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The impact of digitalization on SMEs international strategies: A Bibliometric Analysis

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Many were the ones that proved to be essential for the accomplishment of this arduous job. So, I am forever grateful ...

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Abstract

Digitalization is not a new phenomenon, but it keeps evolving, affecting businesses worldwide, and being an opportunity for small and medium-sized enterprises (SMEs) to participate in the global economy. Although Digitalization, Internationalization, and SMEs are core topics within international business, especially in Europe, the relationship between Digitalization and SMEs' strategies and, consequently, the relationship between Digitalization and SMEs' international strategic decisions has not been systematically studied. The present dissertation addresses this gap by elaborating on an in-depth literature review and developing a bibliometric analysis on the existing literature on Digitalization, Internationalization, and SMEs. Therefore, this study's value lies in exhaustively gathering updated literature and exploring the state-of-the-art of this emerging topic. On the one hand, the literature review analyses the central themes regarding the impact of Digitalization on companies, notably the barriers that SMEs face in adopting a digital strategy, how to adopt a suitable digital strategy, and how Digitalization can boost their entry into foreign markets. On the other hand, the bibliometric analysis of 298 publications from Web of Science and Scopus enabled us to gather the latest work on Digitalization, Internationalization, and SMEs, as well as to deeply analyze the relevant literature, revealing the principal publications, authors and journals, as well as trends and patterns. Results demonstrate that literature on this topic is very recent, from 2005, and that research has been growing exponentially since 2015, with a tendency to continue growing. The bibliometric analysis also revealed that the literature on Digitalization, Internationalization, and SMEs is increasingly focusing on the impact of digital technologies' adoption in enterprises' strategies, focusing on business model innovation, global value chains, collaboration, and performance, also addressing the digital maturity models. Future research could focus on the relation between digital maturity and internationalization (entry modes), and understanding the impact of Digitalization on Internationalization, and the consequent impact on enterprises' performance.

Keywords: International business, digitalization, internationalization, industry 4.0, small and medium-sized enterprises (SMEs), business models, value chain, GVCs, digital maturity, maturity models, entry modes.

Resumo

Apesar de a Digitalização não ser um fenómeno recente, continua a evoluir, afetando as empresas à escala mundial e constituindo uma oportunidade para as pequenas e médias empresas (PME) participarem na economia mundial. Embora a Digitalização, a Internacionalização, e as PMEs sejam temas centrais no domínio dos negócios internacionais, especialmente na Europa, a relação entre a Digitalização e as estratégias das PMEs e, consequentemente, a relação entre a Digitalização e as decisões estratégicas internacionais das PMEs não têm sido sistematicamente estudadas. A presente dissertação aborda esta lacuna ao realizar uma revisão aprofundada da literatura e ao desenvolver uma análise bibliométrica no que concerne à literatura existente sobre Digitalização, Internacionalização e PMEs. Assim sendo, o contributo deste estudo reside em reunir exaustivamente literatura atualizada e explorar o estado da arte deste tema emergente. Por um lado, a revisão da literatura analisa os aspetos centrais relativos ao impacto da Digitalização nas empresas, nomeadamente as barreiras que as PMEs enfrentam na adoção de uma estratégia digital, como é que as PMEs podem adotar uma estratégia digital adequada às suas caraterísticas, e como é que a Digitalização pode impulsionar a sua entrada em mercados estrangeiros. Por outro lado, a análise bibliométrica a 298 publicações da Web of Science e do SCOPUS permitiu recolher os últimos estudos sobre Digitalização, Internacionalização e PMEs, bem como analisar aprofundadamente a literatura relevante, destacando as principais publicações, autores e jornais, bem como as tendências e padrões. Os resultados demonstram que a literatura existente é muito recente, desde 2005, e que a investigação tem vindo a crescer exponencialmente desde 2015, com uma tendência para continuar a aumentar. A análise bibliométrica revelou ainda que a literatura se encontra cada vez mais centrada no impacto da adoção das tecnologias digitais nas estratégias das empresas, centrando-se na inovação dos modelos de negócio, cadeias de valor globais, colaboração e desempenho, abordando também os modelos de maturidade digital. Investigações futuras deveriam centrar-se na relação entre maturidade digital e internacionalização (modos de entrada), bem como na compreensão do impacto da Digitalização na Internacionalização, e o consequente impacto na *performance* das PMEs.

Palavras-chave: negócios internacionais, digitalização, internacionalização, indústria 4.0, pequenas e médias empresas (PMEs), modelos de negócio, cadeias de valor, CVGs, maturidade digital, modelos de maturidade, modos de entrada.

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List of Acronyms

AMTs – Advanced Manufacturing Technologies

AOI – Active Online Internationalization

B2B – Business to Business

B2C – Business to Consumer

BM – Business Model

BMI- Business model innovation

EC – European Commission

EU – European Union

FDI - Foreign Direct investment

GVCs – Global Value Chains

I4.0 - Industry 4.0

ICT – Information and Communication Technologies

MMs – Maturity Models

MNEs - Multinational enterprises

SCOPUS – SciVerse Scopus

SM – Smart Manufacturing

SMEs – Small and medium-sized enterprises

UNCTAD - United Nations Conference on Trade and Development

WoS - WebofScience

WTO – World Trade Organization

Introduction: motivations, goals, and research subject

Digitalization is considered one of the main trends changing society and business nowadays (Parviainen, Tihinen, Kaariainen, & Teppola, 2017; Ritter & Pedersen, 2020; Sweden, 2016). This phenomenon is no longer just an emerging trend, and it is changing the economics of globalization in numerous ways: who takes part, how business is done across borders, and where the economic benefits are flowing (Wautelet, 2017). In fact, properly responding to digital change is the number one medium-term challenge businesses face nowadays (North, Aramburu, & Lorenzo, 2019).

Digitalization, according to Gartner (2019), consists of the process of employing digital technologies and information to transform business operations.

This digital transformation - referred to as Industry 4.0 or Fourth Industrial Revolution when addressing its impact on the manufacturing industry (Müller, Buliga, & Voigt, 2018) - is prompted by new or improved digital technologies, such as artificial intelligence, 3-D printing, robotics and the internet of things (IoT) (Rüßmann et al., 2015), enabling the fusion of digital technologies and their interaction across physical, digital and biological spheres (Schwab, 2016). Hence, the development of interconnected systems is expected to lead to optimization and automation of processes, consequently reducing costs and increasing productivity and profitability (Parida, Sjödin, & Reim, 2019; Schwab, 2017). Industry 4.0 is transforming enterprises' value chains and stimulating the emergence of new BMs, such as digital platforms (for instance, Amazon) and platforms of individual firms, including small and medium-sized enterprises – SMEs (Müller et al., 2018). Such marketplaces enable the direct contact between suppliers and customers, constituting an opportunity for SMEs with limited budgets to achieve a broader range of customers at a low cost (remaining in their own home country) and to increase their share of international activities, and gain market and operational efficiency internationally (Cenamor, Parida, & Wincent, 2019; Savastano, Amendola, & D'Ascenzo, 2018; Wittkop, Zulauf, & Wagner, 2018; Yamin & Sinkovics, 2006).

So, digitalization offers opportunities for SMEs to participate in the global economy by reducing transaction costs and increasing network activities, speed, and scalability (Banalieva & Dhanaraj, 2019; OECD, 2017). However, evidence shows that many SMEs have not been able to reap the benefits of the technological transition due to difficulties in adopting digital

tools, consequently needing guidance in order to develop a digital strategy that impacts the organization as a whole and guarantees a sustainable competitive advantage internationally (Dethine, Enjolras, & Monticolo, 2020; Jin & Hurd, 2018), which vindicates the relevance of research in this topic.

This dissertation aims to answer the overall research question: "How does digitalization impact SMEs' strategies, particularly in what concerns internationalization?".

This dissertation is composed of a comprehensive literature review on the main research trends, followed by a bibliometric analysis of the existing literature, gathered from the leading databases – Web of Science (WoS) and SciVerse SCOPUS (SCOPUS).

The first part, i.e. the detailed literature review, aims to respond to the following questions:

i. How is digitalization affecting enterprises' strategies?
ii. What is the impact of digitalization on enterprises' business models?
iii. How digitalization impacts the way enterprises organize their activities to create value for their customers?
iv. How can enterprises develop a tailored strategy that enables them to succeed within the digital economy?
v. How are SMEs responding to the digital transformation?
vi. What are the digital resources and capabilities that allow SMEs to succeed overseas within the digital economy?
vii. What is digitalization's impact on SMEs' international strategies, particularly their entry modes on foreign markets?

The second part will consist of a systematic bibliometric analysis. According to Teixeira (2014), a bibliometric analysis consists of the most suitable methodology to identify the "leading edge" of a research field and carry out an updated empirical analysis. Therefore, and given the gathering momentum of Digitalization, Internationalization, and SMEs - and the fact that the literature is in its expansion - the application of bibliometric techniques will enable us to draw conclusions on the state-of-the-art of the literature and to contribute to research on this field, unveiling the trends and patterns within the literature, notably the most prominent publications and journals, as well as a chronological and geographical analysis, and understanding the trend topics within the literature.

Chapter 1. Literature Review

Digitalization has been gaining momentum in recent years, being considered one of the major trends changing society and business (Bican & Brem, 2020; North, Aramburu, & Lorenzo, 2019; Parviainen et al., 2017; Sweden, 2016). The transformative impact of digitalization on how business, economy, and society operate (also known as digital disruption) (Autio, 2017) - and the inherent reduction of transaction costs, increase of network activities, speed, and scalability - creates opportunities for SMEs' growth and internationalization, namely through online sales and e-commerce (Jin & Hurd, 2018; Joensuu-Salo, Sorama, Viljamaa, & Varamaeki, 2018; OECD, 2017).

Therefore, the literature review presents some key definitions and debates on the impact of digitalization on enterprises' digital strategies, focusing on internationalization. Thereby, this chapter will review the existing literature on: (1.1) Digitalization and industry 4.0 (i4.0), particularly how it affects enterprises strategies, particularly specifically their business models and value chains; (1.2) how enterprises can improve their digital strategy - particularly how SMEs are approaching the digital transformation and improving their strategy; (1.3) and how digitalization affects SMEs' international strategies.

1.1. Digitalization

Digitalization is broadly referred to as the *"adoption or increase in the use of digital or computer technology by an organization, industry, country"* (Brennen & Kreiss, 2016, p. 1). This concept appeared in a 1971 essay in the *North American Review,* written by Robert Wachal, and, since then, has been massively explored (Brennen & Kreiss, 2016).

Some scholars use the terms "digitalization" and "digitization" interchangeably. However, while digitalization consists of how many spheres of social life are restructured based on the fact that people's interactions are moving away from analog to digital technologies, digitization consists of the material process of converting analog information into digital bids (Brennen & Kreiss, 2016).

Digitalization is often used to describe any changes in the organizations' BM, in order to create new offerings and sources of revenue, improve business and replace or transform

business processes (McAffee, Ferraris, Bonnet, Calméjane, & Westerman, 2011; Wautelet, 2017). This business-oriented definition of digitalization, as mentioned before, has been adopted by Gartner (2019) - a leading information technology research and advisory Company - defending that digitalization consists of the process of moving to a digital business, using technological tools to change the BM, and provide new revenue and value-producing opportunities. It is going to be this more business-orientated definition the one used in this dissertation.

Digitalization is facilitated by the improvement of information and communication technologies (ICTs) (UNCTAD, 2019) like the internet, that standardize information and enable enterprises to code, store, formalize and allocate increasingly amounts of knowledge promptly, improving information and knowledge management inside the enterprise (Cenamor et al., 2019; North, Aramburu, & Lorenzo, 2019; OECD, 2004).

Although digitalization is not a new phenomenon, it keeps evolving and producing new effects on the organization's environment.

The current digital transformation, often referred to as the Fourth Industrial Revolution, is evolving exponentially and distinguishes itself from the previous one – the third revolution, based on ICTs and automation - due to its velocity, scope, and systems impact (Schwab, 2016). The Fourth Industrial Revolution is a learning process characterized by the fusion of digital technologies and the interaction across physical, digital and biological spheres and is revolutionizing enterprises' value chains (North, Aramburu, & Lorenzo, 2019; Schwab, 2017). This phenomenon is also known as Industry 4.0 when addressing the impact of this digital transformation on the manufacturing industry (Müller et al., 2018). Even though European scholars refer to the digital transformation as "Industry 4.0", the same concept is called "Smart Manufacturing" (SM) by most US scholars and by "Smart Factory" predominantly in Korea/Asia (North, Aramburu, & Lorenzo, 2019). In light of this, we will be going to refer to the industrial digital transformation as Industry 4.0.

Industry 4.0 consists of a global transformation of the manufacturing industry by the introduction of digitalization and the Internet, as well as the emergence and diffusion of existing digital technologies, increasing the connectivity along the value chains and the integration of physical assets on digital ecosystems (Parida et al., 2019; Rüßmann et al., 2015; Schwab, 2017; Tjahjono, Esplugues, Ares, & Pelaez, 2017).

Industry 4.0 is based on an array of fundamental technologies, notably artificial intelligence, robotics, big data and analytics, sensors, IoT, cybersecurity, cloud, 3-D printing (additive manufacturing) and virtual and augmented reality (Daugherty, 2016; Rüßmann et al., 2015; Strange & Zucchella, 2017).

Notwithstanding, digital transformation affects more levels of the organization besides the process level (through the adoption of advanced manufacturing technologies (AMTs) and restructuring their processes). Digital transformation also influences the organizational level - by providing new services, discarding obsolete practices, or even transforming the existing services -, the business domain level, changing roles and value chains in ecosystems -, and the social level, notably the type of work (Parviainen et al., 2017).

In the following subsections we aim to explain how digital transformation affects the organization and business domains, focusing on enterprises' business models (1.1.1) and value chains (1.1.2), as well as how they can enhance their digital strategy (1.1.3).

1.1.1. Digitalization and Business Models

Digitalization drives traditional business models into obsolescence, giving way to technologically advanced innovative solutions (Pattnaik, 2018).

Business models describe an architecture for how companies design and conduct activities in order to offer value to their customers, how they are compensated by them, as well as how they interact with their stakeholders (suppliers, partners, and customers) (Müller et al., 2018). In other words, they are a *"matched set of elements encompassing the flows of costs, revenues, and profits"* (Teece, 2018, p. 40) that evolve and change over time.

Over the years, BMs have increasingly become a source of innovation and competitive advantage (Rachinger, Rauter, Müller, Vorraber, & Schirgi, 2019). The utilization of the Internet as a sales medium, notably the electronic-commerce (e-commerce), enables the direct communication between firms and their stakeholders, contributing to the virtual collapse of time and distance, and contributing to the optimization of the existing BMs (Baourakis, Kourgiantakis, & Migdalas, 2002; Dethine et al., 2020; Hamad, Elbeltagi, & El-Gohary, 2018; Pattnaik, 2018; Villa, Ruiz, Valencia, & Picón, 2018).

Villa et al. (2018, p. 41) define e-commerce as "*any transaction made by means of electronic devices, which allows conducting business and transforms internal and external relationships to create value and exploit the market opportunities influenced by new rules of a connected economy. It allows the incorporation of all transactions of information, products, services or payment via electronic networks, and integrates solutions to any transaction via Internet--which is understood as the use of digital communication networks to facilitate the purchase and sale of any product or service".*

According to Kalakota and Whinston (1997), e-commerce can be defined from many perspectives, as follows:

> From a communications perspective, "*electronic commerce is the delivery of information, products/services, or payments via telephone lines, computer networks, or any other means".*
>
> From a business process perspective, e.-commerce is characterized by *"the application of technology towards the automation of business transactions and workflows".*
>
> From a service perspective, electronic commerce "*is a tool that addresses the desire of firms, consumers, and management to cut service costs while improving the quality of goods and increasing the speed of service delivery".*
>
> and From an online perspective e-commerce *"provides the capability of buying and selling products and information on the Internet and other online services"* (Kalakota & Whinston, 1997, p. 3).

Also, the introduction of i4.0 digital technologies allows manufacturing firms to provide new services and product-service systems, developing new customer value (Müller, 2019).

The exploitation of opportunities, notably the ones brought by digital technologies (Müller et al., 2018; Parida et al., 2019), have conducted firms to follow a business model innovation (BMI). Chesbrough (2010) argues that having an innovative and suitable BM is as essential as having new and innovative technologies for firms to be successful in the digital world.

Some authors defend that BMI consists of a process for the development of a BM new to the company or the entire industry, and others describe BMI as the result of an innovative initiative that completely changes or replaces the existing BM (Rissanen, Ermolaeva, Torkkeli, Ahi, & Saarenketo, 2020).

Foss and Saebi (2016, p. 201) define BMI as the "*designed, novel, non-trivial changes to the key elements of a company's BM and/or the architecture linking these elements."*, and this is going to be the definition adopted in the present dissertation.

According to Rachinger et al. (2019), BM changes may include the value chain or the value proposition to its customers or other stakeholders. Therefore, BMI can originate from or prevail in one of the three BM elements: (1) value creation: explains the architecture of firms' processes (Wittkop et al., 2018), defining how and by what means enterprises create value along the value chain; (2) value proposition: following Richardson (2008, p. 139) "*the value proposition is a basic statement of the firm's theory about how to compete*", containing a portfolio of solutions for customers as well as how they are offered, clarifying the overall approach to the competitive advantage (3) and value capture: defines how value propositions are converted into revenues, ensuring a sustainable performance (Clauß, 2017; Wittkop et al., 2018).

The influence of digitalization in enterprises and their BMs can be distinguished into three types: (1) digitization of the product or service, resulting on a cost optimization of the existing BM; (2) digital processes and decision making, reconfiguring the existing BM with the support of i4.0, Big Data or artificial intelligence; and (3) development of a new BM, with the transformation of the value proposition and operating model (Berman, 2012; Matzler, Bailom, von den Eichen, & Anschober, 2016; Rachinger et al., 2019). Ritter and Pedersen (2020) distinguish digitalization's impact on enterprises' BMs between exploitation and exploration. Exploitation consists of new ways of doing business, adapting internal efficiencies, optimizing their capabilities, and understanding their customers. Exploration refers to developing entirely or partially BMs, with new value propositions and customer segments. According to the same authors, enterprises tend to initiate their digital transformation journey by exploiting their BMs, digitalizing the existing processes, and further exploring new commercial opportunities through exploration.

Therefore, new BMs - more flexible, easy to change, with real-time responses to customers' behaviors and knowledge-based - have been developed with digitalization (Ulas, 2019). According to McKinsey (2015), new BMs are emerging from this digital era, notably (1) as-a-service BMs, (2) platforms, (3) intellectual property rights - based BMs, and (4) data-driven BMs.

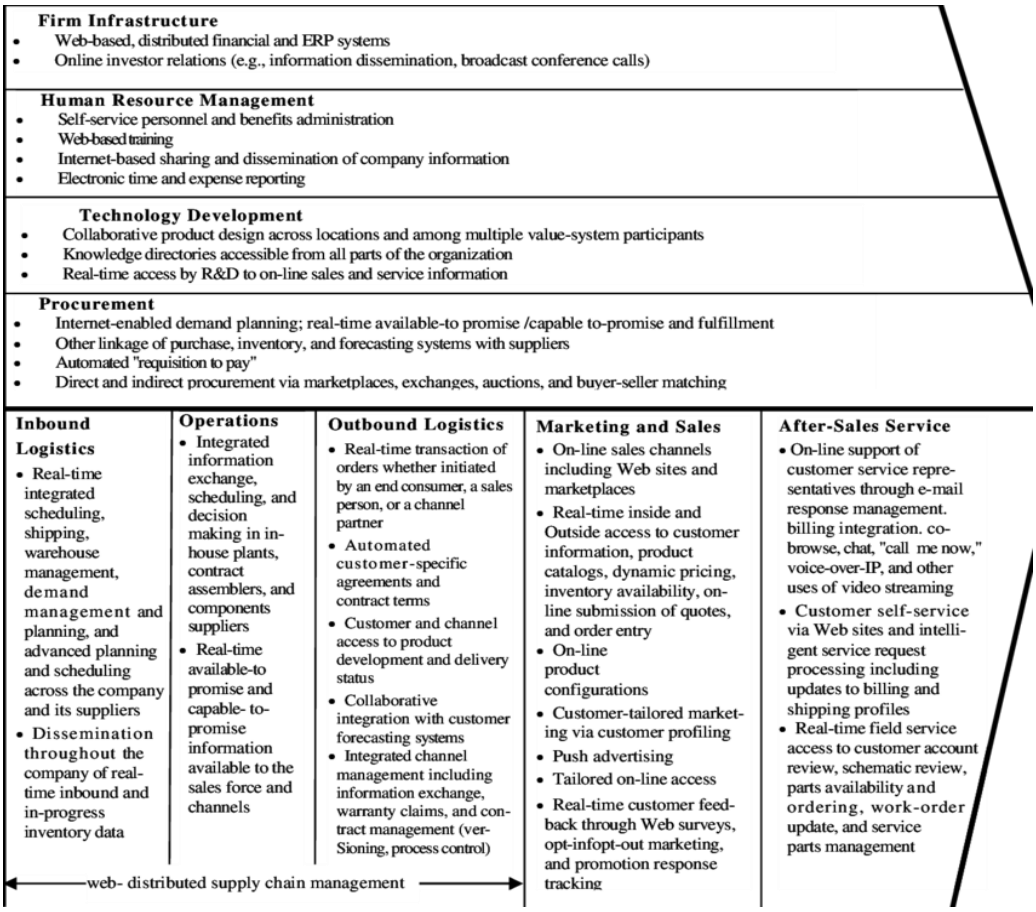
Digital platforms consist of an interactive platform that facilitates interactions between interdependent groups of users, such as buyers and suppliers (Koh & Fichman, 2014), for instance, Amazon and Alibaba. This new type of BM provides a marketplace for firms to commercialize their products and services and help SMEs access capital networks (Cenamor et al., 2019). Hence, SMEs usually try to exploit e-commerce possibilities by selling through

marketplaces, which may facilitate their economic growth by enabling sellers to access new markets and reach new customers at lower costs (DESI, 2019).

1.1.2. Digitalization and Value Chains

Digital disruption is also changing the way firms organize for value creation and delivery, affecting all value chain activities, including the design of the product, production, logistics, marketing and sales, and the after-sales service (Karlsson & Rundcrantz, 2017; Porter, 2001). According to Porter (2001, p. 13), a firm's value chain consists of *"the set of activities through which a product or service is created and delivered to customers"*. Thus, it helps determine which specific activities create value for firms and gives them a competitive advantage (OECD, 2008). Moreover, once every activity involves creating, processing, and communicating information, information technologies (IT) play a vital role in the value chain (Porter, 2001). The most prominent applications of the Internet in the value chain are represented in Figure 1.

Figure 1- Prominent Applications of the Internet in the Value Chain



Source: (Porter, 2001, p. 14)

Besides the fact that the Internet enables the link between firms' activities, allowing the almost instantly availability of real-time data, it also provides the existence of online sales channels, namely firms' websites or marketplaces. Online platforms turn communication and connectivity easier between buyers and suppliers at much lower costs than the existing tools (private networks and Electronic Data Interchange) (Porter, 2001). The adoption of these platforms will, consequently, influence enterprises' marketing and sales, operating as a marketing tool for promotion, removing physical limitations of time, allowing firms to reach a broader range of customers and scale rapidly and effectively (Nejadirani, Behravesh, & Rasouli, 2011; Porter, 2001; WTO, 2019). Furthermore, by applying the Internet as a sales channel, firms improve their production and distribution systems' efficiency, enabling the automation of related internal processes, providing real-time information about inventory, production, sales, and distribution issues (Dethine et al., 2020).

The current digital transformation goes even further, enabling production within value chains to become more efficient, flexible, and consequently allowing enterprises to produce smaller batches to niche markets (Rüßmann et al., 2015; Strange & Zucchella, 2017). The existence of products or machines equipped with sensors enables real-time data access, allowing, for example, preventive maintenance and the coordination and synchronization of product information and flows. In addition to the information generated by this sensors, the fact that firms can access data from a plurality of sources (such as search engines and social media – e.g., Facebook) with low storage costs (through the existence of a cloud) helps them, amongst others, on the decision making, purchasing and sales, production planning, and data management (Mittal, Romero, & Wuest, 2018b; Rüßmann et al., 2015).

Robotics and automation tools are also a source of efficiency. Industrial robots are becoming versatile and mobile, executing more complex tasks, working in less-structured environments, providing, and receiving feedback from other parts of the production systems, and collaborating effectively with humans. Even though they have been costly in the past, robotics are increasingly becoming cheaper, with higher functionality and performance, enabling their adoption by SMEs (Rüßmann et al., 2015). Therefore, since these tools can perform repetitive work, it can improve the quality control and increase production efficiency. The transportation and storage of materials or products can also benefit with these technologies.

The adoption of additive manufacturing, such as 3D printing, is mostly used during the design of the product and production, enabling the easy production of complex products,

consequently reducing overall production time - once several manufacturing steps are consolidated (Rüßmann et al., 2015).

Moreover, digitalization enables the direct interaction between parts, cutting out the middlemen, who can exercise an important role in traditional value chains and may constitute a barrier to SMEs' internationalization (Autio, Nambisan, & Thomas, 2017; OECD, 2008). Hence, reducing the dependency on location-specific value chain resources and opening new opportunities for value-creating interactions with the ultimate users.

In fact, with the progress on ICTs, firms' value chains are becoming global, focusing on core competencies and activities with the highest added value and outsourcing non-core activities. Therefore, different value creation activities may be carried out by different firms or regions of the global production network (OECD, 2008). Thus, value chains are increasingly organized and spread around the world as a result of a process of production fragmentation (C.-L. Chen, 2019) being extended transnationally, leading to the concept of global value chains (GVCs) – *"a network of interlinked stages of production for the manufacture of goods and services that straddles international borders"*(Cheng, Rehman, Seneviratne, & Zhang, 2015, p. 5).

Understanding their current capabilities is crucial for firms to decide what they should do to effectively manage their BMs or value chains and stay competitive. Therefore, both scholars and consulting firms have developed maturity models to support enterprises in their digital transformation (Mittal, Khan, et al., 2018).

1.1.3. Maturity Models: Towards a suitable digital strategy

Assessing their digital maturity allows firms to understand their current capabilities. However, one of the biggest challenges of increasing a firm's digital maturity is *"creating an effective strategy and linking it to overall business objectives"* (G. C. Kane, Palmer, Nguyen-Phillips, Kiron, & Buckley, 2017, p. 7). Therefore, maturity models have been developed in order to provide guidelines to realign, reconfigure and renew the existing enterprises capabilities with the aim of creating an effective digital strategy that enables enterprises to achieve competitive advantage (G. Kane, 2019). In this subsection, we are going to define maturity models and its influence on enterprises' digital maturity.

Maturity models are built in the assumption that organizational evolution follows a linear and predictable path that usually encompass five levels of maturity with an implicit logic of

progression – increases from the lower to the highest levels (Becker, Knackstedt, & Pöppelbuß, 2009; Felch, Asdecker, & Sucky, 2019; Pirola, Cimini, & Pinto, 2019). Therefore, maturity models provide a structured approach to initiate and accompany short-term operational projects, medium-term tactical changes or long-term strategic change (Becker et al., 2009; Felch et al., 2019).

Maturity models describe/determine how capable enterprises are of achieving continuous improvement and suggest steps to attain a higher level of maturity focusing on (1) people capability - *"i.e., to which extent the workforce is able to enable knowledge creation and enhance proficiency"* – (2) processes - *"i.e., to which extent a specific process is explicitly defined, managed, measured, controlled, and effective"* -and/or (3) objects/technologies -*"to which extent a particular object like a software product, a machine or similar reaches a predefined level of sophistication"* (Mettler, 2011, p. 83; Mittal, Khan, et al., 2018).

The literature presents several i4.0 and digitalization approaches in the form of maturity models, readiness assessment methods, frameworks and roadmaps (Mittal, Khan, et al., 2018). Although they are very similar, there are some differences between them.

- Readiness assessment methods can evaluate the preparedness of capabilities (conditions, attitudes and resources) towards the goals, at all levels of the organization (Mittal, Khan, et al., 2018; Pirola et al., 2019).
- Frameworks are "*collections of coherent procedures, methods, and tools"* that provide guidelines for designing a system (Mittal, Khan, et al., 2018, p. 199).
- Roadmaps are procedures to reach technical short-term or long-term goals, towards specific technology solutions (Garcia & Bray, 1997; Mittal, Khan, et al., 2018).

The terms "readiness" and "maturity" are usually used interchangeably in literature, representing the same set of concepts. In fact, both readiness assessment methods and maturity models help firms to address their digital maturity, as well as answer questions such as what needs to be measured and how to assign a specific stage or degree of maturity (Pirola et al., 2019). Therefore, hereinafter this concept will be going to be referred to as "maturity models" for easier reading.

The process of becoming a digitally mature firm is not easy and quick. Instead, leaders must carefully rethink their entire business step-by-step from the ground up so as to build a path towards digital maturity that fits the organization (G. C. Kane et al., 2017). Many definitions of digital maturity have been proposed by scholars.

According to Rader (2019), and based on the book *"The Technology Fallacy",* digital maturity is a learning journey that continues to grow and evolve, being a way to apply digital technology (firstly to promote efficiency and ultimately in creative ways to innovate BM).

G. C. Kane et al. (2017, pp. 5-6) defines digital maturity as "*a continuous and ongoing process of adaptation to a changing digital landscape.".*

The definition of digital mature firms differs between authors, with different points of view, depending on the type of entities under study (process, business models, organization systems and capabilities) (Mettler & Rohner, 2009; North, Aramburu, & Lorenzo, 2019).

According to Westerman, Tannou, Bonnet, Ferraris, and McAfee (2012, p. 3), a firm is digitally mature when *"truly comprehend how to drive value with digital transformation",* combining a *"transformative vision, careful governance and engagement*", and developing a "*digital culture that can envision further changes and implement them wisely",* continuously improving their digital competitive advantage. According to them, a digitally mature firm has higher performance, outperforming their peers in multiple financial measures.

De Carolis, Macchi, Negri, and Terzi (2017) examined a firms' digital maturity according to their processes. Therefore, a digitally mature firm has a "digital oriented" process - having a solid technology infrastructure and a high potential growth organization, with high level of integration and interoperability that promotes "*speed, robustness and security in information exchange, in collaboration among the company functions and in the decision making*" (De Carolis et al., 2017, p. 17).

Igartua, Retegi, and Ganzarain (2018) defend that a digitally mature firm is a firm that has the necessary organizational capabilities in order to succeed in this changing environment (dynamic capabilities), being systematically preparing themselves for digital evolution.

In an interview to Rader (2019), Jonathan Copulsky, a retired Principal of Deloitte Consulting and one of the authors of the book "The Technology Fallacy", defended that digitally mature firms are "*more likely to be agile, experimental, risk tolerant, collaborative and learning organizations. (...) are likely to spend more time, energy and money on ensuring that these cultural characteristics are more than just artifacts and espoused values and are deeply embedded in how the organization actually operates."*(Rader, 2019, p. 47).

Jonathan Copulsky (2019) went further by determining the fundamental areas that separate digitally mature companies from less advanced ones:

- *"The rate at which they identify and assimilate new digital technologies.*
- *Their skills at uncovering the value available through new digital technologies.*
- *Their ability to attract and retain the right digital talent.*
- *The cultivation of a "test fast, learn fast, scale fast" mindset." (*Rader, 2019, p. 29)

Over the past few years many digital maturity models (MMs) have been developed both by academic and non-academic institutions mostly geared towards multinational enterprises - MNEs (De Carolis et al., 2017; Gökalp, Şener, & Eren, 2017; Schumacher, Erol, & Sihn, 2016). However, SMEs have specific characteristics that need to be considered when applying a maturity model for them to improve in the digital era. This topic will be further explained in section 1.2.1.

1.2. Digitalization and SMEs

As one of the key focus of this dissertation is to understand the impact of digitalization on SMEs' strategies, it is crucial to clarify this latter concept. The European definition of SMEs will be used, according to which SMEs can be defined considering their staff headcount and annual turnover or annual balance sheet total. Therefore, when a firm has less than 250 employees and an annual turnover inferior to 50 million euros or an annual balance sheet total until 43 million euros, it is defined as an SME (EC, 2003).

SMEs play a major role in most economies, accounting for most businesses worldwide, and being essential contributors to job creation and global economic development. In 2018, European SMEs accounted for 99.8% of all enterprises, generating, on average, 56.4% of the value-added and 66.6% of the employment (EC, 2019).

Although they are a heterogeneous group, operating in different industries, with different target markets, products and resources, SMEs have in common the necessity to improve and develop their internal and external resources and capabilities in order to adapt to today's rapidly changing environments and stay competitive. Internal efficiencies, cost reductions, better collaboration, new product and service offerings and audience extension are the primary motivations for SMEs to embrace digital economy's potential. (North, Aramburu, & Lorenzo, 2019)

Autio (2017) went further by distinguishing SMEs' adoption of digital technologies in two types. The front-runners - those who contribute to digital transformation – and the followers – those who have to adapt to new technologies (usually they have more traditional systems and might face difficulties with digital transformation).

One of the major trends defining competition for SMEs is the improvement of online technologies, particularly e-commerce (Abebe, 2014; Morgan-Thomas, 2009).

Firms can sell online through their platforms (websites or social media, for example) or existing electronic marketplaces (such as Alibaba or Facebook) (Deng, Duan, & Luo, 2019; Kim, 2020).

On the one hand, by having their website, SMEs can benefit from different functionalities - from information (product catalogues), interactivity (customer feedback) to transactional functions (Kim, 2020). However, these platform's utilization varies between SMEs, from exclusively a communication medium to a platform that "*facilitates customer ordering payment and the management of delivery"* (Morgan-Thomas, 2009, p. 267). Some disadvantages of using their websites are that a firm's website may suffer from limited online traffic and be able to attract only a limited number of visitors. Additionally, the maintenance and setup costs for independent websites are high.

On the other hand, the utilization of digital platforms also has benefits for SMEs. The fact that these platforms aggregate an infinite number of enterprises and customers worldwide enables firms to understand their competitors' and customers' preferences more clearly and, consequently, developing new products effectively. Additionally, communication and showcasing services help firms to promote and communicate their value propositions to customers worldwide effectively. Another advantage of digital platforms is the low maintenance costs and the fact that online traffic is regular. However, by using these tools, SMEs face higher competition and have lower control (Kim, 2020).

E-commerce transactions can be distinguished according to their application and use - business to consumer (B2C) and business to business (B2B) are two of the existing categories (Villa et al., 2018). B2B e-commerce -*"business activities fulfilled electronically in order to enhance competitive advantage, related to selling, buying, exchanging, or transferring goods, services, and information among organizations."* (Hamad, Elbeltagi, Jones, & El-Gohary, 2015, p. 405). - is usually the first technological tool adopted by SMEs, being a key element to operate effectively and to

compete with their rivals (including larger firms) worldwide (Hamad et al., 2018; Scupola, 2003).

Some researchers have suggested that the most important factors to explain the adoption of different forms of ICT, notably e-commerce, in SMEs are the TOE factors (technology-organization-environment) developed by Tornatzky and Fleischer, in 1990 (W. Chen, Huang, & Lu, 2005; Kuan & Chau, 2001). Technological factors include the relative advantage (considered the most significant factor), compatibility and complexity. Organizational factors, which refers to the firm's characteristics, englobe the top management support and the firm size – the studies regarding this topic are controversial. Some authors defend that there is a positive relation between firm size and adoption of e-commerce. Others do not think these two variables are correlated. Environmental factors include the competitive pressure (in a more competitive environment, SMEs tend to adopt ICT so as to gain a competitive advantage), the business partner pressure, and the government support (considered one of the most powerful facilitators at the beginning of the adoption process of B2B e-commerce) (Hamad et al., 2018; Hamad et al., 2015).

Overall, the adoption of e-commerce as a key medium between businesses and their customers enables SMEs to increase their geographical range, responding more efficiently to competitive pressures and reducing operational costs, being a direct or indirect source of competitive advantage (Abebe, 2014). The adoption of e-commerce is considered to be an attractive alternative for SMEs to gain competitive advantage and have access to global markets, given their inherent constraints, aforementioned (Al-Qirim, 2003; Cassetta, Monarca, Dileo, Di Berardino, & Pini, 2020; Hamad et al., 2018; Hamad et al., 2015). One of the most important e-commerce features is the unprecedented reach in terms of the range of customers that can be addressed quickly and cheaply, as well as the opportunity for firms to exchange information at very low costs (Yamin & Sinkovics, 2006).

However, the adoption of digital technologies, by itself, is not enough to guarantee a sustainable competitive advantage for SMEs (Chesbrough, 2010).

To effectively contribute to the improvement of their competitive advantage and value creation, SMEs need to not only invest in digital technologies- such as e-commerce, big data and analytics, IoT and additive manufacturing – but also to combine these tools with their internal competencies and capabilities (Cassetta et al., 2020; Y. Y. Lee & Falahat, 2019). In fact, the potential of digital technologies depends on the integration of these tools, as well as

on the *"reconfiguration of the existing processes, the organizational structure of firms and the level and type of skills"* (Cassetta et al., 2020, p. 6).

However, and besides the fact that digitalization constitutes an opportunity for SMEs to participate in the global economy, these firms are not ripping the full potential of digital evolution (North, Aramburu, & Lorenzo, 2019; OECD, 2017).

In fact, many SMEs are falling behind in the digital transition, and most of them ignore the potential benefits in productivity and competitiveness as they cannot clearly identify their needs, given their lack of commitment or financial resources to access and effectively use digital tools (Bernaert, Poels, Snoeck, & De Backer, 2014; Hewitt-Dundas, 2006; Jin & Hurd, 2018; OECD, 2017). SMEs' lack of investment in complementary knowledge-based assets, such as human resources and process innovation, as well as their lack of innovation culture and human capital and managerial constraints, constitute other of the problems highlighted (Bernaert et al., 2014; Hewitt-Dundas, 2006; Jin & Hurd, 2018; OECD, 2017).

In addition, SMEs often also ignore the specific internal context in which these technologies are adopted, *"failing to consider digital technologies decisions as an integral part of business practices" (Cassetta et al., 2020, p. 67).*

According to Dethine et al. (2020, p. 20) most SMEs invest in digital tools *"on an ad hoc basis",* a short-term vision, sometimes as an opportunistic manner, without "*following any real global digital transformation strategy"*. These investments often result in investment errors, not being able to trigger the organizational changes that maximize the value creation associated with the company's digital transformation as a whole (Cassetta et al., 2020; Dethine et al., 2020).

Considering these constraints, SMEs need guidance in order to develop a digital strategy that impacts the entire organization and, thus, remain competitive or even engage new markets (Dethine et al., 2020). This guidance can be provided by maturity models, as presented in the section 1.1.3.

However, some empirical research on SME's industry 4.0 adoption highlighted the difficulties encountered in the transition towards i4.0 and some concern in using tools designed for bigger companies (Felch et al., 2019; Igartua et al., 2018; North, Aramburu, & Lorenzo, 2019). Trotta and Garengo (2019, p. 69) went even further by highlighting four main SMEs' concerns and difficulties encountered in the transition towards i4.0:

"1) Practitioners in manufacturing SMEs are dissatisfied with the current maturity scales;
2) Current tools developed for bigger corporations are difficult for SMEs to interpret;

3) SMEs implementing Industry 4.0 are often "Industry 2.0" companies or moving between 2.0 and 3.0; 4) Labour shortage and skills are one of the biggest challenges for SMEs." (p.69)

This reality led some academics to analyze the existing digital maturity models and to cross them with the SMEs' characteristics (Felch et al., 2019; Mittal, Khan, et al., 2018; Trotta & Garengo, 2019; Wiesner, Gaiardelli, Gritti, & Oberti, 2018).

1.2.1. A suitable maturity model for SMEs

Given the difficulties highlighted in the previous section for SMEs to take advantage of existing maturity models - which are generally developed for MNEs and do not fit SMEs' characteristics-, studies have been developed to respond to this failure, notably maturity models designed particularly for SMEs.

According to Wiesner et al. (2018, pp. 83-84) there are some fundamental criteria for a suitable maturity model to SMEs:

(1) Importance of organizational issues: *"It should support an agile company, enabling rapid decision-making and adaptation processes throughout every part of the business and across all business process areas";*

(2) Simplicity and implementation easiness: "*should not be too complicated to be understood, explaining the overall idea of digitalization and its related concepts, clarifying uncertainties instead of creating new ones";*

(3) Guidance: *"guidance provided for SMEs on how to attain a higher level of maturity in their specific domain and to continue in the right direction with their business strategy. It should allow them to position their business against external trends and give a guideline to select suitable technological and smart service options";*

(4) Knowledge required to use a maturity model: *"A high initial knowledge constitutes a sort of entry barrier. (…) Companies perceive the concepts of Industry 4.0 as highly complex with no strategic guidance offered and lack a clear idea of Industry 4.0 resulting in uncertainty regarding benefits and outcomes"*

According to Mittal, Khan, et al. (2018), a maturity model is considered suitable for SMEs if it has a "SME perspective". Overall, these authors concluded that SMEs lag behind when it comes to having AMTs (that are crucial to the improvement of some strategic domains of manufacturing, for example, quality and human resources policies) and also their financial constraints do not allow them to easily adopt or upgrade the existing AMTs. Although SMEs

have an informal structure, their organizational culture is not flexible enough to consider initiatives for cutting-edge technologies and they are not able to invest in market research and analysis. Therefore, many SMEs decisions are based on a "gut feeling" with high risk and uncertainty, as opposed to MNEs decisions that are based on market research and are often discussed by a board of advisors or consultants. SMEs also have lack of employee participation, compared to MNEs, once SMEs have less employees and a big part of them are multi-task, not being able to specialize and, consequently, having difficulties in becoming experts in areas such as automation technology. The collaboration feature is also lacking in SMEs, compared to larger firms. Although SMEs usually have strong relationships with their suppliers, they often do not have alliances with universities and research institutions, hence frequently not being able to share and capture knowledge. Moreover, they usually focus on one specific domain, having to outsource core activities. Notwithstanding, SMEs are already doing well when it comes to the development of specialized products that can differentiate them from the competitors. SMEs' financial constraints also affect how they prepare themselves to follow the existing standards (notably, ISO rules). Therefore, most of them only follow the industrial standards. The differences between SMEs and MNEs' features are presented in Figure 2.

Figure 2- SMEs vs MNEs features

#	Features	SMEs	MNEs
1	Financial Resources	Low	High
2	Use of Advanced Manufacturing Technologies (AMTs)	Low	(Very) High
3	Software Umbrella (incl. Data Analytics)	Low (Often Tailored Solutions)	High (With More Standardized Solutions)
4	Research & Development	Low	High
5	Nature of Product Specialization	High	Low
6	Standards consideration	Low	High
7	Organization culture/ Leadership flexibility	Low	High
8	Company Strategy	Dictated by Instinct Of Leader (Owner)	Market Research & Accurate Analyses
9	Decision Making	Restricted to Leader/ Few Knowledge Carriers	Board of Advisors & (Int./Ext.) Consultants
10	Organizational Structure	Less Complex And Informal	Complex And Formal
11	Human Resources Engagement	Multiple Domains	Specialized Domains
12	Exposure to Human Resource Development	High in The Industry/ Low Outside The Industry	Low Within Industry/ High Outside the Industry
13	Knowledge and Experience Industry	Focused In A Specific Area	Spread Around Different Areas
14	Alliances with Universities/ Research Institutions	Low	High
15	Important Activities	Outsourced	Internal to The Organization
16	Dependence on Collaborative Network	High	Low
17	Customer/Supplier Relations	High (Strong)	Low (Not So Strong)

Source:(Mittal, Khan, Romero, & Wuest, 2018, p. 195)

Therefore, according to Mittal, Khan, et al. (2018), a maturity model has an "SME perspective" when it has in consideration the following dimensions: (1) financial resources, (2) AMTs, (3) industrial standards, (4) organizational culture, (5) employee participation, (6) alliances with universities/research institutions and (7) collaborations.

Therefore, Mittal, Khan, et al. (2018) developed a critical review to the existing MMs and its applications to SMEs, based on the existing literature and case studies. After a detailed analysis of 15 maturity models towards i4.0 - so as to understand the existing gaps when applying them to SMEs - only four of the maturity models studied considered an "SME perspective" for i4.0, according to Mittal, Khan, et al. (2018) - notably Anderl et al. (2015), Qin, Liu, and Grosvenor (2016), Ganzarain and Errasti (2016) and J. Lee, Jun, Chang, and Park (2017).

Notwithstanding, and given the newness of these themes and increasing relevance of SMEs on research, other MMs have been developed since this contribution, some of them developed specifically to fit SMEs. Table1 summarizes some of the existing academic maturity models. Some of the existing consulting Models are presented on Table A1. These MMs will not be critically reviewed as none of them were specifically designed for SMEs and given the fact that most consultancy firms treat their MMs as intellectual property, not making the complete version publicly available. Although the correspondent MMs' dimensions were available, we were not able to identify their description. Therefore, we were not able to draw up conclusions on consulting MMs and will focus our research on academic ones.

Overall, the existing academic frameworks and maturity models can be distinguished by their focus: (1) helping SMEs attain a digitally enabled growth (North, Aramburu, & Lorenzo, 2019); (2) helping SMEs to develop structured innovation processes (Igartua et al., 2018); and (3) helping SMEs understanding their readiness towards industry 4.0 paradigm (Chonsawat & Sopadang, 2019; Igartua et al., 2018; J. Lee et al., 2017; Matt, Rauch, & Riedl, 2018; Müller et al., 2018; Trotta & Garengo, 2019). The last topic is divided into the models that designed an i4.0 adoption framework (Mittal et al., 2020; Qin et al., 2016; Spalinger, Grivas, & de la Harpe, 2018) and the ones that enable enterprises to assess their digital maturity and establish a roadmap for them to improve their level of maturity (Anderl et al., 2015; Ganzarain & Errasti, 2016; Pirola et al., 2019).

Table 1- Academic Frameworks and Maturity Models

	Author(s) and year	Model	Description	Maturity Levels
			Frameworks	
1	Mittal et al. (2020)	A smart manufacturing adoption framework for SMEs	This framework is based on the Mittal, Romero, and Wuest (2018a) maturity model and aims to guide SMEs towards i4.0. This framework is based on the assumption that SMEs are struggling when it comes to innovation and competitiveness and that the adoption of "smart manufacturing" is a competitive edge, being a crucial tool for them to become more efficient in their supply chains. Thus, it proposes a framework with five vital steps: (1) identify manufacturing data available within the SME; (2) readiness assessment of the data-hierarchy steps; (3) Developing SM awareness of SME leadership and staff; (4) develop an SM tailored vision for the SMEs; and (5) identify appropriate SM tools and practices necessary to realize the tailored SM vision.	It does not assess maturity levels.
2	Spalinger et al. (2018)	TEA Influence Framework	TEA (Technology Evaluation and Adoption Influence Framework) aims to contribute to SMEs' successful digital transformation. It does not provide step-by-step evaluation and adoption guidelines, as the framework is designed for use in the first phase of the digital transformation, which is dedicated to the preparation of the transformation. This framework comprises two dimensions (internal – culture, IT landscape, resources, IT knowledge, and used practices - and external- Government, competitive field, partner and customer and consultant and vendor), containing influencing factors. The TEA Influence Framework can, therefore, be used to determine the challenges for evaluating and adopting related technologies.	It does not assess maturity levels.
3	Qin et al. (2016)	A Categorical Framework of Manufacturing for Industry 4.0 and Beyond	This framework is composed of a set of technologies that can help SMEs achieve the i4.0 paradigm. These authors considered automation and intelligence capabilities as the enabler for i4.0. This framework only involves production applications in the factory range and lower intelligent technologies, where the Industry 4.0 "ready" is beyond it. However, it draws a development roadmap for accomplishing Industry 4.0.	It does not assess maturity levels.
			Maturity Models	
4	North, Aramburu, and Lorenzo (2019)	DIGROW – Framework	This framework aims to guide the digitally-enabled growth of SMEs. Therefore, it sets a baseline regarding the current position and supports coordinated initiatives for digitally-enabled growth. Thus, evaluates for dimensions: *"1. Sensing digitally-enabled growth potentials: searching for digitally-enabled growth opportunities, understanding and developing digital customer needs, sensing technology-driven opportunities, use of external sources for digital innovation.* *2. Developing a digitally enabled growth strategy and mindset: Digitally enabled growth strategy, digital leadership, digital mindset (attitudes & behaviors), empowered employees.* *3. Seizing digitally-enabled growth potentials: Digitally enabled business models, digital market presence, digital customer experience, agile implementation/deployment of digitalization initiatives.* *4. Managing resources for digital transformation: Digital skills & learning, digital processes, digital technology & security, digital investments."* (North, Aramburu, Lorenzo, & Zubillaga, 2019, p. 247).	Each dimension is evaluated from level 0 to 5.
6	Ganzarain and Errasti (2016)	Three Stages Maturity Model in SMEs towards Industry 4.0	This model describes a strategic development path for the digitization of SME. The model's goal is to guide and train companies identifying new opportunities for diversification in areas within Industry 4.0. Three stages compose this model: (1) Envision; (2) Enable; (3) Enact 4.0; Systematically	(1) Initial: does not exist a company-specific 4.0 vision; (2) Managed: the company has a roadmap of i4.0 strategy;

			carrying out the stages will take a company to their specific vision and collaborative vision between different companies within Industry 4.0.	(3) Defined: customer segments, value proposition, and critical resources are defined; (4) Transform: the transformation of the strategy into concrete projects; (5) Detailed Business Model: the transformation of the BM towards i4.0
3	Müller et al. (2018)	Stage Model of manufacturing SMEs in the context of Industry 4.0	This model does not present the dimensions used so as to determine the levels of maturity, neither develop a roadmap for firms to improve their maturity level.	This stage model defines the following four maturity levels for firms to analyze their position towards i4.0 and, consequently, helps them understand how to derive benefits from i4.0: (1) Craft manufacturers; (2) preliminary stage planner; (3) industry 4.0 users, and (4) full-scale adopters.
7	Trotta and Garengo (2019)	Assessing Industry 4.0 Maturity: An Essential Scale for SMEs	This model was developed to support the SMEs' implementation of i4.0 and is composed of five organizational dimensions: (1) strategy; (2) technology; (3) production; (4) products; (5) people. After responding to a survey, SMEs receive a "radar chart" to understand their level of maturity and the existing critical areas to improve their digital maturity.	The items of each dimension are evaluated between 1 and 5. Level 1 corresponds to "not implemented/not presented", and 5 corresponds to "completely implemented/presented".
8	Chonsawat and Sopadang (2019)	The development of the maturity model to evaluate the smart SMEs 4.0 readiness	This model consists of an i4.0 maturity model and aims to evaluate Smart SMEs' readiness. Therefore, this model is composed of five organizational dimensions and 43 sub-dimensions. The five significant dimensions are (1) Manufacturing and Operations, (2) People Capability, (3) Technology Driven Process, (4) Digital Support, and (5) Business and Organization Strategy.	Each of the 43 sub-dimensions is evaluated from 0 to 4: Level 0 -dimension is not relevant in their organization; Level 1, the critical dimension is relevant but not implemented in the organization; Level 2 - the dimension was implemented in some area of the organization. Level 3 was implemented in most areas of the organization; Level 4 was full implementation.
9	Blatz, Bulander, and Dietel (2018)	Maturity Model of Digitization for SMEs	This model aims to understand the digital maturity level of SMEs and is composed of 5 dimensions: (1) strategy and leadership; (2) company, culture and organization; (3) IT infrastructure; (4) data maturity; (5) process and operations; (6) product (use-phase).	The items can be rated according to a Likert scale (from 0 to 4), where 0 corresponds to "totally disagree," and four correspond to "fully agree. There are three possible levels of maturity: 1- Digitization steps in the company are taken, but no mature approach has been defined. The impact on the company and processes is minimal; 2- Some digitization steps are described formally and are executed accordingly. 3- Quantitative objectives and their evaluation are set—reflection and adaption of actions of digitization.
10	Igartua et al. (2018)	IM2, a maturity model for innovation in SMEs	This model aims to guide small SMEs (10-20 people) towards innovations, providing clear and defined directions to develop structured innovation processes. Therefore, evaluates 11 categories/specific aspects of management evaluating their maturity level: (1) Strategy; (2) Competitiveness; (3) Manufacturing Excellence; (4) Innovation; (5) Value Propositions and BM; (6) Internationalization; (7) Advanced Management; (8) Digitalization; (9) Sustainability; (10) People; (11) Territory.	1. Unaware: Do not care or know – fragile situation; 2. Aware: Do know and care, poorly managed a weak situation; 3. Manage: Management often reactive; 4. Defined: Organization is proactive; 5. Performance: Open innovation approach.
11	Pirola et al. (2019)	Digital Readiness Level 4.0 (DRL4.0)	The DRL 4.0 was specially designed for SMEs to assess their current position regarding the digital transformation process before starting their journey towards "smart manufacturing" (i4.0). Thus, this tool evaluates five different dimensions: (1) Strategy, (2) People, (3) Processes, (4) Technology, and (5) Integration. This model is structured to fit SMEs organizational structure and not require specific a priori knowledge.	The dimensions are divided into 46 questions. The DRL has five levels. DRL 1: $1<I\leq1.8$: Identifies a company not involved in I4.0 pilot initiatives; DRL 2: $1.8<I\leq2.6$: Identifies an intermediate-level company that includes i4.0into its strategic orientation; DRL 3: $2.6<I\leq3.4$: Companies that has formulated an i4.0 strategy and are investing in promoting the introduction of SM;

			After defining each firm's DRL, identify the strengths and weaknesses, and develop a personalized roadmap towards i4.0.	DRL 4: 3.4<I≤4.2: Companies that have are already implementing i4.0 strategy and are monitoring its development with suitable indicators; DRL 5: 4.2<I≤5: Companies that have already implemented i4.0 strategies and are continuously monitoring its implementation.
12	Matt et al. (2018)	Industry 4.0 self-assessment model	Development of a self-assessment model. This model evaluates (1) operations; (2) technology; (3) organization; (4) socio-culture. Each dimension is composed of 3 sub-dimensions, and each sub-dimension has inherent i4.0 methods. On a scale from 1 to 5, each method should be classified by their current status and the target status, and the company should refer if the current competences are internal or external to the organization.	In order to identify the level of i4.0 maturity, each i4.0 method is evaluated within a Likert Scale, from 1 to 5.
13	Imgrund, Fischer, Janiesch, and Winkelmann (2018)	PEMMDO – A maturity model for digital transformation	PEMMDO – Process and Enterprise Maturity Model for Digitalized Organizations – is an extension of the PEMM (process enterprise maturity model) framework (Hammer, 2007) and aims to serve as an orientation for SMEs seeking to embark on the digital transformation journey, helping them to address their challenges. Therefore, besides the PEMM dimensions: enterprises capabilities (leadership, culture, expertise, and governance) and process enablers (design, performers, owners, infrastructure, and metrics), PEMMDO defend that SMEs need to have some digital capabilities so as to approach digitalization: (1) digital strategy; (2) digital awareness; (3) mindset and (4) security.	Non-identified by the authors.
14	Anderl et al. (2015)	Guidelines for Industry 4.0	This tool provides guidelines for firms to assess their vision of i4.0, based on the nature of German SMEs. These guidelines include the possible implementation of "toolbox" with various characteristics, technologies, etc., in at five stages, notably: (1) preparation – knowledge base; (2) analysis – competencies and internal projects; (3) creativity – ideas and business models; (4) evaluation; and (5) implementation.	Each stage corresponds to a different level of maturity.
15	J. Lee et al. (2017)	Analytic Network Process	J. Lee et al. (2017) developed a five-level maturity model considered for achieving i4.0. However, the steps to evaluate the level of maturity are not identified.	(1) Checking; (2) Monitoring; (3) Control; (4) Optimization; (5) Autonomy.

Source: Own Elaboration

Although most of these models were designed specifically for SMEs, each SME has its specificities and, thus, a tailored approach may be the most appropriate one (Mittal, Khan, et al., 2018). A tailored approach considers the unique needs of the organization and was applied by Qin et al. (2016), Anderl et al. (2015), and Mittal et al. (2020). Thus, SMEs may approve the technologies that fit their vision, considering their financial constraints. In this field, the DRL4.0 developed by Pirola et al. (2019) stands out since the questions are structured to suit SMEs organizational structure, and the calculation of the DRL4.0 depends on the SME's context, its vital statistics, and the situation in which each analyzed SME finds itself. Therefore, this model identifies each maturity level, strengths, and weaknesses and develops a customized roadmap towards i4.0.

Moreover, SMEs and MNEs have different starting points regarding their journey towards i4.0. Thus, the MMs that fit SMEs need to address a "level 0" of maturity to help them manage their financial resources, invest in technology, and increase their employee participation and organizational culture (Mittal, Khan, et al., 2018). According to Mittal, Khan, et al. (2018, p. 221), *"a "level 0" may be defined as the stage where organizations are neither aware and nor they have started inclining themselves towards SM or Industry 4.0"*. This existence of a "level 0" was also applied by Ganzarain and Errasti (2016) "initial" stage, where SMEs do not have a specific 4.0 vision, by Müller et al. (2018) "craft manufactures" stage, characterized by a disinterest towards i4.0 based on their structural and manufacturing characteristics, and by Pirola et al. (2019) "DRL1" stage, where companies are not involved in i4.0 pilot initiatives. Blatz et al. (2018), on the other hand, defines only three maturity stages to address SMEs' digitalization, and the lowest level corresponds to "level 1" where digitization steps have already been taken, but there is no mature approach yet identified. Regarding the remaining MMs, we were unable to identify the different levels of digital maturity.

In general, all the MMs studied used a holistic view of the organizations, focusing on dimensions such as strategy, organizational processes, culture, people (employee participation), and technologies. It is important to emphasize that the technological dimension is considered in every maturity model, and the employee dimension was taken into account in the majority of them, only excluding J. Lee et al. (2017) and Qin et al. (2016) models. However, the "standards" dimension was not taken into account in any of the maturity models. Concerning the "financial" dimension, only the tailored approaches and the PEMMOD, developed by Imgrund et al. (2018), had SMEs' financial constraints in consideration. The IM2 ("A maturity model for innovation in SMEs") developed by Igartua et al. (2018) covers the broadest range of dimensions, being the only one considering the

"internationalization" dimension. These authors defend that internationalization plays a crucial role in competitiveness and innovation, and that "*internationalization processes must be taken into account according to the activities and resources of the company, as well as their business and innovation strategy*" (Igartua et al., 2018). Besides this, the IM2 also highlights the importance of micro-SMEs cooperation with Universities and Local Agencies, an aspect that Mittal, Khan, et al. (2018) considers essential to meet the "SME perspective", but this was not taken into account by any of the other models.

Overall, efforts on developing a suitable maturity model for SMEs have been made by scholars. In the next subsection, we will analyze the empirical evidence on SMEs' adoption of digital technologies and their digital maturity.

1.2.2. Empirical evidence on SMEs and digital maturity

Although there is no systematic evidence about the adoption of digital technologies by SMEs, some surveys and case studies were developed in this field in the past few years. Evidence from an online survey to Irish SMEs, developed by Harrigan, Ramsey, and Ibbotson (2011), shows that SMEs are adopting relatively simple internet-based technologies in order to be competitive, resorting from digital platforms. Kennedy and Hyland (2003) analyzed 632 SMEs (both OECD and Non-OECD) and concluded that SMEs are not involved when it comes to deployment of advanced manufacturing technologies, mainly because of their financial constraints.

Mittal et al. (2020, p. 1568) applied their framework to two Indian manufacturing SMEs (with a case study approach) and concluded that, overall, *"SMEs are not aware of the impact data analytics can have on their business"* - keeping themselves away from the advantages of data-driven decision making – or even underuse the resources available. Notwithstanding, they also concluded that SMEs are ready to invest in industry 4.0 technologies.

Müller et al. (2018) studied 68 manufacturing Germany SMEs and concluded that the adoption of i4.0 is cautious and that these firms are still trying to understand the impact of BMI in value creation (Felch et al., 2019). In fact, 38% of the SMEs analyzed were still on the basic level of maturity, "craft manufacturers", meaning that they are not interested in the adoption of i4.0 (Müller et al., 2018).

DIGROW-Framework was applied to a sample of 52 Spanish SMEs to understand their level of maturity for digitally-enabled growth (*vide* Table1). Overall, these firms have a moderate level of digital maturity. Although they have adopted some digital initiatives, they cannot clearly identify their strategy, compromising their future growth, and also have lack of resources to benefit from digitalization opportunities (North, Aramburu, Lorenzo, et al., 2019). Specifically regarding the third level – "Seizing digitally enabled growth potential "- they concluded that 63.46% of firms are able to develop digitally-enabled BMs and 61.53% are implementing digitalization initiatives (having a level of maturity above level 3). However, for the majority of the companies their presence in digital markets is low (76.93% of firms are below level 3 in this dimension), as well as their digital interaction with customers (55.77% of the companies are below level 3 in this dimension) (North, Aramburu, & Lorenzo, 2019).

The DRL 4.0 was applied to 20 Italian SMEs in order to understand their digital readiness towards i4.0. As presented on Table1, the DRL can have five levels, depending on their index (I). This index is composed of 5 dimensions (strategy, people, processes, technology and integration). The average index of digital readiness ($\bar{I}$) is 2.9, meaning that, in average, Italian SMEs are positioned in DRL 3, which means that companies are currently approaching the path towards i4.0 and the digitalization of their process. Moreover, none of the examined SMEs was positioned on the DRL 5, meaning that none of them is in the higher level of digital maturity, thus room for improvement remains. It is, however, important to notice the modularity of the questions, as explained in the previous section. This average index would be lower if the calculation of the "DRL" had not taken into account each SMEs' specific characteristics (Pirola et al., 2019).

1.3. Digitalization and Internationalization

"Digitalization has been identified as an element that fosters the internationalization of SMEs" (Dethine et al., 2020, p. 18).

Internationalization – the foreign expansion of firms' business activities (Ruzzier, Hisrich, & Antoncic, 2006) - has been one of the trend topics on research in the past few decades, specifically when referring to SMEs, once they are facing international constraints similar to the ones faced by larger firms, due to today's international marketplace (Ruzzier et al., 2006). However, the literature on SMEs' internationalization through digitalization remains scarce,

mostly focusing on Born Global or International New Ventures – SMEs that internationalize within three years since their official establishment, typically entering foreign markets through exports. These firms differ from traditional SMEs that mostly operate in domestic markets by not having restricted resources and actively exploring foreign markets' opportunities (Y.-Y. Lee, Falahat, & Sia, 2019).

With the decrease of government-imposed barriers and the technological improvements, the world is becoming increasingly integrated, and SMEs are facing new opportunities to expand its activities to foreign markets, such as through digital platforms and GVCs, thus being an interesting topic of research in International Business (Lu & Beamish, 2001; WTO, 2019).

In this section, we will analyze SMEs' resources and capabilities that are necessary to obtain a sustainable competitive advantage overseas and the impact of digitalization on SMEs' international strategies, focusing on the entry modes.

1.3.1. SMEs' digital capabilities and internationalization

Due to today's digital economy and the fact that the Internet provides a new channel for commercial relationships, marketing and sales, and also enables the increased knowledge on markets and potential competitors, distance and entry costs are decreasing, and some trade barriers are being exceeded (Jin & Hurd, 2018). Overall, SMEs must have strategic capabilities in order to succeed in international markets. Digitalization is itself a specific resource that contributes to a company's competitive advantage (Dethine et al., 2020).

Y. Y. Lee and Falahat (2019) analyzed the existing academic literature regarding SMEs' crucial resources and capabilities to succeed overseas. They concluded that SMEs with strong international capabilities (1) must have advanced innovation skills (both product and process innovation), (2) control its productivity and production costs to meet price flexibility, (3) and have strong marketing capabilities to introduce their products in new markets effectively. Notwithstanding, SMEs should also have strong learning capabilities (dynamic capabilities), supporting product and process innovation, and effectively responding to the changing environment.

Although having digital technologies is not enough to have a sustainable competitive advantage regarding their products or services, it may help manufacturers SMEs to gain a better position internationally through exports if they have a price advantage compared with

their competitors. Firms that do not have capabilities sufficiently strong in order to have a competitive price may instead bet on their products and services advantages, mostly competing with niche strategies (Y. Y. Lee & Falahat, 2019).

Some authors defend that besides having digital technologies and dynamic capabilities, having a strong market-oriented strategy, that includes capabilities such as distribution networks, market knowledge, and customer relationships, can also be crucial to obtain sustainable competitive advantage once it provides particular knowledge about the foreign markets (Knight & Cavusgil, 2004). According to the World Trade Organization (2016), once SMEs engage in internationalization and have already acquired experience and built a network of partners and customers, this experience becomes a capability, also being a source of competitive advantage. However, given the complexity of the international process and the associated disruption within companies, SMEs find it challenging to develop an international strategy and engage a global digital transformation (Dethine et al., 2020).

According to Leonidou (2004), difficulties in developing an international strategy are related to enterprises' internal and external characteristics. On the one hand, internal aspects refer to the resources, organization capabilities, and company's vision, notably lack of financial resources, skills or time, and knowledge about the foreign markets. On the other hand, the external difficulties are related to the internal or external business environment. Costa, Soares, and de Sousa (2020) defend that the SMEs' challenges in accessing an international strategy are their difficulties in establishing a customer's network to compete in foreign markets and identifying and managing the right information.

Adopting digital technologies on an "*ad hoc*" basis instead of following a global digital transformation strategy and the fact that SMEs usually have a short-term vision inhibit SMEs from having a profound transformation, often resulting in incremental development (Dethine et al., 2020). Therefore, in order to keep pace with technological developments, SMEs need guidance in developing their digitalization strategy, prioritizing actions to enable an effective and efficient digital transition (Goerzig & Bauernhansl, 2018). Hence, it might be essential for them to assess their digital maturity, understanding how capable they are of achieving continuous improvement, as well as having access to steps to attain a higher level of maturity and, consequently, having a profound transformation on their organization and a sustainable competitive advantage overseas .

It seems interesting to explore the relationship between digitalization and SMEs' internationalization, understanding how digitalization impacts traditional SMEs' entry modes decisions on the foreign markets.

1.3.2. Impact of digitalization in SMEs' international strategies – entry modes:

When deciding to internationalize, firms must strategically decide the most appropriate entry modes. An entry mode "*is an institutional arrangement chosen by the firm to operate in the foreign market.*" (Kumar & Subramanian, 1997, p. 53) and can be divided into exports, contractual modes, and foreign direct investment (FDI) (Malhotra, Agarwal, & Ulgado, 2003; Pan & David, 2000).

According to Pan and David (2000, p. 535) firms' entry modes decisions are "*closely associated with varying degrees of resource commitment, risk exposure, control, and profit return*", thus being classified as equity – including wholly-owned operations and equity joint ventures (EJVs) - or non-equity modes –contractual agreements or exports. Therefore, while equity modes usually have greater risks and return associated, involving more financial resources, non-equity modes do not need the establishment of an independent organization on the foreign market, hence having, in general, less risks and costs involved. The decision of which are the better methods for serving overseas differs between firms and, according to Helpman, Melitz, and Yeaple (2004), firms opt for exports when the trading costs underweight the costs of maintaining operations in multiple markets.

However, most of the research in this domain focuses on multinational enterprises (MNEs), and the knowledge on how SMEs enter foreign markets is still limited (Laufs & Schwens, 2014). According to Collinson and Houlden (2005), SMEs need to be especially cautious in that choice, given their lack of experience, skills, and know-how. Moreover, SMEs' resource constraints can limit its ability to fully commit to a foreign market by choosing high commitment foreign market entry modes, such as setting up a subsidiary abroad (Dethine et al., 2020; Ripollés, Blesa, & Monferrer, 2012). That being said, and due to SMEs' flexibility, exporting is the primarily mode of entry chosen by SMEs when addressing foreign markets (Young, Hamill, Wheeler & Davies, 1989, retrieved from Kirby and Kaiser, 2003). Exports channels can be distinguished by direct (company-owned subsidiaries or foreign distributors) and indirect (agents or export intermediates) (Kim, 2020).

In particular, manufacturing SMEs tend to expand their businesses internationally, firstly as direct or indirect exporters, the two entry modes with less risk involved, and secondly through FDI (EC, 2014).

These strategic decisions are influenced by digitalization, once it can contribute to the mitigation of traditional barriers to internationalization and, thus, affect the entry modes chosen by SMEs in the digital era (Jin & Hurd, 2018; Zekos, 2005).

Firstly, the Internet is shifting the landscape of SMEs internationalization by promising a *"fast-track option of international expansion"* (Kim, 2020; Pezderka & Sinkovics, 2011, p. 409).

"Internetalization" (Bell, Deans, Ibbotson, & Sinkovics, 2001) and AOI -"Active online internationalization"(Yamin & Sinkovics, 2006) – are two terms used to refer to the application of ICT to the internationalization process and represents a new form of market entry which takes place *"in the virtual rather than the real or special domain*" (Yamin & Sinkovics, 2006, p. 340). The main differences between the traditional market entries (explained previously) and the AOI are the fact that, even if the firm's assets or activities are dedicated to a specific foreign market, with AOI, there is no need of any level of foreign investment (characterized by having high risk and costs associated) (Pezderka & Sinkovics, 2011; Yamin & Sinkovics, 2006). "Online internationalization" can be applied differently between products and services that are entirely digitized and the ones that are not (such as manufactured products). In the case of the products or services that are not entirely digitized, online internationalization only refers to the value chain segments conducted online (sales, for example) (Yamin & Sinkovics, 2006).

Additionally, by adopting cross border e-commerce, the costs of going overseas through exports decreases, and SMEs can expand its businesses internationally while remaining in their home country (Cusolito, Safadi, & Taglioni, 2016; Eduardsen, 2018; Yamin & Sinkovics, 2006). The use of online platforms (their website or marketplaces) helps reducing transaction costs, as well as costs associated with advertising and promotion, speeding the communication between parts, reducing delivery costs, and removing physical limitations of time, enabling SMEs to reach global and niche markets faster and with greater ease (Andersen, 2005; Chulikavit & Rose, 2003; Nejadirani et al., 2011; WTO, 2019). Thus, digitalization can expedite SMEs' internationalization with limited budgets for large-scale market entries, preferably through exports (Wittkop et al., 2018).

It is also expected that the direct sales channels structures surpass the indirect ones (agents and export intermediaries) due to the development exploitation of web sales. Therefore, the range of activities that were so far performed by an export market intermediation can be reallocated to other parties in the export marketing channel (Andersen, 2005). Therefore, as Kim (2020) referred to, the Internet may be seen as a low cost medium for internationalization.

Secondly, SMEs' internationalization decisions may also be promoted by their participation in GVCs. SMEs may join GVCs having a direct and/or indirect forward participation, by exporting intermediated goods or services directly or by supplying inputs to a local firm or MNE. Therefore, they do not need to master the entire production process, focusing on specific segments of the supply chain. SMEs may also be a part of GVCs by importing products as inputs to its production or sourcing products from local firms that use imported inputs, thus having access to new technologies, more sophisticated and competitively priced imports, or even having access to inputs that may not be accessible on domestic markets (OECD, 2008). Hence, this fragmentation of production is also opening new opportunities for SMEs to participate in international trade, once they can more rapidly be able to export "tasks" along GVCs than final products (C.-L. Chen, 2019; Joensuu-Salo et al., 2018; Strange & Zucchella, 2017). GVCs also reduce the need for SMEs to be near to the end-user (specifically when transaction costs are high), promoting the adoption of contractual modes instead of FDI.

Notwithstanding the benefits associated with FDI, with digitalization and its impact on the reduction of international barriers, it is expected that the costs of investing in foreign markets surpass the trade costs, as well as a reduction of location-specific advantages, reducing the importance of FDI towards exports (WTO, 2019; Zekos, 2005). Evidence shows that FDI worldwide is decreasing and that this pattern will continue in the following years. According to UNCTAD (2019), the adoption of digital technologies in many industries is contributing to a change towards intangible assets as well as asset-light ways of international production, reducing the need to heavily invest in foreign markets.

Hence, an increasing relevance of exports and contractual modes may be expected, as well as a reduction of the importance of FDI in SMEs' internationalization decisions (UNCTAD, 2019; Wittkop et al., 2018; WTO, 2019)

Chapter 2. A bibliometric analysis of the impact of digitalization on SMEs' strategic decisions, focusing on internationalization

This chapter aims to explain the methodological approach chosen to respond to this dissertation's main research question: "How does digitalization impact SMEs' strategies, particularly in what concerns internationalization?".

Ideally, this study intended to answer the research question through an empirical analysis of databases, with enterprises' real data. Given the novelty of this subject, there are still no databases available on this subject, and we were not able in a reasonable time to gather that information - due to the pandemic outbreak.

As the literature is expanding and already has a critical mass, we chose to do a bibliometric analysis to capture the latest work on this field. Since the correlation of digitalization and SMEs' internationalization is still an emerging trend and very recent phenomenon, we believe that by analyzing and integrating the largest number of literature related to the theme, it will be possible for us to obtain the much-needed quantitative contribution - complementing the qualitative contribution made in the previous chapter with the literature review.

2.1. Methodology

We will perform a bibliometric analysis on Digitalization and SMEs, focusing on internationalization, evaluating the main trends of research, notably the most influential and cited authors, articles, and journals. This investigation's overall purpose is to draw up the Digitalization and SMEs' internationalization state-of-the-art at the end of the methodological approach. Hence, allowing us to find patterns in the evolution of the digitalization's role in enterprises' internationalization strategy.

Therefore, by applying bibliometric techniques (this topic will be further explained), we will be able to identify the state of the art of this field of knowledge and potential research gaps and knowledge boundaries(de Oliveira, da Silva, Juliani, Barbosa, & Nunhes, 2019).

Bibliometric analysis has been increasingly used and became a practice generalized for almost all knowledge fields over the past century (Hood & Wilson, 2001). The increasing relevance

of bibliometrics is based on the fact that this methodology provides essential information about the influence, specializations, and trends of a given research field, involving a more objective assessment of scientific research standards compared to the traditional literary review. (Cobo, Martínez, Gutiérrez-Salcedo, Fujita, & Herrera-Viedma, 2015; de Oliveira et al., 2019; Du & Teixeira, 2012; Manriquez, Andino-Navarrete, Cataldo-Cerda, & Harz-Fresno, 2015).

The term "bibliometrics" is frequently credited to Pritchard (1969) and is defined as *"the application of mathematics and statistical methods to books and other media of communication"* (p.368). Over the years, many definitions have been proposed in the literature (Du & Teixeira, 2012). For instance, Broadus (1987) defines bibliometric analysis as: *"... the quantitative study of physical published units, or of bibliographic units, or of surrogates of either ..."* (p.376), and Ferreira, Santos, de Almeira, and Reis (2014) defend that bibliometric studies *"…use the extant published research to examine and delve into the patterns and trends of what has been published, thus helping explore, organize and make sense of the work that has been done in a certain discipline or subject of study"* (p.2551). Another definition is the one provided by OECD, where "*Bibliometrics is a statistical analysis of books, articles, or other publications."* (OECD, 2020) – taken from the website, no page defined. Although these definitions may have discrepancies, they all have a common purpose underlying: measuring the outputs of the scientific literature and evaluating its impact in a specific study area, using quantitative, mathematical, and statistical methods.

The application of bibliometric techniques will be based on the method put forward by Teixeira (2014) and Archambault and Gagné (2004). The application of these bibliometric techniques will enable the evaluation of this topic's productivity in terms of the output delivered in academic journals and reference publications, through publication counting and abstract analysis. Additionally, we will also identify the records, authors, and scientific journals that have had the most significant impact in this field.

After defining the field of study, the first step was to define the bibliographic databases that better suit the research. This step's importance lies in the fact that bibliometric analysis's validity depends on the research platforms' quality. In this field, two of the most used platforms are Web of Science (WoS) and SciVerse Scopus (SCOPUS) - two of the world's most extensive citation indexes and premier research platforms, enabling the access of thousands of articles provided by publishers such as Elsevier, Springer, and Google Scholar (de Oliveira et al., 2019; Martín-Martín, Orduna-Malea, Thelwall, & López-Cózar, 2018; Parida et al., 2019).

Both WoS and SCOPUS are multidisciplinary databases with a high citation index. On the one hand, WoS, the oldest citation resource, features the most prestigious academic journals, books, publications, proceedings, and patents (WoS, 2020). This platform covers over 161 million records in 254 different subject areas. On the other hand, and although SciVerse SCOPUS only appeared on 2004, this platform has the largest abstract and citation database of peer-reviewed literature (SCOPUS, 2020), including scientific journals, books and conference proceeding, and combine the characteristics of the existing databases, including WoS, enabling a more precise and personalized search (Falagas, Pitsouni, Malietzis, & Pappas, 2008).

These databases are recognized as reference platforms by the scientific community and provide overall results, increasing the study's relevance and interest, being the ones applied to this dissertation. Using these two distinguished and recognized databases, we will be able to build our research on a more consistent bibliometric analysis.

After defining the bibliographic databases, we selected the fundamental keywords for our research topic in order to have access to the broader set of publications. Therefore, we combined the various designations of "digitalization", notably "digitization", "industry 4.0", "digital transformation", "smart factory", or "smart manufacturing" (and their abbreviations) with the keywords "internationalization" as well as the entry modes, and combined them with the keyword "small and medium-sized enterprises" and its acronym. However, by executing this search, we realized that that were only 25 potential publications available (both from WoS and SCOPUS) - which demonstrates a gap in the literature in this field - and decided to perform two separate investigations, combining the various denominations of digitalization, as presented supra, with internationalization **(search 1)** and combining digitalization with SMEs **(search 2).** The combination of keywords is presented on Table 2.

Table 2- Research Selected Keywords

	Keywords		
Search 1	"Digitalization" "Digitalisation" "Digitization" "Digitisation" "Industry 4.0" "Industrie 4.0" "I4.0" "Smart Factory "Smart Manufacturing" "Digital Transformation"	AND	"Internationalization" "Internationalisation" "FDI" "Foreign Direct Investment" "Contractual Modes" "Contractual Forms" "Franchising" "Licensing" "Turnkey Project" "Technical Agreement" "Service Contract" "Management Contract" "Exports" "Exporting" Outsourcing" "Reshoring" "GVCs" "Global Value Chains
Search 2	"Digitalization" "Digitalisation" "Digitization" "Digitisation" "Industry 4.0" "Industrie 4.0" "I4.0" "Smart Factory "Smart Manufacturing" "Digital Transformation"	AND	"SMEs" "Small and Medium-Sized Enterprises"

Source: Own Elaboration

Although the elaboration of the bibliographic research has already been done, since the present dissertation would be delivered in September 2020, we chose to make the last update of our research on July 27th in order to have the most updated database possible. The research was restricted to the following research areas under study: On WoS, we restricted to Business, Finance, Management, Business finance, and International relations, and on SCOPUS, we restricted to Business, Management, and Accounting. The results of the research are presented on Table 3.

Table 3- Research results: WoS and SCOPUS

Keywords	WoS	SCOPUS	WoS + SCOPUS	Duplications	Abstract not available	Language	Total
Search 1	137	191	328	86	2	23	217
Search 2	121	247	368	58	1	26	283
Source: Own elaboration							500

Both **search 1** and **search 2** were exported to two different spreadsheets and consolidated on an Excel Spreadsheet with the following fields: Author's names; Title of the article; Year of publication, Source title, Total number of citations; Abstract; Author's keywords, Document type, Database, Link; References.

After homogenizing our database and removing the duplicates, both on **search 1** and **search 2**, we proceeded to eliminate the publications that did not have their abstract available or were written in other languages rather than English, Portuguese and Spanish. Hence, we reach 217 publications from **search 1** – relatively to internationalization – and 283 publications from **search 2** – relatively to SMEs.

By summing up the total of **search 1** and **search 2** we reached 500 publications, but 37 of them were duplicates, which leads us to a total of 463 publications. Additionally, we limited the type of publications, excluding erratums (1) and conference reviews (11), which lead us to a database composed of 451 papers.

Therefore, by analyzing all titles, abstracts, and keywords, and if needed, the paper itself, we only considered the documents that presented a relation between digitalization and firms' digital strategies. From this analysis, 125 records were excluded, and we were not able to find 28 publications. Thus, **298** publications were considered pertinent to this investigation. Of 298 publications, 65 papers focused only on internationalization, 179 focused only on SMEs strategies, and 40 focused on Internationalization and SMEs. Fourteen papers did not focus either on SMEs or digitalization but were also considered once they investigated digitalization's impact on the firm's strategic decisions.

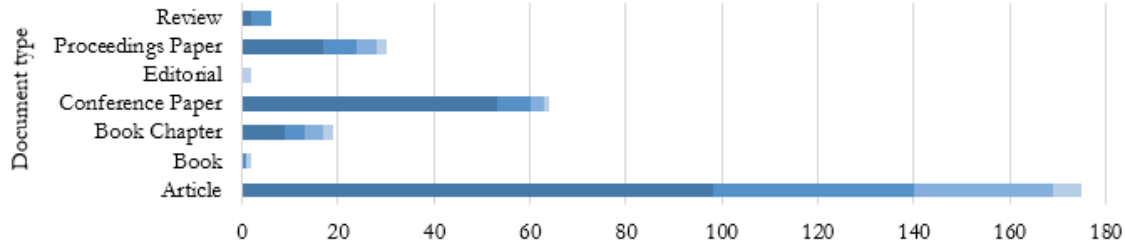
The different types of documents were also identified. According to Schembri (2007) the research documents can be distinguished, notably, between primary and secondary literature. On the one hand, primary literature includes articles and conference papers, documents published in a peer-reviewed scientific journal. Proceeding Papers will also be included in

this category. This type of document was denominated by WoS and consists of conference papers that were peer-reviewed and adapted to be published in scientific journals (González-Albo & Bordons, 2011). By being subject to the scrutiny of other scientific experts in the same field, a peer-reviewed publication provides a reliable form of scientific communication (Kelly, Sadeghieh, & Adeli, 2014). On the other hand, secondary literature includes books, book chapters, and reviews and consists of publications that rely on primary sources for information, once their purpose is to synthesize knowledge in a specific area (Schembri, 2007).

From this sample, we were unable to find the full paper of 28 publications and, consequently, did not include them in our analysis, we would like to highlight that: (1) 96.4% of the papers were published since 2015, with one paper from 2010 – corresponds to 3.6%; (2) analyzing their document type, we reached ten articles, two books, three book chapters, seven conference proceedings, and six proceeding papers. (3) These publications were not highly cited, with only one article with 15 citations – "*The Long-Tail Strategy for IT outsourcing*" developed by Ning Su, Natalia Levina, and Jeanne W. Ross in 2016.

Overall, as presented in Figure 3, our database is mostly composed of articles published in journals (58.72%). Conference papers also have a high weight on this database (21.48%), followed by proceeding papers (10.07%). As for the application of the bibliometric techniques, we will be using all document types in order to draw conclusions on the most updated and relevant data on this emerging topic.

Figure 3- Document type, according to the research focus



	Article	Book	Book Chapter	Conference Paper	Editorial	Proceedings Paper	Review
SMEs	98	0	9	53	0	17	2
Internationalization	42	1	4	7	0	7	4
SMEs and Internationalization	29		4	3	0	4	0
Others	6	1	2	1	2	2	0

Source: Own Elaboration

Note. The topic "others" refers to the publications that focused on enterprises' strategies, but not specifically referred to SMEs or internationalization.

2.2. Main Trends on Research: Results

This section explores the bibliometric analysis's results of digitalization's impact on SMEs strategies, focusing on internationalization. From now on, our research topic will be referred to as "Digitalization, Internationalization, and SMEs" for easier reading. By analyzing the main trends in research, we will be able to better assess the current state and evolution of our research topic, the limitations, and possible contributions for future investigation. Once our research is divided into SMEs and Internationalization, some of the following subsections will explore the results separately.

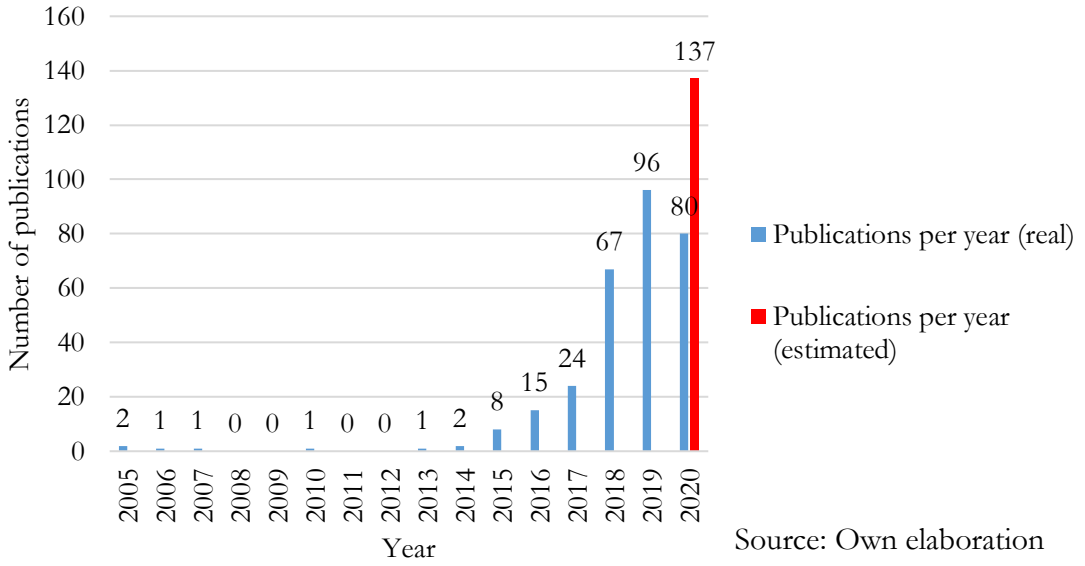
This section will be divided into (1) analyses of the chronological evolution of Digitalization, Internationalization, and SMEs; (2) distinguishing publications according to their category; (3) identifying which countries are being addressed within the empirical literature; (4) identifying the key trending topics on Digitalization, Internationalization, and SMEs; (5) focusing on articles and reviews from scientific journals, we will analyze which are the most influential journals within our subject; (6) analyzing the most influential journal articles or reviews; (7) finally, in the same line of the two previous topics, understanding which are the most influential authors in the field.

2.2.1. Annual Evolution of Literature

The literature on SMEs' digital strategies, more specifically regarding internationalization, has increased exponentially over the past few years. As represented in Figure 4, since 2015, this topic has been of paramount importance for scholars.

The oldest publications on Digitalization, Internationalization, and SMEs are from 2005. In this year, Andersen published the article "*Export intermediation and the internet: an activity-unbundling approach"* that focuses both on SMEs and Internationalization and develops a framework to understand the impact of digitalization of transactions (e-commerce) on the organization of export intermediation (Andersen, 2005). In the same year, another paper was published, the book chapter developed by Christian Longhi, "*Local systems and networks in the globalization process"* from the book *"Research and Technological Innovation: The Challenge for a New Europe"*. This book chapter also focuses on SMEs and Internationalization by analyzing the impact of ICTs' on the inherent costs of internationalization (Longhi, 2005).

Figure 4 -Chronological Evolution on Digitalization, Internationalization, and SMEs



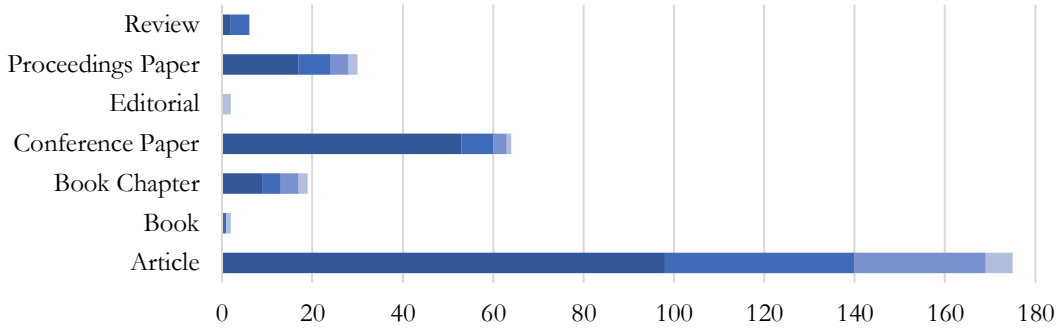
Source: Own elaboration

Until 2015, only eight papers were published, corresponding to 2.68% of the total number of publications, varying from zero articles to two papers *per* year. In 2015, eight papers were published, followed by an exponential growth in the following years. 2018 registered the most remarkable growth compared to the previous year (179%), and from that year onwards, growth has been more moderate (43%). Although we only have data until July of this year, if the pace of publications until July 27th was maintained until December 31st, the number of publications in 2020 would be 137.

By analyzing the chronological evolution separately (Figure 5), we can conclude that our research topic's exponential growth since 2015 is due to SMEs' exponential growth as a research topic.

In fact, the research on internationalization is growing, but at a lower rate and the investigation on SMEs and Internationalization had a peak in 2018 and decreased in 2019. Finally, the increasing importance given to the relationship between Digitalization, Internationalization and SMEs from 2017 to 2018 should be highlighted – from one to 14 publications.

Figure 5- Chronological evolution, according to the research focus



	Article	Book	Book Chapter	Conference Paper	Editorial	Proceedings Paper	Review
SMEs	98	0	9	53	0	17	2
Internationalization	42	1	4	7	0	7	4
SMEs and Internationalization	29		4	3	0	4	0
Others	6	1	2	1	2	2	0

Source: Own Elaboration

Note. The topic "others" refers to the publications that focused on enterprises' strategies, but not specifically referred to SMEs or internationalization.

2.2.2. Number of studies by category

While analyzing the existing literature on our research topic, it becomes essential to study the methodologies used within Digitalization, Internationalization, and SMEs publications. Therefore, we will follow the work elaborated by Pato and Teixeira (2016) and Castro e Silva and Teixeira (2011), dividing the records into (a) Conceptual - papers focus on the development of theories and concepts; (b) Appreciative or discursive- publications whose argumentation is of the opinionated style, not using mathematical models and/or simulation models; (c) Formal - those that rely on mathematical models and/or simulation to present their arguments; and (d) Empirical- involve testing and data following quantitative or qualitative methodologies.

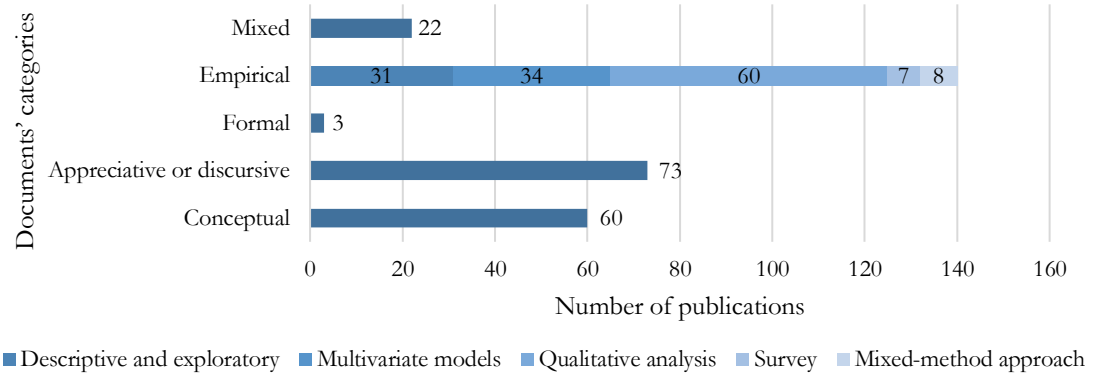
The latest methodology (empirical) will be subject to further analysis and will be divided into the following four categories, as Pato and Teixeira (2016):

1. descriptive and exploratory if they provide numerical and graphic procedures to summarize a collection of data (primary data);

2. multivariate models, if they utilize regression analysis, factor analysis, or cluster analysis, instead of numerical and graphic procedures;
3. qualitative analysis, when the analysis is based on case studies, ethnographic or narrative studies; and
4. survey, in the case of comprehensive reviews based on secondary data.

Additionally, when a study utilizes both a theoretical and an empirical methodology, notably if the authors develop a Framework (theoretical) and realize a questionnaire survey based on that framework to statistical analysis (empirical), it is considered Mixed. The overall results are presented in Figure 6.

Figure 6- Number of documents per category



Source: Own Elaboration

The results reported in Figure 6, clearly indicate that the percentage of theoretical (conceptual, appreciative or discursive, and formal) and empirical studies is similar, 46% and 47%, respectively, and 7% of the studies are mixed.

Additionally, and looking specifically at the Theoretical results, we can realize that many theories and concepts are being developed in this field, notably 60 conceptual publications - 44% of the theoretical papers - and 73 appreciative and discursive - with a percentage of 54%.

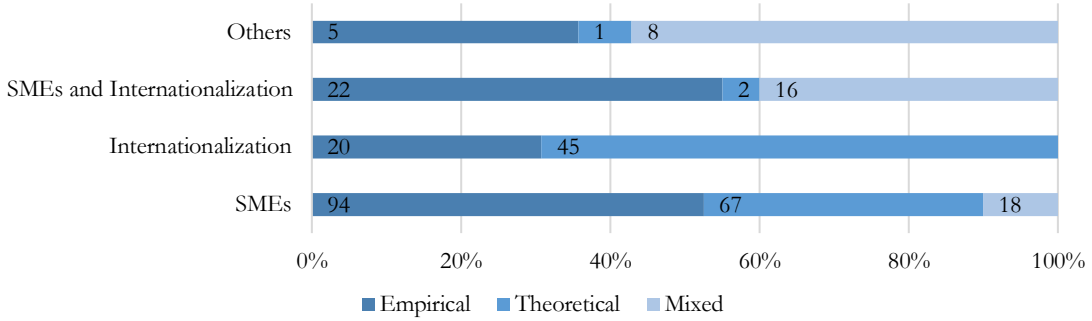
Regarding the Empirical results, the papers are mostly qualitative analysis, mainly based on interviews, with a 43% percentage corresponding to 61 papers. The multivariate models follow the previous results, with a percentage of 24%. These papers were mostly based on regression analysis and factor analysis. Similarly, descriptive and exploratory analysis weighted 22% and were based on statistical methods, such as distribution, ANOVA, correlation tests, and cross-tabulation measures. Surveys had a low weight on this database

of 2%. Finally, we also included the "Mixed-method approach", meaning that the same paper simultaneously utilized two empirical approaches.

Finally, the Mixed Results - different from the mixed-method approach previously explained - correspond to 7% of the total of publications.

Moreover, when looking at the different publications' categories from different focuses (SMEs, internationalization, or both), we realized that internationalization's research is mostly based on theoretical approaches (69%), and SMEs' research is predominantly built on empirical approaches (52%) (see figure 7).

Figure 7- Publications categories, according to the research focus



Source: Own Elaboration

Note. The topic "others" refers to the publications that focused on enterprises' strategies, but not specifically referred to SMEs or internationalization.

2.2.3. Number of publications by geographical focus

Most empirical or mixed publications based their analysis on one or more countries, from developing to developed economies. Therefore, this subsection aims to understand the geographical focus of our database's empirically developed publications. Consequently, we performed an in-depth analysis of all titles and abstracts and, in most of them, the publication itself. At the end of this research, we could not identify 15 empirically developed publications' geographical focus.

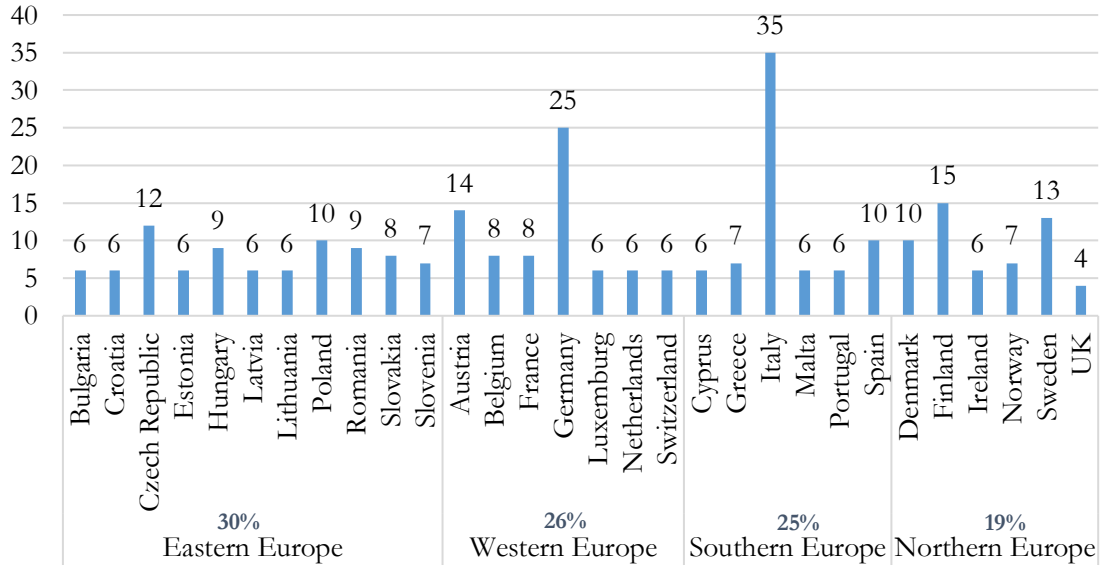
Most of the papers focused on only one country. Only 27 publications focused on two or more countries – 16.67%. In total, 55 countries were analyzed 347 times, in which 82% were European Countries, followed by the Asian continent with 13%, America with 4%, and, finally, Africa with 1%. – the other continents were not part of our database's publications. The number of countries analyzed increased significantly in 2018, both from Asia and

Europe. Particularly in Asia, in 2017, papers focused on China, Korea, and Singapore and, in 2018, Indonesia, Israel, Japan, Pakistan, Taiwan, and Thailand also had the attention of scholars.

Studies on European Union (EU) countries, as whole, appeared in 2016 with the article *"Effects of the use of the Internet and ICTs on Export performances of the EU"* developed by Akhvlediani and Katarzyna. After this publication, others have been developed also focusing on EU and European countries. We also want to highlight the article developed by Bouwman, Nikou, Molina-Castillo, and de Reuver (2018), named *"The impact of digitalization on business models"*. This article studies European SMEs within the manufacturing and non-manufacturing sectors. Combined with the increasing number of empirical or mixed papers from 2017 to 2018, we can also notice an increasing number of empirically developed papers focusing on European Countries. In 2017, scholars focused their investigation on Belgium, Finland, Italy, and Sweden. Since 2018, countries under analysis have increased significantly, including Austria, Czech Republic, Germany, Norway, Poland, Romania, and Switzerland. Investigation on the rest of the European Countries appeared in 2019.

By looking closely at Figure 8, it is observable that Italy and Germany are the countries with more interest in our research field, so far.

Figure 8- Empirical and mixed studies' geographical focus in Europe



Source: Own Elaboration

On the one hand, Italy is of particular interest in the research regarding digitalization and SMEs' relation. These results may be supported by the fact that SMEs represent 99.9% of Italian businesses, generating, in 2019, 78.1% of the employment and contributing for 66.9% of the industry value added (30.4% of this value-added is based on the manufacturing sector). The increase of Italian SMEs' added value can be justified by the Italian government's 2016 "Industry 4.0 plan", which instigates SMEs to invest in digitalization and, consequently, increase their innovation. Hence, and once Italian SMEs have been adopting new digital systems, such as collaborative robotics or IT security, this country has been an interesting research topic over the past few years (EC, 2020).

On the other hand, Germany is the second European country more addressed by the authors. The prominence of this country might be directly addressed to the fact that Germany has one of the most competitive manufacturing industries worldwide - being a global leader in the sector of manufacturing equipment (notably machinery and automotive manufacturing). As importantly, the term "industry 4.0" was first introduced by the German government, in 2011, as a strategic initiative that aimed to initiate industrial manufacturing transformation through digitalization and exploitation of potentials of new technologies. Therefore, and since its introduction, this country has been a current investigation topic in research, academic, and industry communities (Rojko, 2017).

As for the distribution of empirical studies by European regions (see Figure 8), Eastern Europe stands out as being the region with the highest incidence of analysis - 30% of empirical or mixed studies, corresponding to 85 times this region was empirically studied, followed by Western Europe (26%) and Southern Europe (25%), with northern Europe being in the last place, having been addressed by 19% of the empirically developed papers.

In Eastern Europe, the number of publications by country varies between six - in the cases of Bulgaria, Croatia, Estonia, Lithuania, and Poland - and twelve - regarding the Czech Republic-, but with a greater number of countries studied and, as such, more significant weight in research.

Western Europe is the focus of 73 publications. Within this region, Germany was the focus of 37% of the publications, followed by Austria, with 21%. Luxemburg, Netherlands, and Switzerland are the least explored Western European countries.

Southern Europe occupies the third position, being approximately the focus of 25% publications. Studies referring to Italy make up for 50% of this region's publications, with

the remaining countries being analyzed on average six to seven times, except for Spain, which was analyzed ten times.

Finally, the least explored region was Northern Europe (19%). In this region, Finland has been the main target for research (27%), followed by Sweden, with 24% of northern European publications. The UK is the least studied European country regarding Digitalization, Internationalization, and SMEs.

2.2.4. Number of studies by key topics

Identifying the main themes addressed in the literature is a key aim of this dissertation. It allows us to understand the most addressed topics and to identify those that have not yet been sufficiently analyzed in the literature on Digitalization, Internationalization, and SMEs.

We based our research on the keywords selected by the authors of each publication, and, in the case of publications that did not have keywords available, we read the full paper and defined keywords - based on the previously developed literature review.

After aggregating all keywords, we reached a total of 1623 keywords in 298 publications, with an average of 5.4 keywords *per* publication. After analyzing each keyword, we aggregated them into main themes. In this way, the 1623 keywords were divided into 73 main groups. These included the themes that served as the basis for our bibliometric analysis, a topic called "methodologies", which aggregates the methodological approaches presented in the keywords and the topic "others", a residual category including all keywords whose group they belonged to was approached less than three times.

Once this research is underpinned in the topics "Digitalization", "Internationalization", and "SMEs", our focus will be on the set of peripheral research trends that emerge from these topics, not considering Digitalization, Internationalization, and SMEs for further research. Additionally, and since the methodology used in each paper has already been analyzed in subsection 2.2.2. we have chosen to exclude this topic from this analysis as well. Finally, we will also not consider the topic "others", as it aggregates several topics that do not yet have a critical mass to be analyzed. The number of keywords of each main topic that will not be explored is presented in Table 4, representing 38.75% of the 1623 keywords previously mentioned.

Table 4- Main topics not considered for the key topics' analysis

Main topic	Number of Keywords
Digitalization/ Digitization / Industry 4.0 / Fourth Industrial Revolution / Digital transformation / Digital economy	244
Internationalization	17
SMEs	148
Methodologies	52
Others	168
Total keywords not considered in further analysis	629
% keywords not considered in further analysis	38.75%

Source: Own Elaboration

Once every main topic is composed of related keywords, it is possible that two different keywords from the same publication are in the same main topic. However, to simplify the analysis, we are going to assume that if a topic has been cited ten times, ten different documents have analyzed that topic.

The most relevant topics are represented in Figure 9, corresponding to 34 main topics. Most of them focus on the relationship between digitalization and SMEs instead of digitalization and internationalization, which was addressed only 17 times (vindicating that further research specifically on digitalization and internationalization is needed).

Taken together, our findings indicate that Digitalization, Internationalization, and SMEs' literature focuses on digital technologies, including advanced manufacturing technologies (cited 119 times) and the Internet and related technologies (55 times), respectively. Studies on these critical topics aim to understand how digital technologies affect companies' aspects, from incentives and barriers to their implementation to understanding how digital technologies are affecting business activities.

The prominence of these topics lies in the fact that digital technologies are the main drivers of digitalization and industry 4.0 in manufacturing companies. Taking a closer look at the topic of AMTs to understand which digital technologies are driving enterprises to become digital, we conclude that the Internet of Things, Big Data and analytics, artificial intelligence, additive manufacturing (3D printing), cloud, robotics, and cybersecurity are the technologies that are addressed in this area. As previously discussed, the adoption of these technologies contributes to a large extent for companies to improve their production processes, becoming

more efficient and eliminating obsolete practices. Studies on the Internet are mainly focused on the fact that the Internet is a tool that facilitates communication and information transfer and its impact on companies' exports, as explored by Andersen, P.H. (2005). Studies in this area focus on corporate websites and e-commerce.

In the third position, we have the manufacturing companies or industry being approached 49 times, including the automotive, retail, furniture, and medical devices industries. Smart manufacturing is also one of the most discussed topics (5th position).

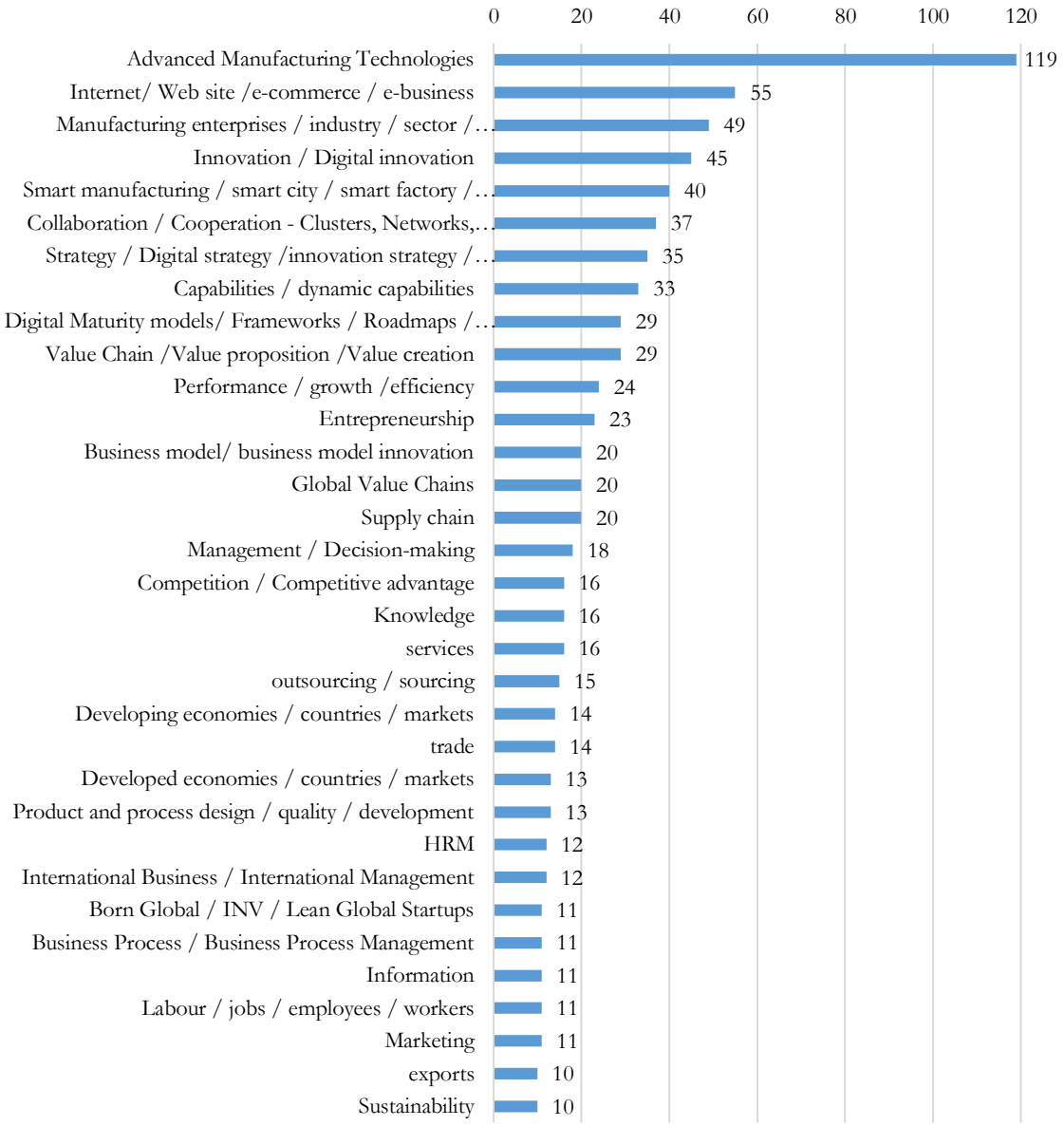
Figure 9 also demonstrates the increasing interest in understanding how digital technologies are impacting enterprise strategies. Studies on innovation are of paramount importance in this field, including the innovation of products and processes as a source of competitive advantage (47 papers). Although less explored (20 papers), business model innovation is gaining scholars' attention, notably from two of the most influential authors on Digitalization, Internationalization, and SMEs, Julian M. Müller, and Kai-Ingo Voigt. Studies on BMI are closely related to enterprises' competitiveness, being explored 16 times.

Another focus of the literature is understanding how SMEs create and deliver value to their customers in the digital age. In this context, 29 studies focused on corporate value chains.

Related to the strategy topic is also the topic of "digital maturity models". The first reference to this topic in our database was made in 2016, by Jaione Ganzarain and Nekane Errasti, developing a maturity model for SMEs to embrace i4.0. Since then, this topic has been addressed 28 times, demonstrating its growing importance in Digitalization, Internationalization, and SMEs. Studies on companies' performance are also of interest and focus on how companies' digital decisions directly affect their efficiency, growth, and performance. Additionally, 23 entrepreneurship studies were developed - mainly related to start-ups and INV.

Scholars are also giving particular importance to collaboration and cooperation within SMEs and clusters, networks, ecosystems, universities, and others. This topic was addressed 37 times, being of great interest for scholars and, although mentioned in our literature review, was not deeply explored.

Figure 9- Key topics with ≥ 10 mentions on Digitalization, Internationalization, and SMEs



Source: Own elaboration

We also want to highlight that most of the papers addressed developed economies, as we could see in the previous subsection (2.2.3), and research on the relation between digitalization, internationalization, and SMEs within developing or emerging economies is still meager.

In addition to identifying the most covered topics in the literature, it is also essential to understand which ones have not been sufficiently explored over time and must retain scholars' attention in future research.

Figure A1 presents the combinations of themes with less prominence in the literature, being observed less than ten times.

By looking at this Figure, it is noticeable that internationalization topics are still in an early stage of investigation and must have scholars' attention. "Markets", "Digital trade", "Reshoring", "FDI", "scalability", "international business development", "location" and "Cross-border activities" have not been sufficiently explored in the literature in the last fifteen years. Evidence on this insufficient attention given to SMEs' internationalization can be seen by the fact that this topic has only been mentioned 17 times within 298 studies, as previously mentioned. As presented in the Literature Review, digitalization is a low-cost medium for enterprises to expand their business worldwide, especially for SMEs and their resource constraints. Additionally, and once SMEs are the core enterprises of many economies, notably in Europe, studies on how they can expand their business worldwide through adopting a digital strategy are needed. Although studies on enterprises' digital maturity models have been increasing over the year, studies that aim to understand the correlation between SMEs' digital maturity and their international strategies are yet to be developed.

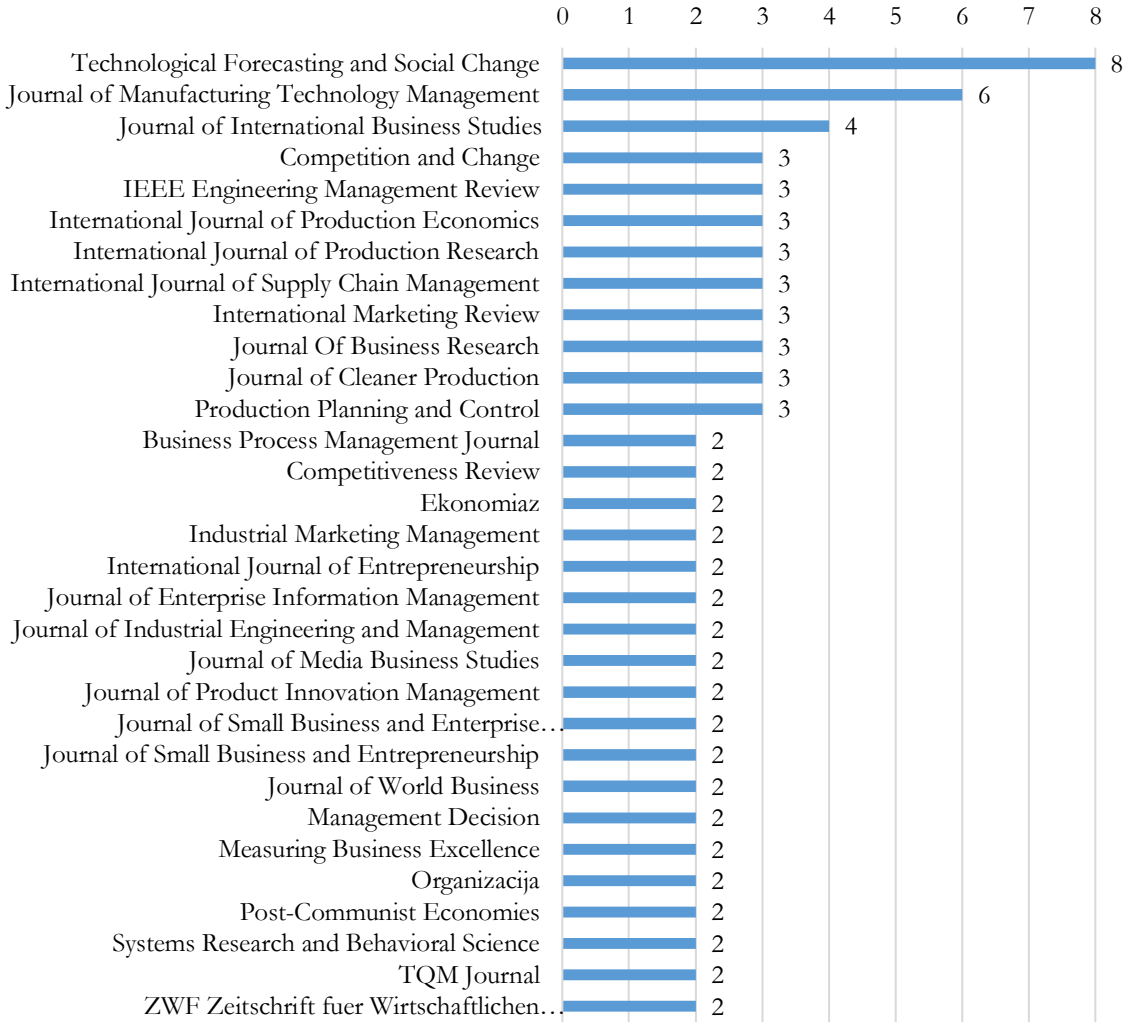
Similarly, studies on digital platforms and how traditional SMEs can benefit from them to export worldwide at low costs remain scarce. Wicent (2019) studied how entrepreneurial SMEs compete through digital platforms, but we could not find an investigation on this subject regarding traditional SMEs.

2.2.5. Top academic journals

This subsection will analyse the journals with greater influence on Digitalization, Internationalization, and SMEs, examining the number of publications per journal in our database and their impact in the literature (measured by WoS and SCOPUS' impact factors). It is important to note that this study will be focused not only on articles, as Pato and Teixeira (2016) but also on review articles published in scientific journals. Articles and reviews are the sources of most up-to-date peer-reviewed knowledge and, therefore, enable us to have a more accurate perception of which academic journals have more impact in this field (de Oliveira et al., 2019), By being peer-reviewed, scientific experts have scrutinized these documents, as explained in section 2.1, thus being the most reliable source of literature (de

Oliveira et al., 2019). Articles and reviews constitute approximately 61% of the relevant publications. Figure 10 exhibits all journals that have more than two publications.

Figure 10- Scientific journals with ≥ 2 studies within Digitalization, Internationalization, and SMEs



Source: Own elaboration

It should be noted that we only considered the journals whose impact factor was available on JCR-Journal Citation Reports – or SJR – SCImago Journal Ranking. WoS' JCR impact factor is a quantitative tool that ranks and evaluates the journals based on the "*frequency with which the "average article" in a journal has been cited in a particular year or period*" (WoS, 2020), no page defined. Therefore, the JCR impact factor of 2019 consists of a division of the items published between 2017 and 2018, divided by the total number and reviews published in that period. SCOPUS' SJR impact factor also consists of a quantitative tool to rank and evaluate the journals based on their citations and publications. However, this metric is calculated based on the citations from the year under analysis, divided by the previous three years' publications (including articles, reviews, and conference papers) (SCImago, 2020).

Approximately 26% of the analyzed journals published at least two studies regarding Digitalization, Internationalization, and SMEs. Concerning the scientific journals that published two studies, we must highlight the "*Journal of World Business*" and the "*Journal of Product Innovation Management"* - two journals with relevance on Business and International Management, Strategy and Management, and Management of Technology and Innovation (SCImago, 2020)

As crucial as identifying what journals more contributed to our field is to understand their impact on the scientific community. The relevance of these journals for their field of study can be analyzed by the impact factors available on WoS and SCOPUS databases, as explained previously.

The SJR impact factor presents an advantage for this dissertation, as its ranking has been normalized to account journals from different fields of studies, as opposed to WOS' impact factor that should only be used to compare journals from the same field study (Bakkalbasi, Bauer, Glover, & Wang, 2006).

Figure 11 presents the top journals – journals with more than three studies – and their correspondent impact factors. The top journals' publications displayed 24.86% of the articles and reviews published in scientific journals. These journals gather information from different subject areas, including Business, Management, and Economics, as well as Computer Sciences, Engineering, and Environmental sciences. Therefore, we will be critically reviewing the impact of journals based on the SCImago Journal Ranking.

The top three journals on our research subject are the following: *"Technological Forecasting and Social Change"* by Elsevier Inc.*, "Journal of Manufacturing Technology Management"* by Emerald Group Publishing Ltd.*,* and *"Journal of International Business Studies"* by Palgrave McMillan. These journals are all located on the 1st quartile of the SJR 2019, and the "*Journal of International Business Studies"* presents the higher SJR impact factor, being a very influential journal, particularly on Business and International Management, Economics, Management of Technology and Innovation and Strategy and Management. The rest of the top journals are also located on the 1st quartile, excluding the *"IEEE Engineering Management Review*" and the "*International Journal of Supply Chain Management*", located in the 3rd quartile.

This analysis demonstrates that these journals have a prominent scientific influence on the categories indexed to them.

Figure 11- Top journals with more records published

B - Business, Management and Accounting;

C - Computer Science;

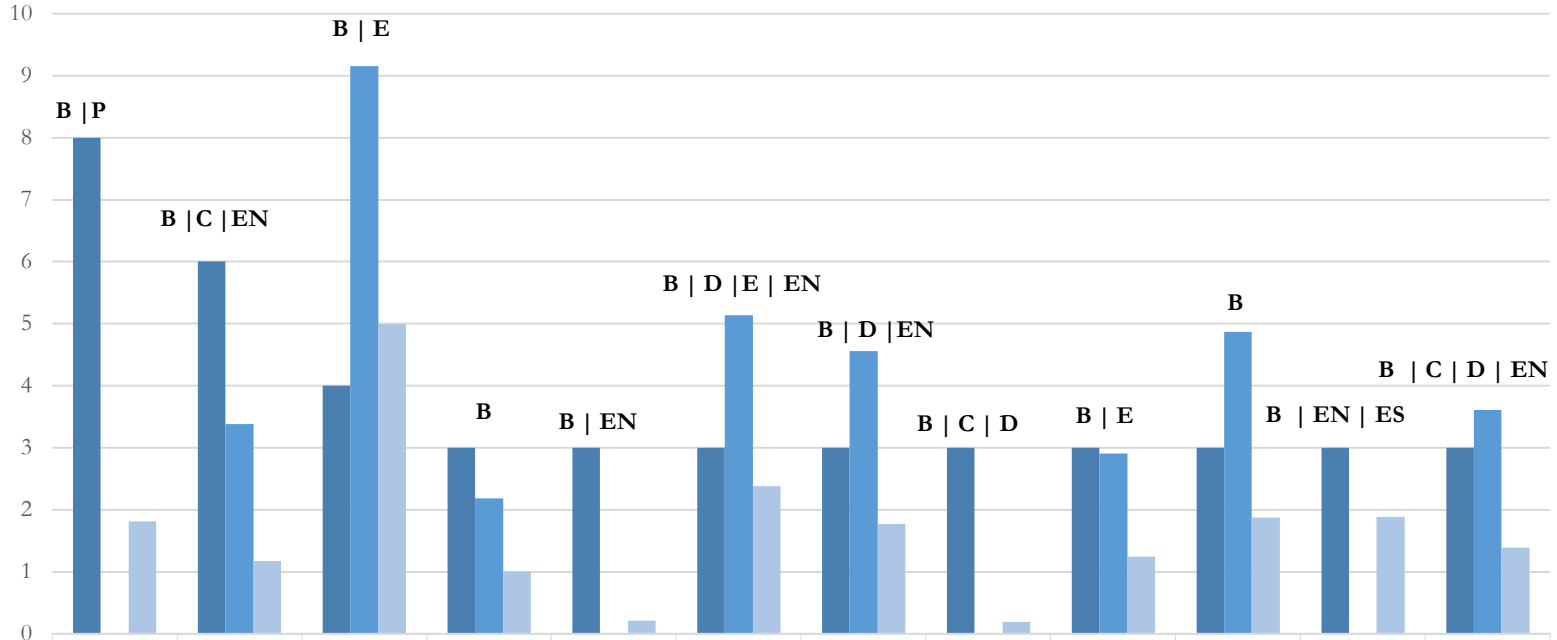
D - Decision Sciences

E - Economis, Econometrics and Finance;

EN - Emgeneering;

ES - Environmental Sciences

P - Psychology



	Technological Forecasting and Social Change	Journal of Manufacturing Technology Management	Journal of International Business Studies	Competition and Change	IEEE Engineering Management Review	International Journal of Production Economics	International Journal of Production Research	International Journal of Supply Chain Management	International Marketing Review	Journal Of Business Research	Journal of Cleaner Production	Production Planning and Control
Number Of Articles or Reviews	8	6	4	3	3	3	3	3	3	3	3	3
JCR impact Factor 2019		3,385	9,158	2,188		5,134	4,557		2,907	4,874		3,605
SJR impact Factor 2019	1,815	1,173	4,994	1,006	0,214	2,379	1,776	0,19	1,249	1,871	1,886	1,394

Source: Own Elaboration

2.2.6. Top 25 most cited journal publications

The purpose of this subsection is to gain a better understanding of the most influential articles on the literature over the past fifteen years. The ranking of the most cited articles and reviews' publications was made based on their citations, from the different databases (WoS and SCOPUS), analyzing the average number of citations *per* year (ANCp), as follows.

$$1.\ ANCp = \frac{WoS\ Citations + SCOPUS\ Citations}{2}$$

Some of the articles or reviews were only published in one of the databases. Therefore, the average number of citations per publication is equal to the corresponding database's citations in these cases. Hence, the ranking of the most cited articles and reviews presented on Table 5 is based on this metric.

Given the novelty of the literature on Digitalization, Internationalization, and SMEs, with several publications from 2020, we decided to focus our analysis on the average number of citations *per* publication *per* year (ANCp *per* year), as follows:

$$2.\ ANCp\ per\ year = \frac{ANCp}{(2020 - year\ of\ publication) + \frac{7\ months}{12\ months}}$$

Overall, the total number of citations per publication is not that high, which was expected due to our research topics' novelty. The top 25 encompasses an average of 1201 citations, which is approximately 73% of the total average citations from articles and reviews - 1646 citations – from our database.

"The industrial management of SMEs in the era of Industry 4.0", developed by Moeuf, Pellerin, Lamouri, Tamayo-Giraldo, and Barbaray (2018) and published on the "*International Journal of Production Research",* one of the journals with a higher impact factor (see Table 5), has the highest citation average number of citations per year, followed by the *"Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0"*. This article was developed by Müller et al. (2018), published on the *"Technological Forecasting and Social Change"*, the journal of more citations from our database. On the one hand, Moeuf et al. (2018) article consists of a conceptual article, exploring and developing a framework in order to understand SMEs' industry 4.0 technologies adoption, more specifically addressing the *"new changes brought to the production planning and control functions in SMEs in the era of Industry 4.0"* (p.1132). On the other

hand, Müller et al. (2018) developed a mixed approach, using qualitative analysis to understand the implications of i4.0 along industrial value chains and developing four SMEs' categories in order to help managers assess their digital maturity towards i4.0.

Specifically, on the subject of internationalization, the article *"Industry 4.0, global value chains and international business"* developed by Strange and Zucchella (2017) distinguishes itself, being positioned on the fifth place on our ranking. By conducting a theoretical analysis, this article addresses the relationship between industry 4.0 technologies and enterprises activities' locations within GVCs.

The publications regarding both digitalization and internationalization correspond to 24% of our top 25. However, the maximum number of citations per year in this field was twelve, from the article "*What do we know about manufacturing reshoring?"* developed by Barbieri, Ciabuschi, Fratocchi, and Vignoli (2018). As we can see by the title, this paper aims to analyze the existing literature on manufacturing reshoring, exploring the impact of i4.0 on enterprises' decisions (including SMEs) to bring back to their home country activities that they had offshored before.

Although the *"Journal of International Business Studies"* is part of our top journals, with the highest impact factor on JCR and SJR, neither of the four studies is part of our top 25. In my view, the most compelling explanation for this finding is the fact that these publications are from 2019 and 2020 and, therefore, did not comprise sufficient citations per publication to be part of this ranking. Notwithstanding, we want to highlight the following theoretical articles that focus both on SMEs and Internationalization*: "Global platforms and ecosystems: Implications for international business theories"*, from Nambisan, Zahra, and Luo (2019), and *"Born digitals: Thoughts on their internationalization and a research agenda"* from Monaghan, Tippmann, and Coviello (2020).

Table 5- Ranking of most influential articles and reviews

Rank	Authors	Title	Year	Source title	Citations			SME	Internationalization
					WoS	SCOPUS	ANCp per year		
1	Alexandre Moeuf, Robert Pellerin, Samir Lamouri, Simon Tamayo-Giraldo & Rodolphe Barbaray	The industrial management of SMEs in the era of Industry 4.0	2018	International Journal of Production Research	118	169	56	x	
2	Julian Marius Müller, Oana Buliga, Kai-Ingo Voigt	Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0	2018	Technological Forecasting and Social Change	100	151	49	x	
3	Lutz Sommer	Industrial revolution - Industry 4.0: Are German manufacturing SMEs the first victims of this revolution?	2015	Journal of Industrial Engineering and Management	74	119	17	x	
4	Wim Coreynen., Paul Matthyssens & Wouter Van Bockhaven	Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers	2017	Industrial Marketing Management	71	116	26	x	
5	Roger Strange & Antonella Zucchella	Industry 4.0, global value chains and international business	2017	Multinational Business Review	88	90	25		x
6	Jaione Ganzarain & Nekane Errasti.	Three stage maturity model in SME's towards industry 4.0	2016	Journal of Industrial Engineering and Management	55	89	16	x	
7	Alnoor Bhimani & Leslie Willcocks	Digitisation, Big Data and the transformation of accounting information	2014	Accounting and Business Research	54	78	10		x
8	Dimitrios Bechtsis, Naoum Tsolakis, Dimitrios Vlachos, Eleftherios Iakovou	Sustainable supply chain management in the digitalisation era: The impact of Automated Guided Vehicles	2017	Journal of Cleaner Production	38	60	14		x
9	Julian Marius Müller & Kai-Ingo Voigt	Sustainable Industrial Value Creation in SMEs: A Comparison between Industry 4.0 and Made in China 2025	2018	International Journal of Precision Engineering and Manufacturing - Green Technology	42	47	17	x	
10	Heini Maarit Taiminen & Heikki Karjaluoto	The usage of digital marketing channels in SMEs	2015	Journal of Small Business and Enterprise Development	34	44	7	x	
11	Maria Bengtsson, Hakan Boter, & Vladimir Vanyushyn	Integrating the Internet and marketing operations - A study of antecedents in firms of different size	2007	International Small Business Journal-Researching Entrepreneurship	37	-	3	x	x
12	Blaz Rodič	Industry 4.0 and the New Simulation Modelling Paradigm	2017	Organizacija	28	46	10	x	

13	Harry Bouwman, Shahrokh Nikou, Francisco J. Molina-Castillo, Mark de Reuver	The impact of digitalization on business models	2018	Digital Policy, Regulation and Governance	-	34	13	x	
14	Dóra Horváth Roland Zs. Szabó	Driving forces and barriers of Industry 4.0: Do multinational and small and medium-sized companies have equal opportunities?	2019	Technological Forecasting and Social Change	28	38	21	x	
15	Paolo Barbieri, Francesco Ciabuschi, Luciano Fratocchi & Matteo Vignoli	What do we know about manufacturing reshoring?	2018	Journal of Global Operations and Strategic Sourcing	31	32	12	x	x
16	Poul Houman Andersen	Regional clusters in a global world: Production relocation, innovation, and industrial decline	2006	California Management Review	-	30	2		x
17	Veronica Scuotto, Francesco Caputo, Manuel Villasalero & Manlio Del Giudice	A multiple buyer–supplier relationship in the context of SMEs' digital supply chain management	2017	Production Planning and Control	24	26	7	x	
18	Otakar Ungerman, Jaroslava Dedkova & Katerina Gurinova	The Impact of Marketing Innovation on The Competitiveness of Enterprises in the Context of Industry 4.0	2018	Journal of Competitiveness	22	-	9	x	x
19	Julian Marius Müller	Business model innovation in small- and medium-sized enterprises: Strategies for industry 4.0 providers and users	2019	Journal of Manufacturing Technology Management	-	21	13	x	
20	Arto Ojala, Natasha Evers & Alex Rialp	Extending the international new venture phenomenon to digital platform providers: A longitudinal case study	2018	Journal of World Business	18	23	8	x	x
21	Beata Ślusarczyk, Muhammad Haseeb & Hafezali I. Hussain	Fourth industrial revolution: A way forward to attain better performance in the textile industry	2019	Engineering Management in Production and Services	19	20	12		x
22	Poul Houman Andersen	Export intermediation and the internet: an activity-unbundling approach	2005	International Marketing Review	16	21	1	x	x
23	Andrea Szalavetz	Industry 4.0 and capability development in manufacturing subsidiaries	2019	Technological Forecasting and Social Change	18	-	11	x	x
24	Laima Gerlitz	Design Management as A Domain of Smart and Sustainable Enterprise: Business Modelling for Innovation and Smart Growth in Industry 4.0	2016	Entrepreneurship and Sustainability Issues	18	-	4	x	
25	Ying-Yu Kerri Chen , Yi-Long Jaw & Bing-Li Wu	Effect of Digital Transformation on Organisational Performance of SMEs: Evidence from The Taiwanese Textile Industry's Web Portal	2016	Internet Research	-	17	4	x	

Source: Own Elaboration

2.2.7. Most influential authors

Concerning the authorship of the 181 records empirically developed, we have identified 387 different authors. The number of studies developed per authors within our database ranges from one to five. 88.1% of the authors published one paper, and only one author (representing 0.3% of the 387) published five records. Only seven authors published more than two articles or reviews, as presented on Table 6.

Table 6- Number of papers per author

Number of papers	Number of papers per author	Number of papers per author (%)
1	341	88,1%
2	39	10,1%
3	4	1,0%
4	2	0,5%
5	1	0,3%
Total	387	100%

Source: Own elaboration

By analyzing the total number of papers per author, we are able to assess the scientific output of a specific researcher, measuring its productivity. However, this metric does not allow us to measure the impact or importance of that author under study.

Hence, our research will also be based on the h-index, an index developed by Hirsch (2005) that aims to measure a researcher's broad impact. The calculation of the h-index proceeds as follows: *"A scientist has index h if h of his or her Np papers have at least h citations each and the other (Np - h) papers have ≤ h citations each"* (Hirsch, 2005, p. 16569). Hence, if an author has an impact factor of 15, that means that this author published 15 records and each record was cited, at least, 15 times.

The number of papers developed per author is strictly related to the newness of our research topic. Therefore, we will be considering every author, except the ones that only have one record.

Table 7 summarizes the 46 authors by ranking, considering their total number of publications, and their correspondent SCOPUS' h-index.

Table 7- Ranking of authors per number of publications

	Author 1	Number of publications	H-Index		Author 2	Number of publications	H-Index
1	Julian M. Müller	5	10	**24**	Rita Faullant	2	9
2	Kai-ingo Voigt	4	13	**25**	Jan Stentoft	2	9
3	Marta Götz	4	3	**26**	Ángel Diaz-Chao	2	7
4	Alessandro Ancarani	3	15	**27**	Tero Rantala	2	7
5	Carmela Di Mauro	3	15	**28**	Simon Tamayo-Giraldo	2	6
6	Andres Szalavetz	3	5	**29**	Chiara Cimini	2	5
7	Marco Pini	3	3	**30**	Zulqurnain Ali	2	4
8	Harry Bouwman	2	**29**	**31**	Mohammad Faridi	2	4
9	Paul Houman Andersen	2	**21**	**32**	Jaione Ganzarain	2	4
10	Robert Pellerin	2	**20**	**33**	Aqsa Mehreen	2	4
11	Erwin Rauch	2	**19**	**34**	Gale Raj-Reichert	2	4
12	Alejandro G. Frank	2	17	**35**	Sabrina Zajak	2	4
13	Francisco J. Molina-Castillo	2	17	**36**	Oana Buliga	2	3
14	Patrick Dallasega	2	15	**37**	Ivano Dileo	2	3
15	Mina Nasiri	2	15	**38**	Bi Gongbing	2	3
16	Veronica Scuotto	2	14	**39**	Alexandre Moeuf	2	3
17	Samir Lamouri	2	13	**40**	Yongdang Chen	2	2
18	Paolo Neirotti	2	13	**41**	Kristian Philipsen	2	2
19	Roberto Pinto	2	13	**42**	Priya Rathi	2	2
20	Juhani Ukko	2	13	**43**	Amit Arora	2	1
21	Joan Torrent-Sellens	2	12	**44**	Ernesto Cassetta	2	1
22	Shahrokh Nikou	2	11	**45**	Nicole Helmerich	2	1
23	Minna Saunila	2	11	**46**	Azam Malik	2	0

Source: Own Elaboration

If we look at the number of publications per author, we are able to realize that the authors with more records published do not have the higher h-index. The authors with a higher h-index are the following

1. Harry Bouwman, from Delft University of Technology, Netherlands. In total, this author has 186 published documents and was cited 3218 times.
2. Paul Houman Andersen, from Aalborg Universitet, Denmark. In total, this author has 55 published documents and was cited 1258 times.
3. Robert Pellerin, from Polytechnique Montréal, Canada. In total, this author has 108 published documents and was cited 1249 times.
4. Erwin Rauch, from Free University of Bozen-Bolzano, Italy. In total, this author has 94 published documents and was cited 960 times.

Although Julian M. Müller, Kai-Ingo Voigt, and Götz do not have a high h-index, these authors should also be taken in consideration, due to the weight of their publications in our research field. The following analysis is going to be based on the SCOPUS' h-index, as well as SCOPUS' Topic Field-Weighted Citation Impact. This metric enables the comprehension of how well the records in a specific topic are cited compared to similar documents. Therefore, if the value is superior to 1.00, this means that the documents are more cited than expected (SCOPUS, 2020).

Muller, from Austria, published 20 documents since 2016 from different research fields. From the sample of records published, documents regarding "Business Model Innovation; Sustainable Business; Digital Transformation", "Business Process Management; Process Orientation; Maturity Model", and "Industry 4.0; Factories; Shop floor" are well-cited compared to the other documents developed by other authors.

Voigt, from Germany, has the higher h-index from the top 3 and published, since 2006, 76 records, having a total of 1318 citations. The documents published by Voigt, are also well-cited regarding the topics discriminated above.

Götz, from Poland, has 20 records published since 2010 and the lowest h-index of the top 3. Notwithstanding, this author is well cited on the topics "Outward Foreign Direct Investment; Emerging Market Multinationals; Outward FDI", "Regional Innovation Systems; Industrial Districts; Innovation Networks", and "International New Ventures; Born Global; Export Performance".

2.3. Key Findings

The literature on Digitalization, Internationalization, and SMEs is remarkably recent (only since 2005), with an exponential growth of publications from 2015 to 2020 and a tendency to continue growing. We believe that research in this area is still at an early stage, and it is expected that more attention will be given to this topic in the upcoming years. Studies regarding internationalization are mostly theoretical, and there are more empirical rather than theoretical studies concerning SMEs.

Regarding the geographic focus, it is noticeable the importance that scholars have given to European countries, emphasizing Italy and Germany. Studies that focus on Asia have been increasing over the years, emphasizing India, Thailand, and China. America has also been gaining prominence, but studies are mainly focused on North America, namely in the US, discarding the rest of the continent. Africa has also not been a target, except for South Africa.

The most referenced topics in the literature refer to digital technologies, namely the Internet and AMTs, to the manufacturing industry, to innovation - namely in business models - as well as to collaboration and strategy of companies. Topics related to internationalization are still rarely addressed, namely "exports", "reshoring" and "FDI", as well as "location".

The "Technological Forecasting and Social Change", the "Journal of Manufacturing Technology Management", and the "Journal of International Business" are the journals that most contributed to research on Digitalization, Internationalization, and SMEs. The latest has the highest impact factor and, thus, central to the literature.

"The industrial management of SMEs in the era of Industry 4.0" and *"Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0"* were published in 2018 and are the most highly cited articles focusing on SMEs. *"Industry 4.0, Global value chains, and international business",* from 2017, is the most cited article regarding internationalization. The analysis of citations to an article or review is fundamental and allows us to understand its relevance to the literature, but we must keep in mind the newness of this subject with articles from 2020, which, although little cited, may also have a valuable contribution to the literature.

The authors most significant to the literature, are Muller, Voigt, Bowman, and Andersen for their number of publications and influence in the scientific community.

Conclusions

Digitalization has been playing an increasingly important role in business strategies, namely for SMEs. Although SMEs have barriers to adopting digital technologies, notably the scarcity of financial resources, they have been increasingly making efforts to bridge this gap and increase their competitiveness through adopting and renewing existing capabilities - including digital technologies - and adopting a digital strategy throughout the organization. Therefore, and in order to effectively initiate their journey towards digital transformation, SMEs must understand their digital maturity, assessing their current situation and the best measures to move towards the intended digital maturity and to enhance their competitiveness.

By embracing digitalization and improving their strategy, SMEs will be able to better compete in the domestic market and expand into new markets - including foreign markets. And to reap the benefits of pure digital (e-commerce) markets or platforms. The correct adoption of a digital strategy will allow them to minimize production and communication costs and, consequently, to compete through their costs or bet on niche markets, as well as enhancing other non-cost based features of their competitive strategy – notably, access to new distribution channels, improvement of their services and increasing the options given to consumers.

Focusing on SMEs' internationalization strategies, we can conclude that digitalization may constitute a low-cost strategy for entering new markets. The Internet allows transactions and communication with third parties to be low cost and efficient, increasing SMEs' direct exports. Simultaneously, the adoption of AMTs - that characterize industry 4.0 - will also contribute on a large scale to the internationalization of SMEs. Additive manufacturing (including 3D printing) is one of the best examples since companies will be able to prototype their products and produce them anywhere in the world. Therefore, SMEs' will not need to create subsidiaries worldwide, which is expected to discourage FDI vis-à-vis other entry modes (such as exports or contractual arrangements).

Given this subject's novelty, we decided to perform a pioneering bibliometric analysis of the existing literature on Digitalization, Internationalization, and SMEs. The results of this

research provide supporting evidence that this topic is gaining the attention of scholars worldwide, especially in Europe, particularly since 2015. Studies on how digitalization affects SMEs' strategies are gaining momentum, notably the impact of innovation (either in products or services or in enterprises' BMs) on enterprises strategies and competitiveness, as well as how SMEs' benefit from adopting AMTs and the Internet for increasing their efficiency. Besides the increasing knowledge of SMEs' participation in GVCs and other collaboration ecosystems, results strongly imply that scholars have not sufficiently explored digitalization's impact on SMEs' international strategies, notably their entry modes decisions.

The present dissertation represents a first attempt to address these issues. We argue that further research examining Digitalization, Internationalization, and SMEs may shed light on empirically understanding the adoption of digitalization by traditional SMEs and its impact on their internationalization strategies, namely enterprises' entry modes. Clarifying the relationship between SMEs' digital maturity and their international strategies should also be addressed in further investigations, as well as the impact of digitalization on internationalization and, consequently, SMEs' performance. Much work remains to be done before a full understanding of the extent of the impact of Digitalization on SMEs' strategies, notably internationalization, is established.

As for the limitations of the present dissertation, we must highlight that the literature on the relationship between Digitalization and SMEs' international strategies is still in its early stage. Hence, a scholar may have published few outputs, yet this small amount of work may yield an enormous impact on our research field. The same occurs regarding the number of publications of a specific journal. Therefore, the bibliometric techniques may not accurately reflect a particular author or paper's relevance within our field.

Despite these limitations, the present study has enhanced our understanding of the relationship between Digitalization and SMEs' international strategies, a novel and extremely relevant topic that warrants certainly further investigation.

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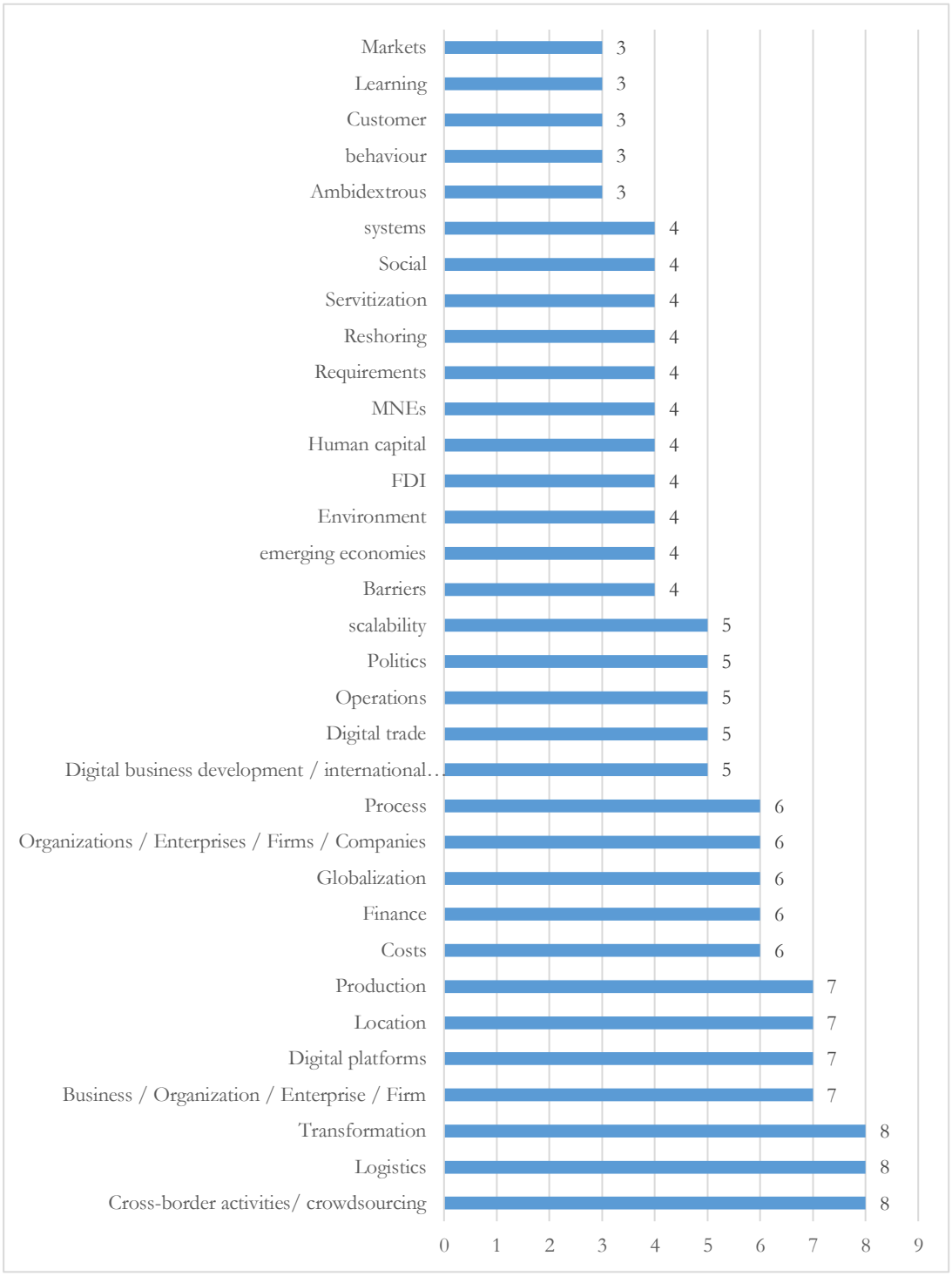
Appendices

Figure A 2 - Key topics with < 10 mentions on Digitalization, Internationalization, and SMEs



Source: Own Elaboration

Table A 2 - Consultant Frameworks and Maturity Models

Consultancy Firm	Maturity Model	Description
Mc Kinsey (2020)	Digital 20/20 assessment tool.	The Digital 20/20 assesses an organization's digital and analytics maturity to discover digital opportunities, identifying gaps between current capabilities and those of digital leaders, and execute a prioritized roadmap of high impact transformation initiatives. Therefore, the tool analyzed 7 different dimensions (marketing, strategy, analytics, technology, operations, people, and automation). Each dimension has its assessment tool and sub-dimensions. (1) Marketing: analyses the digital marketing capabilities that enable an organization's digital strategy. (2) Strategy: this dimension is analyzed by (a) digital quotient (DQ); (b) digital capabilities (DC); (c) digital disruption index (DDI). (3) Analytics: The AQ (analytics quotient) is organized around 6 dimensions (strategy, data, organization, and talent, value assurance, models and tools, and culture) to evaluate the current analytics maturity of the organization. (4) Technology: The digital technology assessment analyzes the technology spends, productivity, and technology identify opportunities to reinvest resources into strategic growth initiatives and modernize IT operations. (5) Operations: Through the utilization of Agile360, it is possible to analyze the organization's agile capabilities to generate specific recommendations for reducing time-to-market, increasing collaboration, and improving the quality. (6) People: this dimension includes the culture, mindset, and behaviors. Using the digital culture index is possible to identify the cultural shift necessary for digital transformation. (7) Automation: Automation 20/20 assesses four key dimensions (strategy, culture, organization, and capabilities) affecting the successful adoption of automation. Thus, by analyzing the results, they can compare their performance with other organizations and recommend interventions with greater impact.
Deloitte (2018)	Digital Maturity Model (DMM)	The DDM aims to be a useful tool to provide guidelines for a clear path throughout the transformation journey, achieving digital maturity to drive growth. Therefore, analyses digital capabilities across 5 dimensions: (1) organization and culture; (2) customer; (3) strategy; (4) technology; and (5) operations.
PwC (2015)	Industry 4.0/ digital operations self-assessment	This MM focuses on the industrial capabilities across the organization, having in consideration 6 different dimensions: (1)Business Model, product and service portfolio; (2) market and customer access; (3) value chains and processes; (4) IT architecture; (5) compliance, legal, risk, security, and tax; (6) organization and culture. By analyzing the dimensions, they can be positioned in one of the four maturity levels: digital novice, vertical integrator, horizontal collaborator, or digital champion.
KPMG (2016)	Digital Readiness Assessment (DRA)	DRA evaluates a firm's digital readiness by analyzing 4 dimensions (development and purchasing, production, marketing, and sales) incorporating two different perspectives, management- transformation intensity – and pervasiveness – operational effectiveness. A set-by-step survey evaluates the maturity level, and each dimension's weight depends on their relevance and the industry in which the analyzed company operates. By analyzing these dimensions, the firm can be positioned in one of the four maturity models: (1) reactive participant; (2) digital operator; (3) ambitious transformer; (4) smart digitalist.

BCG (2018)	Digital Acceleration Index (DAI)	DAI is an assessment tool that helps firms assess their maturity level, uncovering the strengths and weaknesses, determining whether their digital capabilities are lacking or imbalanced, and evaluating how well they perform against peers in digital efforts. Thus, they analyze 4 building blocks ((1) Business strategy driven by digital (2) digitize the core; (3) new digital growth; (4) enablers) with 37 sub building blocks, covering the entire value chain. By assessing these dimensions, the organization can be positioned in one of the 4 digital stages: (1) Digital Passive; (2) Digital Literate; (3) Digital Performer: and (4) Digital Leader.
EY (2018)	Digital Maturity Check and Digital Readiness Assessment	EY provides a Digital Maturity Check, a two-minute self-assessment questionnaire that allows firms to understand their digital maturity quickly. For a more in-depth evaluation, EY has a Digital Readiness Assessment, verifying its current strategy and providing an improvement action plan towards a fully digital organization. This tool benchmark the digital maturity across 7 dimensions: (1) strategy, innovation, and growth; (2) customer experience; (3) supply chain and operations; (4) technology; (5) risk and cybersecurity; (6) finance, legal and tax; and (7) people and organization. Moreover, this model contains 3 stages: developing, established, and leading.
IBM (2009)	Smart Grid Maturity Model (SGMM)	SGMM is applied to the following dimensions: (1) strategy, management, and regulatory; (2) organization; (3) technology; (4) societal and environment; (5)grid operations; (6)work and asset management; (7)customer management and experience; and (8) value chain integration. This model places each SME in one of the following levels of digital maturity: (1) exploring and initiating; (2) functional investing; (3) integrating – cross functional; (4) optimizing – enterprise wide; (5) innovation- next wave of improvements.

Source: Own Elaboration