudinal studies could shed light on the temporal stability of the identified relationships and help in developing more adaptive and responsive risk models. Moreover, investigating the role of macroeconomic factors such as economic cycles or regulatory changes on default risk could further enhance the predictive power of the models.

While all firms face exposure to default, the degree of vulnerability significantly varies across contexts. Hence, as the economic landscape continues to evolve, future researchers will have the challenge to keep default risk models effective in predicting financial distress, adapting to a greater number of contingencies and to the ever-changing economic landscapes.

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sinergie
italian journal of management

ISSN print 0393-5108
ISSN online 2785-549X
DOI 10.7433/s128.2025.07
pp. 161-183

Exploring corporate heritage through digital narrative. A cross-cultural thematic analysis of Henokiens' websites[1][2]

Received 16th June 2025
Revised 28th July 2025
Accepted 9th October 2025

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Abstract

Purpose of the paper: *This study explores the communication of corporate heritage of long-lived firms. It inductively determines the key elements that bicentennial companies typically use to convey corporate heritage through their websites. It also investigates whether and how the culture of the country influences the communication of corporate heritage.*

Methodology: *The study analyzes the websites of 46 bicentennial family firms that are members of the Henokiens association. An inductive thematic analysis was conducted using NVivo 14 software. A cross-cultural comparison based on Hofstede's cultural dimensions was applied to examine narrative differences across firms from Italy, France, Germany, and Japan.*

Findings: *The study identifies three core dimensions of corporate heritage narratives (entrepreneurial mindset, historicity, and inner values) that reflect the values and identity of long-lived firms. These dimensions help companies communicate continuity, authenticity, and heritage. Cultural differences shape how these values are prioritized: for example, Japanese firms emphasize innovation and international projection, while French and German firms stress responsibility and prestige; Italian firms focus on adaptability over time. Finally, innovation emerges as a strategic driver in sustaining heritage relevance in dynamic markets.*

Research limitations: *This study focuses on a specific group of long-lived, bicentennial family-owned firms that actively communicate their corporate heritage. While this limits the generalizability of the findings, the identified narrative dimensions and practices can serve as valuable references for other firms that possess a heritage but have not yet integrated it into their communication strategy. Our results offer guidance on how such firms can strategically leverage their historical and cultural assets to build brand identity and stakeholder engagement.*

Practical implications: *Understanding how heritage dimensions embody corporate values enables managers to align communication with stakeholder*

[2] Research project
This study was carried out as a part of the research project ""Is old really gold?" International consumers' perceptions and attitudes towards Italian cultural heritage and long-lasting brands", PRIN 2022, ERC SH1 Sector, Project Code: 20227RMKFP, CUP Code: I53D2300259006, funded by the European Union - NextGenerationEU.

expectations. The results highlight how heritage storytelling can support brand authenticity and emotional engagement, particularly when tailored to cultural contexts. Furthermore, the emphasis on innovation within heritage narratives suggests that firms can integrate future-oriented strategies without compromising identity. This can guide companies, regardless of age, in using their history as a resource for strategic differentiation.

***Originality of the paper**: This paper contributes to the corporate heritage literature by bringing new elements that describe the identity of long-lived companies through the heritage narrative. It identifies the key elements of digital narratives and provides an opportunity to investigate how well the designed identity reflects their culture identity.*

Key words: *corporate heritage; corporate brand identity; long-lived firms; communication; cross-cultural analysis.*

1. Introduction

As companies increasingly recognize the value of leveraging their history and heritage to establish a strong brand identity, corporate heritage has emerged as a prominent area of interest both in academic research and managerial practice (Balmer and Burghausen, 2015; Mir Bernal *et al.*, 2023; Urde *et al.*, 2007). Long-lived firms are uniquely positioned to draw upon their extensive history and heritage to differentiate themselves in a competitive market (Pfannes *et al.*, 2021) and can use the narrative development process to rediscover and communicate their organizational history and cultural heritage (Napolitano *et al.*, 2018; Riviezzo *et al.*, 2021).

"Narrativization" becomes a key element of effective corporate communication (Burghausen and Balmer, 2014; Garofano *et al.*, 2020; Napolitano *et al.*, 2018; Riviezzo *et al.*, 2021; Riviezzo *et al.*, 2015) and an effective method for historic brands to convey their history and values, establishing an emotional connection with customers and strengthening the relationship with stakeholders (Garofano *et al.*, 2020).

As Urde *et al.* (2007) observed, corporate heritage is inextricably linked to a company's identity, which is formed by its history, values, and cultural context. A strong corporate heritage can provide a sense of continuity and stability, thus facilitating the guidance of company decisions and actions (Balmer, 2013). However, it also presents challenges, such as balancing heritage preservation and integrating innovative elements into corporate communication (Riviezzo *et al.*, 2015). Long-lived firms must navigate the tension between maintaining their legacy and adapting to changing market conditions, as failure could make the company appear outdated or irrelevant (Riviezzo *et al.*, 2023). This requires a deep understanding of the company's history, values, and cultural context and a willingness to innovate and evolve. Consequently, corporate communications are critical to articulating the company's heritage narrative and values and positioning the brand in the market.

Riviezzo *et al.* (2015) noted that long-lived organizations must balance honoring their heritage and embracing change to maintain relevance and

competitiveness. In addition to these challenges, these firms must consider the role of stakeholders in shaping their corporate heritage narrative. Morsing and Schultz (2006) observed that stakeholders are central to shaping a company's reputation and identity. It is therefore incumbent on companies to engage with them in a meaningful way to foster trust and loyalty. Corporate identity encompasses an organization's purpose, vision, activities, ethics, and values, giving it uniqueness, "specificity, stability, and unity" (Larçon and Reitter 1994, cited in Balmer and Podnar 2021, p.733). Corporate identity and corporate reputation are firmly linked: "corporate identity provides the central platform upon which corporate communications policies are developed, corporate reputations are built and corporate images and stakeholder identifications/associations with the corporation are formed" (Balmer, 2008, p. 881). According to Balmer and Burghausen (2015), corporate heritage identities refer to corporate competencies, cultures, philosophies, activities, visual identities, architecture, and service offerings and are seen as part of the past, present, and future. By consolidating the identification of identity-related factors, the company's view of its history prepares the company to open to the market and monitor perceptions of that identity through a brand orientation (Balmer and Podnar, 2021). Within this debate, the discursive practices used by companies to communicate corporate heritage are exciting and still unexplored (Pfannes *et al.*, 2021). To address this gap, the present study investigates how long-lived companies use digital narratives to convey their historical and cultural heritage, aiming to uncover the recurring elements that define their corporate heritage communication. Moreover, it explores how these narratives are shaped by national cultural values. To guide this investigation, the study addresses the following research questions:

RQ1: What are the main narrative elements through which long-lived companies communicate their corporate heritage via digital platforms?

RQ2: To what extent and in what ways do country cultural values influence the content and structure of corporate heritage communication? These questions aim to deepen our understanding of how historical identity and cultural context interact in the construction of corporate heritage narratives, offering relevant insights both for theory development and for managerial practice in international contexts.

2. Theoretical Background

2.1 Conceptualization of corporate heritage

Heritage is a concept rooted in the humanities and social sciences. Only recently has it been extended to the sphere of management (Napolitano and Marino, 2016) to identify a new way of communicating the uniqueness of the company and its products (Urde *et al.*, 2007). The concept of corporate heritage emerged from empirical research on monarchies (Balmer, 2006); according to Balmer (2011), it is a dimension of corporate identity, based on historical and cultural heritage and core values. It is a significant vector

of the past that combines and transcends past, present and prospective future (Balmer, 2011). Through it, the past becomes a key component of the company's identity, positioning, and future directions (Napolitano *et al.*, 2018; Riviezzo *et al.*, 2021). Corporate heritage provides existential anchors that are valuable during uncertain times, offering a sense of the world.

From a marketing perspective, heritage is seen through an evolutionary lens, with a forward-looking approach that aims to inspire and engage both internal and external stakeholders in the corporate's vision. It offers opportunities for successful differentiation and develops long-term engagement with all stakeholders (Napolitano *et al.*, 2018; Riviezzo *et al.*, 2021). Riviezzo *et al.* (2021) explored the heritage marketing opportunities for long-lived Italian companies and identified the multiple opportunities these companies to enhance and communicate their heritage narrative. Heritage marketing refers to the set of decisions aimed at enhancing organizational heritage, generating a sense of belonging to the company, and to the set of tools aimed at using its legacy of brands and products to create lasting emotional bonds with consumers (Misiura, 2006) and other stakeholders (Napolitano *et al.*, 2018; Riviezzo *et al.*, 2021).

The sedimentation of values associated with corporate heritage delineates the corporate heritage identity. This refers to the institutional characteristics that have remained significant and consistent over time, making a corporate heritage identity relevant to the past, present, and future. While the meanings associated with specific aspects of an organization's identity may evolve, heritage identity traits can encompass corporate competencies, cultures, philosophies, activities, markets, and groups, and may also be reflected in unique visual identities, architecture, and service offerings (Balmer and Burghausen, 2015). Furthermore, a strategic and engaging narration of corporate heritage can inspire new choices for the future and enhance the firm's competency base (Riviezzo *et al.*, 2023).

Furthermore, corporate heritage helps clarify the past, crafting a narrative that is meaningful for brand management and resonates with contemporary stakeholders (Blombäck and Brunninge, 2009; Urde *et al.*, 2007). It can also provide lasting value for corporate brands (Greyser *et al.*, 2006), establishing a basis for strong, long-lasting relationships with stakeholder groups (Balmer, 2011; Wiedmann *et al.*, 2011). In this contest, corporate heritage serves as a credible foundation for ritualizing brand consumption and reinforcing a brand's cultural relevance, making it invaluable for developing brand identity. Heritage brand could be defined as "a set of symbols and values that reinforce the identity of the brand and express its anchoring in the past and the continuity between past, present, and future" (Pecot and De Barnier, 2017, p.77

2.2 From corporate heritage to brand heritage identity

A specific feature of the corporate heritage marketing domain is related to the notion of corporate heritage brand. According to Balmer (2006), corporate heritage brand represents a "track record for delivering value to

customers" through the brand promise and supported by the consistency of its core values (Urde *et al.*, 2007, p. 9; Hudson , 2011, p. 1538) and strategically employ symbols to represent their historical roots (Urde *et al.*, 2007).

Corporate heritage brands are a distinct category of institutional brand characterized by a degree of continuity in terms of the brand promise expressed through the organization's identity, behavior, and symbolism. The corporate identity frames and guides corporate communication and interactions with stakeholders (Foroudi and Foroudi, 2021). Corporate heritage identities and corporate heritage brands also confer temporal, territorial, social, and cultural identities to groups of customers and other stakeholders (Balmer, 2013).

Balmer (2013) outlines four unique identity traits of corporate heritage brands. Omnitemporality allows brands to be relevant across multiple periods, meaningfully connecting the past, present, and future. Heritage constancy highlights a brand's ability to consistently uphold its values over time, underlining its authenticity. Provenance, meanwhile, refers to the strong connection these brands maintain with specific places, which enhances their distinctive heritage character and the capability to evoke positive emotions.

Burghausen (2023) adds other two key elements of corporate heritage brand: intergenerational continuity, achieved through substantive and/or symbolic exchanges between generations of stakeholders, and constancy, where a brand's characteristics remain recognizable over time despite undergoing symbolic or substantial changes.

Especially for family firms, corporate heritage serves as a stabilizing influence, providing a sense of continuity in a dynamic world, a symbol of coherence and transparency (Lowenthal, 1998). Family firms often build brand heritage identities (BHIs) by integrating historical references into their brand, creating a unique value proposition. Family heritage may be included in BHIs, as seen in multigenerational employment or the use of family names such as sons/daughters, which symbolize the past, present and future of the brand (Spielmann *et al.*, 2022).

A corporate brand embodies an organization's interpretation of identity elements that persist from the past, remain present, and extend into the future. However, with the emergence of the concept of brand heritage identity, the focus shifts to integrating historical roots and organizational values into the brand identity, making it not only a corporate actor but also a custodian of shared culture and values. This shift implies an authentic narrative and an emotional connection with consumers, who tend to perceive the brand as an element of continuity and stability. Heritage brand identity consequently becomes a strategic differentiation asset.

In this context, this study is the first attempt to investigate the elements that long-lived companies use to build their corporate brand heritage identity. In particular, the paper contributes to the literature on corporate heritage brands and explores corporate heritage communication of historical companies, advancing knowledge of the practices that contribute to the longevity of heritage brands.

2.3 Communicating corporate heritage through digital content across cultures

Cultural heritage has started to play a significant role in corporate marketing and specifically in corporate communication (Riviezzo *et al.*, 2021; Riviezzo *et al.*, 2023). Corporate heritage communication represents a pivotal aspect for companies that want to enhance their historical and cultural heritage, strengthen their organizational identity and, at the same time, promote dialogue with a heterogeneous audience (Balmer, 2013; Hudson and Balmer, 2013; Micelotta and Raynard, 2011; Wiedmann *et al.*, 2011).

Companies communicate their heritage through strategic and operational marketing tools (Napolitano *et al.*, 2018; Riviezzo *et al.*, 2021; Riviezzo *et al.*, 2023), and the advent of digital tools, including social media (Giaccardi, 2012), websites, and immersive technologies such as augmented reality and virtual reality (Escandon-Barbosa *et al.*, 2024), has allowed companies to narrate their heritage in a dynamic, engaging, and accessible way to a global audience (Economou, 2015). Corporate websites play a crucial role in corporate heritage storytelling (Mangold and Faulds, 2009), providing a reliable and highly adaptable digital platform through which companies can present their narrative and identity in a structured and comprehensive way (Blombäck and Brunninge, 2016).

Butcher and Pecot (2022) provide an in-depth exploration of how luxury heritage brands use Instagram to visually construct their brand heritage through aesthetic cues such as symbolism, rituals, and historical continuity. Their findings suggest that visual heritage narratives serve both persuasive and performative functions in engaging stakeholders and maintaining exclusivity.

Mähnert *et al.* (2024) focus on brand heritage communication via Twitter, applying stereotype content theory and text mining to demonstrate how audiences perceive heritage brands in terms of warmth and competence. The study reveals that brand messages vary across industry sectors and that digital narratives are often tailored to elicit distinct emotional and reputational responses, reflecting an active shaping of heritage through micro-messaging.

However, the heritage communication strategy must consider the impact of cultural factors, both in terms of the company's origins and its target audience (Hakala *et al.*, 2011). Cultural variables have a significant consequence in determining how corporate heritage is transmitted and received (Pecot *et al.*, 2023), exerting influence on both the content and styles of corporate communication (Lin and Lou, 2024; Vollero *et al.*, 2020). The different conceptions embraced by different cultures have a profound impact on the way heritage is communicated and received by the public (Baack and Singh, 2007). For example, the concept of time can be perceived as linear or cyclical (McHale, 1978), monochromatic or polychronic (Bergadaà, 2007; Brislin and Kim, 2003), or even as a long- or short-term oriented phenomenon (Hofstede, 1980).

Communicating corporate heritage requires a nuanced approach that aligns with both the corporate identity and the cultural expectations of its audiences (Singh *et al.*, 2005). By recognizing and adapting to different

cultural perceptions, companies can effectively bridge the gap between their heritage and the diverse interpretations of a global audience. This alignment promotes authenticity and relevance, enhancing the resonance of the corporate narrative in different cultural contexts (Urde *et al.*, 2007).

Culture affects how consumers perceive brands and what they value about them (Pecot *et al.*, 2018). It shapes consumers' perception of a brand and its heritage because it directly influences the emotional connection between the company and its customers (Wiedmann *et al.*, 2011): while in some cultures, history and tradition can be elements of great importance, creating a deeper connection with consumers who appreciate the longevity and consistency of a brand over time; in others, the capability to innovate and propose novelties may play a more decisive role (Calver and Page, 2013). Therefore, it is important to consider cultural contexts as they offer a new lens through which to analyze corporate communication and understand the extent to which it should be adapted.

3. Methodology

3.1 Data collection

The study analyzed the corporate heritage narratives featured on the websites of 46 bicentennial family businesses from the Henokiens Association. The initial population comprised 56 firms, but 10 companies were excluded because their websites were either not available in English or lacked sections explicitly addressing corporate heritage. Henokiens firms were chosen as the focus of this study due to their unique historical continuity, with more than two centuries of family ownership and brand identity, making them exemplary cases for exploring digital heritage narratives. For each company, the corporate name coincides with the brand name, ensuring consistency in brand-related references. All relevant web pages and subpages dedicated to corporate history, heritage, and legacy storytelling were systematically collected and converted into a textual dataset. A second analysis was conducted to understand how country culture influences the narrative of corporate heritage. The analysis was limited to the country with more than two companies, and data were obtained from the Hofstede's Country Comparison Tool (HCCT).

3.2 Data Analysis

Textual data were imported into NVivo 14 to conduct a summative content analysis aimed at identifying recurring themes and uncovering the underlying meanings of words and phrases associated with corporate heritage (Babbie, 2020; Catanzaro, 1988). An initial frequency query generated the 100 most common lemma words, deliberately excluding prepositions, adverbs, and other non-substantive terms to focus on semantically relevant content.

To gain further insights, an inductive thematic approach (Braun and Clarke, 2006) was employed with NVivo. Thematic analysis provides

a focal point for the interpretative analysis, offering insights and arguments about the phenomena under investigation (Boyatzis, 1998). In the first round of analysis, open coding was applied to sentences and paragraphs, labeling them with concise descriptors to form first-order codes (Corbin and Strauss, 1990). These codes were then consolidated into conceptually broader second-order themes, and subsequently aggregated into overarching dimensions (Sasaki and Ravasi, 2024; Locke, 2000). To strengthen analytical rigor, coding decisions were revisited through iterative discussions and cross-validation among researchers. This procedure ensured consistent classification of textual units and minimized potential bias during themes generation. Codes and themes were iteratively reviewed and refined in line with Patton's (1980) criteria of internal homogeneity and external heterogeneity, ensuring that each theme was internally coherent and externally distinct. To illustrate the transparency of the coding process, examples of empirical evidence are provided in the Appendix.

In parallel, text network analysis was performed using InfraNodus software (Paranyushkin, 2019) to complement the thematic analysis. This tool visualized the co-occurrence patterns of recurrent terms and themes, highlighting key nodes and revealing the overall structure of the narrative network.

Finally, Hofstede's cultural dimensions (Hofstede, 1980, 2011), considered as proxies for values (Minkov and Kaasa, 2021; Taras *et al.*, 2010), were used to compare the four primary cultures among the companies in the sample - Italy, France, Japan, Germany - and explore the effects of cultural values on the corporate heritage brand narrative.

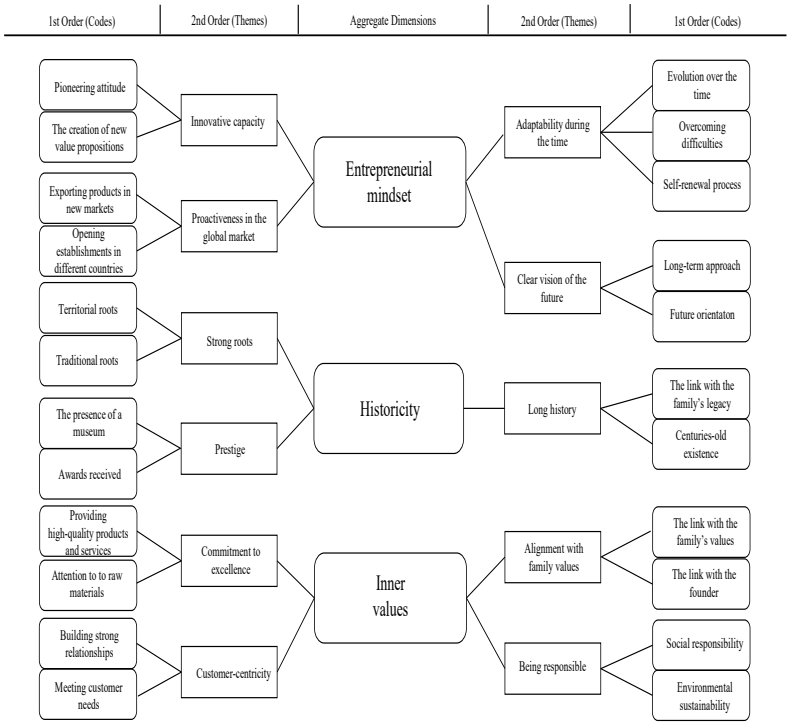
4. Findings

The findings of the thematic analysis of heritage discursive practices on the websites of bicentennial Henokiens revealed the presence of three aggregate narrative dimensions: entrepreneurial mindset, historicity, and inner values (Figure 1), which provide a nuanced understanding of the underlying values and principles that have guided these long-lived companies over the centuries.

4.1 Entrepreneurial mindset

The entrepreneurial mindset reflects the core principles and strategies that have enabled historic companies investigated to face and overcome the challenges of time, while maintaining a clear vision of the future, an innovative approach, and a global projection. This narrative dimension is divided into four main themes: *adaptability during the time, clear vision of the future, innovative capacity, and proactiveness in the global market*.

Fig. 1: Results of thematic analysis



Source: our elaboration

Adaptability during the time indicates the capability to evolve and innovate to compete successfully in an environment of constant change. This theme is articulated into the following codes: *evolution over the time, overcoming difficulties*, and *self-renewal process*. Historic companies utilize their websites to illustrate how they have adapted their identity in response to emerging market opportunities while maintaining strong connections to their historic foundations. The narrative of successfully overcoming difficulties, such as economic crises or logistical challenges, reinforces the image of the corporate and brand's resilience, thus demonstrating how these experiences have contributed to strengthening its character. Ultimately, corporate renewal is evidenced by the implementation of new business models or the introduction of innovative products, which demonstrate the capability to keep up with the times and respond to the demands of an ever-changing market.

Clear vision of the future demonstrates the capability to integrate a long-term approach with an innovation-oriented perspective. This theme includes two codes: *long-term approach* and *future orientation*. Long-lived companies communicate a strategy that embraces a generational perspective, emphasizing how each decision is made with the aim of ensuring the continuity of the company and its brand and pursuing sustainable goals over time. At the same time, future orientation emerges through

the introduction of new technologies, attention to sustainability, and anticipation of market trends. This dual perspective allows long-standing companies to position themselves as innovative leaders, demonstrating the capability to effectively integrate traditional and modern approaches.

Innovative capacity is further articulated into two codes: *the creation of new value propositions* and *pioneering attitude*. The capability to innovate is conveyed through the creation of products or services that respond to emerging needs, while maintaining established standards of quality and values associated with the company and brand. Meanwhile, the role of a pioneer emphasizes the capability to introduce substantial innovations within industries. This is demonstrated by the capability to anticipate emerging trends and establish standards that have subsequently become market benchmarks.

Proactiveness in the global market refers to the international expansion and the capability of historic companies to adapt and compete in different cultural and geographical contexts. This theme includes two codes: *exporting products in new markets* and *opening factories in different countries*. The interviewed companies communicate their export strategy, and the establishment of new facilities abroad, demonstrating the ability to integrate historical roots and international adaptation.

For a detailed overview of the evidences supporting this theme, see table 1 in Appendix.

4.2 Historicity

Historicity reflects the capability of bicentennial companies to communicate their historical roots, cultural relevance, and temporal continuity. This narrative dimension is divided into three main themes: *strong roots, prestige*, and *long history*.

Strong roots concerns how companies convey their deep affiliation to the geographical area and cultural heritage that favored their birth and growth. This theme is articulated into two codes: *territorial roots* and *traditional roots*. The first emphasizes the distinctive link between a company and its place of origin, and it is often conveyed through geographical or historical allusions that serve to reinforce the authenticity of the brand. The websites of the long-standing companies place considerable emphasis on the connection with the territory, which is presented as an integral part of their corporate identity. This approach serves to enhance the recognizability and distinctiveness of the brand. The second theme, "traditional roots", underlines the adherence of the company and its brands to practices and values handed down over time, thus communicating a sense of coherence and authenticity that serves to reinforce the reputation with the public.

Prestige indicates the capability to communicate the excellence and recognition achieved over time. This theme is composed of two codes: *awards received* and *the presence of a museum, archive, or similar institution*. The awards often displayed on company websites, serve as tangible evidence of the excellence and importance of the company and its brands in the industrial and cultural landscape. The establishment of museums or archives, on the other hand, exemplifies the commitment of

the companies to preserving and celebrating the history, offering visitors immersive experiences that reinforce a sense of prestige and authenticity. These elements not only enhance the perceived value of the company and its brands, but also position them as a custodian of tradition and culture.

Long history indicates the narrative of temporal continuity. This theme includes two codes: *the link with the family's legacy* and *centuries-old existence*. The family link shows how many companies communicate the continuity of family management. This is perceived as an element of stability and authenticity, which serves to strengthen the emotional connection with the stakeholders. Conversely, the centuries-long existence of these companies is considered evidence of their capability to survive and thrive over the centuries. This is frequently emphasized to highlight the resilience and strength of the company and its brands. Empirical support for the theme is presented in appendix table 2.

4.3 Inner values

Inner values represent the set of core principles that guide historic companies in their strategic and communicative choices. These principles underscore the companies' commitment to excellence, customer-centricity, family values, and social and environmental responsibility. This aggregate dimension is in fact divided into four narrative themes: *commitment to excellence, customer-centricity, alignment with family values,* and *being responsible*.

Commitment to excellence highlights the companies' emphasis on quality and the use of carefully selected materials. This theme is composed of two codes: *providing high-quality products and services* and *attention to raw materials*. The communication strategy emphasized the companies' dedication to ensuring high standards, with a focus on their craftsmanship and innovative production processes. The emphasis on raw materials, frequently observed on company websites, reflects a dedication to the meticulous selection of resources that respect tradition, authenticity, and sustainability. These elements contribute to the company and brand reputation for reliability and prestige.

Customer-centricity illustrates how long-lived companies prioritize building strong relationships with their stakeholders and meeting customer needs as the cornerstone of their strategic approach. The two codes - *building strong relationship* and *meeting customer needs* - illustrate the capability of these companies to maintain an ongoing dialogue with stakeholders. Digital platforms are used to spread the value of active listening and customization, underlining the commitment to developing experiences in line with consumer expectations and strengthening brand loyalty.

Alignment with family values highlights the importance of the founding principles and interests of the founder as distinctive elements of the company and its members. This theme includes two codes: *the link with its family's values* and *the link with the founder*. The continuity of values handed down over time is a key aspect of corporate communication, as it reinforces the perception of authenticity and consistency with the history of a company. At the same time, the centrality of the founder and his values

serves to reaffirm the sense of mission and vision that has inspired the company and its brand since its inception, thus establishing itself as a benchmark in the industry.

Being responsible emphasizes the commitment of historic companies towards social and environmental sustainability, which have emerged as key elements in corporate communication. This theme is composed of two codes: *social responsibility* and *environmental sustainability*. Social responsibility is manifested through initiatives that demonstrate the contribution of companies to the well-being of the community, such as support for educational or cultural projects. Environmental sustainability, on the other hand, highlights the attention to reducing environmental impact, communicated using eco-friendly materials, innovative production processes, and strategies aimed at preserving natural resources. For further evidence and exemplary quotations, see appendix table 3.

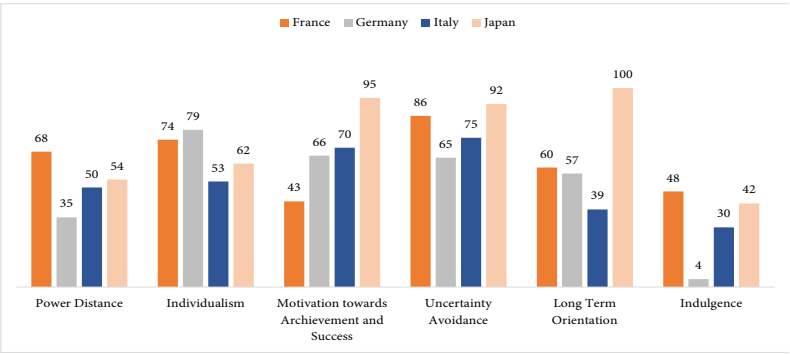
4.4 A cross-cultural analysis

Focusing on the French, Italian, Japanese and German companies in our sample, we observe that corporate heritage communication highlights some important common traits due to the homogeneous characteristics they have in terms of longevity and inclination to enhance their corporate heritage image. However, looking at the importance of the aggregate dimensions and narrative themes, we observe some interesting differences. The importance of these dimensions and themes is assessed based on the place and recurrence they have in the companies' narrative.

To investigate how country culture influences the communication of corporate heritage, we referred to Hofstede's cultural dimensions (Figure 2).

- *Power distance* (PD) refers to individuals' acceptance of an unequal distribution of power, and consequently to the importance of hierarchy and status in relationship and communication.
- *Uncertainty avoidance* (UA) refers to individuals' preference for clearness and safety, and consequently to risk avoidance.
- *Motivation towards achievement and success* (MTA) refers to individuals' focus on goals and performances. It is connected to competitiveness and orientation to control.
- *Individualism* (IDV) refers to individuals' tendency to autonomy and self-reliance. When individualism is low, cultures tend to *collectivism* and focus on collective interests.
- *Long-term orientation* (LTO) refers to individuals' tendency to be pragmatic and catch future opportunities. When long-term orientation is low, people tend to be normative and place more value on traditions and past experiences.
- *Indulgence* (IND) refers to individuals' belief in the free gratification of their personal needs. When indulgence is low, cultures tend to restraint and the respect of social rules is more important than self-gratification.

Fig 2: Hofstede's cultural dimensions for France, Italy, Germany and Japan



Source: Hofstede's Country Comparison Tool

Comparing the narratives the selected companies use in the four countries, we can get some interesting insights into the way they communicate the three main themes - entrepreneurial mindset, historicity and inner values, as well as on the relative different important they recognize to them as elements on which their brand heritage communication relies (Table 4 in Appendix).

In their narrative, Japanese companies give more importance to the aggregate dimension entrepreneurial mindset than to the other two narrative dimensions, while in the websites of French, German and Italian companies' the most important aggregate dimension is inner values, followed by historicity and entrepreneurial mindset.

Analyzing in depth the declination of the three main dimensions is also very interesting, because it shows the different ways companies interpret and emphasize them in their communication. Within the dimension entrepreneurial mindset, for Japanese companies the most relevant theme is *proactiveness in the global market*, while for German and French companies the most relevant theme is *clear vision of the future*. For Italian companies the most relevant theme is *adaptability during the time*.

These differences seem to be strongly connected to cultural values of the countries. Japan is the country with the highest level of MTA, in line with an inclination to competition and success; this value emerges from the heritage narrative of Japanese companies as well as the attention they place on the entrepreneurial mindset, specifically on the theme *proactiveness in the global market*. In countries where the MTA decreases, other narrative dimensions seem to be strongly associated with corporate heritage, and these are inner values and historicity.

The connection between country cultural values and corporate brand heritage is reinforced by the evidence that Japan is also characterized by a high level of LTO, which leads to pragmatism and exploration of opportunities. On the contrary, Italy, characterized by the lowest score of LTO, is the only country where *adaptability during the time* seems to be the most important theme emerging in the narrative dimension entrepreneurial mindset. Adaptability is typical of a focus on the present, on a short-term decision making, but at the same time the tendency to

emphasize the evolution of the brand is in line with the quite high level of MTA, which requires companies to keep competitive over time. The brand vision of French and German Companies is instead in line with their level of LTO, high but lower than Japan and with the combination of LTO and IDV, which stresses the inclination to fill different form others, to pursue uniqueness as a value.

In countries where the MTA decreases, other narrative dimensions seem to be strongly associated with corporate heritage, and these are inner values and historicity. The aggregate narrative dimension historicity is consistent with the UA value, which refers to risk avoidance, and is high in all countries. The themes corresponding to this aggregate dimension related to *long history* and *strong roots* are relevant for all the companies investigated, but in Germany *prestige* is the second theme. In Germany, prestige is consistent with the high level of IDV and the fact that it is mostly connected with the awards is coherent with the quite high level of MTA and the middle-low level of IND.

Finally, within the aggregate dimension inner values, it is very relevant in France, Italy and Germany, and the theme *being responsible* is the most important for French companies, while for Italian, and Japanese companies the most important theme is *commitment to excellence*, and for German ones it is the *alignment to family values*. These differences can be explained by IDV and MTA values: while Japan and Italy have lower IDV scores and higher MTA scores, France shows the opposite. German situation is still different: It is characterized by high level of IDV and quite high level of MTA but differently form the other countries it is also characterized by lower level of PD, which imposes the necessity of a higher involvement and a higher feeling of belonging to people to continue following the project over time. Consequently, in Italian and Japanese culture individuals and organizations pay attention on performances and results but without exalting individual action and interest, while in Germany and France, individuals and organizations focus on individual responsibility and action, and results are measured more in terms of quality of life and harmony, when a low level of MTA prevails - such as in France - or on the alignment with family and founder's values when a low level of PD prevails - such as in Germany.

This cross-countries comparison confirms that heritage is perceived as an important corporate resource in all the four countries, but it also highlights some interesting differences in the way companies interpret the main elements of corporate heritage, and in the way they communicate them. With specifically regard to Entrepreneurial Mindset, while for Italian companies this theme is strongly related to adaptive creativity and historicity, with the continuous research of a balance between legacy and reinvention; in France companies pay more attention to clear vision and innovation. The adaptive attitude of the former is typical of collectivistic, short-term and low indulgent cultures, while the future orientation of the latter is typical of high IDV and LTO countries. On the same hand, in Japan entrepreneurial mindset is strongly connected to proactiveness, which is coherent with the high levels of MTA and LTO. The country is characterized by a deep pragmatism, which finds evidence also in the

interpretation of the dimension inner values, where commitment to excellence is the most important theme, and historicity where the theme long history is the most important and connected more to the century-old existence than to the family legacy. Some examples to what discussed can be found in Table 5 in the Appendix.

5. Conclusions

Our findings provide a nuanced understanding of key elements of corporate heritage narratives on Henokiens companies websites. Our analysis highlighted three aggregate narrative dimensions: entrepreneurial mindset, historicity, and inner values. *Entrepreneurial mindset* highlights the capability of the investigated long-lived companies to adapt, innovate, and expand globally. While for Japanese and French companies, its theme is mainly associated with companies' proactivity in global markets, for Italian and German companies, it is mostly associated with the capability to adapt over time. *Historicity* refers to companies' capability to showcase their rich history and prestige, which serve as a competitive advantage in the global market. This narrative dimension is connected to longevity and embeddedness across countries, but for French companies historicity is also strongly associated with prestige. *Inner values* instead emphasize the long-lived companies' commitment to excellence, long-term relationships with stakeholders, social responsibility, and strong family values in corporate decision-making. With reference to this dimension - which promotes continuity and tradition, both vital for long-term stability and growth - while in Italian and Japanese companies it emerges that the commitment to excellence is the important theme, for French and German companies responsibility takes on an undisputed centrality.

6. Implications

Our findings have significant implications for scholars, entrepreneurs, and managers seeking to understand and leverage the key elements of corporate heritage narratives. The study contributes to literature by conceptualizing corporate heritage as a multidimensional construct that encompasses entrepreneurial mindset, historicity, and inner values. This perspective extends current theoretical understandings by emphasizing the strategic function of heritage as both a resource for innovation and a vehicle for stability across time.

From a practical standpoint, the study offers guidance for heritage management by identifying actionable levers that long-lived companies employ to preserve and communicate their legacy. Cultivating an entrepreneurial mindset enables firms to foster innovation and resilience, while emphasizing historicity reinforces brand authenticity and corporate reputation. Prioritizing inner values, such as excellence, responsibility, and commitment, supports long-term cohesion and stakeholder trust.

These firms, recognized as among the most successful bicentennial family businesses globally, serve as benchmarks for other organizations aiming to develop effective heritage branding strategies. Importantly, the insights from this study are relevant not only for companies that already communicate their heritage, but also for those that possess historical and cultural assets yet remain silent about them. For these firms, adopting a structured heritage narrative can represent a strategic opportunity for differentiation and long-term positioning.

Furthermore, understanding how cultural dimensions shape heritage communication allows companies to tailor their narratives in a way that resonates with local audiences, avoiding ethnocentric biases and enhancing international appeal. The dual relationship between culture and corporate heritage, whereby culture shapes narrative, and narrative reinforces cultural anchoring, demands careful consideration in transnational communication strategies. In this light, the study provides both conceptual and practical tools for firms that aim to align their heritage narratives with diverse cultural expectations while sustaining authenticity.

7. Limitations and future research opportunities

Although this study provides valuable insights into the corporate heritage narratives of long-lived firms, it presents several limitations that should be acknowledged. First, the analysis focuses exclusively on the digital narratives published on the corporate websites of Henokiens member companies. This digital-only scope, limited to institutional website pages, does not capture the full breadth of a firm's heritage communication across other platforms (e.g., social media, physical spaces, or internal communication), potentially omitting important narrative nuances or informal practices. Future studies could broaden the methodological lens by incorporating additional media, such as social platforms or immersive environments, and by conducting in-depth interviews with managers to explore internal perceptions and strategic intent.

Second, while the Henokiens offer a unique and relevant empirical context, their status as highly successful bicentennial family firms may limit the generalizability of the findings to younger or less heritage-oriented organizations. The relatively small sample and its confinement to specific countries further constrain the comparative scope of the study. Expanding the number of companies and including additional national or cultural contexts may reveal further patterns or exceptions in heritage communication strategies.

Third, our analytical framework is grounded in Hofstede's cultural dimensions, which provide a valuable but partial lens on cultural variance. Future research could integrate alternative models of culture (e.g., Schwartz's cultural values, Hall's high-/low-context theory) to enrich the interpretive depth of cross-cultural comparisons.

Despite these limitations, the study contributes to the growing literature on corporate heritage and opens several avenues for future research. Future studies could extend the investigation to different sectors and

organizational types, assess how corporate heritage narratives evolve over time, or explore how consumers perceive and interpret heritage messaging, thus evaluating the alignment between managerial intent and stakeholder reception (Pfannes *et al.*, 2021).

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APPENDIX

Table 1: Entrepreneurial mindset - Exemplary evidences

2nd order themes	1st Order codes and exemplary evidence
Adaptability during the time	**Evolution during the time** *A new business model is born and today, Lombard Odier provides banking technology to 12 external banks. (Banque Lombard Odier & Cie SA)* *In 1813, the company turned towards the joinery trade. Catherineau outfits schooners and lighters that provide the transportation across the Garonne river. In 1872, the company specializes in wooden patterns for foundries …… In 1961, Catherineau makes its first cabin interior furniture for the Falcon. Alain, the actual president, grows the business by expanding this completion activity for the French aircraft manufacturer and its European completion center. He focuses the aeronautics business on lightweight, high quality furniture. (Catherineau)* **Overcoming difficulties** *After many years of losses, Johannes and Cornelis Petrus decide to divide the business. The distilleries in Delfshaven go to Cornelis Petrus, whilst Johannes stays on at the Rotterdam distilleries. The business owned by Johannes (and his son Cornelis) forms the basis for the company today. (De Kupyer Royal Distiller)* *The rest of the surviving family managed to escape to Italy, leaving behind all their belongings which were soon confiscated by the partisans; the company was nationalized. It appeared then that after more than a century of activity the Luxardo company was destined to disappear. In 1947, however, the last surviving brother GIORGIO LUXARDO together with the young fifth generation NICOLÒ III had the courage and the vision to rebuild the distillery in Torreglia, a village beneath the Euganean Hills in the North-Eastern part of Italy (Luxardo)* **Self-renewal process** *The new factory in Via Campomorone is born, in the vanguard and highly technological, but which maintains unaltered the original processes. (Grondona)* *He began a rigorous restructuring plan: he invested in new machinery and trained the employees. (Revol)*
Clear vision of the future	**Long-term approach** *Our sustainable performance is based on strong values that serve shared objectives and a long-term vision. (Groupe Bollorè)* *As a family-owned business with 200 years of history, we maintain a long-term perspective in all our activities; as entrepreneurs, we think in terms of years, not quarters. (Groupe Mirabaud)* **Future orientation** *Our mission is to nourish quality of life with experience and knowledge for generations to come. (Van Eeghen Group)* *we continue to meet today's challenges and shape the future with innovative ideas (Mollergroup)*
Proactiveness in the global market	**Exporting products in new markets** *Thanks to the high quality of the fabrics it was producing, the company began to export successfully the world over, not only in Europe, but also in the Americas, the British Raj, and even China (Vitale Barberis Canonico)* *The London company Matthew Clark & Sons becomes a very important customer. Clark does not only purchase De Kuyper's products for the UK, but also develop a strong taste for Dutch gin. Around 1870, 85% of exports are destined for the UK and Canada. (De Kuyper Royal Distiller)* **Opening establishments in different countries** *The Mellerio brothers were looking for a new market and decided to try their luck abroad by setting up in Madrid, Spain, where they opened the "Mellerio-Hermanos" sign in 1850. (Mellerio)* *The Pinto Basto Group, which has always pioneered the business activities it got engaged in, started its internationalization in 2002 by establishing itself in Angola. (Pinto Basto)*
Innovative capacity	**Pioneering attitude** *In 1731 Amarelli's established a "concio" one of the first pre-industrial organization in order to extract the juice of this beneficial plant. (Amarelli)* *Richard Hoare did not invent the cheque, but he was certainly one of English banking's earliest adopters. (C. Hoare & Co.)* **The creation of new value propositions** *Intelligent, intuitive and charismatic, Pietro introduced the most modern machining systems and created innovative products, such as the first semi-automatic pistol, the 9 mm Glisenti Model 1915 adopted by the Royal Army, one of the very first machine guns, the Model 1918 dubbed the "Automatic Musket" and later the famous Model 1938 "MAB" (Beretta Automatic Musket), adopted by the Italian Army (Fabbrica d'armi Pietro Beretta)* *In 1952, J.D. Neuhaus made the work of our colleagues in the mines so much easier with its innovation of using a compressed air motor instead of the, at the time, conventional practice of operating hoists by hand (J.D. Neuhaus)*

Table 2: Historicity - Exemplary evidences

2nd order themes	1st Order codes and exemplary evidences
Prestige	**The presence of a museum** *It was at the Manoir d'Odet, in Ergué-Gabéric, that the Bolloré family decided to create a museum dedicated to the Breton history of the Bolloré Group. (Groupe Bollorè)* *The revival of this unique history can be found in "Giorgio Amarelli's Museum" in the historical family residence. (Amarelli)* **Awards received** *Named 'European Car of the Year' in 1969, the PEUGEOT 504 was (and still is) PEUGEOT's longest-produced commercialised model (Establissement Peugeot Freres)* *In 2014 the Amarone Calcarole became the first wine from the region ever to be awarded Red Wine of the Year by Gambero Rosso. (Guerrieri Rizzardi)*
Strong roots	**Territorial roots** *The history of the Pictet family deserved to be written because it is an integral part of the history of Geneva, even to the point of sometimes merging with it. (Banque Pictet & Cie SA)* *But true stories, too, such as that of the Naviglio, an artificial canal, ditched in 1458, obtained from the derivation of the waters of the Mincio river. Since then it never missed to ensure the water supply to the people settled on its banks, who had immediately learned to use its current: via Naviglio, the Mantuans were able to move the rammers "magli" that beat iron and copper and other manufacturing utilities, as the fullings "folli" used in paper production. (Cartiera Mantovana)* **Traditional roots** *The Lobmeyr company focuses on a contemporary interpretation of glass and light, and never stops cultivating its heritage. The old inspires the new, and traditional knowledge facilitates innovation. (J&L Lobmeyr)* *Several years ago, Billecart-Salmon decided to return to ancestral champagne-making methods in the Clos Saint-Hilaire by using work horses and sheep (Champagne Billecart-Salmon)*
Long history	**The link with the family's legacy** *Banque Hottinguer is an independent bank controlled by the Hottinguer Family for 7 generations (Banque Hottinguer)* *The philosophy was passed on from one generation to the next, thanks to Grandpa Orlando and his notes, which became the top reference and inspiration for the brand (Grondona)* **Centuries-old existence** *Akafuku was established about 300 years ago in 1707 as a tea house in Ise to welcome those visiting the Ise Grand Shrine. (Akafuku)* *We have been developing our operations for almost three centuries (Pollet)*

Table 3: Inner Values - Exemplary evidences

2nd order themes	1st Order codes and exemplary evidences
Commitment to excellence	**Providing high-quality product-service** *Quality is at the centre of our preoccupations. Our two-centuries-old skills, our technical heritage, the accuracy of each gesture and our standards in quality are the very foundations of our company. Excellence, more than an end in itself, is our history and our daily life. (Revol)* *The family vineyard is made up of exceptional appellations, and every year offers wines, known for their formidable quality. (Louis Latour)* **Attention to raw materials** *These collections are created from carefully selected, traceable, and natural raw materials (Fratelli Piacenza 1773)* *The Hugel estates are planted with only the noble Alsace grape varieties, with vines averaging 35 years of age. (Hugel & Fils)*
Being responsible	**Social Responsibility** *We pledge to actively promote the development of the local communities where we operate. We are aware of the intricate interconnection between businesses and their territories, firmly believing in the mutual benefits of a flourishing and growing ecosystem. (Acetaia Giusti)* *We pledge to actively promote the development of the local communities where we operate. We are aware of the intricate interconnection between businesses and their territories, firmly believing in the mutual benefits of a flourishing and growing ecosystem. (Banque Lombard Odier & Cie SA)* **Environmental sustainability** *In its constant quest for excellence, Billecart-Salmon favours cultivation methods that aim to protect the environment and promote biodiversity. Committed to preserving the cycle between winemaker and nature, the House has long been convinced that such a course of action is essential in the pursuit of environmental sustainability. The House's philosophy is simple: respect the terroir in order to produce great wines. Long before being certified High Environmental Value and Sustainable Viticulture in Champagne in 2017, Maison BillecartSalmon was already focused on managing its vineyards with the utmost respect for the environment. (Champagne Billecart-Salmon)* *In addition, in Monastier the by-products created during distillation are processed and transformed into new resources to be used in different fields. This ecological process is an emblemof the Nardini family's respect for the environment and for its territory. (Ditta Bortolo Nardini)*
Customer-centricity	**Building strong relationship** *We do this by building responsible partnerships with our clients and the companies in which we invest (Banque Pictet & Cie SA)* *Our preferred customers are cleaning companies, communities, major retail outlets and industry, with whom we cultivate close relationships to constantly strengthen our expertise and meet the real needs of users. (Pollet)* **Meeting customer needs** *All of the bank's services are tailored to the specific needs of the individual client (Les Fils Dreyfurs & Cie SA)* *… responding to the needs of the markets and placing their capacities at the service of the needs and expectations of their Customers, with a view to their total satisfaction (Pinto Basto)*
Alignment with family values	**The link with its family's values** *The family's values are today shared by a young, passionate team which makes Giusti's heritage, attention to detail and constant progress the cornerstones of their work. (Acetaia Giusti)* *Underpinned by Hoare family values of honesty, empathy, excellence and social responsibility, personal relationships are the heart of our business. (C. Hoare & Co.)* **The link with the founder** *The Pictet of today retains the pioneering drive of its founders, combining unconventional thinking with hard-won experience (Banque Pictet & Cie SA)* *The notebook also includes Grandpa Orlando's own notes and observations about the techniques used for kneading and conserving the natural mother sourdough called Madre Bianca, which is still used to this day. (Grondona)*

Table 4: A cross-countries comparison of themes' distribution

	Japan		Italy		Germany		France	
Themes	N. F.	Cit	N. F.	Cit	N. F.	Cit	N. F.	Cit
Entrepreneurial mindset	**4**	**26**	**13**	**64**	**3**	**16**	**14**	**75**
Adaptability during the time	*2*	*3*	*9*	*29*	*1*	*2*	*9*	*20*
Evolution over time	0	0	7	13	1	2	6	9
Overcoming difficulties	2	3	6	9	0	0	3	4
Self-renewal process	0	0	6	7	0	0	5	7
Clear vision of the future	*1*	*2*	*5*	*8*	*2*	*6*	*10*	*22*
Long-term approach	0	0	2	2	1	1	4	7
Future orientation	1	2	4	6	2	5	8	15
Proactiveness in the global market	*3*	*20*	*7*	*12*	*3*	*4*	*4*	*12*
Exporting products in new markets	1	1	6	8	2	3	3	3
Opening factories in different countries	3	19	2	4	1	1	2	9
Innovative capacity	*1*	*1*	*7*	*15*	*2*	*4*	*10*	*21*
The creation of new value proposition	1	1	6	12	1	1	8	19
Pioneering attitude	0	0	2	3	2	3	2	2
Historicity	**5**	**17**	**13**	**68**	**3**	**17**	**16**	**97**
Prestige	*2*	*2*	*9*	*12*	*3*	*8*	*7*	*21*
Presence of museum, archive, or similar institutions	1	1	3	4	1	2	1	1
Awards received	1	1	7	8	3	6	6	20
Strong roots	*3*	*7*	*11*	*27*	*1*	*1*	*9*	*26*
Territorial roots	3	4	9	15	0	0	8	14
Traditional roots	2	3	6	12	1	1	7	12
Long history	*5*	*8*	*13*	*29*	*3*	*8*	*16*	*50*
Link with the family legacy	3	3	10	16	1	2	14	32
Centuries-old existence	5	5	11	13	3	6	16	18
Inner Values	**4**	**14**	**11**	**78**	**3**	**48**	**16**	**101**
Committment to excellence	*3*	*8*	*11*	*34*	*2*	*10*	*12*	*31*
High quality product-service	3	4	10	20	2	8	12	21
Attention to raw materials	3	4	7	14	1	2	6	10
Being Responsible	*2*	*4*	*7*	*25*	*3*	*8*	*8*	*32*
Social responsibility	1	2	4	10	2	4	5	15
Environmental sustainability	2	2	7	15	2	4	6	17
Customer centricity	*1*	*1*	*3*	*6*	*3*	*7*	*9*	*20*
Building strong relationship	1	1	1	3	3	4	4	6
Meeting customer needs	0	0	2	3	2	3	8	14
Alignment with family values	*1*	*1*	*9*	*13*	*3*	*23*	*8*	*18*
Link with its family values	0	0	4	5	3	9	7	14
Link with the founder	1	1	6	8	3	14	3	4

N.F = number of firms included in Henokiens website and considered for the analysis
Cit = number of coded sentences referred to the different themes and aggregate narrative dimensions.

Table 5: Cultural Variation in the Narrative Dimensions

Country	Cultural Dimensions (Hofstede)	Most Emphasized Theme(s)	Example Quotes
Italy	High Uncertainty Avoidance and Motivation towards Achievement, Moderate Individualism and Power Distance, Short-Term Orientation, and low Indulgence	Inner Values & Historicity	*"The production is still carried out through a natural process constantly immersed in the sweet liquorice scent that, in the same way of the museum, fascinates everyone, adults and children."* *"Founded in 1526, XXX is still run by the same family and proudly rooted in ….."*
France	High Power Distance, Individualism and Uncertainty Avoidance, Moderate Long-Term orientation and Indulgence, Low Motivation towards achievement	Inner Values & Historicity	*"XXX favours cultivation methods that aim to protect the environment and promote biodiversity."* *"Since 1613, the XXX… 15 generations… values of work, honesty and discretion."*
Germany	High Individualism, Uncertainty Avoidance and Motivation Long-Term Orientation, Low Power Distance and Indulgence	Inner Values & Historicity	*"Our success is based on long-term partnerships and mutual trust with our employees, customers and suppliers."* *"Today, in the 17th generation, we continue to combine craftsmanship and technological leadership."*
Japan	High Long-Term Orientation, Uncertainty Avoidance and Motivation towards achievement, Moderate Power Distance and Individualism, Low Indulgence	Entrepreneurial Mindset & Historicity	*"We are now in a position to play the role of a 'best global sourcing partner' that contributes to manufacturing."* *"Toraya was founded in the early 16th century… current proprietor is the 18th generation."*

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italian journal of management

ISSN print 0393-5108
ISSN online 2785-549X
DOI 10.7433/s128.2025.11
pp. 185-205

Digital green transformation: technology-specific insights into advancing environmental sustainability[1]

Received
5th December 2024
Revised
30th October 2025
Accepted
17th November 2025

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Abstract

Frame of the research: *Digital transformation and environmental sustainability have emerged as parallel strategic priorities in contemporary academic and managerial discourse. Nevertheless, existing studies frequently examine them in isolation, overlooking their potential complementarities. This fragmentation limits our understanding of how heterogeneous digital technologies, such as the Internet of Things, Artificial Intelligence, Robotics, and Cloud Computing, can generate differentiated environmental outcomes beyond their conventional efficiency-enhancing functions.*

Purpose of the paper: *The paper seeks to clarify how individual digital technologies contribute, both directly and indirectly, to environmental sustainability, with particular attention to the organisational logics, motivations, and adoption pathways through which firms operationalise them. By doing so, the study advances a technology-specific perspective on the twin transition, shedding light on the differentiated environmental affordances embedded in distinct digital tools and on how firms unintentionally generate sustainability gains while pursuing efficiency, quality, or competitiveness objectives.*

Methodology*: The analysis draws on a multiple case study of four Italian manufacturing firms, selected for their varied digital maturity and sustainability trajectories. Semi-structured interviews, document analysis, and on-site observations were combined to capture how managers interpret and deploy different digital technologies within their operational processes. This qualitative, in-depth design enables a granular examination of technology-specific mechanisms and provides contextualised insights into how environmental impacts emerge from concrete organisational practices.*

Findings: *Three key patterns emerge: (i) established technologies including Internet of Things, Artificial Intelligence and Robotics improve efficiency and competitiveness while simultaneously reducing water and energy consumption and limiting material waste; (ii) emerging solutions such as Augmented Reality / Virtual Reality and 3D printing are perceived as promising yet only marginally integrated into sustainability-oriented processes; and (iii) other tools, notably the metaverse, are widely considered irrelevant in industrial practice. Overall, managers interpret efficiency-driven digitalisation as an unexpected catalyst for environmental benefits, reinforcing the strategic value of these technologies.*

***Research limits**: The study is based on a limited number of cases drawn from a single national context, which constrains the generalisability of the findings and calls for caution in extending the results to other industries or institutional environments. Furthermore, the analysis captures managerial perceptions and self-reported practices, suggesting that future research could integrate quantitative performance data or cross-country comparisons to validate and expand the proposed interpretations.*

***Practical implications**: The study provides manufacturing firms with actionable guidance on how to design digital strategies that simultaneously advance efficiency and sustainability objectives. Specifically, it highlights which technologies generate the most immediate environmental returns, how firms can prioritise investments across mature and emerging solutions, and how to align digital roadmaps, process redesign, and resource allocation with broader sustainability ambitions. These insights can support more informed decision-making in contexts of technological uncertainty and budget constraints.*

***Originality of the paper**: The paper offers a technology-specific interpretation of the twin transition, illuminating the heterogeneous pathways through which digital tools enable sustainability and highlighting indirect ecological benefits that emerge from efficiency-oriented digital adoption.*

Key words: D*igital technologies, environmental sustainability, manufacturing industry, digital green transformation.*

1. Introduction

The twin transition, digital and green, has become a central concern on global political and managerial agendas. International institutions, including the European Commission (2022), stress that the convergence of digital technologies and environmental sustainability (ES) is critical to addressing pressing challenges such as climate change, resource scarcity, and the need for more inclusive growth. Within the framework of the Sustainable Development Goals (SDGs), digital technologies are not only drivers of competitiveness but also enablers of innovative practices for resource management, emissions monitoring, and waste reduction (Mio *et al.*, 2020; Jibril *et al.*, 2024).

The academic literature has acknowledged this potential yet often treats digital transformation and ES in isolation or conceptualises digital transformation as a monolithic process, thereby neglecting the heterogeneity of individual technologies (Costa, 2024). Much research focuses on the aggregate effects of digitalisation in terms of economic performance or sustainable innovation (Hanelt *et al.*, 2017; George and Schillebeeckx, 2021; Schaltegger and Wagner, 2011), without extricating the specific trajectories through which different technologies, such as Internet of Things (IoT), Artificial Intelligence (AI), robotics, blockchain, or metaverse, affect ES. Although recent contributions have begun to explore this interface (Bhatia *et al.*, 2024; Camodeca and Almici, 2021), the picture remains fragmented and dominated by generic approaches that overlook the concrete mechanisms of environmental value creation.

This gap is significant for at least two reasons. First, digitalisation is far from homogeneous: each technology differs in maturity, implementation costs, side effects, and potential to generate positive or negative environmental externalities (Rejeb *et al.*, 2020; Bohnsack *et al.*, 2022). For example, IoT enables consumption monitoring and process optimisation, while 3D printing accelerates prototyping but raises concerns about material recyclability (Lanfranchi *et al.*, 2025; Javaid *et al.*, 2021). Second, the literature tends to privilege firms' strategic intentions, such as adopting explicitly "green" technologies, while devoting less attention to what managers actually perceive as the effective or unexpected outcomes of adopted technologies. Managerial perceptions are nonetheless a valuable lens, as they reveal how organisations recognise (or overlook) the environmental implications of their digital choices (Patton, 2002).

This study contributes to this debate by advancing a technology-specific perspective on the digital-green convergence. Its aim is to understand how managers perceive the environmental effects, intended or unintended, associated with specific digital technologies in the Italian manufacturing sector. This sector provides a particularly suitable context for analysis, given its high environmental impact (Conejo *et al.*, 2020) and the mounting regulatory and competitive pressures to adopt sustainable practices. At the same time, Italian manufacturing is a dynamic arena where firms of different sizes coexist, exhibiting heterogeneous levels of digitalisation, innovation, and sustainability orientation.

To investigate these dynamics, the research employs a multiple case study (Eisenhardt, 1989; Yin, 2018) of four manufacturing firms operating in distinct industries (automotive, logistics, shipbuilding, and safety equipment). The methodological design integrates the Analytic Hierarchy Process (AHP) with semi-structured interviews conducted with executives and innovation/sustainability managers, complemented by qualitative coding through NVivo (Richards, 1999). This approach enables the identification of both intentional trajectories and unexpected effects in the adoption of specific technologies.

The study's contributions are twofold. Theoretically, it develops a technology-specific reading of the twin transition, distinguishing among consolidated, emerging, and marginally relevant technologies. Managerially, it provides concrete insights into how efficiency and sustainability objectives can be jointly integrated into digital strategies, highlighting that the pursuit of efficiency frequently serves as an unexpected driver of environmental benefits.

The article is structured as follows: Section 2 outlines the theoretical background on digital transformation and environmental sustainability; Section 3 details the research methodology; Section 4 presents the empirical findings; Section 5 discusses the theoretical contributions and managerial implications; and Section 6 concludes with limitations and avenues for future research.

2. Theoretical Framework

2.1 Digital transformation and environmental sustainability

Digital transformation has been defined as "a process that aims to improve an entity by triggering significant changes in its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2021, p. 118). It therefore extends well beyond the mere adoption of technological tools: it entails a profound reconfiguration of business models, internal processes, and relationships with customers, suppliers, and other stakeholders (Westerman *et al.*, 2014; Hanelt *et al.*, 2017). Digital transformation should thus be understood as a socio-technical phenomenon, one that integrates technological innovation with organisational, cultural, and strategic shifts, often characterised by complexity and non-linear dynamics (Crupi *et al.*, 2025; Lu *et al.*, 2023).

The literature consistently highlights that digital transformation does not follow a uniform path but instead unfolds in sector-specific and context-dependent ways, shaped by technological maturity and firms' organisational capabilities (Jamwal *et al.*, 2025; Álvarez *et al.*, 2019). Some studies distinguish between incremental approaches, aimed at improving efficiency and automation, and radical approaches, which generate entirely new business models and redefine value chains (Ali *et al.*, 2025). In both cases, digitalisation is never purely technical: it requires substantial investment in human capital, the development of digital skills, and a sustained commitment to change management (Moncada *et al.*, 2025).

A further element of complexity lies in the heterogeneity of technologies encompassed by Digital transformation (V K *et al.*, 2025; McAfee, 2003). This spectrum includes mature solutions such as ERP systems or cloud computing, rapidly diffusing technologies such as IoT, AI, and robotics, and emerging solutions like 5G, blockchain, AR/VR, and additive manufacturing (Ghobakhloo and Fathi, 2020; Minoli and Occhiogrosso, 2019). Such heterogeneity implies highly differentiated impacts on firms' economic performance as well as on social and environmental outcomes. Yet mainstream literature continues to overlook the fact that each technology carries its own opportunities, risks, and implementation pathways (Crupi *et al.*, 2025; Appio *et al.*, 2021).

Finally, digital transformation is increasingly conceptualised as a dynamic and ongoing process, one that evolves in response to both external pressures (e.g., globalisation, regulatory demands, environmental crises) and internal drivers (e.g., growth strategies, capability development) (Jiang, 2025). This processual perspective underscores that Digital transformation is not a fixed destination but a trajectory of organisational learning and continuous experimentation, redefining competitive boundaries while opening new challenges linked to sustainability and social impact (Mozaffar & Candi, 2025).

In parallel, environmental sustainability (ES) has become a non-negotiable priority for firms and policy makers, driven by mounting pressures linked to climate change, the scarcity of natural resources, and the evolving expectations of stakeholders (Elder, 2025; Bansal and

Song, 2017). From a managerial perspective, ES has been defined as the ability of organisations to mitigate the negative impacts of their activities on ecosystems while simultaneously contributing to long-term socio-economic resilience (Tammaraksa *et al.*, 2025; Geissdoerfer *et al.*, 2017). Scholars emphasise that sustainability cannot be regarded as a peripheral activity; rather, it must be fully integrated into corporate strategy and everyday management practices (Palmiè *et al.*, 2025 MANCA IN BIBLIO; Schaltegger *et al.*, 2012). This requires moving beyond a reactive stance, oriented toward regulatory compliance and risk reduction, toward a proactive orientation in which sustainability becomes a source of innovation, reputation, and competitive advantage (Lichtentaler, 2025).

Nonetheless, firms face considerable structural barriers in implementing environmental practices. High implementation costs for green technologies and processes often represent the first obstacle (Kim *et al.*, 2025). Added to this are the persistent difficulties of establishing clear and widely accepted metrics for measuring environmental performance (Dade *et al.*, 2025; Hahn *et al.*, 2015). Many firms also struggle with a lack of internal expertise and specialised skills (Álvarez *et al.*, 2019; Oliveira *et al.*, 2022), compounded by cultural and organisational resistance to change (Ruiz-Palomino *et al.*, 2025; Lozano, 2013). These challenges are particularly acute in energy-intensive industries such as manufacturing, where environmental impacts translate into significant emissions, heavy resource consumption, and substantial production waste (Shaik *et al.*, 2025; Conejo *et al.*, 2020). As a result, these sectors are subject to heightened scrutiny by regulators, consumers, and civil society, all of whom demand tangible commitments to more sustainable production models (Sasso *et al.*, 2025).

Alongside these external pressures, internal dynamics also play a role. Many firms adopt environmental practices not only in response to regulation or stakeholder expectations but also as part of efforts to innovate their business models and exploit new market opportunities (Krishnan *et al.*, 2025). Examples include initiatives in the field of the circular economy (Kirchherr *et al.*, 2018) or the development of lean and "low-carbon" production systems (Wang *et al.*, 2024). Yet the translation of these strategies into concrete outcomes depends on the ability to reconcile sustainability with other business priorities, such as productivity, competitiveness, and risk management (Parida *et al.*, 2019).

Within this context, a fundamental tension emerges: while sustainability is increasingly perceived as a driver of value, managers continue to struggle with balancing environmental, economic, and social objectives (Islam, 2025; Hahn *et al.*, 2010). This tension often manifests in compromises, trade-offs, and processes of organisational learning that shape the capacity of firms to embed sustainability into their long-term practices (Porro and Lanfranchi, 2025).

2.2 The twin transition: the convergence between digital and green transition

In recent years, the notion of the twin transition has gained increasing prominence in both academic debates and public policy. The European Commission (2019; 2022) has stressed that the digital and green transitions

must be understood as complementary and interdependent dimensions of industrial transformation. The future competitiveness of firms will depend largely on their ability to integrate the adoption of digital technologies with strategies oriented toward environmental sustainability (Cobbinah *et al.*, 2025; Annarelli *et al.*, 2021). The literature highlights a wide range of potential synergies between digitalisation and sustainability (Galvani *et al.*, 2025; Florek *et al.*, 2025). Digital technologies can enable environmental goals by facilitating real-time monitoring of resource consumption and emissions through IoT and AI (Muhoza *et al.*, 2023); by optimising production processes and improving energy efficiency via robotics and advanced automation (Ogbemhe *et al.*, 2017); by enhancing transparency and traceability across value chains through blockchain and big data (Xu *et al.*, 2025); and by supporting circular and low-carbon business models through technologies such as additive manufacturing and digital platforms (Devito *et al.*, 2024). These mechanisms have been documented across multiple sectors, including agriculture, transportation, and manufacturing (George and Schillebeeckx, 2021; Camodeca and Almici, 2021).

Specifically, recent contributions have begun to investigate this digital-green interface more explicitly. Li *et al.* (2018) examined how digitalisation supports circular economy practices in manufacturing firms, while Ali *et al.* (2024) introduced the concept of *Green Digital Transformation,* emphasising the integration of digital innovation with environmental objectives as an emerging strategic trajectory. Similarly, Alabdali *et al.* (2024) demonstrated empirically that digital technologies contribute to the achievement of the SDGs only when coupled with adequate organisational and institutional capabilities.

The literature also acknowledges the ambivalent nature of digitalisation. On the one hand, it has the potential to reduce waste, emissions, and energy consumption; on the other, it may generate negative externalities, such as increased demand for electricity, growth in electronic waste, and dependence on resource-intensive technological infrastructures (Bohnsack *et al.*, 2022). In this respect, digitalisation does not automatically represent a pathway to sustainability but rather a set of potentially divergent trajectories, contingent on the type of technology, the industrial context, and the capabilities of the adopting firms (Ghobakhloo and Fathi, 2020). More recent studies underscore that the twin transition remains a paradigm under construction, supported by limited empirical evidence. Bhatia *et al.* (2024), for example, show that digital technologies can accelerate progress toward carbon neutrality, but only under specific conditions of governance and inter-organisational collaboration. Therefore, literature on the twin transition continues to exhibit two critical limitations. First, it tends to privilege theoretical and conceptual contributions at the expense of robust empirical validation. Second, it frequently treats digital transformation as an aggregate phenomenon, overlooking the heterogeneity of individual technologies.

To further position this study within the existing body of knowledge, Table 1 summarizes the most relevant contributions addressing the intersection between digital transformation and ES. For each study, the context, method, main findings, and contribution to the literature are

reported. The review highlights that, while a growing number of studies acknowledge the potential of digital technologies to foster sustainable practices, the majority of contributions remain either conceptual or quantitative in nature. Only a limited number of works (e.g., Pflaum and Gölzer, 2018; Javaid *et al.*, 2021) focus on technology-specific trajectories. This gap provides the foundation for the present research, which aims to disentangle the differentiated pathways through which digital technologies contribute, directly or indirectly, to environmental sustainability (Reuter, 2021).

Tab. 1: Key studies on Digital Transformation and Environmental Sustainability

Author(s) (Year)	*Method*	*Main Findings*	*Contribution to the Literature*
Li *et al.* (2018)	Quantitative survey	Digital transformation strengthens organizational and entrepreneurial capabilities	Shows the role of dynamic capabilities as a foundation for digital adoption, with implications for sustainability
Ali *et al.* (2024)	Conceptual/ empirical (cases and models)	Digital transformation, combined with circular business models, enhances green innovation and resilience	Introduces the perspective of sustainable tech entrepreneurship
Alabdali *et al.* (2024); Crupi *et al.*, 2025	Quantitative survey / Conceptual study	Green digital transformation contributes to SDGs when supported by leadership and a digital-green culture	Highlights organizational conditions for the digital-green convergence
Appio *et al.* (2021)	Review	DT is still treated as a generic phenomenon, with little focus on specific impacts	Provides a research agenda to explore DT and innovation in more detail
George and Schillebeeckx (2021)	Conceptual	Digital innovations support the fight against climate change	Defines the emerging field of digital sustainability
Bohnsack *et al.* (2022)	Literature review	Digitalisation has both intended and unintended sustainability effects	Emphasizes trade-offs and ambivalences in the twin transition
Camodeca and Almici (2021)	Document analysis	Digital practices support SDGs implementation	Provides empirical evidence from the Italian context
Bhatia *et al.* (2024)	Survey and review	DT can accelerate carbon neutrality, but faces barriers and risks	Explores drivers and obstacles in the twin transition
Pflaum and Gölzer (2018); Lanfranchi *et al.*, (2025)	Conceptual/Review	IoT fosters data-driven models	Demonstrates the IoT-efficiency link, with indirect green effects
Javaid *et al.* (2021)	Review	3D printing reduces time and material use but raises recycling challenges	Shows ambivalent sustainability impacts of additive manufacturing
Rejeb *et al.* (2020)	Review	AR improves traceability and transparency	Highlights opportunities and limitations in energy/ organizational terms
Lu (2017)	Literature survey	Maps enabling technologies for Industry 4.0	Provides a foundation to distinguish the heterogeneous impacts of different technologies
Hanelt *et al.* (2017)	Empirical survey	IS supports eco-innovation performance	Links DT adoption to environmental performance
Engert and Baumgartner (2016)	Conceptual	ES must be integrated into corporate strategies	Bridges the gap between sustainability strategy and implementation

Source: Author's own work

3. Methodology

3.1 Research context

This study is situated within the Italian manufacturing sector, a context of critical economic and occupational relevance that simultaneously faces pressing challenges in terms of environmental impact and digital transformation. Manufacturing remains one of the cornerstones of the national production system, contributing substantially to overall value added and exports, and thus provides a fertile ground for examining the dynamics of convergence between digitalisation and sustainability. From an environmental perspective, manufacturing is characterised by high energy intensity, elevated levels of emissions, and significant consumption of natural resources alongside substantial waste generation (Conejo *et al.*, 2020). These features have subjected the sector to growing regulatory and societal pressures, both at the national and European levels, to adopt sustainable practices and pursue decarbonisation strategies (Costantini and Mazzanti, 2012). At the same time, the digital landscape of Italian manufacturing is highly heterogeneous: while some firms have already integrated consolidated technologies such as IoT, AI, and robotics, others are experimenting with emerging solutions, including additive manufacturing and augmented reality. This heterogeneity makes the sector a privileged setting for exploring how managers perceive the differentiated impacts of specific digital technologies on both efficiency and sustainability.

Within this context, four firms were selected through purposive sampling (Eisenhardt, 1989; Yin, 2018), designed to ensure technological variety, environmental relevance, and access to data. The selection criteria included: adoption of heterogeneous digital technologies, ranging from established (IoT, AI, robotics) to emerging (AR/VR, additive manufacturing); exposure to significant environmental challenges and regulatory pressures; representation of distinct industrial domains (automotive, logistics, shipbuilding, and safety equipment) to enable cross-sectoral comparison; and willingness of managers to participate in in-depth interviews and provide internal documentation. This strategy ensured both theoretical relevance and empirical richness, allowing for an investigation into how the adoption of different digital technologies is perceived to translate into environmental sustainability outcomes. Both companies operate within the manufacturing industry, specializing in the production of high-quality components and machines for diverse industries, including automotive and aerospace. The first company is renowned for its technological prowess and unwavering commitment to innovation. This company has held a strong reputation in the market for decades. The second company is actively engaged in the production and distribution of manufacturing products, catering to a wide array of sectors. With a comprehensive supply chain and logistics network, this company is well-equipped to deliver tailored solutions and services to its clientele. The third company specializes in the production of components for the nautical industry. With a focus on high-quality materials and precision engineering, this company provides essential parts and accessories for

various types of vessels, ensuring durability and performance in marine environments. The fourth company is dedicated to the development and manufacturing of fire-rated doors and safety devices. Known for their rigorous testing standards and innovative safety solutions, this company supplies essential products that enhance fire protection and security in residential, commercial, and industrial settings (Table 2)

Tab. 2: details of firms subject to the study

Company	Employees	Revenues	Market
A	>1000	>300 mln €	Manufacturing for automotive
B	>600	>120 mln €	Manufacturing for logistics
C	>500	>100 mln €	Manufacturing for vessels
D	>400	>110 mln €	Manufacturing for safety

Source: Author's own work

3.2 Data collection and analysis

The research design adopted for this study is the multiple case study (Yin, 2018), a methodology particularly suited to exploring complex and under-investigated phenomena such as the intersection of digital transformation and environmental sustainability. The objective was not statistical generalisation but rather analytical generalisation, that is, the construction of concepts and theoretical propositions derived from systematic comparison across heterogeneous cases. The adoption of this methodology was driven by its capacity to provide a thorough and profound understanding of the underlying processes and dynamics through which phenomena occur, enabling meticulous and detailed interpretation (Bansal and Corley, 2012). Moreover, qualitative methods are particularly adept for exploring uncharted research domains (Eisenhardt, 1989).

Data collection relied primarily on semi-structured interviews conducted between 2022 and 2023. In total, fifteen interviews were carried out, approximately four per firm, including one meeting that involved two managers simultaneously. The interviewees included CEOs, CTOs, production managers, sustainability officers, and R&D managers. Each interview lasted an average of 90 minutes, was conducted in Italian, fully transcribed, and subsequently translated into English. To complement these primary data, secondary sources such as corporate reports, internal documentation, and official websites were also gathered, enabling triangulation and reducing the risk of bias linked to managerial perceptions alone.

As a preliminary step to qualitative analysis, the study employed a mixed-methods approach incorporating the Analytic Hierarchy Process (AHP) (Saaty, 1990), a multi-criteria technique designed to evaluate alternatives through comparative judgments (Hülle *et al.*, 2011). In this context, AHP was used to assess the degree of knowledge and familiarity managers held with different digital technologies[2]. Participants were asked

[2] Appendix A provides the full details of the Analytic Hierarchy Process.

to provide pairwise comparisons across technologies, which generated composite scores for each technology in terms of perceived awareness. This procedure allowed for a clearer distinction between perceptions grounded in direct experience and less consolidated opinions, thereby providing a robust basis for the subsequent qualitative analysis.

Consequently, we employed a qualitative analysis, using semi-structured interviews that are, as noted by Bansal and Corley (2012), characterized by a set of predefined questions but allowed room for follow-up questions based on participants' responses. The comprehensive details of the interview and interviewers are meticulously documented in Appendices B and C.

For the textual analysis of interviews, data were processed using NVivo software (Richards, 1999) and examined through the Gioia Methodology (Gioia *et al.*, 2013). This inductive approach unfolds in three stages: (i) identification of first-order concepts in the language of participants; (ii) clustering of these into second-order themes with theoretical relevance; and (iii) synthesis into aggregate dimensions, which form the foundation of the final conceptual framework. Coding was carried out by three researchers, who conducted double coding on a subset of interviews to test reliability and collectively discussed any discrepancies.

This combination allowed us to capture both the relative awareness of managers toward specific technologies (via AHP) and the deeper interpretive patterns emerging from their narratives. Additionally, the integration of AHP, inductive coding, triangulation with secondary sources, and iterative researcher comparison ensured methodological rigor and internal consistency. This approach enabled the emergence of robust conceptual categories that are firmly grounded in empirical evidence.

4. Findings

4.1 Digital technologies awareness and knowledge among manufacturing firms (AHP)

The preliminary analysis conducted through the AHP (Table 3) enabled a comparative assessment of managers' familiarity with major digital technologies. The results reveal a clear pattern: while Italian manufacturing firms demonstrate solid knowledge of established technologies such as the IoT, AI, Cloud Computing, and Robotics, they also exhibit marked uncertainty and scepticism toward more experimental or recently introduced solutions. Established technologies are generally perceived as already embedded in business processes, supporting production monitoring, predictive maintenance, and cost optimisation. As the CTO of Firm A remarked, "*The adoption of IoT has transformed our production monitoring, allowing us to identify inefficiencies in real time*". Similarly, the Chief Technology Officer of Firm B emphasised AI as a competitive asset: "*Integrating AI into decision-making processes has given us a significant competitive advantage*".

By contrast, emerging technologies such as the metaverse, blockchain, and 5G are viewed with substantial skepticism, with managers struggling to envision concrete applications in the manufacturing context. The stance is often unequivocal, as illustrated by the Chief Technology Officer of Firm C: "*The metaverse does not exist for us; we are a company that manufactures physically, we live on the shop floor. For me, the metaverse is pure fantasy in our industry*". Such statements underscore the gap between the hype surrounding certain technologies and their actual transferability into industrial practice. Overall, the AHP analysis allowed the identification of three categories of technologies. First, consolidated technologies (IoT, AI, Cloud, Robotics), which combine operational efficiency with initial indirect environmental benefits. Second, advanced technologies (3D printing, AR/VR) are regarded as promising but are still selectively applied. Third, emerging technologies (metaverse, blockchain, web 4.0) are largely perceived as marginal or of limited utility in the short term.

This classification forms the basis for the subsequent thematic analysis, showing that managers' familiarity and hands-on experience not only shape adoption trajectories but also condition their ability to recognise the potential indirect environmental impacts of specific technologies. It is also worth noting that the interviewed firms differ substantially in size, from small and medium enterprises (SMEs) to large corporations, which influenced the scope and pace of their digital-green transformation. Larger firms benefitted from greater resource availability and structured sustainability departments, whereas SMEs relied more on external collaborations and incremental experimentation. This heterogeneity should be considered when interpreting the findings.

Tab. 3: Calculating Criteria Weights

Factors	*Criteria Weights*	*Criteria weight (%)*
IoT	0,2689	27
Big Data	0,1455	15
AI	0,1308	13
Cloud Computing	0,0534	5
3D Printers	0,0615	6
Robotics	0,1595	16
AR	0,0457	5
Blockchain	0,0246	2
Machine Learning	0,0648	6
Metaverso	0,0146	1
Materiali Intelligenti	0,0307	3

Source: Author's own work

4.2 Thematic analysis

The thematic analysis, conducted with the support of NVivo and guided by the Gioia Methodology (Gioia *et al.*, 2013), enabled the transformation of managerial perceptions into structured analytical categories. Beginning

with first-order concepts, that is, the recurring expressions used by participants, the analysis identified a set of second-order themes that captured theoretically relevant dimensions. These themes were subsequently consolidated into broader aggregate dimensions, among which the most salient to emerge was the notion of Digital Green Transformation. The following sections present the results organised around the main thematic clusters, illustrated with selected excerpts from the interviews.

4.2.1 Consolidated digital transformation technologies

The first theme concerns consolidated digital transformation technologies, including IoT, AI, Big Data, and Cloud Computing. These solutions are widely perceived as integral to business processes and as strategic levers for enhancing efficiency, competitiveness, and, indirectly, sustainability. As the Head of Plant of Firm A remarked, "*The adoption of IoT has transformed our production monitoring, allowing us to identify inefficiencies in real time*". Echoing this perspective, the Head of Plant of Firm B highlighted the role of digital data in waste reduction: "*Our familiarity with Big Data has enabled us to optimise operations and cut down on waste*".

AI, in particular, is described as a technology capable not only of improving decision-making but also of supporting more sustainable practices. As the Corporate Social Responsibility Officer of Firm C explained, "*We discovered that AI can predict machine failures with remarkable accuracy, reducing downtime and production waste*". A similar point was raised by the Managing Director of Firm D: "*We are aware that decarbonisation is a priority, and we are investing in technologies that help us reduce emissions*".

Taken together, these insights illustrate how consolidated technologies, though often adopted primarily for efficiency and competitiveness, also generate significant indirect environmental benefits, contributing to reductions in energy consumption, waste, and emissions. Their centrality in the digitalisation trajectory of manufacturing firms constitutes a first step toward the broader convergence between digital transformation and sustainability, which is further examined in the subsequent sections.

4.2.2 Advanced manufacturing technologies

A second cluster emerging from the thematic analysis concerns advanced manufacturing technologies, including robotics, additive manufacturing (3D printing), and augmented/virtual reality (AR/VR). These technologies are widely perceived as high-potential tools capable of accelerating processes and reducing errors, yet their adoption remains limited and strongly contingent upon product characteristics and production line configurations.

Among this group, robotics stands out as the most consolidated, associated with tangible benefits in both productivity and workplace safety. As the Head of Plant of Firm B noted, "*Robotics has significantly reduced production times while at the same time improving operator safety*".

Similarly, the CTO of Firm A remarked, "*We have observed that robotics not only increases efficiency but also enhances safety in the factory*".

In the case of 3D printing, managers primarily emphasise its value in prototyping and new product development. The Head of Innovation of Firm C explained, "*The introduction of 3D printing has been useful for speeding up prototyping and reducing design errors*". At the same time, adoption remains selective: "*The use of 3D printing varies greatly depending on the type of product and its specific requirements*".

Immersive technologies such as AR and VR are considered to be at an early stage in manufacturing, though managers acknowledge promising applications, particularly for workforce training and remote maintenance. As the Head of Innovation of Firm D observed, "*We are evaluating the use of augmented reality to improve operator training, but for now these remain pilot projects*".

Overall, these opinions suggest that advanced manufacturing technologies are regarded as promising but still experimental. Their sustainability contribution is perceived in terms of reducing design errors, lowering material use in prototyping, and improving working conditions, yet not as a systemic or large-scale impact. This differentiates them clearly from consolidated technologies, positioning them as potential drivers of the twin transition, though still distant from full integration into production processes.

4.2.3 Emerging technologies

The third cluster concerns emerging technologies, including blockchain, the metaverse, advanced machine learning, web 4.0, and 5G. Although these solutions are frequently highlighted in debates about the future of digitalisation, within the manufacturing context under study, they are generally met with scepticism and regarded as having limited short-term relevance for production processes.

This scepticism is most visible in the case of the metaverse. As the Chief Technology Officer of Firm C stated unequivocally, "*The metaverse does not exist for us; we are a company that manufactures physically, we live on the shop floor. For me, the metaverse is pure fantasy in our industry*". A similar view was echoed by the Chief Technology Officer of Firm B: "*We do not see how the metaverse could have a real impact on our operations, except in scenarios that are very distant*".

Other frontier technologies are also struggling to find meaningful applications. The Managing Director of Firm D commented, "*Blockchain is widely discussed, but for us it has no direct applicability in manufacturing production*". Likewise, the Head of Plant of Firm A observed, "*We know that 5G will have important impacts in the future, but at the moment we do not see an immediate return on investment*".

Such remarks highlight a significant gap between the hype surrounding emerging technologies and their actual transferability to industrial practice. From an environmental standpoint, moreover, these technologies are not perceived as delivering tangible benefits: unlike IoT or AI, there is no evidence here of positive spillovers in terms of reduced consumption, emissions, or waste.

Taken together, the findings suggest that while managers acknowledge the potential long-term role of blockchain, the metaverse, and 5G, these technologies currently remain at the margins of corporate strategies. Their status is that of "awaiting validation", distant from contributing meaningfully to the twin transition.

4.2.4 ES as a transversal dimension

Another thematic cluster concerns ES, which emerged as a transversal dimension across all interviews. Although it was not identified as the primary motivation for adopting digital technologies, sustainability consistently appeared as an unexpected yet significant benefit, gradually recognised by managers as an integral component of corporate strategies.

Several respondents stressed the growing importance of decarbonisation and emission reduction. As the Head of Innovation Firm D explained, "*We are aware that decarbonisation is a priority, and we are investing in technologies that help us reduce emissions*". Similarly, the Head of Plant of Firm B highlighted the contribution of digital monitoring: "*Digital tracking allows us to monitor energy consumption and intervene more quickly to reduce it*".

Consolidated technologies were frequently associated with indirect environmental impacts. The Managing Director of Firm C noted, "*Our digitalisation strategy aims to balance operational efficiency with environmental sustainability*". Echoing this perspective, the Chief Sustainability Officer of Firm A observed, "*We have seen that the use of IoT and robotics not only reduces costs but also helps to limit material waste*".

The theme of sustainability was also linked to waste and energy management. The Head of Innovation of Firm C pointed out, "*Our familiarity with big data has enabled us to optimise operations and reduce waste*". Likewise, the Head of Plant of Firm B emphasised the integration of economic and environmental objectives: "*Decarbonisation and efficiency are not separate goals, digital technologies help us achieve them together*".

While digital adoption in manufacturing firms was initially driven by considerations of competitiveness and efficiency, managers have increasingly recognised its capacity to advance environmental sustainability objectives. This intertwining of economic and ecological performance reinforces the idea that digitalisation, even when motivated by business imperatives, functions as an unexpected driver of the green transition.

4.2.5 Human factors and competences

Another second-order code concerns human factors and competences, which managers consistently identified as essential conditions for fully realising the potential of digital technologies. Digitalisation is not perceived merely as a technical process but as an organisational transformation that requires new skills, adaptability, and careful attention to employee well-being.

The theme of continuous training was repeatedly emphasised across interviews. As the Head of Innovation of Firm C explained, "Our digital

transition is supported by constant training programmes; without them, technologies would never be fully exploited". Similarly, the Plant Manager of Firm B observed, "Managers' familiarity with digital technologies has facilitated a smoother transition to new processes".

The issue of competences also intersects with organisational adaptability. The Head of Plant of Firm D noted, "Advanced technologies cannot be adopted without developing organisational agility; we must be ready to change models and processes quickly".

A particularly salient aspect is the link between digitalisation and worker well-being. The CTO of Firm A highlighted, "Robotics not only improves productivity but also reduces risks for operators, enhancing overall workplace safety". Additionally, several firms are moving towards open innovation approaches to address competence gaps. The Managing Director of Firm C explained, "We have launched experimental projects with universities and technology partners to acquire know-how that we can later internalise".

These quotes show that the success of sustainable digitalisation depends not only on the availability of new technologies but also on firms' ability to develop skill readiness and manage change inclusively. The twin transition is thus also a human transition, one that intertwines competences, organisational culture, and worker welfare.

4.3 Aggregate theme: Technology-specific pathways to the Digital Green Transformation

The thematic analysis revealed that the integration of digitalisation and sustainability does not follow a uniform trajectory but rather unfolds as a technology-specific pathway, in which each technology contributes differently, and with varying intensity, to the green transition. This result, summarised in Figure 1, illustrates the progression from managers' language (*first-order concepts*) to *second-order themes* and ultimately to the aggregate theme.

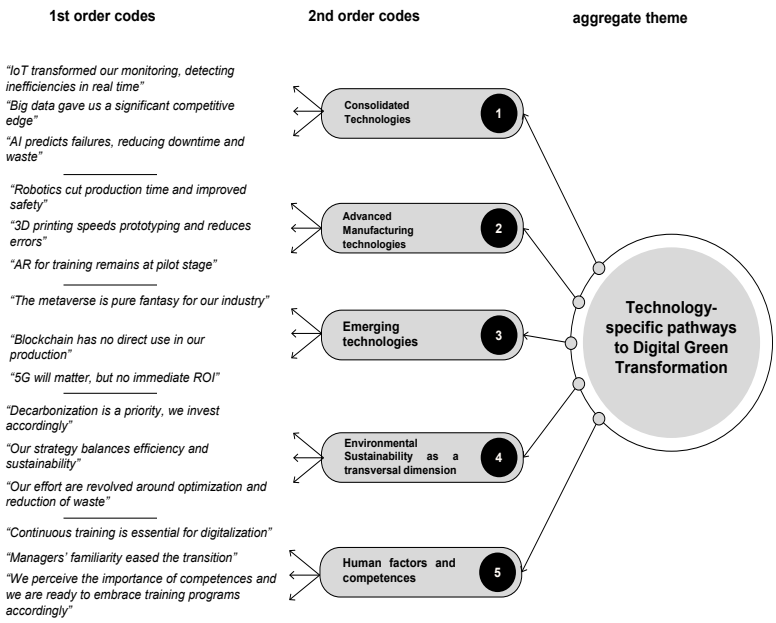
Consolidated technologies, such as IoT, AI, Big Data, and Cloud, emerge as the principal drivers of digital and green transformation. Although primarily adopted for efficiency and competitiveness, they also generate unexpected environmental benefits, including reductions in energy consumption, waste minimisation, and enhanced workplace safety. Advanced technologies, robotics, additive manufacturing, and AR/VR occupy an intermediate position. They are regarded as promising and already demonstrate positive effects on prototyping, error reduction, and workforce training. Yet their diffusion remains context-dependent, and they are still distant from systemic integration.

Emerging technologies, including blockchain, the metaverse, and 5G, are generally perceived as marginal or irrelevant to the current manufacturing context. They represent the more speculative side of digitalisation, still awaiting empirical validation and rarely associated with concrete environmental outcomes.

Across these categories, the sustainability cluster highlights that environmental objectives are seldom the primary motivation for adoption.

Instead, sustainability typically emerges as an indirect and unintended outcome of digitalisation: managerial pursuit of efficiency often translates into lower emissions, reduced consumption, and less waste, thereby turning the business case into a lever for environmental performance. Similarly, the human and competences cluster underscores that the twin transition cannot be realised without adequate human capital: continuous training, organisational agility, and attention to employee well-being are indispensable conditions for enabling these trajectories. The overarching theme is captured by the notion of Technology-Specific Pathways to the Digital Green Transformation. The digital-green transition does not advance as a single, homogeneous phenomenon but through differentiated trajectories shaped by the maturity and applicability of individual technologies. Italian manufacturing firms thus demonstrate that digital efficiency can act as an unexpected driver of sustainability, provided it is supported by appropriate competences and by the strategic reframing of environmental benefits arising from digital technology adoption. Figure 1 presents the results of the Gioia methodology applied in this study. Illustrative first-order concepts, derived from managers' quotes, were grouped into five second-order themes: consolidated technologies, advanced manufacturing technologies, emerging technologies, environmental sustainability, and human factors and skills. These themes converge into the aggregate dimension of "Technology-specific pathways to the Digital Green Transformation," highlighting how digital technologies contribute to sustainability outcomes in differentiated ways depending on their level of maturity and contextual applicability.

Fig. 1: Technology-specific pathways to the Digital Green Transformation



Source: Author's own work

5. Discussion

5.1 Theoretical implications

Our study advances the debate on the intersection between digital transformation and environmental sustainability in three connected ways. First, we contribute by developing a technology-specific interpretation of the twin transition in the Italian manufacturing sector. Whereas much of the extant literature treats digital transformation as a unitary and homogeneous process (e.g., Guandalini, 2022; Bohnsack *et al.*, 2022), our multiple case study shows that this view risks obscuring the heterogeneity of digital technologies. By analysing managerial perceptions, we demonstrate that consolidated technologies such as IoT, AI, Big Data, and Cloud Computing already deliver tangible environmental benefits, often introduced under the guise of efficiency; that advanced technologies such as robotics, 3D printing, and AR/VR remain promising but are selectively deployed (Markowitz *et al.*, 2018; Wang *et al.*, 2021); and that emerging technologies such as the metaverse, blockchain, and 5G are perceived as marginal. This contextualised evidence underscores that the twin transition does not evolve as a uniform phenomenon but grows through multiple, uneven trajectories shaped by the maturity and applicability of each technology (Lu, 2018; Hanelt *et al.*, 2017; Camodeca and Almici, 2021). By disaggregating the digital into its component technologies, our study challenges the dominant all-inclusive perspective and provides a more nuanced framework for understanding how specific tools enable sustainability in manufacturing.

Second, our findings highlight efficiency as a hidden driver of sustainability. In line with managerial sensemaking, most digital initiatives were motivated by efficiency, competitiveness, and cost reduction rather than by explicit environmental objectives. Nevertheless, managers consistently reported positive spillovers in the form of reduced waste, lower emissions, and greater energy efficiency. This extends prior research that has framed sustainability largely as a strategic orientation or a response to regulatory and social pressures (Hart and Milstein, 1999; Costantini and Mazzanti, 2012; Hahn *et al.*, 2015; George and Schillebeeckx, 2021). Our contribution lies in showing that sustainability frequently emerges unintentionally as a by-product of efficiency-oriented digital adoption. In doing so, we add an important layer to the business-case logic in sustainability research (Porter and Kramer, 2011; Engert and Baumgartner, 2016), demonstrating that environmental outcomes, though initially unintended, can be strategically leveraged by firms.

Third, we bring the human dimension into the debate on digital-green convergence. Our analysis reveals that technologies alone do not guarantee sustainability outcomes; their effectiveness depends critically on the availability of skills, organisational agility, and attention to employee well-being. Digital investments generated meaningful sustainability effects only when accompanied by continuous training, managerial competence development, and collaborative initiatives with external partners such as universities and research centres. This finding resonates

with prior work on the role of human capital and dynamic capabilities in enabling organisational change (Eisenhardt and Martin, 2000; Engert and Baumgartner, 2016; Chesbrough, 2006) but extends it by positioning human readiness as a fundamental enabler of technology-specific sustainability pathways. In this way, our study bridges the literature on digital sustainability (Seele and Lock, 2017; Guandalini, 2022) with research on skills and organisational resilience, highlighting that the twin transition is as much a social and cognitive process as it is a technological one (Crupi *et al.*, 2025). Taken together, these contributions suggest that the Digital Green Transformation is a mosaic of technology-specific pathways shaped by efficiency imperatives, organisational competences, and managerial sensemaking.

Interpreting technology-specific pathways through the RBV and DC lens

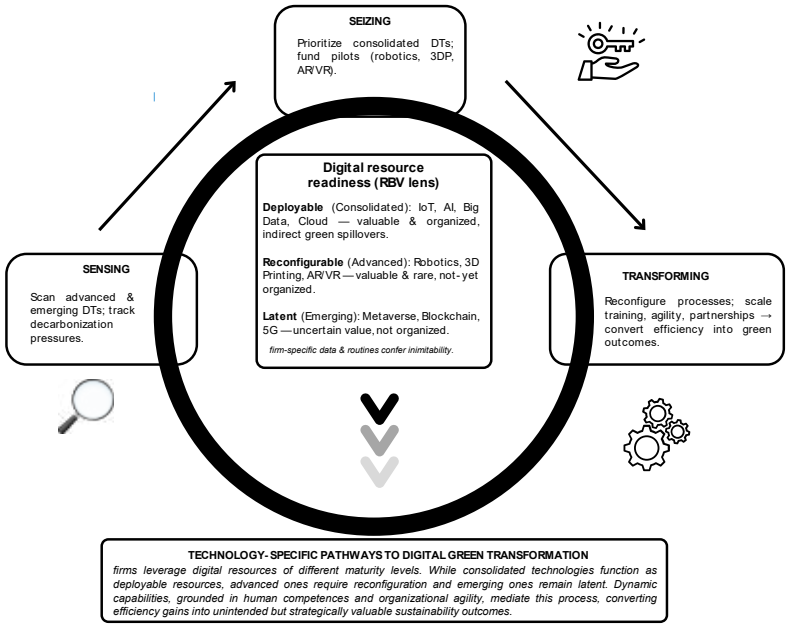
To better grasp the essence of our findings, we interpreted them through the lens of the Resource-Based View, which posits that firms achieve sustained competitive advantage by mobilising resources that are valuable, rare, inimitable, and organisationally embedded (Barney, 1991; Peteraf, 1993).

As stated in the previous paragraph, within Italian manufacturing firms, digital technologies clearly emerge as heterogeneous resources. Consolidated technologies, such as IoT, AI, Big Data, and Cloud Computing, already function as deployable resources embedded in operational routines, generating efficiency and, often unintentionally, environmental benefits. Advanced manufacturing technologies, including robotics, 3D printing, and AR/VR, constitute resources with strong potential, but their application remains limited and contingent on product and process characteristics. Emerging technologies, such as the metaverse, blockchain, and 5G, are not yet incorporated into firms' resource bases and are therefore perceived as minor. This resource-based interpretation underscores that the digital-green nexus cannot be conceptualised in aggregate terms; rather, it depends on the distinct features and maturity levels of the technologies firms command.

Yet, as the Dynamic Capabilities perspective reminds us, the mere possession of resources does not suffice to sustain competitive advantage (Teece *et al.*, 1997; Eisenhardt and Martin, 2000). What matters is the capacity to integrate, reconfigure, and transform these resources in response to shifting environmental and market conditions. Our findings confirm the need for dynamic capabilities of sensing, seizing, and transforming. Firms must: sense advanced and emerging technologies while interpreting environmental pressures such as decarbonisation; seize opportunities by allocating resources to consolidated technologies while financing targeted experiments with advanced ones; transform processes by scaling training, fostering organisational agility, and engaging in external partnerships so that efficiency gains can be converted into tangible environmental outcomes. In this perspective, human and organisational competences act as the micro-foundations of dynamic capabilities that enable the transformation of digital resources into sustainability pathways.

The final component of the framework synthesises this central insight: Digital Green Transformation unfolds as a constellation of technology-specific pathways, shaped by the maturity of digital resources and by firms' dynamic capabilities. Sustainability, in this view, emerges as an unintended but strategically significant outcome of efficiency-driven digital adoption. Building on this integrated perspective, we advance a framework (Figure 2) that conceptualises technology-specific pathways to the Digital Green Transformation.

Fig. 2: Framework for achieving the Digital Green Transformation



Source: Author's own work

5.2 Managerial implications

The findings of this study provide valuable insights for manufacturing firms seeking to embrace Digital Green Transformation and enhance their ES practices. First, our analysis delivers a snapshot of the technologies currently most relevant to the Italian manufacturing sector, highlighting their varying degrees of maturity and adoption. Managers should capitalise on these outcomes, making them visible to stakeholders and translating efficiency gains into legitimacy and competitive advantage. Second, advanced technologies call for targeted experimentation and selective investment. Their value extends beyond efficiency, offering opportunities to redesign processes and products while improving workplace safety. To achieve systemic impact, however, managers must complement experimentation with investments in organisational capabilities and pathways for scaling successful initiatives. Third, emerging technologies

still show limited applicability in manufacturing. A prudent approach is recommended: firms should monitor these technologies through sensing activities and pilot testing only where clear returns are foreseeable, avoiding premature investments that may divert resources from more mature and impactful solutions.

Finally, across all clusters, human competences and organisational agility are the decisive levers for turning technologies into tangible outcomes. Continuous training, cross-functional learning, and stronger collaborations enable firms to build the dynamic capabilities required to align digital innovation with ES objectives. Therefore, managers should view digital transformation as a pattern of differentiated technological trajectories. By assessing the current state of the sector, prioritising investments wisely, and developing the necessary organisational competences, firms can steer the Digital Green Transformation toward pathways that simultaneously enhance competitiveness and create environmental value.

5.3 Limitations and future research directions

This study is not without limitations, which at the same time open up promising directions for future research. First, the analysis is narrowed to the context of Italian manufacturing, which inevitably limits the generalisability of the findings to other industries or to geographical contexts characterised by different industrial structures. Comparative studies at the international level could enrich our understanding of digital-green trajectories across more heterogeneous production systems. Furthermore, the classification of technologies into three clusters provides a useful analytical map, but one that remains necessarily streamlined. Certain technologies may fall into more than one category depending on sectoral and organisational conditions. More fine-grained analyses, conducted on individual technologies or specific supply chains, would allow for deeper insights into their peculiarities and interdependencies. Additionally, the study does not capture the temporal dimension of technological adoption. Longitudinal approaches would be valuable to trace how pathways of Digital Green Transformation evolve over time, particularly in response to external shocks or new policy interventions (e.g., the Italian PNRR or the European Green Deal). A further limitation concerns the timeliness of data collection, which took place in 2022. Considering the fast-evolving nature of digital and green technologies, as well as the regulatory and market pressures shaping sustainability strategies, some contextual conditions may have changed since then. Accordingly, the results should be interpreted with caution, recognising that more recent developments could influence firms' digital-green trajectories. Future studies may therefore update or replicate this analysis using new data to capture the dynamic evolution of digital-green initiatives over time. Finally, although this research highlights the importance of competences and dynamic capabilities, it does not fully explore the organisational, cultural, and institutional factors that may either enable or constrain adoption. Future investigations, potentially drawing on qualitative methodologies, could shed light on

these dimensions, offering a more comprehensive understanding of the mechanisms underpinning transformation. At the same time, this study highlights the need for quantitative studies capable of systematically measuring the effects of different clusters of digital technologies on firms' environmental performance at the point of adoption.

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A – APPENDIX

Utilizing the AHP's methodology process, we refined the scaling system and mathematical operations to suit the specific needs of our study, ensuring precise calculations. The scoring spectrum, ranging from 1 (the lowest possible score) to 9 (the highest), was derived from participant responses, indicating the potential impact of each technology.

Judgments	Numerical Value
Extremely superior	9
Strongly superior	7
Moderately superior	5
Superior	3
Equal	1

Based on the simulation outcomes, we established a classification system to interpret these scores: a value of 9 indicates that Technology A revealed to be extremely more useful and well-known compared to Technology B. A value of 7 represents a significantly higher level of awareness and utility. A value of 5 signifies a moderate superiority of Technology A over Technology B. Lastly, a value of 3 indicates a slight superiority of Technology A over Technology B. If a value of 1 is assigned, it signifies that the technologies have an equal level of perceived awareness and utility.

Table A. Pair wise comparison matrix

Factors	Iot	Big Data	AI	Cloud Computing	3D Printers	Robotics	AR	Block chain	Machine Learning	Metaverso	Materiali intelligenti
Iot	1	5	3	7	7	1	7	9	5	9	5
Big Data	1/5	1	1	5	5	1	3	7	3	9	5
AI	1/3	1	1	5	3	1	3	7	1	9	5
Cloud Computing	1/7	1/5	1/5	1	1	1	1	3	1	5	1
3D Printers	1/7	1/5	1/3	1	1	1	3	3	1	5	1
Robotics	1	1	1	1	1	1	7	9	5	9	5
AR	1/7	1/3	1/3	1	1/3	1/7	1	5	1	5	1
Block chain	1/9	0	1/7	1/3	1/3	1/9	0	1	1	3	1
Machine Learning	1/5	1/3	1	1	1	1/5	1	1	1	7	5
Metaverso	1/9	1/9	1/9	1/5	1/5	1/9	1/5	1/3	1/7	1	1
Materiali Intelligenti	1/5	1/5	1/5	1	1	1/5	1	1	1/5	1	1
Sum	**3,58**	**9,52**	**8,32**	**23,53**	**20,87**	**6,77**	**27,40**	**46,33**	**19,34**	**63,00**	**31,00**

Subsequently, after entering the values for the comparison between individual technologies and obtaining the sum of perceived values for each technology, we proceeded to normalize the values to ensure a fair and meaningful comparison among the technologies. Normalization allowed us to standardize the values and bring them within a common range, enabling a more accurate assessment and comparison of their relative importance and utility.

Table B. Normalized Pair wise comparison matrix

Factors	Iot	Big Data	AI	Cloud Computing	3D Printers	Robotics	AR	Block chain	Machine Learning	Metaverso	Materiali intelligenti	Sum	Criteria Weights
Iot	0,2790	0,5252	0,3605	0,2975	0,3355	0,1478	0,2555	0,1942	0,2585	0,1429	0,1613	2,9578	0,2689
Big Data	0,0558	0,1050	0,1202	0,2125	0,2396	0,1478	0,1095	0,1511	0,1551	0,1429	0,1613	1,6007	0,1455
AI	0,0930	0,1050	0,1202	0,2125	0,1438	0,1478	0,1095	0,1511	0,0517	0,1429	0,1613	1,4387	0,1308
Cloud Computing	0,0399	0,0210	0,0240	0,0425	0,0479	0,1478	0,0365	0,0647	0,0517	0,0794	0,0323	0,5877	0,0534
3D Printers	0,0399	0,0210	0,0401	0,0425	0,0479	0,1478	0,1095	0,0647	0,0517	0,0794	0,0323	0,6767	0,0615
Robotics	0,2790	0,1050	0,1202	0,0425	0,0479	0,1478	0,2555	0,1942	0,2585	0,1429	0,1613	1,7548	0,1595
AR	0,0399	0,0350	0,0401	0,0425	0,0160	0,0211	0,0365	0,1079	0,0517	0,0794	0,0323	0,5022	0,0457
Block chain	0,0310	0,0150	0,0172	0,0142	0,0160	0,0164	0,0073	0,0216	0,0517	0,0476	0,0323	0,2702	0,0246
Machine Learning	0,0558	0,0350	0,1202	0,0425	0,0479	0,0296	0,0365	0,0216	0,0517	0,1111	0,1613	0,7132	0,0648
Metaverso	0,0310	0,0117	0,0134	0,0085	0,0096	0,0164	0,0073	0,0072	0,0074	0,0159	0,0323	0,1605	0,0146
Materiali Intelligenti	0,0558	0,0210	0,0240	0,0425	0,0479	0,0296	0,0365	0,0216	0,0103	0,0159	0,0323	0,3374	0,0307
												11	1

Once the values were normalized, we proceeded to calculate their consistency ratio. The consistency ratio provided a measure of the reliability and consistency of the pairwise comparisons made during the analysis. It ensured that the obtained rankings are not affected by inconsistencies or random variations in the decision-making process. By calculating the consistency ratio, we can assess the reliability of the obtained results and ensure that they accurately reflect the perceived differences in the utility and awareness of the technologies being compared.

Table C. Calculating Consistency Ratio

C.W.	0,2689	0,1455	0,1308	0,0534	0,0615	0,1595	0,0457	0,0246	0,0648	0,0146	0,0307			
Factors	Iot	Big Data	AI	Cloud Computing	3D Printers	Robotics	AR	Block chain	Machine Learning	Metaverso	Materiali intelligenti	Weighted sum value	Criteria Weights	WSV/CW
Iot	0,2689	0,7276	0,3924	0,3740	0,4306	0,1595	0,3196	0,2211	0,3242	0,1314	0,1534	3,5026	0,2689	13,03
Big Data	0,0538	0,1455	0,1308	0,2671	0,3076	0,1595	0,1370	0,1719	0,1945	0,1314	0,1534	1,8525	0,1455	12,73
AI	0,0896	0,1455	0,1308	0,2671	0,1846	0,1595	0,1370	0,1719	0,0648	0,1314	0,1534	1,6356	0,1308	12,51
Cloud Computing	0,0384	0,0291	0,0262	0,0534	0,0615	0,1595	0,0457	0,0737	0,0648	0,0730	0,0307	0,6560	0,0534	12,28
3D Printers	0,0384	0,0291	0,0436	0,0534	0,0615	0,1595	0,1370	0,0737	0,0648	0,0730	0,0307	0,7647	0,0615	12,43
Robotics	0,2689	0,1455	0,1308	0,0534	0,0615	0,1595	0,3196	0,2211	0,3242	0,1314	0,1534	1,9692	0,1595	12,34
AR	0,0384	0,0485	0,0436	0,0534	0,0205	0,0228	0,0457	0,1228	0,0648	0,0730	0,0307	0,5642	0,0457	12,36
Block chain	0,0299	0,0208	0,0187	0,0178	0,0205	0,0177	0,0091	0,0246	0,0648	0,0438	0,0307	0,2984	0,0246	12,15
Machine Learning	0,0538	0,0485	0,1308	0,0534	0,0615	0,0319	0,0457	0,0246	0,0648	0,1022	0,1534	0,7705	0,0648	11,88
Metaverso	0,0299	0,0162	0,0145	0,0107	0,0123	0,0177	0,0091	0,0082	0,0093	0,0146	0,0307	0,1731	0,0146	11,86
Materiali Intelligenti	0,0538	0,0291	0,0262	0,0534	0,0615	0,0319	0,0457	0,0246	0,0130	0,0146	0,0307	0,3843	0,0307	12,53
													L.max=	12,37

L.max - n	1,37
n - 1	10
CI	0,14
CR	0,09

RI=1.51

B – APPENDIX

Semi-structured questions

Could you describe the company's structure, including the number of manufacturing plants, the number of employees, and its international relations?
Does the company have a research and development (R&D) department? If yes, how many people work in that department?
Does the company have a dedicated department for environmental sustainability?
Is the R&D department currently conducting experiments related to the potential of digital technologies? If yes, what types of experiments?
Is the company currently initiating projects specifically dedicated to sustainability?
In which functional areas do you believe significant achievements in environmental sustainability can be made?
Which of these digital technologies are you familiar with and find interesting for future developments in the mechanical industry?
- Internet of Things (IoT)
- Big Data and Analytics
- Artificial Intelligence
- Cloud Computing
- 3D Printers
- Robotics
- Augmented Reality
- Blockchain
- Machine Learning
- Metaverse
- Virtual Reality
- Smart Materials
- Web 4.0
- 5G
- Agility

C – APPENDIX

Interviewed	***Company***	***Age***	***Gender***
Head of Business Development	A	30-40	Male
Chief Technology Officer	A	40-50	Male
Chief Sustainability Officer	A	30-40	Male
Head of Plants	A	40-50	Male
Chief Technology Officer	B	40-50	Male
Chief Sustainability Officer	B	30-40	Male
Head of Plants	B	40-50	Male
Head of Innovation	C	30-40	Female
CSR manager	C	40-50	Female
Managing Director	C	30-40	Female
Chief Technology Officer	C	40-50	Male
Managing Director	D	20-30	Male
Head of Innovation	D	30-40	Male
Head of Plants	D	40-50	Male

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italian journal of management

ISSN print 0393-5108
ISSN online 2785-549X
DOI 10.7433/2025.08
pp. 211-239

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Book chapters

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Registered with Law Court of Verona, Italy, reg. no. 570, 1 April 1983

20 copies printed by

GRAFICHE BAIETTA -Via Carcirago, 14, 37022 Fumane (VR) Italy - Tel. 045 770 2088
December 2025

€ 66, 00

Sinergie italian journal of management

Official Journal of Italian Society of Management
Vol. 42, Issue 3 - September/December 2025 - ISSN 0393-5108 ISSN 2785-549X

Quadrimestrale - Poste Italiane s.p.a. - Spedizione in Abbonamento Postale D.L. 353/2003 (conv. in L. 27/02/2004 n. 46) art. 1, comma 1, DCB VERONA