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Digital entrepreneurship: The role of entrepreneurial orientation and digitalization for disruptive innovation

Sascha Kraus^{a,d,*}, Katharina Vonmetz^a, Ludovico Bullini Orlandi^b, Alessandro Zardini^c, Cecilia Rossignoli^c

^a Faculty of Economics and Management, Free University of Bozen-Bolzano, Piazza Università 1, 39100 Bolzano, Italy

^b Department of Management, University of Bologna, Via Capo di Lucca 34, 40126 Bologna, Italy

^c Department of Business Administration, University of Verona, Via Cantarane 24, 37129 Verona, Italy

^d University of Johannesburg, Department of Business Management, 2092 Johannesburg, South Africa

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ABSTRACT

Innovation boosts economic growth, and one of the most critical factors when considering innovation-driven growth is the role of disruptive innovation, which is hailed as a lodestar by leaders of both small and large firms. However, little is known about the role of entrepreneurial orientation (EO) and digitalization strategy in enhancing or hindering firms' disruptive innovation. Our study thus addresses the relationships between EO and firms' ability to develop disruptive innovation under consideration of the firm's digital strategy. Our empirical analysis is based on quantitative survey data from a sample of 242 firms across a variety of industries, geographic locations, and sizes. Our results demonstrate that EO has a significant positive effect on disruptive innovation and that deployment of a digitalization strategy is perceived as a metaphorical cage for disruptive innovation among highly entrepreneurially oriented firms. However, a digitalization strategy supports disruptive innovation when firms are less entrepreneurially oriented. The insight of this work is that firms should focus on EO to allow disruptive innovation and increase or decrease digitalization strategy deployment and planning depending on the level of EO.

1. Introduction

It is widely accepted that innovation and entrepreneurship contribute to economic growth (Ahlstrom, 2010), and *disruptive* (i.e., breakthrough or radical) *innovation* that has the potential to completely change markets (e.g., Hu and Hughes, 2020) is often considered the guiding star of such growth (Christensen et al., 2015). Given that technology is not the only source of disruptive innovation, the term “disruptive technology”, which was initially used to describe such innovation, is increasingly replaced with the term “disruptive innovation” (Hopp et al., 2018) to acknowledge the critical role of innovation in business models, processes, and services (Mahto et al., 2020). Disruptive innovation can be defined as “an innovation that changes the performance metrics, or consumer expectations, of a market by providing radically new functionality, discontinuous technical standards, or new forms of ownership” (Nagy et al., 2016, p. 122). In the past decade, the concept has increasingly influenced academic literature and management thinking (Reinhardt and Gurtner, 2011; Si and Chen, 2020;

Si et al., 2020; Sadiq et al., 2022). Successful examples of disruptive innovations are Amazon with its online distribution (O'Reilly and Binns, 2019); Apple with its strategic action in the industries of music and cellular telephony (Burgelman and Grove, 2007); and Dell through selling computers directly to the customer (Charitou and Markides, 2003).

Digitalization is increasingly becoming a key influencing factor for entrepreneurial action, and the existence of a digitalization strategy is increasingly becoming a decisive factor for the success of a company. For example, the digital world of the financial industry has recently explored how strategies combined with entrepreneurial orientation (EO) can achieve high performance (Niemand et al., 2020). The European Union considers digitalization a changing force that could support joint efforts in facing societal challenges as it responds to phenomena such as the global COVID-19 pandemic with its first financial instrument — the Digital Europe (DIGITAL) program — which supports businesses, citizens, and public administration with a digital technologies budget of €7.5 billion (European Commission, 2021). During the lockdowns of the

* Corresponding author.

E-mail address: sascha.kraus@zfk.de (S. Kraus).

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pandemic, one of the lessons learned is that organizations with higher digital maturity are generally more flexible than those lower digital maturity (Fletcher and Griffiths, 2020). The importance of this flexibility was highlighted in Lucas Jr. and Goh's (2009) study of Kodak, which found that management, corporate culture, and a rigid bureaucratic structure prevented a rapid response to the evolution of digital photography. The study demonstrated that Kodak had difficulties in matching the progress of the market and consequently saw a drop in its market share (Lucas Jr. and Goh, 2009). Perhaps having a forward-thinking digitalization strategy would have enabled Kodak to respond to and progress with this revolution.

The disruptiveness of innovation is strategically crucial (Govindarajan and Kopalle, 2006a, 2006b), and the presence of entrepreneurial orientation leads to innovativeness, but what is the importance of digitalization within this context? Under the overall umbrella of "digital entrepreneurship" (e.g. Nambisan, 2017; Kraus et al., 2018), this study attempts to find this out by empirically analyzing the role of EO and digitalization strategy in the context of disruptive innovation. To achieve this aim, we examine step-by-step whether EO, digitalization strategy, and disruptive innovation have a positive relationship with each other. We also investigate whether a strong and structured digital strategy could hinder organizational ability to innovate disruptively, as has been suggested in relation to strategic planning in new product development (NPD) research (Song et al., 2011). To test our hypotheses and address our research question, 242 companies from Italy across a wide range of industries, geographic locations, and sizes are empirically analyzed.

2. Theoretical background

2.1. Entrepreneurial orientation

Schumpeter was the first economist to emphasize the importance of entrepreneurship — change brought about by innovation — for economic development (Ferreira et al., 2019). The theoretical roots of EO as the manifestation of entrepreneurial behavior can be found in Mintzberg's (1973) description of entrepreneurial organizations, which asserts that uncertainty can often be faced when actively seeking new opportunities (Wales et al., 2021). The new opportunities that are found can be used to generate competitive advantage (Covin and Slevin, 1989; Lumpkin and Dess, 1996) and entrepreneurial success. In short, EO is recognized as a strategy building process (Kollmann et al., 2021) and the idea of EO refers to *how* a firm operates rather than *what* it does (Lumpkin and Dess, 1996). Miller (1983), one of Mintzberg's students, described EO through three dimensions *risk-taking*, *proactiveness*, and *innovation* (Wales et al., 2021). EO brings together innovative and proactive entrepreneurial behaviors as well as the managerial attitude to gain opportunities with unknown results (Anderson et al., 2015). First, risk-taking accepts the chance of failure along with large resource commitments (Dess and Lumpkin, 2005) and often forsakes tried and tested behaviors to undertake a leap of faith (Pérez-Luño et al., 2011). Second, proactiveness results from opportunity-seeking in competitive future markets (Lumpkin and Dess, 2001). By implementing proactive action or decision-making, a firm can respond swiftly to market demand (Wright et al., 1995). Third, innovativeness motivates the search for new products and the creation of technological leadership (Covin and Slevin, 1991).

2.2. Digitalization strategy

The most notable sociotechnical transformation affecting industries currently is undoubtedly digitalization (Ritala et al., 2021; Hess et al., 2016). This means that firms must master the challenge of integrating digitalization and promoting digital transformation through a digitalization strategy (Gobble, 2018). Consequently, firms must consciously examine their strategic orientation while ensuring a digitalization

strategy that suits this orientation (Becker and Schmid, 2020). However, the concept of a digitalization strategy is a highly current research topic (Bharadwaj et al., 2013; Hess et al., 2016.; Woodard et al., 2013; Pagani, 2013) and remains in the infancy of investigation (Mithas et al., 2013).

Considering the term "digitalization" as the interaction of digital technologies and social and institutional processes through which the modern community and the economy are shaped (Teubner and Stockhinger, 2020), and the term "strategy" as a plan or guideline for future decision-making (Mintzberg, 1978), the following definition of "digitalization strategy" is offered—a business strategy that is supported by high-performance, simple, and accessible technologies that provide distinctive, integrated business functions that can adapt to flexible market conditions (Sebastian et al., 2017).

2.3. Disruptive innovation

The academic community has wrestled with providing the definition of "disruptive innovation" (Mahto et al., 2020). Although Christensen (2006) original conceptualization is often considered critical or inconsistent (Hopp et al., 2018), it is fundamental to understanding the idea. According to Christensen (2006), disruptive innovation can be roughly divided into the two categories of low-end and new-market disruption (Yu and Hang Chieh, 2008), and is a process that first begins in a niche market (Petzold et al., 2019). Low-end disruption presents a low-cost and reduced-quality alternative to already available products or services but provides no further performance progress (Henderson, 2006). In contrast, new-market disruption presents functionality to customers in a new way (i.e., a product or service with different features and performance attributes from those of existing products or services) (Reinhardt and Gurtner, 2011). With time, disruptive innovation comes to be demanded by mainstream customers, who initially rejected the innovation (Schmidt and Druehl, 2008). Therefore, some scholars agree that disruptive innovations develop new markets and new functionalities, which in turn disrupt existing industries (Adner, 2002; Charitou and Markides, 2003; Christensen and Bower, 1996; Danneels, 2004; Gilbert, 2003). This conceptualization is found in Schumpeter's (1942) theory of economic change with the first interpretation of "creative destruction", which considers the innovation process as "incessantly destroying the old one, incessantly creating a new one" (p. 83).

3. Development of hypotheses

Disruptive innovation has been investigated from several different perspectives; for example, pursuit of financial gain as the driving factor behind disruption (Adner, 2002); the potential response strategies of incumbents (Charitou and Markides, 2003); market/economic growth (Ahlstrom, 2010; Gilbert, 2003); additional factors that affect the rate of disruption (Nair and Ahlstrom, 2003); challenges to the definition of disruptive innovation (Danneels, 2004); how the process of disruption is driven by changes in technology and in the structure of consumer demand (Adner and Zemsky, 2006); making ex-ante predictions about the results of innovation (Christensen, 2006); measurements of disruptiveness, addressing several of Danneels's (2004) criticisms of disruption theory (Govindarajan and Kopalle, 2006b); competence-based explanations for the innovator's dilemma (Henderson, 2006); proposals of refinements to the definition of disruptive innovation (Markides, 2006); offers of new conceptualizations of "new-market disruption" with implications for industry-spanning innovation (Burgelman and Grove, 2007); firm resource allocation (Lucas Jr. and Goh, 2009); exploration of disruption as firm exit or industry destruction rather than loss of industry leadership (Bergek et al., 2013); proposal of theory that to succeed, some entrants must work together with incumbents (Marx et al., 2014); and explanation of why disruption occurs rapidly or slowly in different industries (Adner and Kapoor, 2016). Thus far, the role of entrepreneurship/EO and/or digitalization has not been considered in the research on disruptive innovation, which makes our study unique

and timely.

Research has considered the individual dimensions of EO in relation to innovation. The first dimension of EO, risk-taking, is positively related to innovation (Lomberg et al., 2017; Pérez-Luño et al., 2011) because through the risk-taking behavior, innovation can be achieved, and new products and services can be introduced into the market (Frishammar and Andersson, 2009; Li et al., 2008). The second dimension of EO is proactiveness, through which attitude, in combination with innovation, can improve firm performance and help to maintain entry barriers against other organizations, meanwhile decreasing vulnerability (Rosenbusch et al., 2011). The third dimension of EO is innovation, which according to Lumpkin and Dess (1996), is a crucial component of EO because through innovation, firms can follow new opportunities.

Just as EO confronts uncertainty, so does disruptive innovation. It actively seeks new opportunities or competitive advantages. Disruptive innovation is linked with greater insecurity, emerging markets, and an undetermined consumer (Reinhardt and Gurtner, 2011). The market evolution of disruptive innovation is not predictable and is marked by greater intensity of risk-taking as well as a trial and error mentality (Govindarajan and Koppale, 2006a). This unpredictability leads firms to invest fewer resources in disruptive innovation projects and spend more on sustainable innovation, which increases the performance dimensions that are already valued by mainstream customers (Reinhardt and Gurtner, 2011). Therefore, it focuses on existing customers, to whom more products are sold at a higher margin and at a higher level of profitability (Christensen et al., 2018), to the point where the disruptive innovation catches up to the level of quality expected by mainstream customers (Christensen et al., 2015). The mainstream customer's needs are adequately met, and the disruptive innovation as the new market leader displaces the incumbent technology and, synchronously, the incumbent provider (Reinhardt and Gurtner, 2011). When incumbents are overly focused on their current customers and large margins and are acting in the firm's best interests by minimizing risk, they can fail to invest in disruptive innovation (Henderson, 2006). This phenomenon is known as the "innovator's dilemma" (Reinhardt and Gurtner, 2011; Christensen et al., 2015; Henderson, 2006). The dilemma is that the new and the existing ways are in conflict, which makes it difficult for the two to coexist in the same firm (Markides, 2006).

The three dimensions of EO (risk-taking, proactiveness, and innovation) are positively related to innovation, and research has demonstrated that there is a direct link between EO and (product/service) innovation (Kollmann et al., 2021). More precisely, because innovation has a positive relationship with EO (Avlonitis and Salavou, 2007), it is assumed that EO also has a positive relationship with disruptive innovation. Therefore, we propose the first hypothesis as follows.

Hypothesis 1. There is a positive relationship between EO and disruptive innovation.

Various scholars have observed that entrepreneurial behavior supports a firm's growth potential as well as its competitiveness (Fellnhofer, 2019). EO is a product of entrepreneurial behavior and strategic decision-making with uncertain outcomes (Anderson et al., 2015). EO supports dynamic economic development (Lumpkin and Dess, 1996) and refers to the strategy formation processes of firms performing entrepreneurial tasks (Lumpkin and Dess, 2001). Mintzberg (1973) proposed three different modes of strategy formation: adaptive, entrepreneurial, and planning. The entrepreneurial mode was defined by the active search for new opportunities and impressive leaps forward in the realm of uncertainty (Mintzberg, 1973). Lee et al. (2001) found that entrepreneurial firms are more responsive and stronger than their peers. This may be due to the proactive behavior of entrepreneurial firms, which is strongly associated with the deadline-mover advantage (Pérez-Luño et al., 2011). A first-mover advantage is said to exist when the firm can achieve a better position than its competitors or rivals by entering the market early. Research has found that firms gain an unbeatable step ahead through the first-mover advantage (Suarez and Lanzolla, 2005).

Strategic thinking characterizes EO and digitalization. Given that digital density increases exponentially (McDonald, 2012) and strategic planning for digitalization becomes an enterprise-wide feature (Kraus et al., 2018), a digitalization strategy is only useful if it accelerates resource allocation and capital deployment (Sebastian et al., 2017). For example, the benefits of digitalization include reducing costs, increasing revenue potential, increasing productivity (Hess et al., 2016), and developing new business models (Becker and Schmid, 2020). The implementation of a digitalization strategy can be improved by clear and transparent communication of this digitalization throughout the organization so that employees can more easily track and understand the evolution toward digital services and online tools (Niemand et al., 2020).

Both EO and digitalization strategies have a strategic orientation; they are focused on action plans to develop a competitive advantage (Henderson, 1989). It has been observed that banks achieve higher business success when their strategic visions for digitalization and EO are combined (Niemand et al., 2020).

Thus, we propose that there is a positive correlation between EO and the level of deployment of digitalization strategy in the following hypothesis:

Hypothesis 2. There is a positive relationship between EO and the deployment of digitalization strategy.

Innovation is no longer considered a function of research and development, and digitalization is now no longer considered a part of information technology work or marketing (Gobble, 2018). Digitalization enables the entire firm to be transformed (including the firm's relationships with customers, employees, and the entire market), and thus a corporate strategy is needed (Gobble, 2018). The inherently multi-functional characteristic of a digitalization strategy (Bharadwaj et al., 2013) requires simultaneous reconfiguration of information technology and business resources firm-wide, which is one reason adjusting or implementing a digitalization strategy can be challenging (Yeow et al., 2018). Fundamentally, organizations must articulate digitalization strategies in a changing environment (Yeow et al., 2018). Pagani (2013) also demonstrated that digitally enabled networks drive technology as well as business strategies.

Moreover, it has been found that a digital business strategy can be a reaction to the competitive environment of the digital business (Mithas et al., 2013). Digitalization can undermine organizations' current business models because of the heavy shift in consumer behavior; for example, instead of buying physical goods, customers may turn to buying online items that may be printed at home (Hopp et al., 2018). However, digitalization and the strategies to face it can also boost firms' innovation (Sandström et al., 2009; Roblek et al., 2021). For example, in the retail sector, effective deployment of social media allows the development of both incremental and disruptive innovations, and this positive relationship is mediated by digital organizational capabilities (De Oliveira et al., 2020).

As stated, EO can lead to a higher level of firm innovation; however, the digital lead innovations must be supported by a structured digital strategy that can orient organizational investments, managerial efforts, and operations (Ross et al., 2017). Therefore, building on this literature, we propose our third hypothesis:

Hypothesis 3. There is a positive relationship between the deployment of a digitalization strategy and disruptive innovation, and the firm mediates the relationship between EO and disruptive innovation.

Even if part of the existing literature seems to support the three proposed hypotheses, a debate in NPD literature suggests that the role of digital strategy cannot be as straightforward as hypothesized. Structured strategic planning could reduce a firm's innovativeness in NPD because innovativeness cannot always be planned in advance, and strategic planning routines may result in rigidities that hamper innovation (Song et al., 2011). Structured strategic planning, even if aimed at supporting

innovation activities by eliminating useless phases and speeding up the process, may result in hindering innovation through reducing the speed of innovation (Eisenhardt and Tabrizi, 1995). In addition, strategic planning may reduce improvisation and increase rigidity (Slotegraaf and Dickson, 2004). Following this line of reasoning (Eisenhardt and Tabrizi, 1995; Slotegraaf and Dickson, 2004), a strong deployment of the organizational digitalization strategy as part of strategic planning could be a hindering factor of the firm’s innovation outcomes. In particular, the three dimensions of EO (risk-taking, proactiveness, and innovation) can be positively related to disruptive innovation but can also be restricted by strongly structured strategic planning (Kollmann et al., 2021; Avlonitis and Salavou, 2007).

Therefore, this study adopts a *competing hypotheses approach*, which is suggested to increase the objectivity of hypotheses (Armstrong et al., 2001), to propose a competing moderating hypothesis:

Hypothesis 4. The deployment of digitalization strategy moderates the relationship between EO and disruptive innovation, such that the higher the deployment of a digitalization strategy, the lower the effect of EO on disruptive innovation.

Fig. 1 presents our overall research framework:

4. Method and data collection

4.1. Research method and data collection

The empirical research method employed in study work follows a quantitative approach, and statistical data analysis is used to understand and explain the relationships (Ary et al., 2002). First, the model for this research framework is developed and subsequently empirically tested and analyzed through a standardized questionnaire with subsequent statistical evaluation. This statistical evaluation is based on the mediation and moderation analysis.

The initial sample was obtained by drawing a random sample of 1000 firms from the Aida–Bureau Van Dijk database, the most important database for limited Italian firms. The data collection, which began in May 2019 and continued until January 2020, was gathered through a quantitative, standardized questionnaire that the invited firms received through an online survey. The respondents were chief executive officers and other middle-level and top-level managers in strategy-related areas (e.g., marketing, sales, information and communication technologies). Respondents were assured of anonymity and the use of aggregated data was employed to comply with Italian and European privacy laws. The resulting sample of potential respondents consists of a broad range of industries, geographic locations within Italy, and sizes. First, the data collected on the firm structure is presented, followed by the evaluation of the data gathered from the participants.

A total of 242 firms completed the questionnaire in full. From the data collected on the structure of the firms, it is evident that most of the participating firms are active in the food industry. It should be noted that industries that accounted for <4 % of the total in our data are not reported individually. A total of 38.8 % of the firms surveyed are older than 50 years; 52.3 % are between 11 and 50 years of age; and 8.9 % are

young firms (up to 10 years of age). The number of employees in the firms was also reported, with than 60 % of the participating firms being small firms (30 % have 10 to 49 employees) and medium firms (36.3 % have 50 to 249 employees). Large firms with >250 employees account for 22.5 % of the total sample. Micro-firms (i.e., employing fewer than ten people) accounted for 11.2 % of the total sample. The respondent firms represented a good level of variety in industry (see Table 1), with six industries represented by at least 5 % of the sample; the industries represented by <4 % of the sample are grouped as “Other industries” in the table.

In addition to the characteristics of the firms, the characteristics of the people who completed the questionnaire on behalf of the firm were also recorded. It was found that 24 % of the participants hold the role of chief executive officer in the firm. The other most represented roles are chief operating officer (11.6 %); the chief marketing officer (8.7 %); and chief information officer (5.6 %). The main proportion of participating employees in this survey has been employed in the firm for more than ten years (55.30 %). This is followed by the group of employees who have been employed by the firm for no more than five years (28.30 %). The participants employed by the firm for six to ten years account for 16.40 % of the total sample. The age of the participants was also surveyed, with most participants being between 36 and 55 years of age (67.10 %). The group of 56–60 years of age accounted for 12.70 % of the total sample.

4.2. Definition and measurement of variables

The questionnaire contains multi-item scales already developed in previous management and information systems research and used seven-point Likert-type scales (1 = strongly disagree to 7 = strongly agree).

- **Digitalization strategy (DS):** the level of deployment of the digitalization strategy is measured by employing a multi-item scale based on Rossmann (2018), which measures whether organizations have developed, documented, communicated, and implemented a digitalization strategy at the corporate level.
- **Entrepreneurial orientation (EO):** to measure EO, the scale by Eggers et al. (2013) is employed; this scale consists of 14 items reflecting risk-taking (four items); proactiveness (five items); and

Table 1
Industries.

Industry	Frequency	Percentage
Manufacturing	51	21.1
Food	40	16.5
Services (other)	30	12.4
Agriculture	27	11.2
Fashion	16	6.6
Retail	13	5.4
Others industries	65	26.9
Total	242	100

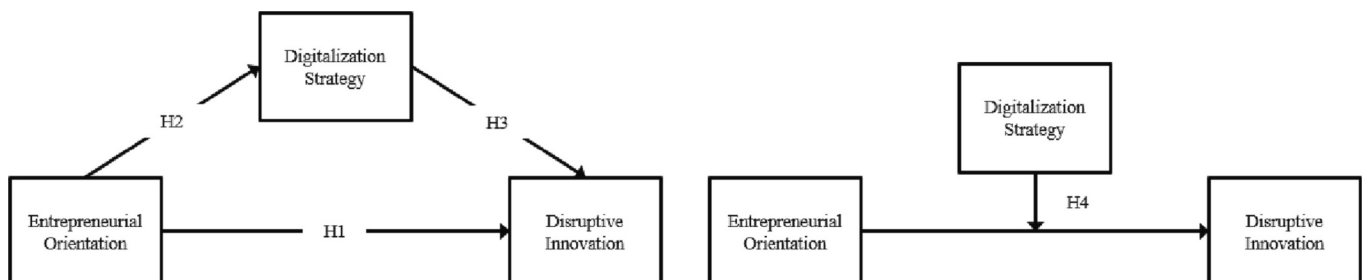


Fig. 1. Competing research framework of the relationship between EO, deployment of digitalization strategy, and disruptive innovation.

innovativeness (five items). Due to cross-loadings on two factors and factor loadings below 0.5 — the threshold representing a significant loading, given the sample size (Hair et al., 2010) — two items from EO innovativeness and one from EO proactiveness were excluded from the analysis (see Table 1).

- **Disruptive innovation (DI):** the level of innovation was measured in terms of disruptive, radical, or breakthrough innovations that can be considered “new-to-the-world”, bringing significant and novel value to customers, often addressing new and emerging needs, based on the scale from Spanjol et al. (2012). The first item is adapted with seven values of percentages of total sales from breakthrough products introduced by the firm in the previous three years (1 = <5 %; 2 = 5–10 %; 3 = 11–15 %; 4 = 16–20 %; 5 = 21–25 %; 6 = 25–30 %; 7 = >30 %). Due to factor loadings below 0.5, the third item was removed in the final analysis.
- **Control variables:** eight control variables are included: the number of employees measured on a seven-point scale, the logarithm of business age, and six dummy variables for the six more representative industries (i.e., manufacturing, food, services, agriculture, fashion, and retail).

The scales’ psychometric properties (i.e., reliability, convergent validity, and discriminant validity) are assessed through the following analyses: (1) exploratory factor analysis (EFA); (2) coefficients composite reliability (CR), Cronbach’s alpha (CA), and average variance extracted (AVE); and (3) confirmatory factor analysis (CFA).

Table 2 presents the results of the EFA with item loadings presented in brackets near each item. The EFA analysis is run in SPSS 23, making it easier to visualize the results; CR, CA, AVE, and CFA are calculated employing the lavaan package in R.

Reliability was assessed through analysis of the CA and CR scores, all of which were above the suggested threshold of 0.7. Furthermore, the items’ loadings were almost all above 0.7, apart from four that were above or near 0.6, which is an acceptable level for the study’s sample size (Hair et al., 2010). The results for CR (Hair et al., 2010) support convergent validity, and all the AVEs (except EO as a second-order construct) were above 0.5 (Fornell and Larcker, 1981). Discriminant validity was assessed, except for EO as a single construct, verifying that the squared root of AVE was higher than the other interconstruct correlations (Fornell and Larcker, 1981). Furthermore, we ensured that each item’s loading on its assigned construct was greater than all the possible cross-loadings on other constructs (Farrell, 2010).

For the final step, CFA with the three-factor structure of EO displayed adequate fit indexes suggesting goodness of fit of the measurement model: χ^2 of 228.05 with 109 df and CFI = 0.94, TLI = 0.93, RMSEA = 0.067, SRMR = 0.048, and p-value = 0.000 (Table 3).

In addition, nonresponse and common method bias were investigated. For investigating nonresponse bias, characteristics of early and late respondents (Armstrong and Overton, 1977) were compared, and no significant differences emerged, suggesting that nonresponse bias was not an issue for this research. Common method variance was considered in the study design following best practices for designing and administering surveys (Woszczyński and Whitman, 2004). Namely, respondents were assured of anonymity, and it was ensured that the employed scales minimized the risk of social desirability bias, demand characteristics, and ambiguity (Podsakoff et al., 2003).

Ex-post, the level of common method bias was tested employing Harman’s single-factor test (Podsakoff et al., 2003; Woszczyński and Whitman, 2004). The single factor extracted on the basis of the eigenvalue in the unrotated matrix accounted for 37.62 % of the variance, far below the 50 % threshold; the result suggests that common method bias is unlikely.

Finally, before analyzing the mediation and moderation effects, some observations had to be removed due to missing data on the output variable; therefore, the dataset for mediation and moderation analysis comprised 201 observations.

Table 2
Constructs, items, and source.

Construct	Items #	Scale items (item loading)	Source
Deployment of digitalization strategy (DS)	DS 1	Our firm has implemented a digitalization strategy (0.85) The digitalization strategy of our firm is documented and communicated (0.90) The digitalization strategy of our firm has a significant influence on the existing business model (0.79) The digitalization strategy is being continuously evaluated and adapted when necessary (0.81)	Rossmann (2018)
	DS 2		
	DS 3		
	DS 4		
EO-Risk-taking (EO_RT)	EO_RT 1	We encourage people in our firm to take risks with new ideas (0.81) We value new strategies/plans even if we are not certain that they will work (0.89) To make effective changes to our offering, we are willing to accept at least a moderate level of risk of significant losses (0.65) We engage in risky investments (e.g., new employees, facilities, debt, stock options) to stimulate future growth (0.64)	Eggers et al. (2013)
	EO_RT 2		
	EO_RT 3		
	EO_RT 4		
EO-Proactiveness (EO_PR)	EO_PR 1	We consistently look for new business opportunities (removed) Our marketing efforts try to lead customers, rather than respond to them (0.70) We work to find new businesses or markets to target (0.63) We incorporate solutions to unarticulated customer needs in our products and services (0.87) We continuously try to discover additional needs of our customers of which they are unaware (0.77)	Eggers et al. (2013)
	EO_PR 2		
	EO_PR 3		
	EO_PR 4		
	EO_PR 5		
EO-Innovativeness (EO_IN)	EO_IN 1	We highly value new product lines (removed) When it comes to problem solving, we value creative new solutions more than solutions that rely on conventional wisdom (removed) We consider ourselves an innovative firm (0.57) Our business is often the first to market with new products and services (0.95) Competitors in this market recognize us as leaders in innovation (0.86)	Eggers et al. (2013)
	EO_IN 2		
	EO_IN 3		
	EO_IN 4		
	EO_IN 5		
Disruptive innovation (DI)	DI 1	In answering the next question, consider that when referring to breakthrough products/services, we mean new-to-the-world products/product lines. Percentage of total sales from breakthrough products/service introduced by your firm in the past three years*	Spanjol et al. (2012)
	DI 2		
	DI 3		

(continued on next page)

Table 2 (continued)

Construct	Items #	Scale items (item loading)	Source
		(0.92)	
		In the past three years, our firm frequently introduced breakthrough product/service innovations that were totally new to the firm (0.83)	
		Compared with our main competitors, our firm introduced more breakthrough products/services in the past three years (removed)	
		*(1 = <5 %; 2 = 5–10 %; 3 = 11–15 %; 4 = 16–20 %; 5 = 21–25 %; 6 = 26–30 %; 7 ≥ 30 %)	

5. Results

The results of the four hypotheses are illustrated through the mediation and moderation analysis. The fourth hypothesis is discussed through the graphic with three-way interactions. Given the aim to verify both a mediation and moderation effect, we employed a regression approach with bootstrapped confidence intervals (CIs), which is a reliable approach to verifying the significance of direct and indirect effects in mediation and interaction in moderation analysis (Hayes, 2017). Fig. 2 demonstrates that the relationship between EO and disruptive innovation is mediated by the deployment of digitalization strategy.

The PROCESS script in SPSS 27 was employed to run the analysis presented in Tables 4, 5, and 6.

The tables present the regression coefficients (b); the standard errors (s.e.); the values of t-statistic (t); the p-values (p); the lower limit

Table 3
Assessment of constructs' convergent and discriminant validity.

Constructs	M	SD	CR	CA	AVE	1	2	3	4	5	6
1. DS	4.94	1.41	0.90	0.90	0.69	0.83					
2. EO_RT	4.77	1.28	0.83	0.84	0.58	0.29	0.76				
3. EO_PR	5.12	1.12	0.82	0.82	0.53	0.24	0.41	0.73			
4. EO_IN	4.86	1.42	0.87	0.87	0.69	0.46	0.45	0.48	0.83		
5. EO	4.92	1.00	0.87	0.87	0.39	0.41	0.81	0.78	0.79	0.62	
6. DI	4.78	1.43	0.89	0.88	0.81	0.31	0.40	0.28	0.47	0.48	0.90

1. M = mean; SD = standard deviation; CR = composite reliability; CA = Cronbach's alpha; AVE = average variance extracted.
2. Numbers on the diagonal are the square root of AVEs. The other numbers are correlations among constructs.

confidence interval (LLCI); and the upper limit confidence interval (ULCI). In some cases, CIs were bootstrapped (Boot), employing 5000 samples.

The first hypothesis, concerning the positive relationships between EO and the level of firms' disruptive innovation, is confirmed (b = 0.74, p-value = 0.000). Therefore, we find strong empirical support that more entrepreneurially oriented firms are able to develop more disruptive innovations. Furthermore, the second hypothesis, concerning the positive relationship between EO and deployment of digitalization strategy, is also tested and verified (b = 0.57, p-value = 0.000), supporting that firms with a high level of EO are better able to structure their digitalization strategy than firms with a low level of EO.

The third hypothesis, suggesting that the deployment of the digitalization strategy can play a relevant role as a mediator in the relationships between EO and disruptive innovation, is also supported by the analysis (see Table 4). Deployment of the digitalization strategy was found to have an effect on disruptive innovation (b = 0.17, p-value = 0.043). The analysis also suggests that part of the effect of EO on disruptive innovation passes through the level of maturity of the digitalization strategy. The indirect effect is 0.10 of the total 0.84 effect, and the bootstrapped CIs suggest that it is different from zero (the LLCI-ULCI interval does not contain zero).

Finally, the analyses employed to verify the competing hypothesis about the moderation effect of the deployment of digitalization strategy in the relationship between EO and disruptive innovation provide some contrasting—but probably more interesting—results. The moderation analysis (see Fig. 3) confirms the existence of a negative moderation effect of digitalization strategy (moderator) on the relationship between EO (independent variable) and disruptive innovation (dependent variable).

Analyzing the moderation of deployment of the digitalization strategy on the positive relationship between EO and disruptive innovation, a negative and significant interaction effect emerged (EO*DS) (b = -0.27,

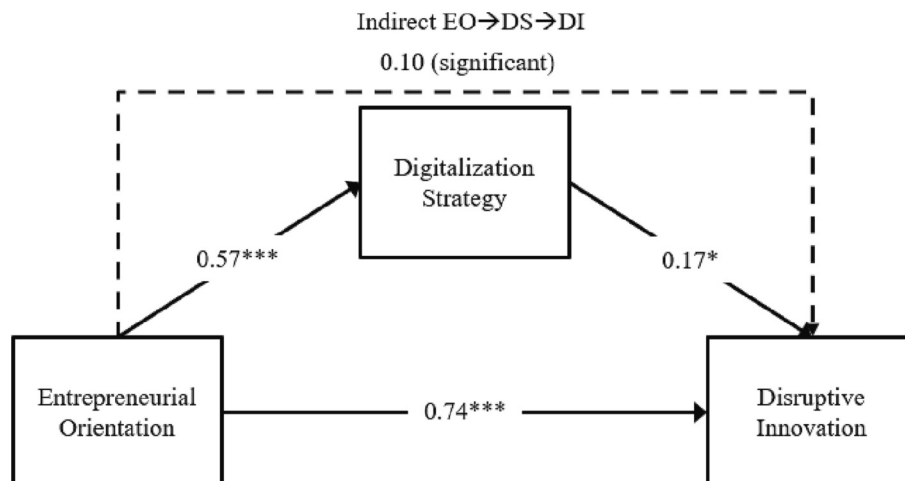


Fig. 2. Mediation analysis.

Table 4
Mediation effect of digitalization strategy in EO-disruptive innovation.

Outcome: DS						
Model summary:	R	R-squared	Df	p		
Model	0.46	0.21	191	0.000		
Constant	b	s.e.	T	p	LLCI	ULCI
EO	2.36***	0.6	3.91	0.000	1.17	3.55
No. of employees	0.57***	0.09	6.32	0.000	0.39	0.75
Log of business age	0.05	0.07	0.78	0.433	-0.08	0.18
Manufacturing	-0.16	0.21	-0.75	0.453	-0.58	0.26
Food	-0.30	0.25	-1.2	0.230	-0.8	0.19
Services	0.06	0.29	0.21	0.834	-0.52	0.64
Agriculture	0.06	0.31	0.19	0.846	-0.56	0.68
Fashion	-0.32	0.31	-1.05	0.294	-0.93	0.28
Retail	-0.78	0.41	-1.89	0.060	-1.59	0.03
	0.77	0.42	1.84	0.067	-0.06	1.60

Outcome: DI						
Model summary:	R	R-squared	Df	p		
Model	0.53	0.29	190	0.000		
Constant	b	s.e.	T	p	LLCI	ULCI
EO	-0.43	0.72	-0.59	0.553	-1.84	0.99
DS	0.74***	0.11	6.52	0.000	0.52	0.96
N° of employees	0.17*	0.08	2.04	0.043	0.01	0.33
Log of business age	0.00	0.08	-0.03	0.974	-0.15	0.15
Manufacturing	0.00	0.25	0.02	0.988	-0.48	0.49
Food	0.19	0.29	0.66	0.511	-0.38	0.76
Services	0.26	0.34	0.77	0.444	-0.41	0.93
Agriculture	0.98	0.36	2.73	0.007	0.27	1.69
Fashion	0.03	0.35	0.08	0.936	-0.67	0.73
Retail	0.01	0.48	0.02	0.983	-0.93	0.95
	-0.17	0.49	-0.34	0.731	-1.13	0.79

Table 5
Mediation effect of deployment of digitalization strategy in EO-disruptive innovation: total, direct, and indirect effects.

Total effect model						
Model summary:	R	R-squared	Df	p		
Model	0.49	0.24	195	0.000		
Constant	b	s.e.	T	p	LLCI	ULCI
EO	-0.03	0.70	-0.04	0.969	-1.40	1.35
No. of employees	0.84***	0.10	8.04	0.000	0.63	1.04
Log of business age	0.01	0.08	0.08	0.934	-0.14	0.16
Manufacturing	-0.02	0.25	-0.10	0.925	-0.51	0.47
Food	0.14	0.29	0.48	0.633	-0.43	0.71
Services	0.27	0.34	0.79	0.429	-0.40	0.94
Agriculture	0.99	0.36	2.74	0.007	0.28	1.71
Fashion	-0.03	0.36	-0.07	0.941	-0.73	0.67
Retail	-0.12	0.48	-0.26	0.799	-1.06	0.82
	-0.04	0.49	-0.08	0.940	-1.00	0.92

Total, direct, and indirect effect						
Total effect	B	s.e.	T	p	LLCI	ULCI
EO→DI	0.84	0.10	8.04	0.000	0.63	1.04
Direct effect	B	s.e.	T	p	LLCI	ULCI
EO→DI	0.74	0.11	6.52	0.000	0.52	0.96
Indirect effect	b	Boot s.e.			Boot LLCI	Boot ULCI
EO→DI via DS	0.10	0.05			0.0036	0.2105

p-value = 0.000). This effect is not interpretable in a straightforward way when the graphical analysis of the maturity of the digitalization strategy moderation effect is employed.

Fig. 4 permits an understanding of the behavior of the deployment of digitalization strategy moderation effect that can be described as

Table 6
Moderation effect of deployment of digitalization strategy on EO-disruptive innovation.

Outcome: DI						
Model summary:	R	R-squared	Df	p-value		
Model	0.58	0.34	189	0.000		
Constant	b	s.e.	T	p-value	LLCI	ULCI
EO	4.23***	0.42	10.02	0.000	3.40	5.06
DS	0.77***	0.11	6.99	0.000	0.55	0.98
EO*DS	0.10	0.08	1.16	0.249	-0.07	0.26
No. of employees	-0.27***	0.07	-3.93	0.000	-0.41	-0.14
Log of business age	-0.04	0.07	-0.52	0.606	-0.18	0.11
Manufacturing	0.07	0.24	0.29	0.771	-0.40	0.54
Food	0.15	0.28	0.53	0.597	-0.40	0.70
Services	0.29	0.33	0.89	0.375	-0.35	0.93
Agriculture	1.19	0.35	3.38	0.001	0.49	1.88
Fashion	0.01	0.34	0.03	0.975	-0.66	0.68
Retail	-0.06	0.46	-0.13	0.893	-0.97	0.85
	-0.19	0.47	-0.40	0.687	-1.11	0.74

follows. When EO is low (-1 standard deviation (SD) from the mean), firms with a high level of deployment of digitalization strategy also have a higher disruptive innovation performance. This relationship is reversed in the case of firms with a high level of EO (+1 SD from the mean). In such a context, firms with a high level of deployment of digitalization strategy display a lower level of disruptive innovation performance than firms with low deployment of digitalization strategy. This effect seems to suggest that when EO is low, the digitalization strategy plays a fundamental role in supporting disruptive innovation performance, but when firms have a high level of EO, then the maturity of the digitalization strategy can act as a “cage” for them and reduce their ability to introduce disruptive innovation.

6. Discussion

The aim of this work was to investigate the influence of EO and digitalization strategy on disruptive innovation. From one perspective, previous literature suggests that EO and digitalization strategy can be positively related to innovation in general (Roblek et al., 2021). By contrast, NPD literature problematizes the straightforwardness of these positive relationships, suggesting that strategic orientations (such as EO) could also be perceived as hindering innovation outcomes. However, the previous academic literature has not empirically investigated these competing hypotheses. Even if the positive relationship between EO and firms’ outcomes - such as performance, learning, product, and business model innovation - could already be widely confirmed (Wales et al., 2021), a specific investigation about the role of EO in enhancing disruptive innovation and under which contingency in terms of digitalization, was missing so far. Our results can thus contribute to filling this gap, and further contributing to the still underdeveloped but rising avenue of research using digitalization as a context for entrepreneurial behavior (Ritala et al., 2021).

First, our results confirm hypothesis 1 by demonstrating that EO has a significant positive impact on disruptive innovation. This result is in line with previous study results that attest to a positive relationship of EO to product or service innovation in general (e.g., Kollmann et al., 2021) or different types of innovation, such as business model innovation. With our results we can show first evidence that it is worthwhile to be entrepreneurial, i.e. proactive, innovative, and willing to take risks, if one aims at real groundbreaking, i.e. disruptive innovations as a result, which have the potential to turn market conditions upside down.

At the same time, hypothesis 2 is confirmed, showing the existence of a positive correlation between EO and digitalization strategy. Using the example of banks, Niemand et al. (2020) found that the combination of

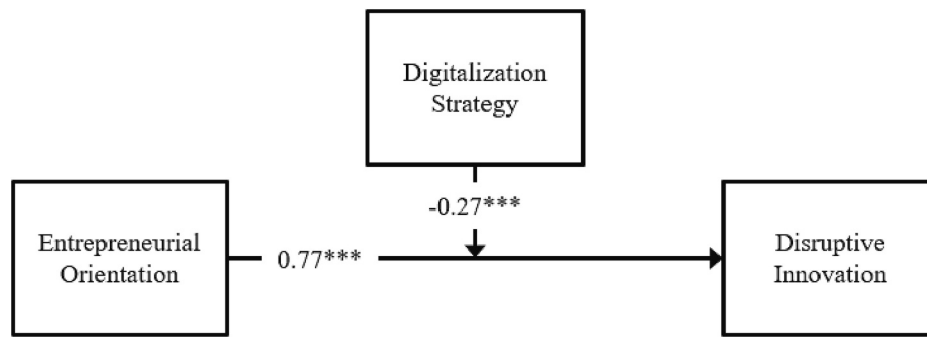


Fig. 3. Moderation analysis.

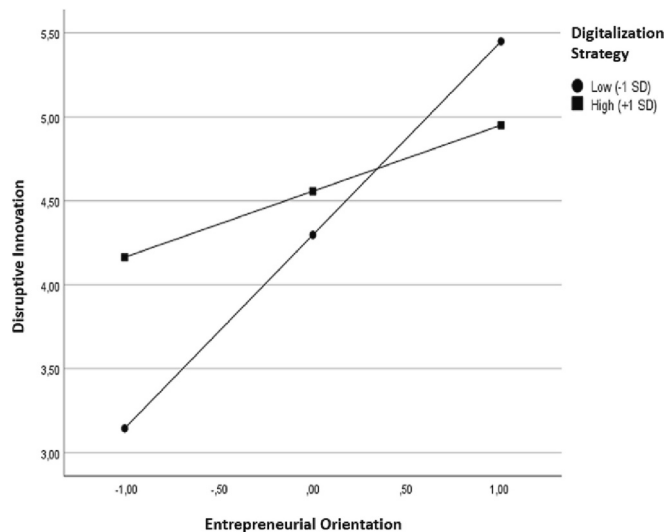


Fig. 4. Moderation effect of deployment of digitalization strategy on EO-disruptive innovation.

EO and a strategic vision for digitalization positively influences their corporate success. Thus, EO not only seems to promote innovation (see hypothesis 1), but also strategic thinking, which seems obvious since it is a strategic orientation (Hakala, 2011). Based on our study, we found that the existence of EO has a positive effect on the deployment of a digitalization strategy, i.e., the more proactive, innovative and risk-taking a firm is, the more likely it is to use this strategic orientation to develop a digitalization strategy and ultimately to apply it. Thus, firms with a high EO level seem to be better able to shape their digitalization strategy than firms with a low EO level.

Strongly entrepreneurial firms can also use the digitalization strategy in a structured way when gaining the first-mover advantage. This is because these firms do not want to follow the competition as mere on-lookers, but proactively seek solutions to unarticulated customer needs in their products and services. This last point is strongly connected with hypothesis 3, which is also confirmed, suggesting that digitalization strategy has a significant positive effect on disruptive innovation, and part of the total effect of EO on disruptive innovation runs through the level of digitalization strategy. These findings confirm similar previous research, which has been able to elaborate that digitalization and its strategy as such can be a key driver of innovation (e.g., Sandström et al., 2009; Roblek et al., 2021), and that a firm’s digital organizational capabilities can have a mediating influence on such relationships (e.g., Oliveira et al., 2020). For example, can a digitalization strategy support customer orientation with personalized offers, digital communication, and sales channels. This allows them to constantly discover additional, previously unknown customer needs and integrate solutions for these

needs into products and services. In addition, a digitalization strategy can support digital marketing through automated approaches to distribution, sales, communication, service, and customer engagement. The risk-taking of the surveyed firms can indirectly influence disruptive innovations through the digitalization strategy, for example, by motivating employees to take risks for new ideas through digital idea management. This ensures valuable ideas are visible instead of disappearing into oblivion. Ideas management can be seen as a valuable collection point for idea generation because every employee is an expert in their field and can contribute to the firm by providing thought-provoking ideas and suggestions for improvement. Through this workforce participation, change processes and the associated opportunities and challenges can be highlighted.

The digitalization strategy also indirectly supports risk-taking. That is, automated processes safeguard entrepreneurial processes through the digitalization strategy, which strengthens the firm operations, and the digitalization strategy can promote reasoned risk-taking through strategic trend forecasts and competitive analyses.

As stated, this study adopts a *competing hypotheses approach* to shed light on the debate about the role of strategic planning in innovation outcomes. As the NPD literature suggests, our study confirms that strategic planning can be a double-edged sword for innovation depending on organizational conditions. Our results confirm Hypothesis 4, which proposes that a higher level of EO requires a lower level of deployment of digitalization strategy to promote disruptive innovation. The reverse is also true, that is, firms with a low level of EO can reach a higher level of disruptive innovation when they have a higher level of deployment of digitalization strategy.

The strong influence of EO on disruptive innovation can be explained by the fact that the three dimensions of EO (risk-taking, proactivity, and innovation) are reflected in disruptive innovation. Disruptive innovation has uncertain and risky outcomes but requires that firms proactively address as yet undefined customer needs and seek innovative solutions to these unmet needs. In addition, EO, through its three dimensions, provides more flexibility for creative experimentation to support new ideas and exploration and to respond to unforeseen changes. In contrast, in terms of disruptive innovation, a planned digitalization strategy forms a sort of “closed shell” around the enterprise and acts as an organizational tool to accelerate resource allocation and capital deployment.

The digitalization strategy strengthens structured organizational processes but limits the potential for ideas with this structure based on a hierarchy of defined responsibilities. The example of the digitalization strategy process makes this clearer: the management defines the digitalization strategy for the firm and appoints project managers to implement the digitalization strategy for their own organization. The specialist departments in the individual organizations then work through the task packages in a targeted manner and in accordance with their responsibilities. Upper management is informed of the interim results and gives the green light for further project implementations or postpones adjustments until after the end of the project. Idea generation is not a controlled process but an exploration in which control could be

harmful, at least at the beginning. Disruptive innovation requires firms to think and act “outside the box” and to engage with the unexpected. To do this, firms must leave their comfort zone and enter a realm of uncertainty. In strongly entrepreneurially oriented firms, the sort of “cage” that the digitalization strategy builds around the firm hinders rather than encourages disruptive innovation.

However, our results also demonstrate that digitalization strategy promotes disruptive innovation in firms with low EO, although not to the same extent as in firms with high EO. This could be because the digitalization strategy helps build internal firm communication networks. The digitalization strategy can also support the cultivation of the external digital network with other firms, research institutions, and universities. Other perspectives are often helpful for idea generation because employees can become lost in operational blindness and fail to notice what they should have recognized as a driver for innovation. An external partner offers a new perspective on the problem, and new solutions can emerge.

However, if the firm is heavily entrepreneurially oriented, then a strongly structured digitalization strategy can be a hindrance to innovation because while EO is strategically focused, it also has a degree of openness. While a digitalization strategy is a helpful organizational tool, strategic focus can be hindered by rigidity that can come with strategy.

7. Conclusion

This study contributes to the advancement of existing knowledge and theory in the fields of entrepreneurship and innovation management, with special emphasis on the increasingly important digitalization as both of their influencing factors. It can therefore also be assigned to the rapidly growing research field of “digital entrepreneurship” (e.g. [Nambisan, 2017](#); [Kraus et al., 2018](#)).

The main objective of this work was to show the role of EO and digitalization strategy for achieving disruptive innovation. It builds on the recent increased and in-demand literature on the role of digitalization in the context of EO ([Hervé et al., 2021](#); [Ritala et al., 2021](#)) and extends it insofar as EO is not only related to general company or innovation success, as has been the rule so far (e.g. [Wales et al., 2021](#)), but arguably the most radical and thus most important type of innovation, disruptive innovation, could be elaborated as dependent on EO on the basis of our empirical results, and furthermore the role of digitalization, which is important in this context, could be included.

Particularly in the field of EO, the disposition of entrepreneurial behavior, digitalization as an influencing factor has so far been largely unnoticed, although equally relevant, as initial research results from individual industries (e.g. [Niemand et al., 2020](#) for the financial services industry) show. Our study is one of the first to empirically examine such relationships using a cross-industry sample.

The digitalization strategy can be both perceived as leverage or as a cage for disruptive innovation, depending on the level of firms’ EO. Digitalization strategy is conducive to disruptive innovation when firms have low EO. Conversely, high EO firms must examine whether their digitalization strategy is a hindrance to disruptive innovation. Such firm self-examination is important because the biggest enemy of disruptive innovation can be the firm itself. This is seen in the case of Kodak, which was a highly dominant firm that did not want to cannibalize its own established business model through disruptive innovation, and ended up losing its market position in only several years.

Disruptive innovation, which is lauded as a lodestar, should be promoted more strongly by policymakers, and digitalization should not be overprioritized. A European comparison shows that Italy promotes the spirit of innovation more than digitalization. According to the analysis of this study, this would put Italy on the path to enhancing disruptive innovation. It will not work without courage and openness to new ways: planning certainty versus risk, “inside-the-box” thinking versus a proactive mindset, and routine processes versus innovative processes. Finally, digitalization must be promoted in ways other than

through rigid strategic planning in highly entrepreneurially oriented firms. More flexible, culturally relevant, and learning-related ways of promoting digitalization should be tested inside firms where disruptive innovation is critical for their survival and success.

Our study holds some managerial implications that can enhance managers’ and organizational decision makers understanding in relation to innovation. First, organizations, must maintain focus on EO. To increase the level of disruptive innovation, firms should focus on EO (i.e., by engaging in risk-taking and being proactive and innovative) and not overestimate the importance of an organizational digitalization strategy. This study demonstrates that EO has a strong significant influence on disruptive innovation, and digitalization strategy can actually disadvantage disruptive innovation in firms that are highly entrepreneurial. However, in firms with less EO, a digitalization strategy can support disruptive innovation, but not to the extent that EO does. The idea of digitalization permeates discussion in organizations of all types, levels, sizes, and stages of maturity, which means that it is almost inevitable to be part of the current digital society. However, firms should be aware that the level of deployment of their digitalization strategy should be calibrated depending on both their level of EO and their interest in aiming for disruptive innovation. Second, disruptive innovation requires flexibility, adaptation, and allowing a margin for free-thinking. Indeed, digitalization is boosting both incremental and disruptive innovation in several industries, but focusing too strongly on structuring a digitalization strategy may result in a counterproductive effect on innovation in high EO firms. Therefore, such firms should find alternative ways to boost digitalization without creating a strategic cage that could limit innovation. Some seminal studies have recently suggested that a more relaxed way of promoting digitalization inside firms, such as digital evangelists and other types of digital mentoring, could be very effective and avoid having a digitalization strategy that is overly structured.

Despite its contributions, this study is characterized by some limitations. First, employing self-reported perceptual data based on a single key informant could weaken the internal validity of the study. Substantial precaution was taken to narrow common method bias, but future research should consider sampling multiple respondents for each firm to check for inter-rater validity. Second, the collected response rate of almost 25 %, which should also be considered. In absolute figures, 242 of 1000 firms completed the questionnaire, thus contributing to quantitatively meaningful sample size. Considering these facts in relative terms, 75 % of the firms surveyed did not respond for various reasons. One possible reason could be that perhaps only firms interested or engaged in disruptive innovation responded. However, the comparison between early and late respondents seems to suggest that nonresponse bias should not be an issue. Third, it should be noted that all the firms in our study were located in Italy; therefore, care should be taken when generalizing the results.

This study can also open interesting avenues for future research. The opportunities and strengths of enhancing disruptive innovation through EO should be highlighted in research, and research should also consider ways of circumventing the innovation dilemma. However, it is important that researchers consider the possible risks of strategic planning on disruptive innovation (i.e., through the deployment of digitalization strategy). In addition, research should explore in more detail the other organizational contingencies under which the digitalization strategy is an organizational means to increase efficiency while also limiting innovation. Future research should consider whether return on investment for the digitalization strategy is positive in the long term or whether the digitalization strategy builds a metaphorical cage around the firm where the downsides are only perceived in the long term.

CRedit authorship contribution statement

Sascha Kraus: Writing – review & editing, Writing – original draft, Validation, Investigation, Project administration, Supervision, Writing – review & editing. **Katharina Vonmetz:** Writing – original draft, Formal

analysis, Data curation. **Ludovico Bullini Orlandi**: Writing – original draft, Formal analysis, Data curation. **Alessandro Zardini**: Writing – original draft, Supervision, Project administration, Data curation. **Cecilia Rossignoli**: Writing – review & editing, Writing – original draft, Supervision, Project administration, Conceptualization.

Data availability

The data used in this article will not be available due to privacy considerations.

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Rossignoli has published, among others, on *Journal of Innovation & Knowledge*, *Review of Managerial Science*, *Journal of Business Research*, *European Management Journal*, *Industrial Marketing Management*, *Electronic Markets*, *Journal of Intellectual Capital*. She is member and

co-founder of ItAIS (Italian Chapter of AIS). She served as President of itAIS from 2015 to 2019.