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Digital maturity as startup internationalization process enabler

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Abstract

Purpose – While Industry 4.0 has led many firms to rethink their internationalization strategies and enabled others to expand rapidly across borders, studies on how Industry 4.0 technologies reshape the internationalization process of startups at various stages of maturity remain limited. This study aims to explore how adopting Industry 4.0 technologies influences the internationalization process of startups. Specifically, it investigates how digital maturity and advanced technologies enable startups to enhance their internationalization strategies, scope and speed.

Design/methodology/approach – A multiple-case study methodology was used, gathering data from nine European startups across various industries. In-depth semi-structured interviews were conducted to assess the digital maturity and the deployment of Industry 4.0 technologies in their internationalization efforts. The collected data were analyzed through theoretical coding using Atlas.ti software.

Findings – The findings reveal that adopting advanced technologies, such as artificial intelligence, big data and cloud computing, significantly supports startups in market screening, global collaboration and decision-making during international expansion. Moreover, digital maturity was found to enhance the speed and scope of internationalization, with more digitally mature firms adopting faster and broader global strategies.

Originality/value – This study contributes to the literature by integrating internationalization theories with the digital maturity model, providing practical insights into how Industry 4.0 technologies reshape the internationalization process of startups. It offers a comprehensive framework for understanding how digital maturity impacts strategy, scope and speed in the global expansion of startups. The research bridges a critical gap in understanding the relationship between digitalization and startup internationalization in a rapidly evolving technological landscape.

Keywords Industry 4.0, Advanced technologies, Digitalization, Internationalization, International new ventures, Born-global, Uppsala model, Startup

Paper type Research paper

Introduction

Industry 4.0 (i4.0) has brought significant advancements in cutting-edge technologies, such as big data, artificial intelligence, the Internet of Things (IoT) and cloud computing, which

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have enabled firms to rethink their strategies and explore new markets and ecosystems (Castagnoli *et al.*, 2022). In international business, existing research suggests that i4.0 can be seen as a key factor for companies' rapid and early internationalization (Bhatti *et al.*, 2022; Hannibal, 2020).

While research has explored the role of i4.0 in accelerating internationalization processes for firms, there is limited understanding of how these technologies influence startups, especially at various stages of digital maturity. Specifically, the literature on the internationalization of digital startups remains fragmented, often overlooking the role of digital maturity in shaping strategies, scope and speed of expansion across borders (Bhatti *et al.*, 2022; Castagnoli *et al.*, 2022; Luo and Zahra, 2023; Strange *et al.*, 2022).

Firms exert varying digital maturity levels (Azhari *et al.*, 2014). In the era of i4.0, these varying levels, i.e. the degree of Industry 4.0 adoption and the kind of technologies adopted, should play a crucial role in their internationalization strategy (Castagnoli *et al.*, 2022; Drori *et al.*, 2024). In their extensive literature review, Castagnoli *et al.* (2022) argue that scholars are increasingly directing their attention toward examining the outcomes of i4.0, establishing connections between these two research domains (Castagnoli *et al.*, 2022; Götz, 2020). Nevertheless, because of the emerging nature of the field, the existing literature remains fragmented and incomplete, lacking a comprehensive view of how startups leverage advanced technologies in their internationalization processes. Most existing studies are based on a limited sample or individual case studies addressing specific industries, thus not enabling a generalizable understanding of the interaction (Castagnoli *et al.*, 2022).

The i4.0-triggered digitalization and global digital platforms have ushered in expansion opportunities for startups by amplifying market knowledge and customizing international strategies in terms of accessing global markets (Guo *et al.*, 2023; Hu *et al.*, 2024; Kumar *et al.*, 2024; Troise *et al.*, 2023). The recent works (Caputo *et al.*, 2021; Krings *et al.*, 2021; Troise *et al.*, 2023) explain how digital platforms and social media usage facilitate managing and relationship-building between startups and their customers. The relationship deepens as startup develops and nurtures its strategies and offerings across the globe. The born-global research highlights alliances as the path to early and rapid internationalization (Bhatti *et al.*, 2022; Ma and Wu, 2024; Gabrielsson *et al.*, 2022; Vrontis *et al.*, 2024).

Furthermore, while digital maturity has been discussed as a critical enabler of operational and strategic innovation (Azhari *et al.*, 2014), its role in the internationalization of startups remains under-explored. We argue that digital maturity acts as a key enabler, facilitating startups' ability to leverage advanced technologies to overcome challenges related to market entry, overcome foreign liabilities, assess foreign demand and risk and conduct effective market research (Bertello *et al.*, 2021; Dam *et al.*, 2019; Fish and Ruby, 2009).

Therefore, this study bridges gaps in the aforementioned works and sheds light on the evolving interplay between i4.0-based technologies, digital maturity and internationalization. As startups tend to operate with fewer resources and greater agility, this study provides unique insights from startups into the intersection of digital transformation and global expansion. We contribute to the literature by showing how digital maturity facilitates their internationalization process. Additionally, this study addresses critical gaps in both the international competitive and international organizational research streams, as identified by Castagnoli *et al.* (2022), positioning these areas as key avenues for advancing the understanding of internationalization in the context of Industry 4.0. We aim to contribute by identifying advanced technologies adopted in the startups' internationalization process.

We approach this by combining internationalization theories with the digital maturity model by Azhari *et al.* (2014) to discover in detail how startups leverage such technologies (Luo and Zahra, 2023). Our empirical context is particularly unique and valuable, as it draws

on cases from nine European startups across multiple industries, highlighting the diversity and richness of the data set. By examining startups from several European countries, this study captures cross-country variations in digital maturity and internationalization approaches, providing broader insights into how digital transformation supports international expansion. This multi-country, multi-industry perspective not only strengthens the empirical rigor of the research but also broadens its contribution to international business and digital transformation.

We approach this study by exploring how startups leverage i4.0 technologies in practice, influencing their strategy, scope and speed of the internationalization process. The existing internationalization theories discuss the fundamental concepts of strategy, scope and speed, but they need to identify which role advanced technologies play and how they shape related decisions. Santangelo *et al.* (2024, p. 6), in their editorial, underscore the need to focus on micro foundations and specifically recommend "why and how" questions. The scholars point out that such a perspective "delves more deeply into emergence-enabling processes at the unit level and the firm level. This is because processes need to be tailored to the specific individual heterogeneities that need to be managed." This research examines the influence of advanced technologies on the strategy (in terms of the market entry decision), the scope, the decision of where to expand and the speed of internationalization (analyzed by pace and timing of entry). Using data from nine Europe-based startups, we answer the research question:

RQ1. How does digital maturity facilitate startups' internationalization process?

In answering this question, this research aims to contribute to the existing debate. First, it builds on established internationalization theories and analyzes them in light of the influence of i4.0-enabled technologies on startup expansion. Our endeavor contributes to existing studies by collecting insights on the adoption of i4.0 technologies in the internationalization process of startups, and it goes beyond this by combining internationalization theories with the digital maturity model by Azhari *et al.* (2014). Secondly, it attempts to address a critical research gap identified by Castagnoli *et al.* (2022, p. 586) regarding firms' processes and pace of internationalization, "the degree of Industry 4.0 adoption, the kind of technologies adopted, and the relative performance."

This study adopts a systematic approach to answer this research question comprehensively. It begins by conducting a literature review, analyzing relevant scholarly literature on the internationalization process and i4.0 adoption in startups. Building on the literature review, a theoretical foundation is developed and explained. Subsequently, the methodology is explained, describing the research design and the applied methods. Then, the main findings from the data analysis are presented and discussed. Finally, the study's main results are summarized, highlighting the theoretical contributions and managerial implications, outlining the limitations and identifying possible areas for future research.

Literature review

Theoretical considerations on the internationalization of companies have kept many researchers occupied over recent years. Valuable frameworks such as the Uppsala model, the network model and the discussion on born-globals have emerged to analyze how firms internationalize (Cavusgil and Knight, 2015; Johanson and Mattsson, 1986; Johanson and Vahlne, 1977; Vahlne and Johanson, 2017). The Uppsala model explains internationalization as a stepwise process of expanding into foreign markets (Vahlne and Johanson, 2017). The network model suggests that firms leverage their network relationships to facilitate

international expansion (Hadley and Wilson, 2003; Johanson and Mattsson, 2015; Johanson and Vahlne, 2003).

The concept of born-global, drawing from literature on international new ventures and international entrepreneurship, highlights companies that opt for early and rapid international expansion (Cavusgil and Knight, 2015; Olivia *et al.*, 2022; Oviatt and McDougall, 2005; Oviatt and McDougall, 2018). All three theories show how companies differ in their internationalization and their choices in terms of their strategy, geographic scope and timing of expansion. In light of i4.0, additional research is required to understand how these deviations occur, particularly how startups may leverage advanced technologies in their internationalization processes.

Previous literature within these two streams has focused, among other areas, on the impact of i4.0 on the internationalization process and has begun to challenge the Uppsala model by translating it to today's digital context and questioning its validity (Bhatti *et al.*, 2022; Coviello *et al.*, 2017). They concluded that while the Uppsala model seems to be still valid, international startups today can learn and expand much faster and more efficiently (Bhatti *et al.*, 2022; Cheng *et al.*, 2020). Coviello *et al.* (2017) further note that in the Uppsala model, it needs to be clarified how the rapidly changing technological advances are considered. In addition, they say that today's companies are more focused on exchanges rather than production, as was assumed by Vahlne and Johanson (2017), and international exchanges are drastically driven by technologies, even more than Johanson and Vahlne's network perspective suggests (Coviello *et al.*, 2017).

Furthermore, i4.0 has spurred the discussion of born-globals, emphasizing technology as a driving force for early and rapid internationalization (Monaghan *et al.*, 2020; Oviatt and McDougall, 2005). i4.0 has transformed international information exchange, facilitated knowledge acquisition in foreign markets, improved international operational efficiency and performance and enabled born-global startups to overcome their liability of smallness (Coviello and Cox, 2006; Lu *et al.*, 2010; Raymond *et al.*, 2015). Castagnoli *et al.* (2022) observed that there needs to be more literature regarding the process and pace of internationalization and, in particular, in the theoretical debate about which models of internationalization will prevail in the era of i4.0. Specifically, they highlight the need for studies that examine whether new firms increasingly lean toward rapid born-global internationalization or favor a more gradual Uppsala internationalization process.

Internationalization process of startups

Internationalization is a critical strategy for startups seeking to expand their reach, gain a competitive edge and achieve long-term growth (Olivia *et al.*, 2022). Our understanding of startup internationalization builds upon existing internationalization theories. Notably, three aspects of internationalization are discussed repeatedly in the literature. It examines the firm's strategy in selecting the optimal market entry mode, discusses the decision of geographic scope and, finally, the timing of internationalization, considering the variations between rapid and gradual internationalization approaches.

A well-known theory, the Uppsala model, shows how companies intensify their activities in foreign markets by emphasizing internationalization as a gradual process (Vahlne and Johanson, 2017). According to Vahlne and Johanson (2017), companies initially enter foreign markets relatively close to their domestic markets, gradually expanding to more distant markets as they gain experience. They typically begin by exporting their products and then establish their own operations after several years of exporting. This indicates a strategy of increasing commitment to foreign markets over time. Johanson and Wiedersheim-Paul (1975) categorized these entry strategies into four types: sporadic export activities, export via

independent representatives, establishing a foreign sales subsidiary and establishing foreign manufacturing units.

Furthermore, the Uppsala model suggests that firms start their international expansion in psychically closer markets with low uncertainty (Johanson and Wiedersheim-Paul, 1975). In summary, the Uppsala model proposes a four-stage internationalization strategy, emphasizing companies' gradual, slower approach. This includes building a domestic base, acquiring market knowledge and limiting the initial scope to markets with lower uncertainty. In contrast to the Uppsala model, literature explores the phenomenon of born-globals. While often referred to by different names, research on "born-globals," "international new ventures" or "international entrepreneurship" addresses the phenomenon of companies that rapidly globalize from their inception without prior extensive domestic knowledge acquisition, possess a global vision and aim to exploit global opportunities, seeking a competitive advantage by operating in several countries (Cavusgil and Knight, 2015; Olivia *et al.*, 2022; Oviatt and McDougall, 2005; Oviatt and McDougall, 2018).

The internationalization strategy of born-global firms differs from traditional companies, which often follow the Uppsala model (Olivia *et al.*, 2022). In particular, a born-global's entry mode choice is critical to their international performance. Their decision is underlined by the dilemma of balancing between their lack of resources because of their smaller size, which advocates choosing a low-commitment entry mode, and their reliance on their expertise and skills, which are at risk of dissemination and therefore support a high-commitment entry mode (Efrat and Shoham, 2013). However, some authors say born-globals are more motivated to choose a low-commitment entry mode (Freeman *et al.*, 2006; Gabrielsson and Kirpalani, 2004). Moreover, born-globals tend to be highly innovative, focused on technologies and use flexible business structures that allow them to adapt quickly in an international environment and be easily scalable from the beginning (Coviello *et al.*, 2017). This is driving both the speed and scope of their internationalization, enabling them to expand quickly and simultaneously into numerous near and distant markets (Bürgel and Murray, 2000; Monaghan *et al.*, 2020).

A third theory discussed in the literature is the network model. According to the network theory, firms can leverage their relationships with suppliers, customers, competitors and other stakeholders in their network to expand their international reach and access to new markets (Hadley and Wilson, 2003; Johanson and Mattsson, 2015; Johanson and Vahlne, 2003). Regarding firms' internationalization strategy, the network model suggests that international expansion is the result of interaction with firms in the business network of the host country, and thus entry modes may vary. The authors Johanson and Mattsson (1988) discuss four cases of internationalization. Early starters and lone international firms are active in networks without important international relationships. In contrast, among other companies, late-starters and international companies can exploit their relationships to enter foreign markets through strategic alliances (Johanson and Mattsson, 1988). While it is argued that a company is initially tied into a primarily domestic network, relationships can be used to remove market barriers and expand into far-distant markets (Johanson and Vahlne, 2003). This suggests that the geographical scope of expansion depends on the quality of relationships with a company's foreign networks (Johanson and Vahlne, 2003). When successfully interacting with a network, the internationalization of companies progresses more quickly, as the exchange of knowledge with partners in this network creates a competitive advantage, increasing the speed of internationalization (Johanson and Mattsson, 2015). Having discussed how the internationalization process varies across firms, it is now interesting to discuss the impact of i4.0 on startups and the relationship between the adoption of i4.0 and internationalization.

In summary, while all three models offer valuable lenses to understand internationalization, they differ across several key dimensions. The Uppsala model emphasizes a gradual process, where firms incrementally commit to foreign markets, typically starting with psychically close countries and low-risk entry modes such as exporting. In contrast, the born-global model focuses on speed and scope, with firms expanding rapidly, often within the first three years, into both nearby and distant markets, usually using high-commitment digital channels such as e-commerce, SaaS platforms, or international offices. The network model, meanwhile, explains internationalization as an outcome of leveraging preexisting or newly built relationships, where strategy and entry modes are shaped by access to partners, rather than experience or digital readiness. In this study, we use the distinctions speed, scope, entry mode and decision rationale as analytical anchors to assess how startups align with or deviate from each framework, especially in relation to their digital maturity.

Industry 4.0 adoption in startups and their level of digital maturity

One of the central concepts of this study addresses the adoption of i4.0 technologies by startups. In the past decade, high-tech startups have gained increasing attention from scholars (Bala-Subrahmanya, 2022). Typically, these startups adopt advanced technologies grouped under the term "i4.0," which refers to the fourth industrial revolution (Kagermann *et al.*, 2011). i4.0 encompasses different advanced technologies that are shaping our business environment today. To name a few, big data, IoTs, cloud computing, augmented reality, advanced ICT, cybersecurity, artificial intelligence, blockchains, 3D printing, robotics and many more.

Big data forms the core of i4.0, which feeds all these technologies. Artificial intelligence, for instance, uses big data for optimized production and improved decision-making (Hervé *et al.*, 2020). The use of artificial intelligence is still in its early stages for many startups. However, it offers a variety of tools such as chatbots, translation software, autonomous driving, predictive analytics and image classification (Benabed *et al.*, 2022). Cloud computing is an essential capability for working with big data, as it provides a network of computing platforms with on-demand and easily accessible services for data storage (Wang *et al.*, 2008). The IoT involves the integration of sensors that can collect and process data into smart products that can thus interact with each other (Rüßmann *et al.*, 2015). Aspelund and Moen (2004) highlight the role of advanced ICT adoption in global collaboration in high-tech firms. In general, SMEs adopting i4.0 technologies benefit from higher manufacturing quality, lower operating costs, operational efficiency, increased flexibility and competitive advantage (Masood and Sonntag, 2020). There are too many advanced technologies to discuss in detail (Figure 1), and many impacts are still under-researched. What is certain, however, is that i4.0 technologies will reshape traditional business, management and internationalization processes as we know them.

Depending on the industry, business model and strategy, startups are, to varying degrees, ready to adopt and use advanced technologies. To measure the level of adoption of i4.0 in startups, it is useful to introduce the framework of Azhari *et al.* (2014), which discusses the digital maturity of companies. We acknowledge that there are numerous digital maturity models. However, in this study, we have used the Azhari *et al.* (2014) framework to assess the level of digitalization and adoption of i4.0 technologies of the startups studied because of its multi-dimensional structure, which aligns well with the diverse challenges faced by internationalizing startups. Unlike models such as Westerman *et al.* (2014), which provide broad categorizations, or Schumacher *et al.* (2016), which is tailored to manufacturing, Azhari *et al.* (2014) comprehensively assess digital maturity across strategy, technology, leadership and organizational culture – critical factors for firms navigating the complexities of global expansion. Alternative models, including Kane *et al.* (2015) and Gill and Van Bosheveldt (2020), which

Technology	Key Functions	Source
Big Data Analytics	Data mining, Predictive analytics	Bertello *et al*., 2021, Dam et al., 2019
Cloud Computing	Data storage, Data Sharing	Wang *et al*., 2008; Ferri *et al*., 2020; Xue & Xin, 2016
Artificial Intelligence	Decision-making, Predictive analytics	Hervé *et al*., 2020; Benabed *et al*., 2022; Fish & Ruby, 2009;
Internet of Things	Smart products, Smart processes	Rüßmann *et al*., 2015
Integration	Linking systems	Shahin *et al*., 2020
Additive Manufacturing	3D-printing, Customization	Hervé *et al*., 2020
Augmented & Virtual Reality	Simulation, Customer experience	Hassouneh & Brengman, 2011
Cybersecurity	Privacy security and protection	Westerlund, M., (2020).
Advanced Robotics	Automation, Economies of Scale	Bergamaschi *et al*., 2021
Blockchains	Recording transactions, Security	Hooper & Holtbrügge, 2020
Advanced ICT	Remote collaboration, Virtual structure	Aspelund & Moen, 2004; Ledro *et al*., 2022; Westerlund, M., 2020

Figure 1. Various Industry 4.0 technologies
Source: Authors' compilation

emphasize cultural and capability-driven perspectives on digital maturity, are to a larger extent accounted for in the Azhari *et al.* (2014) model.

The model comprises eight stages across five different levels of maturity (Figure 2). The dimension "strategy" measures the maturity level of the digital strategy. In addition, it captures how and with what frequency new experiences lead to the adoption of digital strategies. "Leadership" examines the management team's role in implementing the strategy. It analyses the leadership culture as well as management methods. "Products" discusses the progress of a company's digital transformation at the product and service level, including product innovation and the degree of innovation in digital value creation. "Operations"

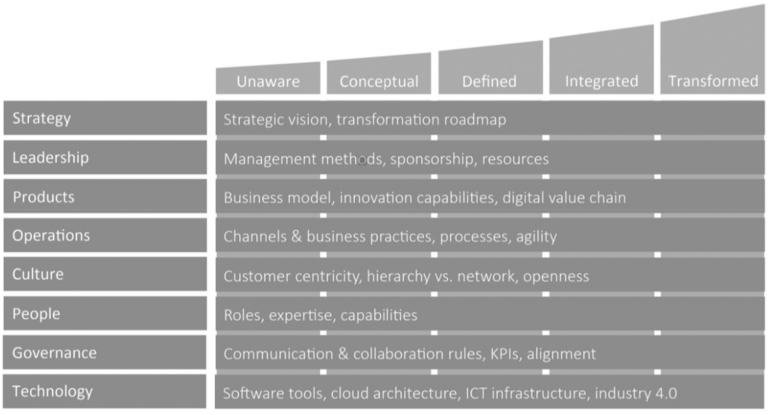

Figure 2. Digital maturity model
Source: Azhari *et al.* (2014)

assesses the current utilization of digital channels and digital activities in operational processes. The "culture" dimension is used to measure the corporate culture, as culture determines decision-making processes and can act as a brake on innovation (Azhari *et al.*, 2014). "People" looks at the extent to which the company has already acquired digital expertise, the right human resources and whether a permanent learning process has been institutionalized. "Governance" assesses how effectively the digital strategy has been implemented and, finally, "technology" looks at the technologies acquired, the ICT infrastructure and the cloud architecture of a company.

Considering these dimensions, a company can be classified into one of the five levels of digital maturity. The first stage, "unaware," is characterized by the need for a coherent digital strategy, with digital transformation being discussed occasionally but not at the management level and digitalization not embedded in the company's product or services. Secondly, "conceptual" considers companies with the first digital projects and offerings. However, a cross-divisional strategy is not yet apparent, and management commitment regarding digital transformation is rather weak. Thirdly, "defined" companies are those that develop a more company-wide, initial basic awareness of the topic and competence building is actively driven by management. The fourth maturity level, "integrated," describes companies where digital strategies are developed and implemented across functions, and a clear management commitment to transformation can be observed. Furthermore, digitalization reaches the company's core processes, products and services. Finally, the fifth stage, "transformed," refers to companies characterized by integrating digitalization into core processes, products and services; new approaches to the business and operating model; continuous innovation; and a clear culture to support digitalization.

Numerous companies do not have the necessary know-how to integrate i4.0 technologies into their existing business processes. The level of digital maturity is closely related to the readiness to adopt Industry 4.0 technologies (Sony and Naik, 2020). This suggests that companies with a higher level of digital maturity are more inclined to adopt i4.0 technologies, enabling them to leverage more technologies during their internationalization process. Consequently, this study assesses digital maturity as an indicator of the likelihood of adopting i4.0 technologies in internationalization.

Influence of Industry 4.0 adoption of internationalization processes

In the past decade, a new research area emerged examining the impact of Industry 4.0 on the internationalization process. As a result of this, some scholars began to question existing internationalization theories. In their critique of the Uppsala model, Coviello *et al.* (2017) highlighted the absence of digital context in their internationalization process. In response, Bhatti *et al.* (2022) recognize new technologies and highlight that in light of i4.0, the very manner in which firms organize themselves and the environment they operate in is being disrupted by advanced technologies. i4.0 strongly influences the processes of learning, knowledge development and engagement in international activities. It reveals previously unimagined opportunities and transforms business models by enabling greater connectivity between suppliers, customers and other stakeholders (Bhatti *et al.*, 2022). Their study is of particular interest to this research, as it raises the question of whether the Uppsala model still holds as more and more startups pursue their internationalization early and advanced technologies may influence the scope, speed and entry mode of their foreign expansion. Bhatti *et al.* (2022) conclude that they are convinced that the mechanisms of the revised Uppsala model still persist, but their study only provides data based on a single case study, highlighting the need for additional evidence.

Coviello *et al.* (2017) also highlight a limitation of the Uppsala model, stating that it does not adequately address the implications of rapid technological advancements. Furthermore,

Coviello *et al.* (2017) argue that today's companies have shifted their focus from production to exchange, which differs from the assumption that Johanson and Vahlne make in the Uppsala model of internationalization. They highlight that advanced technologies significantly influence international exchange (Coviello *et al.*, 2017). Exchanges and business networks play an increasingly important role, even beyond what Johanson and Vahlne's network perspective suggests.

In addition, i4.0 has spurred the discussion of born-globals, which emphasizes technology as a driving force for early and rapid internationalization (Monaghan *et al.*, 2020; Oviatt and McDougall, 2005). We can observe how born-digital firms that rely on the internet for their operations successfully leverage advanced technologies in internationalization (Monaghan *et al.*, 2020). These include internet platforms, fintech enterprises, e-commerce ventures or Software-as-a-Service (SaaS) providers. But also, companies with a physical market offering, such as Peloton, benefit from technologies. These digital born-globals suggest that, unlike the Uppsala model, early internationalization can occur at a rapid pace and large scope (Domurath *et al.*, 2020). Their ability to generate data, use advanced technologies, learn quickly about foreign markets, test new ideas with users and adapt their market offerings has led them to enter markets in new ways (Monaghan *et al.*, 2020). For instance, cloud computing infrastructures expand the boundaries of companies by enabling fully virtual enterprises (Ahokangas *et al.*, 2014).

The current literature addresses different application scenarios of advanced technologies in internationalization. However, many existing studies tend to focus on single technologies, resulting in a fragmented and disorganized perspective. Big data capabilities positively impact internationalization activities in terms of speed, scope and finding a successful entry mode (Bertello *et al.*, 2021). In particular, firms may use big data to address challenges such as liability of smallness and foreignness, scan international markets, assess country risks and find suitable partners (Bertello *et al.*, 2021). Moreover, big data capabilities facilitate the adoption of exporting as a viable market entry strategy (Naglic *et al.*, 2020). Cloud computing can bring about organizational and economic improvements and remove various barriers to market entry (Xue and Xin, 2016). The benefits of cloud computing include increased global collaboration, lower opportunity costs, scalability and access to international venture capital and the global market (Ferri *et al.*, 2020). Firms for market screening and risk assessment can leverage artificial intelligence.

Fish and Ruby (2009) proposed a cost-effective artificial intelligence approach that SMEs could use in their international market screening efforts to improve decision-making and prediction analytics. Furthermore, firms can leverage artificial intelligence in customer relationship management by using AI-powered chatbots or translation services (Benabed *et al.*, 2022; Ledro *et al.*, 2022). Finally, adopting advanced ICT technologies and using key information systems such as CRM and ERP software are driving the internationalization of firms (Westerlund, 2020). Advanced ICT facilitates the process of identifying foreign markets, increases international sales and is an effective tool for implementing management's vision in international markets (Aspelund and Moen, 2004).

By analyzing how startups leverage i4.0 technologies, this study aims to examine the impact of such technologies on speed, scope and strategy. The objective is to gain insights into the utilization of i4.0 technologies by startups and understand their implications for internationalization theories.

This conceptual model (Figure 3) provides an overview of the different constructs discussed in this study and how they relate to each other. It illustrates the level of i4.0 adoption in startups, measured by five levels of digital maturity (see Azhari *et al.*, 2014). It shows how these levels of digital maturity can lead to adopting and exploiting several technologies in the

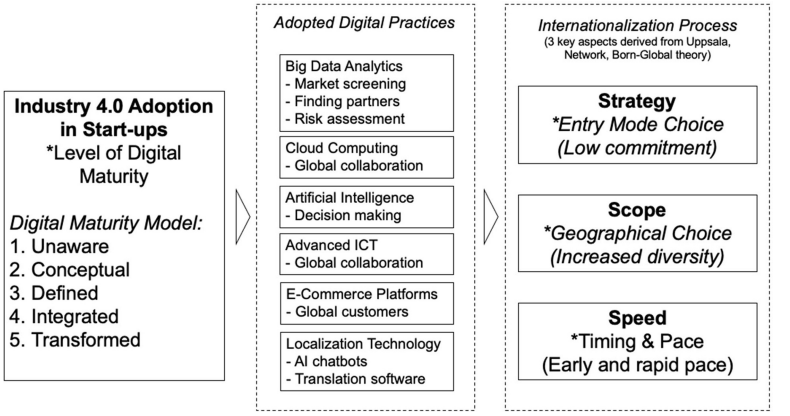

Figure 3. Conceptual model
Source: Authors' compilation

internationalization process (adopted digital practices). Finally, it describes how these technologies impact the strategy, scope and speed of internationalization, three concepts derived from the Uppsala model, the network model and the born-global theory. The existing literature suggests that startups often opt for a low-commitment entry option, have a wider geographic scope and start their internationalization early and at a fast pace. The central argument of our conceptual model is that a startup firm's digital maturity level impacts the adopted digital practices and thus predicts the strategy, scope and speed of internationalization.

Methodology

Research design

This study uses a multiple-case study approach, a method particularly suited for exploratory research in evolving and complex fields. Welch *et al.* (2011) identify four qualitative methods for theory building, with this study adopting the natural experiment method. This approach explains cause–effect linkages and generalizes insights toward theory development (Welch *et al.*, 2011). Furthermore, Yin (2009), a key advocate of this method, emphasizes its relevance for case studies that aim to explain "how" phenomena occur, making it well-suited for this research. The study investigates the cause-effect relationship between the adoption of Industry 4.0 (i4.0) technologies and their utilization for successful internationalization. To explore this dynamic, a qualitative research design incorporating semi-structured interviews is used. This method was chosen because it enables an in-depth examination of how advanced technologies are leveraged in the internationalization process. Unlike quantitative approaches, qualitative methods do not constrain results to predefined variables, allowing researchers to use exploratory and probing questions to capture nuanced insights and emerging themes.

Furthermore, research on digital maturity in startup internationalization is still developing (Castagnoli *et al.*, 2022; Luo and Zahra, 2023), necessitating exploratory research methods to understand how and why digital technologies influence firm expansion strategies. A quantitative approach would limit the ability to capture in-depth mechanisms and contextual factors. In international business research, qualitative case studies are considered essential for exploring new constructs and integrating complex phenomena, such as Industry 4.0

technologies within traditional internationalization models (Coviello and Jones, 2004). Yin (2018) further supports case study research for analyzing contemporary, complex and context-dependent topics, particularly when the boundaries between the phenomenon and its context are not clearly defined.

Welch *et al.* (2011) suggest that multiple-case studies allow for robust theory development, particularly in areas where quantitative generalization is premature because of evolving theoretical constructs. Given that digital maturity's role in internationalization is still being conceptualized, the study seeks to develop a theoretical foundation rather than statistical generalizability. A multiple-case study approach is particularly valuable for understanding real-world applications, firm strategies and decision-making processes – areas that a quantitative survey would struggle to fully capture.

For these reasons, a multiple-case study research approach was chosen, as it provides rich theoretical insights, particularly when analyzing decision-making processes (Eisenhardt, 1989); uncovers contextual drivers behind firm behaviors that cannot be easily quantified (Ghauri and Grønhaug, 2010); and recognizes that internationalization is an incremental, evolving process, making qualitative approaches well suited for examining how firms adapt their strategies over time (Johanson and Vahlne, 2009). By using multiple case studies, this research ensures greater analytical depth, allowing for comparative insights across firms with different levels of digital maturity.

As this is research within the positivism paradigm, the primary aim is to test the applicability of a theory to a population, which in turn means for this study whether digitalization supports the internationalization of startups (Healy and Perry, 2000). To ensure the highest reliability, the research process is described in as much detail as possible; the questions have been developed after a close examination of the existing literature and have been created to provide this study with the most relevant data possible. The theoretical coding follows the same, and all interviews are transcribed word-for-word (Golafshani, 2003). To ensure validity, probing questions were asked to determine whether the respondent understood the question correctly. Finally, to guarantee internal and external validity despite the relatively small sample, the results were shared with the participants, and they were given the opportunity to share additional feedback. Furthermore, the study was designed to be transparent at every step.

Data collection

The study data collection was done via purposeful sampling, emphasizing the importance of selecting cases based on theoretical relevance while also accounting for unique contextual factors (Welch *et al.*, 2011; Poulis *et al.*, 2013). This was done through reaching out mostly to warm leads and some cold connections via LinkedIn. As we aimed for diversity of firms in an attempt to incorporate variations in context (Poulis *et al.*, 2013), we focused firms on the broader European startups to avoid country bias. After contacting these firms, nine European startups indicated interest in participating in the interview. These startups are from different countries and industries. All interviews were conducted in spring 2023.

In this multiple-case study, each interview had a length of around 30 min. The interviews were conducted online, and a request to record the interview was made at the beginning. This enabled the transcription and translation of the interviews, which was necessary for the further analysis of the collected data. The study respondent detail is described below.

Each interview was divided into two parts. First, acquiring information to gauge the digital maturity and adoption of i4.0 is an important construct of this study. Second, information was collected for the construct of the internationalization process, which is divided into the strategy of the startup in terms of choosing the appropriate form of market

entry, the decision on where to expand in terms of geographical scope and, finally, the timing and speed of internationalization. Each time, follow-up questions were raised to identify how the startups are leveraging advanced technologies for each subconstruct of the internationalization process. The information obtained through these follow-up questions formed the third construct, namely, the adopted *i*4.0 technologies and digital practices in the internationalization process of startups.

Although the number of interviews conducted was limited, Guest *et al.* (2006) argue that saturation can often be achieved with a smaller sample size when interviews are well focused and yield rich, in-depth data. This study reached theoretical saturation after nine interviews, as the semi-structured format enabled participants to explore the subject matter in depth. The data produced became repetitive, with no new themes or insights emerging, indicating that saturation had been achieved. The consistency in participant responses further supported the conclusion that theoretical saturation had been reached.

Data analysis

The data was analyzed using theoretical coding with the Atlas.ti software. Specifically, theoretical coding refers to the process of deriving theory from data with methods such as open coding, axial coding and selective coding (Strauss and Corbin, 1998). At first, open coding was conducted in Atlas.ti and key concepts were identified in the data. The open codes gave a first impression of the digital and international operations as well as the technologies involved. The second step, axial coding, involved categorizing these concepts based on their association with the relevant constructs of this study: digital maturity, internationalization process, technologies used in the internationalization process and an additional sub-construct of practical tools and software.

Finally, the previously found categories and open concepts were further organized in the third step, selective coding, where the decision was made against typical network trees in Atlas.ti and in favor of well-structured tables. The advantage of using tables was the effective organization of the data, which allowed for clear visibility of the relationships between the different constructs. The outcome of this process and the tables containing information on all three steps can be found in the following section. These include the main findings, the digital maturity levels of the startups, the findings on the varying internationalization processes and, finally, an additional table with deeper insights into practical tools and software deployed by startups during the internationalization process.

Results and interpretation

Digital maturity

In this study, the digital maturity model of Azahri *et al.* (2014) was used to assess the level of digitalization and adoption of i4.0 technologies of the startups studied. Of the nine startups examined, in Table 1, four fell into the highest category, "transformed." A digital service or product offering, digitalized core processes and operations, a clear digital strategy and continuous innovation, and a widespread digital culture throughout the company characterize all four. All four can be considered "born digitals," as they rely heavily on technology and the internet and have been highly digital since their inception (Monaghan *et al.*, 2020).

Two companies fell into the "defined" category, as they had a digital service offering and digitally transformed processes but were found to need a clear digital strategy and had weaker digital awareness. Three companies were classified as "conceptual," with two being described as "early conceptual" because of their weaker commitment to digital innovation. All three had an analog offering, increasingly digital processes with early digital innovation, experimentation with new technologies and, to some extent, awareness of the digital age.

Table 1. Interviews – summary of digital maturity

	Industry	Sector	Digital maturity	Key characteristics
1	Food	Plant-based food	Conceptual	- analogue offering - increasingly digital processes - digital innovation and experimenting with technologies - encouraged digital awareness
2	Venture capital	Financial services	Early conceptual	- analogue offering - increasingly virtual processes - significance of analogue processes, weak innovation - digital awareness
3	Technology	Software development	Transformed	- digital offering - digital core processes - digital innovation and strategy - digital culture
4	Transportation	Autonomous driving	Transformed	- digital offering - digital core processes - digital innovation and strategy - digital culture
5	Finance	Cryptocurrency trading	Transformed	- digital offering - digital core processes - digital innovation and strategy - digital culture
6	Advertising	Marketing services	Defined	- digital offering - digitally transformed processes - encouraged digital innovation, lack of strategy - company-wide and encouraged digital awareness
7	Environment technology	Sustainable technology	Early conceptual	- analogue offering - digital transformation of processes - weaker digital innovation, weaker commitment - digital awareness
8	Social media	Community networking	Transformed	- digital offering - digital core processes - digital innovation and strategy - digital culture
9	Technology	IT consulting	Defined	- analogue + digital offering - digitally transformed processes - emerging digital strategy - company-wide and encouraged digital awareness

Source(s): Authors' compilation

Interestingly, none of the startups fell into the "unaware" category, which is plausible as startups need to be innovative and respond to the latest trends to receive sufficient funding.

Internationalization process of startups

The second construct under consideration was the internationalization process of startups, which was divided into three sub-constructs: scope, strategy and speed. The study attempts to find a theoretical approach that most closely explains and resembles the internationalization process of the companies under study. The main results (internationalization process theory,

scope, strategy and speed) can be found in Table 4. To examine the internationalization process from a theoretical point of view, we categorized firms into three theoretical models: the Uppsala model, the network model and the born-global approach. Given the increasing role of digital technologies and network effects in international business, a structured classification framework is necessary to ensure clarity in firm categorization. We used three key criteria as shown in Table 2: speed of internationalization, entry mode and expansion drivers (Johanson and Vahlne, 1977, 2009; Johanson and Mattsson, 1988; Oviatt and McDougall, 1994, 2005).

For firms exhibiting characteristics of multiple models, we assigned both models explicitly, reflecting their combination of gradual knowledge-based learning with network-based expansion or rapid internationalization with selective local market adaptation. The 2009 revision of the Uppsala model (Johanson and Vahlne, 2009) integrates network relationships into the internationalization process. We acknowledge that this presents a challenge in distinguishing between the Uppsala and network models. To address this, firms were classified under the Uppsala model when their expansion was driven primarily by incremental learning and risk reduction. Firms were classified under the network model when they expanded based on preexisting business relationships, rather than stepwise learning. If firms combined gradual market learning with strong network reliance, they were categorized as Uppsala–network hybrids. Table 3 shows the internationalization process theory mapping, showing key traits of the theoretical rationale and explicit categorization of how each firm fits or does not fit into each framework.

Four of the nine companies studied have a born-global strategy, with one company deviating a little and exhibiting characteristics of the Uppsala model. The first three born-globals offer a global scope, while the fourth company offers a SaaS that could theoretically be global. However, the company's strategy limits the scope to specific target markets to avoid losing confidential information and firm-specific advantages. What underlines this strategy is that despite a digital offering, this company decides to expand internationally by setting up greenfield operations, limiting the loss of firm-specific advantages (Verbeke, 2013). The other three born-globals enter the markets virtually via an internet-based platform. Their internationalization speed was rapid from inception.

Two startups follow the Uppsala model in their internationalization process. In terms of scope and speed, they expanded gradually into countries with low psychic distance in the first five years after their establishment. As a strategy, they chose a low-commitment export mode, either B2C or B2B. Four companies follow a similar process to the network model. For three of them, the main strategy is to build a global network in which strong partnerships play an essential role. For the fourth company, foreign partners were the main reason to enter psychically distant countries that would never be up for discussion without the partner. Their expansion occurred gradually within the first five years of operations. An exception is one firm that has not actively internationalized in the first five years because of a product and demand testing phase but rapidly internationalized globally after that.

Table 2 shows that some companies follow a mixture of two approaches. It is also much more likely that internationalization happens by chance. Especially in the case of startups, internationalization sometimes seems less planned and more random.

Adopted technologies and digital practices in the internationalization process

The third construct studied was the adopted technologies and digital practices in the internationalization process of startups. It is the key construct of this research as it provides the most important insights into how the adoption of i4.0 can support the internationalization process of startups. The main results can be found in Tables 4 and 5. All of the startups have used technologies to some degree in their international expansion process, with more

Table 2. Interviews – summary of internationalization process

	Industry sector	Internationalization process (theoretical view)	Scope[1]	Speed	Strategy	Motive and decision explanation
1	Plant-based food	Uppsala and network model	*NL*, DE (in process: UK, JP, DK)	4 years after inception, gradual expansion	Export to distributor (B2B)	Market-seeking; proximity, company history, foreign partners and contacts
2	Financial services	Network model	UK, USA, Europe	One year after inception, gradual expansion	Creation of local network, US office	Market-seeking; access to the right talent pool and networks
3	Software development	Born-global	Worldwide, target markets and foreign offices (*AT*, DE, ES, BiH)	From inception, rapid expansion	Worldwide accessible platform	Market-seeking, HR seeking; foreign offices because of the need for local presence, company history, foreign employees
4	Autonomous driving	Born-global, Uppsala model	*SE*, Europe, North America, ASIA-Pacific	Two years after inception, rapid expansion	Greenfield, foreign partner for non-core activities	Market-seeking; relatively culture-independent allows for rapid expansion
5	Cryptocurrency trading	Born-global	Unregulated[2]: Worldwide *Regulated: AT*, DE, (in process: USA)	*Unregulated*: from inception, rapid *Regulated*: 2,5 years after inception, gradual	Unregulated: Worldwide platform *Regulated:* Virtual company in the host country	Market-seeking Acquiring legal licenses for financial services; cryptocurrencies are by nature an international product

(*continued*)

Table 2. Continued

	Industry sector	Internationalization process (theoretical view)	Scope[1]	Speed	Strategy	Motive and decision explanation
6	Marketing services	Network model	Worldwide, internal publishing platforms DACH, North America	Experimenting and test phase for five years, and from this on, rapid expansion	Creation of a global network	Market-seeking; building connections with publishers worldwide
7	Sustainable technology	Uppsala model	GER, EU-wide export (focus on AT)	Five years after inception, gradual expansion	Export to customer (B2C)	Market-seeking; admin. and language similarities
8	Community networking	Born-global	Worldwide	From inception two years after inception, first active expansion	Entry through app store and play store, country managers	Market-seeking; random internationalization, scaling through network effect, translation in target markets
9	IT consulting	Network model	Europe-wide customers; offices in *AT*, DE, IL	Two years after inception, gradual expansion	Past: entry through local offices; present: virtual entry, building of network "hubs"	Market-seeking; building European digital innovation hubs, company history

Note(s): [1]First country abbreviation refers to the home country location; [2]distinction between unregulated product and regulated product
Source(s): Authors' compilation

Table 3. Construct for categorization of internationalization process models of firms

Constructs	Descriptions
Uppsala model	Firms followed a gradual internationalization process, characterized by incremental learning, expansion into physically close markets and risk-averse strategies Market entry was primarily through exporting or low-commitment modes such as partnerships Expansion decisions were based on accumulated market knowledge and uncertainty reduction
Network model	Firms expanded primarily through existing business relationships, partnerships and strategic alliances, rather than incremental learning Internationalization decisions were based on network ties rather than market experience Market entry modes included creating international partnerships or setting up local offices through industry contacts
Born-Global model	Firms internationalized rapidly from inception, often expanding within their first few years Digital platforms and Industry 4.0 (i4.0) technologies played a significant role in enabling fast global market entry Market entry was characterized by high commitment modes, such as direct international sales, e-commerce or foreign offices

Source(s): Authors' compilation

digitally mature companies deploying more advanced technologies. Six of the startups have adopted artificial intelligence in their go-to-market process to conduct market screening. It is also leveraged to analyze data, discover trends and gain a general overview of a foreign market.

In addition, artificial intelligence played a role in localization efforts by supporting the translation of services into foreign languages and leveraging customer service chatbots. Only one of the companies has developed its own AI and big data-based market screening software to perform market analyses through detailed Pestel analyses. Unfortunately, gaining further insights into this software was impossible because of confidentiality reasons. Most of the startups studied used AI through OpenAI's software (see Table 5) and are still in the early stages of exploring the full potential of AI in their internationalization process. All startups have adopted cloud computing software and cloud infrastructures that are closely related to and often interact with AI and big data. Many of them use highly automated, cloud-based platforms such as customer relationship (CRM), enterprise resource planning (ERP), go-to-market (GTM) and project management tools to plan internationalization, facilitate decision-making by analyzing company data and simplify global collaboration with partners and, for example, distributors. In addition, cloud computing supports international and secure data exchange both internally and externally.

Furthermore, this sample highlights the trend toward virtual business operations, with all startups using advanced information and communication technology (ICT). Virtual meetings and even public virtual conferences to network and find potential partners have transformed business processes and significantly increased the efficiency of global collaboration. Global transaction processes have been streamlined, especially in combination with advanced tools such as AI-assisted meeting transcription or simply digital signatures (Interviews 1 and 2). In addition, simulation plays a role in internationalization by testing different scenarios in foreign markets during market entry (Interview 8). Finally, e-commerce, either in-house or outsourced, and digital marketing through paid ads, social media or automated email

Table 4. Interviews – practical details on digital tools for managers

	Industry sector	Digital maturity	Adopted technologies in internationalization	Key tools and software
1	Plant-based food	Conceptual	(1) Artificial intelligence	(1) OpenAi, otter.ai
			(2) (Advanced) ICT	(2) Slack, G suite
			(3) e-Commerce	(3) QSTA, AH, crisp, TooGoodToGo
			(4) Cloud computing	(4) G suite, share; trello, miro (projectm.), hubspot, bowimi (CRM), exact (ERP)
2	Financial services	Early conceptual	(1) (Advanced) ICT	(1) Zoom, microsoft teams, LinkedIn sales navigator
			(2) Cloud computing	(2) iDeals, ShareVault, firmex
			(3) Big data analytics	(3) BCIQ analytics
			(4) Digital signatures	(4) DocuSign
3	Software development	Transformed	(1) Artificial intelligence	(1) Apollo.io
			(2) (Advanced) ICT	(2) Slack, G suite
			(3) Cloud computing	(3) Hubspot (CRM)
5	Cryptocurrency trading	Transformed	(1) Artificial intelligence	(1) OpenAi: Chatgpt, midjourney
			(2) (Advanced) ICT	(2) Slack, calendly, figma
			(3) Digital marketing	(3) MixPanel
			(4) Cloud computing	(4) AWS, GitHub
6	Marketing services	Defined	(1) Digital marketing	(1) Trackier
			(2) (Advanced) ICT	(2) Slack, G suite, figma, LinkedIn
			(3) Cloud computing	(3) Asana (ProjectM.), ZenDesk (CRM), AdobeCloud
7	Sustainable technology	Early conceptual	(1) (Advanced) ICT	(1) Slack, microsoft teams
			(2) e-Commerce	(2) Shopify, amazon
			(3) Digital marketing	(3) Klaviyo
			(4) Cloud computing	(4) DreamRobot (ERP), FlyCloud

(*continued*)

Table 4. Continued

	Industry sector	Digital maturity	Adopted technologies in internationalization	Key tools and software
8	Community networking	Transformed	(1) Big data analytics (2) (Advanced) ICT (3) Cloud computing	(1) Smartlook analytics (2) Slack, G suit, figma (3) Notion, personio, letters (projectm.), salesforce (crm)
9	IT consulting	Defined	(1) Artificial intelligence (2) (Advanced) ICT (3) Cloud computing	(1) OpenAi (2) Microsoft teams, LinkedIn (3) Demandbase (GoToMarket)

Source(s): Authors' compilation

Table 5. Interviews – summary of key findings

	Industry sector	Digital maturity	Internationalization process (theoretical view)*	Adopted technologies in internationalization	International use scenario
1	Plant-based food	Conceptual	Uppsala and network model	(1) Artificial intelligence (2) (Advanced) ICT (3) e-Commerce (4) Cloud computing	(1) Market research, translation of service (2) Global collaboration, networking, finding partners, virtual communities, AI meeting transcriptions (3) Digital mode of entry to international customers (4) Global data sharing, track n trace, global project management, ERP, CRM
2	Financial services	Early conceptual	Network model	(1) (Advanced) ICT (2) Cloud computing (3) Big data analytics (4) Digital signatures	(1) Global collaboration, networking, virtual investor conferences (2) Global data sharing, secure data rooms (3) Analysis of global databases to assess portfolio companies (4) Collection of foreign partners signatures
3	Software development	Transformed	Born-global	(1) Artificial intelligence (2) Big data (3) (Advanced) ICT (4) Cybersecurity (5) Cloud computing	(1) Market research, matching algorithm fine-tuning for each market (2) Matching algorithm with market data (3) Global collaboration (4) International cybersecurity (5) Global project management, CRM
4	Autonomous driving	Transformed	Born-global, Uppsala model	(1) Artificial intelligence (2) Big data analytics (3) (Advanced) ICT (4) Cybersecurity (5) Cloud computing	(1) Market research (2) Internally developed market screening software (pestle analysis) (3) Global collaboration (4) International cybersecurity (5) Global cloud computing infrastructure

(*continued*)

Table 5. Continued

	Industry sector	Digital maturity	Internationalization process (theoretical view)*	Adopted technologies in internationalization	International use scenario
5	Cryptocurrency trading	Transformed	Born-global	(1) Artificial intelligence (2) Big data analytics (3) (Advanced) ICT (4) Cybersecurity (5) Digital marketing (6) Cloud computing	(1) Market research (2) Immediate trading with foreign crypto exchanges (3) Global collaboration (4) International cybersecurity (5) Digital ads, local blog marketing (6) Global data sharing, track n trace, global project management, ERP, CRM
6	Marketing services	Defined	Network model	(1) Artificial intelligence (2) (Advanced) ICT (3) Cloud computing	(1) Ai chatbot (CRM) (2) Global collaboration, sustaining global publisher network (3) Global data sharing, track n trace, global project management, CRM
7	Sustainable technology	Early conceptual	Uppsala model	(1) (Advanced) ICT (2) e-Commerce (3) Digital marketing (4) Cloud computing	(1) Global collaboration (2) Digital mode of entry to international customers, international payment methods (3) Digital ads, automated e-mail marketing (4) Data sharing, track n trace, ERP, CRM
8	Community networking	Transformed	Born-global	(1) Artificial intelligence (2) Big data analytics (3) (Advanced) ICT (4) Cybersecurity (5) Simulation (6) Cloud computing	(1) Market research, user categorization, translation (2) International user data analysis (3) Global collaboration (4) International cybersecurity (5) App simulation, digital prototyping (6) Global data sharing, track n trace, global project management, ERP, CRM

(*continued*)

Table 5. Continued

	Industry sector	Digital maturity	Internationalization process (theoretical view)*	Adopted technologies in internationalization	International use scenario
9	IT consulting	Defined	Network model	(1) Artificial intelligence (2) (Advanced) ICT (3) Cybersecurity (4) Digital marketing (5) Cloud computing	(1) Market research, analysis, texting (2) Global collaboration, virtual conferences, virtual events (3) International cybersecurity (4) e-Mail newsletter (5) Go-to-market software, data sharing

Note(s): *Theoretical theory that is most similar to the internationalization process of X
Source(s): Authors' compilation

marketing facilitated some of the startups' entry into foreign markets by reaching a larger number of customers and tailoring marketing to their.

Influence of digital maturity and technologies on internationalization processes

To reach a meaningful conclusion, it is necessary to interpret the influence of digital maturity on the internationalization processes. From the results, a summary provided in Table 5, the scope of internationalization appears to be greater as digital maturity increases and includes expansion into physically distant markets. This suggests that advanced technologies support broader international expansion (see Figure 4). Figure 4 visualizes the relationship between digital maturity and the scope of internationalization across the nine case firms. The scatter plot reveals a clear upward trend, where firms with higher levels of digital maturity, particularly those categorized as "Transformed" tend to internationalize with greater geographic breadth, often entering multiple psychically distant or global markets. In contrast, firms at "Conceptual" or "Early Conceptual" stages generally exhibit more limited regional or psychically close international activities. This pattern supports the interpretation that digital maturity and the underlying adoption of advanced technologies such as cloud computing, AI and digital platforms enable broader and faster global expansion. The findings reinforce the proposition that digital maturity acts as a critical enabler for startups to overcome traditional barriers associated with distance and uncertainty in internationalization.

Moreover, the use of advanced technologies and a high level of digital maturity seem to facilitate the speed of expansion. All of the startups internationalized in their first five years of operations, and in fact, many of the transformed companies did so from their inception and at a rapid speed. Finally, in terms of the internationalization strategy, it is evident that new forms of market entry modes exist in the digital age, for instance, digital market entry via internet platforms. However, market entry via exports also continues to play a major role. A lower level of commitment characterizes both of these entry modes. However, it cannot be said that digital technologies promote low-commitment forms of entry, as three interviews show the importance of having local offices and someone on the ground, highlighting that greenfield market entry is essential when securing competitive advantages.

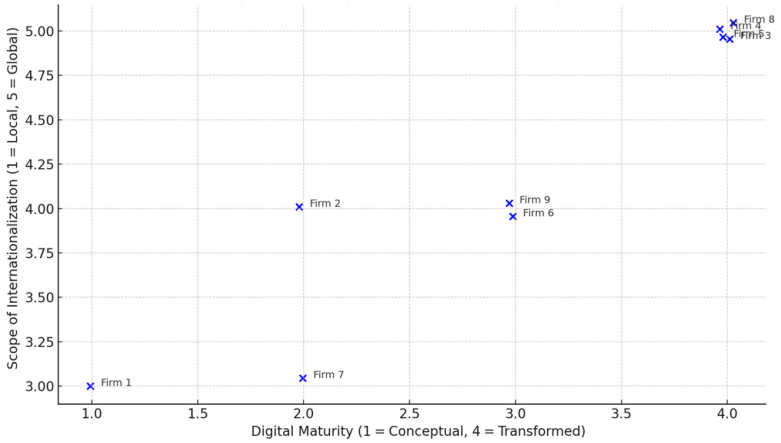

Figure 4. Digital maturity vs scope of internationalization
Source: Authors' compilation

Conclusion

To sum up, our study explored how adopting i4.0 technologies facilitates startups' internationalization process. Therefore, three constructs were examined in more detail: digital maturity, internationalization and adopted digital practices in the internationalization process. The results have been discussed and interpreted above and show that both the level of digital maturity and the extent of internationalization vary among the startups studied. Furthermore, several advanced technologies were adopted in their internationalization process. As presented earlier, the literature remains fragmented and incomplete, lacking a comprehensive view of how startups leverage advanced technologies in their internationalization processes (Castagnoli *et al.*, 2022; Götz, 2020). Our study underscores that the most important technologies were artificial intelligence, combined with big data analytics and cloud computing, advanced ICT, digital marketing, e-commerce, simulation and cybersecurity. These technologies have been used for market research and risk assessment, global collaboration, finding partners and international networking, planning and managing the internationalization process, building a global brand and localizing the offering and, finally, securing confidential information through cybersecurity technologies.

The latest research points out the importance of digital platforms and social media fostering and strengthening relationship-building between startups and their customers (Caputo *et al.*, 2021; Krings *et al.*, 2021; Troise *et al.*, 2023). Relationship building leads to a better understanding of consumer needs to offer appropriate value propositions and streamline internationalization strategy.

In conclusion, it was found that the higher the level of digital maturity, the greater the scope and speed of internationalization. i4.0 alone does not determine the strategic decision on whether to enter a foreign market with a low or high level of commitment, as this additionally depends on other firm-specific factors. To answer the research question, the adoption of Industry 4.0 technologies does facilitate the startup internationalization process in a variety of ways, as discussed above.

Theoretical implications

This study contributes to the evolving discourse on internationalization by reframing existing theories, such as the Uppsala model, born-global theory and network theory, through the lens of Industry 4.0 (i4.0) technologies and digital maturity. By empirically examining how startups leverage advanced technologies, this research extends traditional models to reflect the realities of an increasingly digitalized business environment. Furthermore, Santangelo *et al.* (2024) highlight that decision-making in international business is an *emergent process*, influenced by individual differences and firm-specific factors. This aligns with our study's perspective that internationalization strategies are not fixed but shaped by technology adoption, digital capabilities and organizational adaptability. Understanding these enabling factors helps businesses make informed decisions in an increasingly complex and digitalized global landscape.

Our findings reveal that digital maturity accelerates internationalization, challenging the incremental approach of the Uppsala model. While the Uppsala model posits gradual expansion based on market knowledge (Vahlne and Johanson, 2017), this study suggests that digitally mature startups rapidly acquire market insights through AI, big data and cloud computing, bypassing traditional learning curves. This supports born-global perspectives, where firms internationalize from inception (Monaghan *et al.*, 2020; Oviatt and McDougall, 2005). However, the persistence of hybrid approaches, combining rapid entry with localized expansion, suggests an evolution of internationalization theories rather than outright displacement.

By integrating the digital maturity framework by Azhari *et al.* (2014) with internationalization theories, we propose a theoretical model that predicts international expansion strategies based on a startup's digital profile. Startups at higher levels of digital maturity demonstrate broader market scopes, faster entry speeds and novel digital entry modes (e.g. e-commerce and SaaS platforms). This introduces digital maturity as a predictive factor influencing the scope, speed and strategy of internationalization, addressing the research gap highlighted by Castagnoli *et al.* (2022) regarding the role of i4.0 in reshaping internationalization patterns. The existing literature on i4.0 adoption in internationalization remains fragmented across specific technologies and isolated case studies. This study synthesizes insights across nine startups, providing a comprehensive framework that links technological adoption to internationalization outcomes. We propose that future research systematically apply digital maturity as a unifying lens to compare startups across sectors and geographies.

Furthermore, our study shows that firms may exhibit characteristics of both the Uppsala model and born-global internationalization approaches even though the Uppsala model and born-global theory are traditionally considered distinct internationalization strategies. Thus, our findings suggest that the rigid distinction between the Uppsala model and born-global firms may no longer fully capture the realities of modern internationalization. Firms exhibiting hybrid characteristics often leverage digital maturity to accelerate market entry (a born-global trait) while simultaneously relying on incremental learning and risk reduction strategies (an Uppsala trait) in specific markets. This aligns with recent research suggesting that digitalization allows firms to rapidly acquire foreign market knowledge, reducing the traditional barriers to early internationalization (Bhatti *et al.*, 2022; Coviello *et al.*, 2017).

Moreover, our case studies indicate that firms with high digital maturity may initially pursue born-global strategies but later transition to a more gradual, knowledge-based internationalization approach in more complex or institutionally distant markets. This suggests that digital maturity acts as a "bridge" between the born-global and Uppsala paradigms, enabling firms to flexibly switch between these pathways based on market conditions (Monaghan *et al.*, 2020; Luo and Zahra, 2023). Further research is needed to examine whether this hybrid approach represents an emerging internationalization pattern in digitally enabled firms.

Based on these insights, we propose the following theoretical propositions:

P1. Startups with higher digital maturity are more likely to pursue multi-market entry strategies akin to born-global firms.

P2. Digital maturity mediates the relationship between resource constraints and international expansion, mitigating the liabilities of smallness and newness (Bertello *et al.*, 2021).

P3. i4.0 technologies enable new hybrid pathways, blending incremental Uppsala expansion with rapid digital internationalization (Bhatti *et al.*, 2022).

In sum, this study enriches international business theory by demonstrating how digital transformation reshapes startup internationalization, offering a blueprint for future research at the intersection of digitalization and global strategy. Our findings align with and confirm previous research on the impact of i4.0 on internationalization (Bhatti *et al.*, 2022; Coviello *et al.*, 2017). Specifically, this study supports prior claims that advanced digital technologies, including AI, big data and cloud computing, significantly enhance market research, decision-making and global collaboration (Fish and Ruby, 2009; Bertello *et al.*, 2021). Furthermore, our findings reaffirm that digitally mature startups tend to internationalize faster (Monaghan *et al.*, 2020) and that

digitalization reduces the liability of foreignness by providing real-time market insights (Oviatt and McDougall, 2005; Westerlund, 2020).

Furthermore, beyond confirming prior research, this study extends internationalization theories by integrating them with digital maturity frameworks. While the Uppsala model traditionally emphasizes gradual internationalization based on learning and uncertainty reduction (Johanson and Vahlne, 1977, 2009), we demonstrate that digitally mature firms accelerate this process by leveraging AI-driven insights, cloud-based market entry and global digital platforms. This suggests that digitalization supplements or even substitutes the stepwise learning process proposed in the Uppsala model. Similarly, we expand born-global theory by showing that rapid internationalization is not only driven by an entrepreneurial mindset (Knight and Liesch, 2016) but also by the firm's digital capabilities – enabling scalability, low-cost market entry and global customer acquisition. Finally, we contribute to network theory by illustrating how virtual networks and digital platforms serve as new forms of relationship-building mechanisms, supplementing traditional business networks (Johanson and Mattsson, 1988).

Furthermore, this study refines internationalization theories by introducing hybrid pathways, where firms combine digital scaling strategies with selective localized expansion. While born-global firms expand rapidly, our findings indicate that some firms intentionally blend rapid digital entry with localized market adaptation, combining elements of the Uppsala, network and born-global models. This hybridization of models reflects the evolving nature of internationalization in a digitalized world (Castagnoli *et al.*, 2022), which has not been emphasized in prior studies. Thus, our hybrid trajectory, where startups flexibly combine born-global and Uppsala strategies depending on market complexity and institutional distance, that is, where firms rapidly enter multiple markets digitally, yet selectively revert to gradual or partner-based strategies in more complex regions, has not been emphasized in prior studies.

Also, our study provides a comparative multi-case analysis across diverse industries and digital maturity levels, revealing that firms with even moderate digital maturity (e.g. "Defined" level) can achieve global reach when supported by targeted digital tools such as CRM, project management and cloud infrastructure. Third, our findings show that internationalization today is increasingly unplanned or reactive, driven by algorithmic matchmaking, app store visibility and virtual network effects, challenging linear or staged models assumed in earlier literature. Finally, we refine internationalization frameworks by proposing digital maturity as a moderating factor in international expansion speed, scope and strategy. This suggests that firms at higher digital maturity levels follow distinct internationalization patterns – either through fully digital entry strategies (e.g. SaaS firms) or a combination of digital-first entry followed by localized presence.

Managerial implications

The outcome of this study provides managers with valuable information on how the adoption of i4.0 technologies can support startups' internationalization process. The study suggests that managers should consider that companies adopting i4.0 can internationalize earlier, faster and further because of improved global collaboration, better access to knowledge of foreign markets and trends, and more effective relationships with suppliers, employees and customers. It identifies certain technologies' benefits and describes their use scenarios in internationalization, offering managers a roadmap for leveraging targeted digital tools at different stages of maturity to support international expansion. Furthermore, Table 5 provides managers with a detailed list of tools currently adopted by startups that facilitate

international expansion. Ultimately, it urges managers to keep up with technological advances and seize the opportunities of digital progress in today's world.

Policy implications

The study highlights the importance of digital maturity as a dynamic capability that influences not only how fast or how far firms go internationally, but also how flexibly they can respond to varying institutional, cultural and strategic demands in foreign markets. Given that the study involved startups from multiple European countries, we propose the following policy recommendation. European policymakers should foster digital innovation by providing support for i4.0 technology adoption across sectors. Policies aimed at subsidizing the development and deployment of AI, cloud computing and cybersecurity technologies can enable more startups to achieve digital maturity, enhancing their global competitiveness.

Additionally, governments can encourage small firms to enter foreign markets more effectively by offering grants and incentives for digital infrastructure. Harmonizing digital regulations across the EU would further ease cross-border operations and reduce compliance costs for startups. Finally, developing pan-European digital innovation hubs and networks would facilitate collaboration and resource-sharing, ensuring that even smaller firms with limited resources can leverage advanced digital tools to internationalize rapidly.

Limitations and recommendations for future research

Despite its important contributions, it must be pointed out that this study has a number of limitations, of which the reader must be aware. First of all, a sample of nine startups does not provide enough data to ensure generalization. Furthermore, the sample has a clear European bias, containing data from five different European countries but not providing any insights into startups in other parts of the world. As previously mentioned, a further limitation is its limited conclusion regarding the impact of i4.0 on the decision of entry mode in internationalization. This study did not succeed in identifying a clear trend as to which type of market entry is preferred by startups, as the analysis showed that this decision depends on further company-specific factors. Furthermore, one of the major limitations is that technologies change rapidly, and this study only provides findings for a certain period of time without knowing what can be done in the future. Future research should, therefore, thoroughly reexamine the influence of i4.0 on market entry decisions and simultaneously include other internal and external factors in the analysis. Additionally, further data is needed to enrich this study, especially from startups outside Europe. In particular, startups from emerging economies are underrepresented in this sample.

Moreover, an important limitation of this study is the heterogeneity of the sampled firms across industries and sectors (see Figure 5). While this diversity strengthens the exploratory richness and comparative scope of the findings, it also introduces potential confounding factors that may influence both digital maturity and internationalization patterns. For example, certain sectors (e.g. SaaS or fintech) may be inherently more digital by nature and structurally predisposed to faster internationalization, independent of firm-level digital maturity. This makes it more challenging to determine whether digital maturity alone is the key driver of international expansion. Future research is, therefore, encouraged to adopt quantitative approaches such as regression analysis or structural equation modeling to control sector-specific effects and statistically isolate the role of digital maturity. Alternatively, future studies could focus on sector-specific samples (e.g. digital health, mobility or software startups) to minimize industry-level variance and derive more robust causal inferences.

	Industry	*Sector*	*Country*	*Position of Interviewee*	*Length*
1	Food	Plant-based Food	Netherlands	Sales Representative	30 min
2	Venture Capital	Financial Services	United Kingdom	Investment Analyst	30 min
3	Technology	Software Development	Austria	Key Account Manager	30 min
4	Transportation	Autonomous Driving	Sweden	Product Strategy	30 min
5	Finance	Cryptocurrency Trading	Austria	Co-Founder & CEO	30 min
6	Advertising	Marketing Services	Germany	Support Manager	30 min
7	Environment Technology	Sustainable Technology	Germany	Managing Director	30 min
8	Social Media	Community Networking	Germany	Marketing & Sales	30 min
9	Technology	IT Consulting	Austria	Managing Director	30 min

Figure 5. Sample overview
Source: Authors' compilation

Finally, it may be relevant to compare this study at a future point in time to gain insights into how startups leverage advanced technologies in their internationalization in our rapidly digitalizing world.

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