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Additive manufacturing in international business: Bridging academic and practitioners' perspectives

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ABSTRACT

Additive manufacturing has recently gained prominence in the international business literature due to its disruptive potential. The paper aims to investigate the intersection between additive manufacturing and international business to identify and highlight challenges and opportunities tied to its adoption. Additionally, the study proposes a broader perspective on internalization and global value chain theory to understand the implications of additive manufacturing for the global strategy of international business ventures. This study employs both thematic and content analysis using academic sources and professional documents such as business cases, newspaper articles, and specialized blogs. The goal is to bridge the gap between industry and academia on additive manufacturing in international business. Our integrated view from both academia and industry reveals how the adoption of additive manufacturing has several potential benefits, ranging from the shortening of the value chain, enhanced customer relationships through higher levels of customization, and a more sustainable production pattern with reduced environmental impact compared to traditional manufacturing. Along with the benefits, this study illustrates a few challenges that might hinder the adoption of additive manufacturing in international business, with theoretical and practical implications.

1. Introduction

Additive manufacturing (AM) is an emerging technology transforming companies' operations. By definition, AM technology enables the 3D printing of physical objects. According to ASTM International, AM technology is “a process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies” (ASTM, 2012). Initially designed for prototyping (Strange and Zucchella, 2017), AM now has extensive applications in industries such as aviation for low-volume parts and healthcare for medical implants (Ghadge et al., 2018; Akmal et al., 2022). Due to AI-enhanced systems and supply chain digitization (Corsini et al., 2022; Gaudio et al., 2020), intelligent production systems are actively disrupting the competitive landscape. Scientific production on smart manufacturing is vast and rapidly growing, with several specific literature streams developing around the topic, such as mass customization (Chatterjee et al., 2021), strategic and operational flexibility (Shams et al., 2021), and the servitization of manufacturing (Baines et al., 2009). Within smart manufacturing, AM is identified as a disruptive technology with potential to alter global production through mass customization, changing the international manufacturing landscape from

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globalized to localized (Rayna and Striukova, 2014; Ben-Ner and Siemsen, 2017; Laplume et al., 2016). Furthermore, the literature stream on AM contributes to a broader stream of intelligent manufacturing and Industry 4.0 for international business, as scholars have progressively unveiled the implications of AM in terms of global value chains and international competition (Laplume et al., 2016; Strange and Zucchella, 2017).

Whereas both AM and international business literature have proliferated over the years, the intersection of the two streams is only recently starting to develop, albeit rapidly, with an increasing number of empirical studies published each year (Rylands et al., 2016). Delving deeper into the intersection of the two streams, scholars have called for research on the advantages and challenges of AM technologies in international operations (De Beule et al., 2022). Magnani et al. (2022) pointed out that although AM opens up opportunities tied to new markets and customer needs, it also comes with new challenges and risks of its own. Furthermore, Caviggioni and Ughetto (2019) highlighted the significant gain in terms of momentum of the AM literature, although thus far, most of the scientific literature has focused on exploring the evolution of this technology and its technical features rather than its implications for international business. In other words, despite the interest shown in AM technologies as enablers of international business opportunities, there is a clear lack of research agenda that could effectively synthesize current scientific production and pave the way for future scientific production on the topic (Ahi et al., 2022; Bouncken and Barwinski, 2021). Previous literature reviews have not explored the implications of AM for international business (Gardan, 2016), thus highlighting the need to synthesize extant knowledge on the topic in conjunction with a structured research agenda that could drive forward the development of the field (Petricevic and Teece, 2019).

However, the holistic view of AM's role in international businesses remains underexplored, particularly concerning its impact on new markets and the potential shift from globalized to localized manufacturing. In other words, the totality of what we know about AM in international business remains unclear, most notably when investigating opportunities and challenges rising from the opening up of new markets and customer segments and given how disruptive the potential move from globalized international manufacturing to localized production (Ben-Ner and Siemsen, 2017; Laplume et al., 2016). Additionally, the academic-practitioner divide is noticeable in international management literature, as data scarcity has limited the exploration of the link between smart manufacturing and internationalization (Autio et al., 2021; Hannibal, 2020; Kano et al., 2020). As Autio et al. (2021) highlighted, "research rarely comes to grips with the root concept of digitalization or considers the deeper impact of digitalization on global business," thus warranting a deeper exploration granted by the analysis of insights from both industry and academia.

Based on the gaps listed above, this manuscript aims to unveil the advantages and challenges of AM technologies in the context of international business. To achieve its goal, this study proposes a broad perspective based on both thematic and content analysis (CA) (Shelley and Krippendorff, 1984) on a comprehensive set of scientific sources and professional documents, including business cases, newspaper articles, press releases, and specialized blogs. The joint vision behind this approach is meant to close the gap between theory and practice, thus producing a better understanding of the multifaceted nature of AM in international businesses through the eyes of both academia and industry. The importance of an intensified industry-academia dialogue in supporting the adoption of AM in the global value chain has been echoed by both academia and industry (Fasogbon and Adebo, 2022), a collaborative effort involving government, higher education institutions, and the private sector is needed to advance the collective understanding of its potential. Our approach, inspired by previous efforts (Ahi et al., 2022; Bouncken and Barwinski, 2021; Massaro et al., 2021; Romme et al., 2015), aims to facilitate dialogue and uncover common interests and discrepancies between these perspectives. Through an exploration of documents produced by both scholars and professionals on AM in international business, we seek to answer specific research questions, discussed below.

The results show the disruptive potential of AM in international business, ranging from product specialization, dispersion of production toward developing countries, and diminishing needs for specialized training (Ben Rejeb and Roussel, 2022; Strange and Zucchella, 2017). Additionally, our results highlight both significant implications for the global strategy of internationally oriented companies, and a few barriers and challenges to adoption (Damjanovic et al., 2021; Deepthi and Bansal, 2022). The originality of this study lies in several factors. First, it is one of the first attempts to develop a structured research agenda that could drive forward the field of AM in international business. Second, by triangulating scientific production and practitioners' perspectives, the study allows us to provide a more comprehensive overview of the challenges and benefits of AM in the international business environment. Finally, this study contributes to a novel yet rapidly developing stream of research that is extremely relevant in today's competitive landscape. This study aims to advance the knowledge of AM and international business by unveiling the benefits of its application, along with the challenges that come with it, and doing so by merging real-life and theoretical perspectives.

The remainder of this manuscript is structured as follows. The next section provides a brief overview of the topics under discussion, with the intent of better contextualizing our research question and our choices in terms of research design. This is done by illustrating the link between AM literature and international business literature, and the reasons as to why the triangulation between scientific and professional sources is appropriate for our objective. Subsequently, we discuss the methodological approach chosen for the study by unveiling the research protocol using a clear, transparent, and replicable approach. We then present the results of our investigation by first illustrating the descriptive statistics of the dataset and then performing a qualitative CA to extract emerging themes. Subsequently, we develop a structured research agenda based on what has emerged from a comparison of professional and academic sources. We then conclude the manuscript by discussing its theoretical and practical implications, along with a few limitations intrinsic to the research design used herein.

2. Literature review

2.1. AM and international business

As technology innovation continues to disrupt the competitive landscape, it has enabled internally oriented ventures to launch their operations on a global scale. However, whereas the strategic implications of digital transformation have been investigated from a domestic perspective, their impact on global strategies is an under-researched area in the international business literature (Efrat and Asseraf, 2019). Similarly, international business scholars actively debate the convergence and divergence issues connected to global operations (Ozturk and Cavusgil, 2019), albeit there is still a strong need for future research to clarify the diverse aspects and implications of de-globalization, from both a practical and a theoretical perspective (Witt, 2019). Thus, there is a need for modern international business research to rethink the theories connected to a global strategy in light of recent developments in digital transformation (Petricevic and Teece, 2019).

Literature streams on digital transformation and international business are strictly connected and have been for the better portion of the past two decades. In fact, since the beginning of the new millennium, scholars have investigated disruptive technologies as enablers of the internationalization of businesses, as well as the need for companies to develop relationships with international partners (Jafari-Sadeghi et al., 2020). Although two decades ago, the scientific discourse was mostly centered on the Internet and communication technologies (ICT) for international business, the interplay between the two streams has progressively shifted toward Industry 4.0 and the ways in which disruptive technologies are reshaping the global industrial system. In fact, amid the myriad of opportunities provided by disruptive technologies, many researchers have begun investigating the potential of AM technology for the creation of a new breed of international entrepreneurial opportunities.

2.2. Opportunities and challenges of AM in international business: research gaps

Despite its inherent complexity, AM technology provides a unique set of opportunities and challenges for the industrial and economic development of international entrepreneurial ventures. First, AM technology can be applied in virtually any location, whereas from an industrial point of view, more advanced technologies are mostly exclusive to economically developed countries. For instance, AM technology has been successfully used in the Sahara desert and rural Nepal (Scott and Harrison, 2015). In other words, AM technology is often associated with the concept of “de-globalization”, as it is contributing to a gradual shift toward localized production, closer to where products are sold and consumed (Strange and Zucchella, 2017). “De-globalized” production enables manufacturers to produce tailored products to match the customers' needs. The end result might be mass customization, in contrast to traditional mass serial production (Ben-Ner and Siemsen, 2017). However, since the impact of AM varies from industry to industry, a thorough exploration of the challenges and opportunities connected to the use of AM in international business is needed.

Hannibal and Knight (2018) noted that despite general optimism toward AM and the future development of international business, systematic and scholarly research is needed to investigate the conjunction between the two streams. Although both streams have been developing independently at a fast pace, the intersection of the two suffers from a gap between the results of professionals and those of academics. In other words, research into the business aspects of AM technology is still sparse and would benefit from a structured research agenda built upon the synthesis of both practical and theoretical data (Caviggioli and Ughetto, 2019). Thus, an integrated approach could provide scholars with more empirical evidence to fuel their research while analyzing the adversities faced by practitioners and developing pathways for future research to answer their needs.

2.3. AM in international business: the need to establish an industry–academia dialogue

Several works have highlighted the importance of an intensified industry–academia dialogue. For instance, Fasogbon and Adebo (2022) noted how a tripartite effort by the government, higher education institutions, and the private sector is needed to support the AM initiative. According to the authors, governments should increase funding allocation for educational institutions, thus enabling them to carry out quality research on AM and, consequently, disseminate the product of their research to the benefit of the private sector (Fasogbon and Adebo, 2022). Gammeltoft and Cuervo-Cazurra (2021) pointed out the importance of further research on the challenges connected to the use of AM in international business, thus calling for future studies to adopt a comprehensive view from both practitioners' and academics' perspectives in an effort to address the above issue.

Furthermore, practitioners may find it challenging to connect with scientific production, mostly due to the intrinsic differences between the two approaches. This notion also holds true for the literature on AM in international business, as scholars struggle to find empirical evidence to corroborate their theoretical assumptions, while practitioners collide with an ever-changing competitive landscape made volatile by disruptive technologies (Ben-Ner and Siemsen, 2017). In an effort to solve the gap and address the calls for research made by previous contributions (Fasogbon and Adebo, 2022; Ford and Despeisse, 2016), we decided to undertake the approach proposed by Romme et al. (2015) and create a dialogue between the different perspectives in an effort to highlight potential zones of common interest and discrepancy. Thus, by exploring documents produced by scholars and professionals on the topic of AM in international business, we intend to answer the following research questions:

RQ1. What are the challenges and opportunities connected to the use of AM in international business, according to academics' and practitioners' perspectives?

RQ2. What are the implications of AM technology in regards to the global strategy of internationally oriented companies?

3. Methodology

3.1. Content and thematic analysis

We deemed a thematic and CA the most appropriate methods to address our research question (Ford and Despeisse, 2016). CA is one of the most used qualitative methods as it allows for an in-depth investigation of a topic. Additionally, using computer-assisted data analysis tools has evolved the methodology, as researchers can now gather, analyze and extract information from significantly large datasets in a clear, transparent, and replicable manner. Consequently, CA is now widely used in social science research, particularly in the field of international business (Elsahn and Earl, 2022; Zahoor et al., 2022). While several categories of CA exist, as Hsieh and Shannon (2005) pointed out, our research adopts a conventional approach by deriving our coding categories directly from the data at our disposal. The choice of conventional CA over direct or summative CA is due to the exploratory nature of our approach and the novelty of our field of investigation, which prevents us from using a theory or relevant findings as a guide for initial coding activity. Thus, after carefully considering the above mentioned points, this study adopts a two-step CA of textual data gathered from academic and scientific sources (Ben-Ner and Siemsen, 2017). The integrated approach was inspired by previous research highlighting the need for joint insights from industry and academia (Ahi et al., 2022; Bouncken and Barwinski, 2021; Massaro et al., 2021). In the first step, we created two distinct datasets, one for practitioners' data and one for academics' data.

3.2. Data collection

In order to collect data for the two datasets needed for the study, we looked for two databases that could provide us with academic and practitioner documents. After much deliberation, we ultimately decided to use Elsevier's Scopus as a source of academic data for a few reasons. First, Scopus is widely adopted in social science research and, more precisely, in international business research as a source for CA studies (Alon et al., 2020; Elia et al., 2020; Song, 2014). Second, it is more extensive than WebOfScience, thus allowing for a more comprehensive look at available data. Third, records featured in Scopus undergo quality control when uploaded. We chose not to use Google Scholar both due to its lack of a user application programming interface (API) that could allow us to automatically collect documents and its lack of quality control evaluation on the publication outlets featured in the database (Massaro et al., 2021).

Consequently, we developed a search string that could comprehensively capture the most articles related to AM in international business. In order to obtain an exact string, we carefully analyzed previously published systematic reviews on the two topics and compared the previous search strings. Through an interactive process, we have then synthesized the keywords used in previous studies, thus developing our string, which included the following: ("Additive Manufact*" OR "3D Print*") AND ("International Business" OR "International" OR "Global*" OR "Multination*"). The search revealed a total of 257 distinct records. We then applied a series of inclusion and exclusion criteria to refine the sample. Thus, we excluded publications from conference proceedings, book chapters, and non-peer-reviewed sources. Consequently, we have considered only papers published in peer-reviewed sources, composed in English, and fitting this study's conceptual boundaries for our analysis. The final sample of academic papers was then set to 65 different publications.

We have used the Nexis Uni database to collect practitioners' documents. Scholars in the international business field have used the database extensively to collect news, business, and legal sources, and it has been used in similar studies (Alon et al., 2020; Elia et al., 2020; Song, 2014). Nexis Uni is a comprehensive online research platform that provides access to a vast collection of legal, news, business, and government documents, and is vastly adopted by both academia and industry (Chatterjee et al., 2019; Astvansh and Eshghi, 2023). We used the exact string used in Scopus. However, since Nexis Uni features a vastly more significant number of records, we followed the ulterior step taken by Massaro et al. (2021). We only included records in which the keywords were within five terms of distance. This search strategy allowed us to extract a more feasible and accurate data set, resulting in 382 different results.

3.3. Data analysis via Leximancer

Once the data was successfully extracted, we conducted a three-step analysis to highlight emerging themes and better interpret the results. The first step involves the use of Leximancer (Massaro et al., 2021). The tool performs an automatic CA searching and extracting thesaurus-based concepts from textual data. Furthermore, Leximancer's approach is unsupervised. In other words, the software allows for an unbiased, objective, and higher-level view of the dataset for researchers that does not depend on pre-constructed frameworks. Finally, we employed an iterative process of going back and forth and recombining data using internalization theory and global value chain theory as theoretical lenses to interpret the information (Strange and Humphrey, 2019).

3.4. Latent Dirichlet allocation and topic modeling as control methodology

Machine learning has been extensively applied to accounting research to analyze and extract information from large amounts of textual data. What topic modeling does is to identify clusters of frequently co-occurring words in a corpus of textual documents. The algorithm is based on Bayesian statistics. Thus, it assigns each word a probability of belonging to a specific topic. Researchers will then be able to label the topic based on their qualitative interpretation.

More specifically, we used the Latent Dirichlet Allocation (LDA) algorithm as a control methodology to validate the information extracted via Leximancer. We used Python's package MALLET to perform an LDA analysis on the bibliometric data extracted from Scopus. The goal was to extract emerging topics and compare the results with those obtained through Leximancer, thus strengthening their validity.

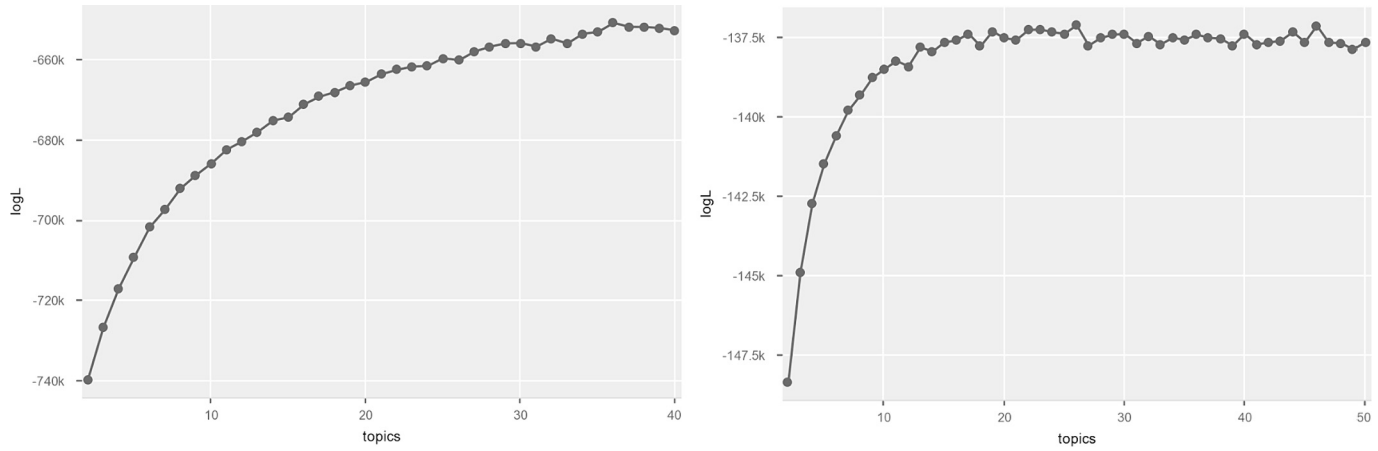


Fig. 1. Harmonic Mean Score of the practitioner corpus (left) and academic corpus (right).

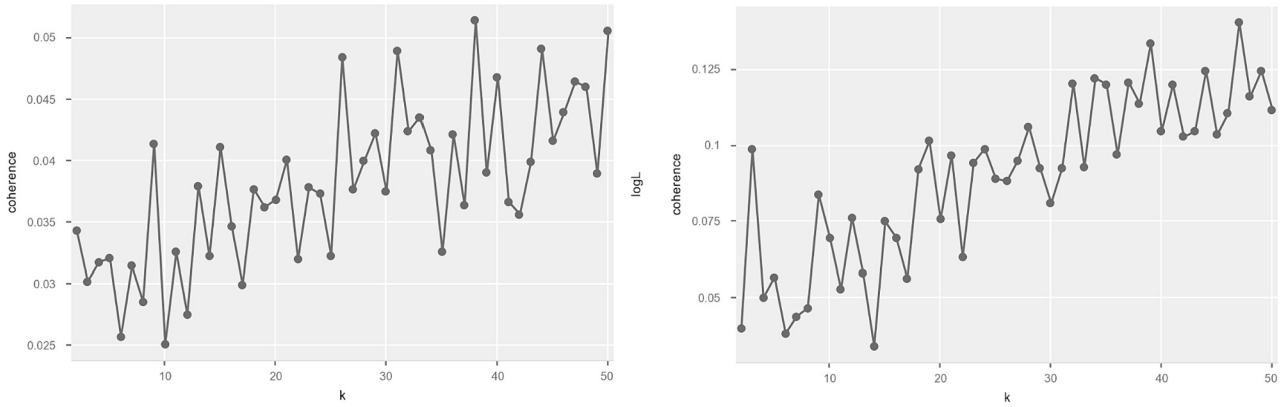


Fig. 2. Coherence Score of the practitioner corpus (left) and academic corpus (right).

Table 1
LDA Topics extracted from the academic corpus.

	Topic	label_1	Coherence	Prevalence	top_terms
t_1	t_1	digital_technologies	0.015	4.949	printing, technology, food, also, injection, however, authors, injection_moulding
t_2	t_2	supply_chain	0.084	7.952	supply, printing, design, chains, manufacturing, chain, model, additive, use, supply_chains
t_3	t_3	manufacturing_structures	0.078	5.73	manufacturing, additive, additive_manufacturing, process, structures, different, properties, also, based, proposed
t_4	t_4	international_manufacturing	0.058	5.971	technologies, manufacturing, additive_manufacturing, market, internationalization, global, level, may, impact
t_5	t_5	internet_things	0.078	5.927	new, technologies, many, technology, development, technological, construction, world, iot, review
t_6	t_6	concrete_printing	-0.019	4.357	matching, global, technology, study, business, industrial, affect, de, form, importance
t_7	t_7	energy_consumption	0.255	4.912	global, knowledge, consumption, energy, energy_consumption, ltd, building, analysis, elsevier, elsevier
t_8	t_8	digital_identity	0.042	5.151	manufacturing, system, parts, additive, efficiency, lead, digital_identity, shared_digital, technology, due
t_9	t_9	digital_technologies	-0.002	4.198	digital, parameters, research, first, global, control, risks, nature, purpose, current
t_10	t_10	supply_chain	0.135	5.032	supply_chain, chain, parts, manufacturing, systems, supply, automotive, spare_parts, operations
t_11	t_11	international_business	-0.019	4.553	industry, business, study, results, framework, environmental, designs, textile, industries
t_12	t_12	digital_technologies	0.075	5.829	firms, production, part, technology, international, economy, data, digital, materials, application
t_13	t_13	supply_chains	0.064	6.194	supply, additive_manufacturing, additive, production, technology, spare, manufacturing, global, study
t_14	t_14	spare_parts	0.109	5.446	research, paper, value, implications, industrial, purpose, technologies, main, elsevier, early
t_15	t_15	governance	-0.013	5.012	production, business, particular, times, manufacturing, manufacturing_technologies, information, find, governance
t_16	t_16	spare_parts	0.3	4.572	process, energy, machining, processing, surface, conventional, additive, cost, supports, laser
t_17	t_17	concrete_printing	0.065	4.882	industry, research, products, new, literature, provides, significant, manufactured, conditions, making
t_18	t_18	social_sustainability	0.128	4.655	using, stiffness, study, developed, laboratory, help, source, manufacturing, fablabs, inovaã
t_19	t_19	design_methodology	0.195	4.677	manufacturing, design, flexibility, originality, study, power, sources, production, supply_chain, systems

3.4.1. Goodness-of-fit statistics

In order to determine the overall amount of topics to be extracted from the sample, we had first to conduct a series of tests, namely goodness-of-fit statistics. The aforementioned goodness-of-fit tests serve the purpose of testing whether or not a specific amount of topics is ideal to represent the narrative content featured in a corpus. Since an indefinite number of topics can potentially be extracted from a corpus through LDA topic modeling, goodness-of-fit statistics help in determining the ideal amount of optics said model should contain to be the most fitting. Tests are run on varying amounts of topics, each with their own score based on how effectively they represent the information featured in the sample. More precisely, we have drawn from previous research to perform Harmonic Mean and Coherence tests. The triangulation between the two analyses allowed us to determine the most consistent topics to be extracted from the sample (Figs. 1 and 2).

Harmonic mean for the LDA model in is defined as:

$$\frac{1}{M} \sum_{m=1}^M \left(\frac{1}{K} \sum_{k=1}^K \theta_{m,k} \right)^{-1}$$

where $\theta_{m,k}$ is the topic distribution for document m and topic k . In other words, harmonic mean measures in what degree of intensity the distribution varies across all the topics. Higher harmonic mean values equate to a more even distribution of words across topics, whereas lower harmonic mean values suggest that a distribution is concentrated exclusively on a few sets of topics.

In addition to the harmonic mean test, we calculated the coherence score on models ranging from 2 to 50 topics. Coherence was calculated using the UMass score between words $w_{\{i\}}$ and $w_{\{j\}}$ as

$$C_{UCI}(w_i, w_j) = \log \frac{P(w_i, w_j) + 1}{P(w_i) \cdot P(w_j)}$$

where $P(w)$ is probability of seeing word w in the topic. Topic coherence measures the degree of semantic similarity between high scoring words in the topic. In other words, in models with low coherence scores, topics tend to share the same words, whereas in models with high coherence scores, each topic is more distinguished from the next.

Table 2
LDA Topics extracted from the academic corpus.

	Topic	label_1	Coherence	Prevalence	top_terms
t_1	t_1	manufacturing_innovation	0.015	4.543	manufacturing_innovation, singapore, sustainability, industry, years, approach_partnership, people, set, critical, southeast, connectivity, transform, enterprises
t_2	t_2	component	0.063	5.234	print, component, solution_system, costs, process, network, software, customers, platform, sapphire,
t_3	t_3	technology	0.034	5.5	systems, software, things, high, industrial, parts, scale, large, small, fuel
t_4	t_4	growth	0.028	4.234	global, companies, year, products, industry_growth, company, key, business, work, grow_higher
t_5	t_5	cooperation	0.123	5.012	conference, cooperation, technical, industrial, economic, discussion, printing, experts, trends, communications
t_6	t_6	transportation	0.028	4.012	mobility, union, august, railway, devices data, considered, developments, railroad, transportation, shippers
t_7	t_7	corporate	0.034	3.094	energy, including, option, corporation, commercial, dividend, equity, treatment, testing, directors
t_8	t_8	governmental_support	0.583	3.012	opportunities, asia, singapore, support, government, transformation, enterprise_projects, board, investments, countries
t_9	t_9	universities	0.002	2.123	business, co-founder, university, incubator, launches, began, intern, coordinator, artistic, career
t_10	t_10	environmental_impact	0.325	4.032	environment_impact, carbon_footprint, energy, consumption, percent, product, sustainable, reduction, environmentally
t_11	t_11	additive_manufacturing	-0.921	5.553	additive_manufacturing, production, printing, materials, design, technology, parts, material, impact
t_12	t_12	international_business	0.034	5.891	trade, market, venture, meetings, ventures, customers, economy, exports, format, benefit
t_13	t_13	global_market	0.056	4.345	market, global, analysis, application, size, type, product, decisions, current, segmentation
t_14	t_14	economic_development	0.531	5.446	government, response, update, spin-off, funding, rmulti-year, stockholders, economic_development, studies, open
t_15	t_15	automotive_sector	-0.021	3.092	expected, study, revenues, vehicle, plan, gas, fuel, health, conference, stock
t_16	t_16	studies	0.353	4.201	report, studied, sensors, forecast, period, workers, corporation, challenges, software, asia
t_17	t_17	engineering	0.098	3.607	advanced_engineering, facility, surface, industrial, institute, investment, components, value_chains, powders, powerhouse
t_18	t_18	covid-19	0.249	2.891	patients, pandemic, adjusted, evaluating, stock, in-line, covid, effective, oral, financial_risk
t_19	t_19	licensing	0.247	2.234	consensus, wires, electric, copyright, total_experience, licensing, appropriate, models, control, offering
t_20	t_20	international_business	-0.012	4.981	technology_development, international, markets, demand, solutions, project, additional, growing, transportation, logistics
t_21	t_21	partnerships	0.67	4.572	agreement, acquisition, network, approval, partnership, automotive, speeds, reports, comparable, abstracts
t_22	t_22	collaborations	0.069	3.122	collaboration, human_capital, announced, company, business, therapeutics, transaction, announces, subsidiary, solutions
t_23	t_23	customization	0.128	4.005	customers, local_production, applications, continue, quality, customization, customer, goal, adoption, portfolio
t_24	t_24	regional_impact	0.195	2.677	region, impact, shares, system, estimated, service, players, general_analysts, exchange, infrastructure
t_25	t_25	3-D_printing	0.208	2.001	printing, 3-D_print, filaments, portfolio, mechanical_shields, stability, waste, polypropylene, developed, raw_materials
t_26	t_26	digital_ownership	0.098	0.586	digital, diffusion, intellectual_proprerty, privacy, concern, additive, computer, technology, policy

4. Findings

The profiling of each topic was drawn up by analyzing the results of the Leximancer analysis, along with the triangulation with the information extracted from the LDA analysis. A panel composed of the four authors and three external experts was put together to better understand the critical emerging topics from each corpus. The panel performed qualitative coding by using the themes emerging from Leximancer. The results of the automated LDA analyses are presented in Table 1 and Table 2, whereas the results of the automated Leximancer analysis are featured in Fig. 3 and Fig. 4. While Leximancer's analyses were fully automated, the overall amount of topics extracted through LDA was determined by comparing the Goodness-of-fit Statistics of each corpus. The authors ultimately agreed on the extraction of 19 topics from the academic corpus and 26 from the practitioner corpus. The authors then interpreted the data through an iterative process involving qualitative coding through the theoretical lens of internalization theory and global value chain theory (Strange and Humphrey, 2019). Ultimately, in order to answer the research question, the authors classified each topic into four main categories, namely the advantages of AM in international business according to academic sources, the advantages of AM in international business according to practitioners' sources, the challenges of AM in international business according to academic sources and the challenges of AM in international business according to practitioners' sources.

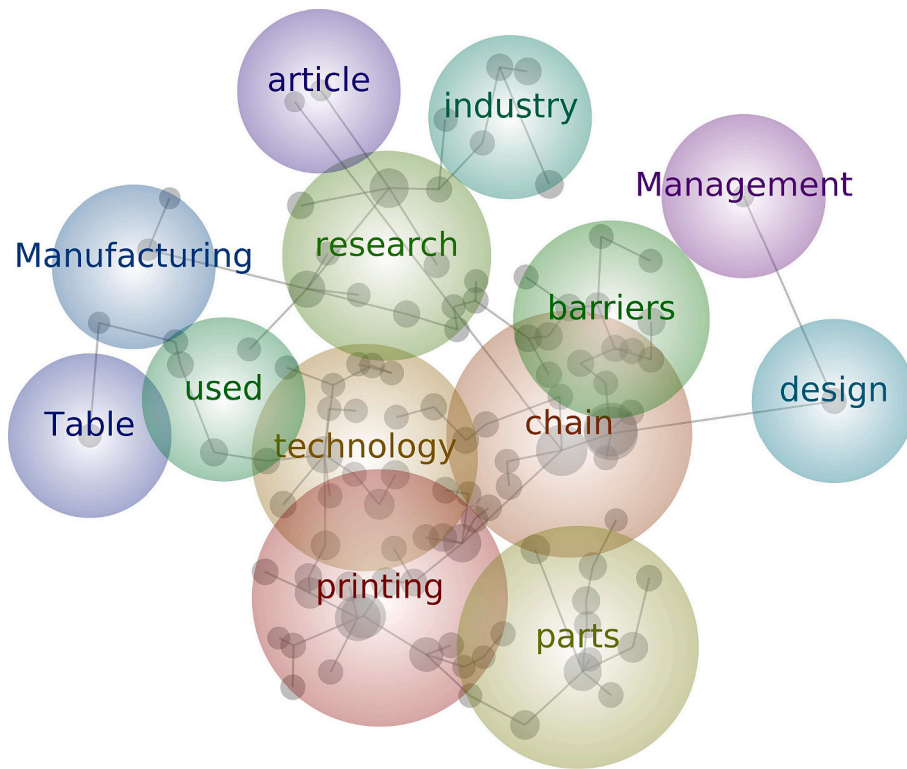


Fig. 3. Key themes and their relationship in academics' sources.



Fig. 4. Key themes and their relationship in practitioners' sources.

4.1. Advantages of AM in international business in academic sources

In this section, we will attempt to synthesize the scholarly literature in regards to the advantages provided by AM in the context of international business. As previously described, our analysis is deduced from a co-occurrence approach, which has allowed us to identify the key concepts discussed in academic sources and to see how they relate to each other. As shown in Fig. 3, scientific production has mostly focused on topics such as 'supply chain,' 'management,' 'region,' and 'customers.' One of the main advantages of AM in the global value chain is its emphasis on customization (Hannibal and Knight, 2018). In other words, AM shifts the logic of production from mass manufacturing to small-batch, highly specialized production, thus shaping an industrial future in which production is geographically dispersed and closer to the end users (Atzeni and Salmi, 2012). A similar sentiment was echoed in the study by Frigant (2020), who used the word "de-globalization" to describe the trend described above. In conjunction with the disruptive impact AM might have on global value chain configurations in the near future (Strange et al., 2022; Magnani et al., 2022), Bogers et al. (2016) note how a shift toward mass customization will create opportunities for new and more customer-centric business models.

Interestingly, we find numerous studies investigating the implications of AM in regards to sustainable development and production. Although the shortening of supply chains can be considered a competitive advantage, as it leads to cost optimization, among other benefits (De Beule et al., 2022), Laplume et al. (2016) suggested that AM could significantly reduce the need for international companies to transport components globally, thus implying a reduction in the environmental impact of production. Similarly, Ford and Despeisse (2016) highlighted how the application of AM technologies could eventually lead to more sustainable production and consumption. Notably, AM technology appears to have several potential for a circular economy as well, since it allows for the recycling of materials and spare parts (Rodrigues Dias et al., 2022). In the long run, AM could allow manufacturers to fine-tune their production processes to achieve a lower environmental impact with an economic balance (Peng et al., 2019; Torres-Carrillo et al., 2020). In other words, through AM, it is possible to optimize production, thus possibly leading to a lower environmental impact compared to conventional manufacturing (Deepthi and Bansal, 2022).

From a broader perspective, AM has the potential to reshape notions such as partnerships and alliances, which have been key areas of interest in international business research for several decades (Achrol and Kotler, 1999; Coviello and Munro, 1997; Johannisson, 1988). More specifically, scholars have begun to explore the relationship between customers and manufacturers to highlight the competitive advantages connected to localized AM production. In other words, scholars agree that AM has the potential to make global value chains more agile, resilient, and sustainable by significantly shortening them compared to traditional manufacturing (Attaran, 2017; Basu et al., 2022).

4.2. Advantages of AM in international business in practitioner sources

As evidenced by Fig. 4, the debate among practitioners has been developing around the topics of 'sustainability,' 'customers,' and 'challenges'. Practitioners' impressions regarding the future of AM in the context of international business show a significant degree of optimism, especially in considering the long-term growth of the technology. Generally speaking, practitioners show confidence in the long-term growth drivers for international business and for the AM industry (WEDC, 2020). Adoption of AM solutions continues to grow, thus promoting a somewhat diffuse optimism regarding the future of Industry 4.0 (News Bites US Markets, 2022). Concurrently, ASTM International's Additive Manufacturing Center of Excellence is working on creating and maintaining a set of international standards needed by the AM industry as it continues to develop and transform.

More precisely, our results show that there is trust in the potential of AM for the development of international business opportunities (Oerlikon, 2017). Christine Furstoss, the technology director of General Electric, stated that AM can, in fact, open up new opportunities for international development and help enhance existing international business models by, for instance, delivering spare parts to customers in a more cost-effective way (Rudarakanchana, 2014). More specifically, practitioners believe that AM technology will lead to the creation and development of new global value chain configurations, along with new international business models (IBM, 2018). For instance, our findings reveal opportunities for 'on demand' industries, which would benefit more from AM compared to traditional mass manufacturers. More specifically, practitioners find it more profitable to shorten their supply chain and relocate production locally.

Further, a common theme found among practitioners' sources is the implications of AM technology for cost optimization. In other words, practitioners are confident that AM can improve the quality and efficiency of their finished products while simultaneously reducing the costs connected to their production (3D Systems Inc., 2022). This discussion spiked during the pandemic, as AM technology enabled the decentralized production of urgently needed medical devices through on-demand local production. Consequently, interest in AM and digital supply chains has maintained its significance in post-pandemic times, as the volatility of the market and constant uncertainty have led international manufacturers to prioritize adaptability and flexibility in their global supply chains (News Bites US Markets, 2022).

From a broader perspective, our results show how AM falls within a specific group of digital technologies able to effectively and rapidly change the dynamics of entire industries, thus promoting a value chain redesign for a significant number of internationally oriented companies. Amid the potential opportunities brought by value chain redesign is the goal of a more sustainability-oriented approach to manufacturing. In other words, practitioners believe that AM could bring faster production cycles and lower resource requirements, thus limiting the environmental impact of waste and power consumption (Oerlikon, 2017). For instance, according to Braskem's manager of Innovation & Technology for Additive Manufacturing, Fabio Lamon, AM is a zero-waste process, as finished products can be fully dismantled and recycled, thus reinforcing the companies' commitment to sustainability and a circular economy (Abdulkareem et al., 2021; Braskem, 2020).

Table 3
Comparing the perspectives of academia and practice.

Academia	Practice
Increased practitioner awareness of intellectual property rights and local policies presents opportunities for researchers, who believe the AM field is lively and will rapidly develop in the upcoming years.	Similarly to academia, practice has also shown confidence in the future of AM and its rapid development, with a shared emphasis on topics related to sustainability and customer relationship management.
Academia is focused on AM development research, striving to build meaningful connections with practice as to further advance their knowledge of AM and its implementations.	Practitioners appear to emphasize topics connected to sustainability and customer relationship management, at least partially due to their strategic relevance.
Scholars face challenges in gathering new insights and empirical evidence due to the ever-changing, yet still relatively new digital landscape of AM. Overall, scholars believe AM is not a 'magic bullet', as the technology is nuanced, particularly in policy-making and distribution aspects.	The primary concern in AM's international business implementation is its complexity. Here, academics and practitioners converge, as the scholars' current struggles in finding empirical insights are tied to the practitioners' difficulties in implementing AM on a large scale.
Transition from globally dispersed value chains to decentralized AM-based production is complex, and cultural changes may be necessary for successful implementation. Scholars have shown interest in the cultural implications of said changes.	Despite its advantages, AM adoption may be slow due to factors like limited financial resources and the need for specific competencies, thus requiring effort in both technical and skill development aspects. Practitioners have shown more interest in the skill/competence development ramification of AM implementation, rather than its cultural effects.

4.3. Challenges of AM in international business in academic sources

Although the adoption of AM in international business has shown significant potential, it also presents a few challenges to overcome. Scholars have attempted to highlight the extant barriers that are currently hindering the widespread adoption of AM in the global value chain while suggesting possible solutions to overcome these challenges. Broadly speaking, the authors agree that the conjunction of AM and internationalization is beneficial for companies, as it implies openness to new markets and customer needs. However, several risks emerge with the separation of R&D and production (Magnani et al., 2022; Öberg, 2019), and that is the general direction toward which AM points.

A few limitations are inherent in AM technology, given that to harness the full benefits of AM, new functionalities, such as microelectronics, need to be embedded into finished products (Ford and Despeisse, 2016). Further, compared to traditional manufacturing, AM has a few weaknesses. Although AM is certainly suitable for the production of prototypes and components (Ford and Despeisse, 2016), Gao et al. (2015) warned that only a few international markets can truly benefit from AM and its low-volume, highly customized production. In other words, the cost of achieving economies of scale through AM is significantly higher than through conventional manufacturing, thus limiting AM's benefits to a selected number of markets.

Although rethinking internalization and global value chains may come with potential benefits, they simultaneously bring unprecedented challenges to internationally oriented companies on various fronts. For instance, the transition from vertically fragmented, globally dispersed global value chains that characterize modern international business (Laplume et al., 2016; Strange and Zucchella, 2017) to decentralized AM-based production is not straightforward and might require significant cultural and organizational changes to be fully implemented (Strange et al., 2022). Further, although AM allows components to be digitally stored rather than physically shipped across countries (Strange et al., 2022), it simultaneously concerns knowledge appropriability (De Beule et al., 2022; Zhang et al., 2022). In fact, manufacturers might be more prone to malicious hacks, thus leading to patent infringement and other intellectual property violations (Desai and Magliocca, 2013).

4.4. Challenges of AM in international business in practitioner sources

A diffuse sense of optimism emerges from practitioners' sources; however, a few challenges can also be identified and discussed. The primary concern of AM in international business is its complexity, which makes its widespread implementation challenging. As pointed out by Dr. Jennifer Johns of the University of Bristol, practitioners should refrain from considering AM a 'magic bullet'. Instead, AM technology is much more nuanced, especially in terms of policy making and distribution (Johns, 2022). Additionally, we find a set of challenges connected to industrial processes themselves. One concerns the need for closed-loop control. In other words, to achieve an efficient level of automation in production, sensors and machines need to be able to constantly monitor the final properties of the parts they are building, thus constantly adjusting their parameters and compensating for phenomena such as drifting or misalignments. Similarly, Christine Furstoss, the technology director of General Electric, noted that companies are still learning about final products and materials (Rudarakanchana, 2014). Consequently, manufacturing processes, such as the inspection of finished products, require some time to master. Similarly, the Minister of Trade and Industry of Singapore, Chan Chun Sing, highlighted how mastering AM for internationally oriented companies is not straightforward (Grace Ho, 2020). Instead, it will require the improved competitiveness of local firms through the constant upgrading of the workforce's skills (Gaudio et al., 2020). In other words, despite its numerous advantages, AM requires time to be fully adopted, whether due to a lack of financial resources or the required set of competencies needed to master the technology.

5. Discussion

After having depicted the perspectives of academia and practice, we provide a synthesis of the main insights in Table 3. We then

devote the remainder of Section 5 to depict in greater detail the both perspectives. As noted in Table 3, there are some points of convergences between academics and practitioners, as well as some divergences.

5.1. De-globalization through AM: a new perspective on internalization theory and global value chain theory

For decades, internalization theory has explored the integrated multi-location configuration of international businesses. However, as time progressed, international businesses have shifted their configuration toward decentralization, thus making their value chains increasingly separated in space (Eyers et al., 2018). The above paradigm has prompted several research outputs meant to explore global value chain theory (Laplume et al., 2016).

Against the above theoretical scenario, the rise of AM technology will most likely lead to the increased “de-globalization” of manufacturing goods (Frigant, 2020; Nauwelaerts et al., 2022). In other words, AM could enable companies to relocate their production from popular mass production platforms to local and smaller sites. Our results show that practitioners are confident that AM would provide significant competitive advantages to their international businesses. For instance, Siemens claimed that AM increases global supply chain resiliency, and lowers environmental impact (Siemens, 2022). Similarly, Oerlikon mentioned that the decentralization of production enabled by AM will eventually likely redefine some of the more conventional manufacturing value chains, with mass customization as the main driving factor (Oerlikon, 2017).

This perspective is also reflected in the literature. De Beule et al. (2022) illustrated that AM firms are more likely to have a foreign production subsidiary than non-AM firms, thus further corroborating the impact AM has on the redesign of a global value chain and the internationalization of companies. Although our results confirm and expand upon those of De Beule et al. (2022), the debate on convergence and divergence issues in international business has yet to be fully explored (Ozturk and Cavusgil, 2019). According to internalization theory and global value chain theory, the need for highly customized non-standard products is what drives internationally oriented companies toward the acquisition and use of subsidiaries (Strange and Humphrey, 2019).

However, AM technology opens up a new perspective on the above theoretical background, as it may reduce firms' incentives to offshore production (Magnani et al., 2022), thus potentially restructuring and shortening the global value chain (Buonafede et al., 2018). As Strange et al. (2022) pointed out, international business scholars might have to rethink the concepts of internalization and the global value chain due to the significant disruptive potential AM technology possesses. In other words, AM has the potential to reverse the trends toward organizational centralization and globalization of production and distribution, instead giving way to decentralization and localization (Ben-Ner and Siemsen, 2017). Consequently, a new line of literature could explore this new perspective. For instance, future studies could investigate the impact of the heterogeneity of industry sectors on the adoption and diffusion of AM technologies in the global value chain (De Beule et al., 2022; Buonafede et al., 2018). Similarly, scholars could compare micro-multinational companies to larger companies to highlight the potential presence of barriers to AM adoption, along with ways to overcome them. Finally, a comparative study could be conducted from a cross-cultural perspective, as our results show how cultural differences may have an impact on AM adoption (Öberg, 2019).

5.2. A paradigm shift in customer interactions

We discussed how AM technology has the potential to increase customer interaction according to academic sources (Bogers et al., 2016). Similarly, practitioners stress their renewed focus on partnering with customers to create value-added production applications through AM. A significant advantage of AM technology is the enabling of mass customization, which will allow customers to incorporate design changes and customize products to fit very specific needs (Hannibal and Knight, 2018). The paradigm shift from conventional manufacturing to mass customization manufacturing is, however, complex, and has several implications for international business theories (Rylands et al., 2016).

First, the new paradigm will lead companies to profoundly rethink planning and strategy related to the configuration and coordination of global value chains (Hannibal and Knight, 2018). Our results show how companies such as Burloak Technologies see AM as an enabler of a new collaborative evaluation and learning approach to customer interactions. In other words, Burloak Technologies uses AM technology to collaborate with customers in the development of specific prototypes that support their vision while simultaneously determining the feasibility of the materials and printed parts. This line of research could expand upon previous work on international partnerships and alliances in light of the disruptive changes brought about by AM technology.

5.3. Sustainable global value chains through AM

Our results show that both practitioners and academic sources nurture interest in the ramification of AM and sustainable production. Academic sources have highlighted several ways in which global factories can become more sustainable through the adoption of AM. First, additive manufacturing processes can be reversed, thus allowing finished products to be converted into raw materials that can be reused at a later time (Ahi et al., 2022). Aside from the considerable reduction in waste and the consequent environmental impact, the above direction has notable implications for the circular economy (Rodrigues Dias et al., 2022; Garmulewicz et al., 2018). Second, by relocating production closer to the end customers, long-distance transportation is not needed, which decreases both the costs of logistics and the environmental impact of the carbon footprint (Ahi et al., 2022; Rodrigues Dias et al., 2022).

Against this background, Belhadi et al. (2022) noted that research on the impact AM has on the sustainability of global value chains is in its infancy, thus requiring further attention from the scientific community. A first step toward the assessment of the environmental impact of AM was taken by Cozzolino et al. (2022); however, there is plenty of room for international business scholars to explore the

managerial ramifications of AM and sustainable development. For instance, [Rodrigues Dias et al. \(2022\)](#) suggested that future research should focus on drivers and barriers to the adoption of sustainable AM manufacturing and explore how they are affected by changes in location and culture.

5.4. Closing the gap between academia and industry

Our results show the need to close the gap between industry and academia. This call is also reflected in academic sources and could be a decisive factor in the development of AM in international business. More precisely, [Kolade et al. \(2022\)](#) advocated the need to rethink the relationship between academia and industry, as higher education institutions could actively contribute to the economic development of their territory, while industrial players could foster academic research by establishing a continued dialogue with researchers.

A few future challenges could be addressed through the concerted efforts of academia and industry. First, our results show increased awareness among practitioners regarding issues connected to intellectual property rights and local policies. [Gao et al. \(2015\)](#) hypothesized a shift in the ways companies fill and protect their design patents, thus prompting researchers to explore the ramifications of their concerns, possibly through more sophisticated encryption algorithms. A similar sentiment was echoed by [Fasogbon and Adebo \(2022\)](#), who pointed out how vital it is for industry and academia to establish a collaborative effort, namely through the allocation of more significant amounts of funds allocated to AM development, which would in return allow scholars to carry out quality research, hence contributing to the development of the field.

The divide between industry and academia is, however, further exacerbated by the difficulties that scholars face in gathering new insights and empirical evidence from the ever-changing digital landscape of AM ([Eskindarov et al., 2019](#)). Moreover, our results highlight a convergence between academic themes and industry ones, as practitioners appear to emphasize topics connected to sustainability and customer relationship management, whereas the academic literature also reports these themes as of particular interest ([Arukala and Pancharathi, 2020](#); [Chatterjee et al., 2022](#); [Hong et al., 2018](#)). We can interpret these results as a potential match between academics and practitioners' interests, thus creating a common ground between practitioners' interests in these fields and future scientific production to support them. Further research on the aforementioned topics might unveil possible ways to bridge the academic-practitioners' divide, thus establishing a dialogue between academia and industry with mutual benefits ([Gao et al., 2015](#)).

6. Conclusions, implications, and limitations

Clearly, our contribution answers several calls for research on the exploration of the advantages and challenges of AM in international business ([Deepthi and Bansal, 2022](#); [Fasogbon and Adebo, 2022](#); [Ford and Despeisse, 2016](#); [Steenhuis et al., 2020](#)). Although the two streams of research have been developing separately, their recent conjunction shows the potential for further developments that could benefit both academia and industry ([Meyer et al., 2022](#)). Our research shows the disruptive potential of AM in international business ([Ozturk and Cavusgil, 2019](#)), ranging from product specialization ([Ben-Ner and Siemsen, 2017](#)), dispersion of production toward developing countries ([Witt, 2019](#)), and diminishing needs for specialized training ([Rodrigues Dias et al., 2022](#); [Strange and Zucchella, 2017](#)). However, along with the potential benefits, this study revealed several challenges tied to AM implementation. These include financial and cultural barriers to AM adoption, structural changes to global value chains ([Laplume et al., 2016](#); [Strange and Zucchella, 2017](#); [Woodson et al., 2019](#)), and risks related to the violation of intellectual property rights ([Gaudio et al., 2020](#); [Steenhuis et al., 2020](#)).

Additionally, we reflected upon the implications of AM on the de-globalization and strategy of internationally oriented companies ([Nauwelaerts et al., 2022](#)). Globalization is the process of increasing interdependence among nations and has been discussed at length in the international business literature over the past few decades ([Chase-Dunn et al., 2000](#); [Verbeke et al., 2018](#)). However, we define de-globalization as the process of weakening interdependence among nations ([Witt, 2019](#)). Our results corroborate the disruptive potential of AM in terms of global value chains ([Steenhuis et al., 2020](#)), as the benefits of fine-slicing activities on which current global value chains are based are likely to decline due to AM ([Laplume et al., 2016](#); [Magnani et al., 2022](#); [Strange and Zucchella, 2017](#)). Instead, AM will lead to new forms of integration in global value chains ([Magnani et al., 2022](#); [Muhammad et al., 2022](#); [Strange et al., 2022](#)) by prioritizing decentralized local production ([Bogers et al., 2016](#)).

As noted by several researchers, the implementation of AM in international business calls for a concerted effort between public and private stakeholders, thus prompting our effort to compare the perspectives of professionals and scholars. Through the theoretical lens of both internalization theory and global value chain theory ([Strange and Humphrey, 2019](#)), our research has focused on bridging the divide between professionals and scholars on AM in international business ([Gao et al., 2015](#)). We achieved this goal through an in-depth investigation of two databases—Scopus and NexisUni—from which we have extracted scientific papers, reports, news articles, and press releases. Given the novelty of the research stream, we believe that both academics and practitioners would benefit from tightening the gap between each perspective, thus providing stepping stones for further theoretical and empirical developments in AM and international business literature.

6.1. Practical and theoretical implications of the study

This study has both practical and theoretical implications. From a practical perspective, we have highlighted how the general discussion concerns the supposed end of globalization and the rise of localized production ([Berman, 2012](#); [Wang et al., 2021](#)). The above trend will lead to a cultural shift in both producers and consumers, which requires collaboration between private and public

stakeholders, new models for the global value chain, and a change in the mission of companies (Fasogbon and Adebo, 2022). In other words, AM represents a fundamental shift in how products are designed and manufactured, which could prove to be difficult to absorb for some employees and markets, as it would require them to rethink the way they handled production up until today. Additionally, scholars have begun to point out the social ramifications of such cultural shift, as AM technology could provide several positive impacts on employees' health and safety, higher expectations for the future, and new opportunities in terms of skill development (Matos et al., 2019).

Above all, the main practical takeaway of the study is the need for a cultural reset on the university–industry–government relationship. In other words, the dialogue between the three must be intensified. The present work has highlighted how several discrepancies remain in the efforts from academia and practice, which can be considered far from concerted. As such, we urge entrepreneurial universities to contribute to the debate by actively aiding in the economic development of their territory through, for instance, incubation units and spin-offs. Concurrently, industries must actively look for collaboration opportunities with higher education institutions, thus fostering the development of new ideas (Ghadge et al., 2018; Strange and Zucchella, 2017). Finally, the government should consider investing in financial support for developing areas that may lack the resources needed to kickstart AM production (Kolade et al., 2022).

A second practical implication of the study is the fact it highlights the effects of AM in the cultural shift from mass standardized production to a mass personalized one (Fasogbon and Adebo, 2022). In the foreseeable future, practitioners will need to focus on working closely with customers in order to develop value-added production applications through AM, thus greatly intensifying customer interactions (Bogers et al., 2016) for the sake of tailoring production around a customer's needs (Hannibal and Knight, 2018; Rylands et al., 2016). This study provides practitioners with a comprehensive overview of the complexity of such paradigm shifts, illustrating its several ramifications, concerns, and opportunities for businesses operating internationally. AM and the global value chain undeniably act as enablers of this shift; however, what remains to be seen is how they will shape the future market and competitive landscape. Thus far, the literature has only provided theoretical assumptions on how AM will shape the future of international business due to the lack of empirical evidence and the somewhat primordial state of its implementation (Rayna and Striukova, 2014). Again, we believe that the above divide calls for a more intensified dialogue between academia and industry as a means of providing academics with readily available case studies of pioneering companies.

Third, the present study stresses the pivotal role of practitioners in the transition from mass standardized production to a mass personalized production, as managers and policymakers are expected to develop a detailed understanding of the role of AM in international business and act accordingly. The knowledge derived from and presented in this SLR will help practitioners better harness their key benefits of its implementation. Yet, as discussed at length throughout the review, the diffuse sense of optimism connected to the adoption of AM in international business comes at the cost of a few challenges and complexities needing to be addressed, and carefully evaluated. Issues such as closed-loop control in automation, quality inspections, and the need for a vast upgrade of the workforce's skills are matters that require the full attention of practitioners, and tangible actions to be performed.

Finally, a fourth practical recommendation is for managers and practitioners to rethink planning and strategy in the global value chain, as to more properly integrate AM as enabler for customer interactions (Hannibal and Knight, 2018). In other words, while the benefits and potential of AM have been illustrated at length throughout the review, it is up to managers and practitioners to fully integrate it in the strategic planning process of their companies, so that such innovation warrants a more integrated adoption, with proper risk management and assessment, along with proper sets of key performance indicators to go along with it. This way, AM would help companies rethink their value chain not only from a logistics perspective, but from a strategic planning point of view as well.

From a theoretical perspective, this study also provides several contributions. First, it is the first attempt to systematically review extant empirical research on AM in international business and to provide a structured research agenda that could drive forward this nascent research stream. Drawing on both internalization theory and global value chain theory (Strange and Humphrey, 2019), we were able to identify some new streams that could help address the academic-practitioner divide (Gao et al., 2015). Second, it addresses several calls for research by addressing the need for a debate between academia and industry (Hannibal and Knight, 2018; Hohn and Durach, 2021), and the comprehensive review of each perspective's needs and requests. As noted by several authors, there is a need for academics and organizations to act together on the future of AM in international business (Eskindarov et al., 2019), despite the fact that professionals still show skepticism toward management science academics (Kolade et al., 2022; Massaro et al., 2021), as the structured academic rigor and methodological approaches, sometimes, clashes with the needs of practitioners to think holistically at their issues. Bartunek (2007) envisioned a future in which academia and practice engage in recurring conversations and mutual relationships, in a mutual supportive exchange in which practitioners are helped by academics to further their understanding of phenomena pertaining to their daily operations, and academics are helped by practitioners in providing empirical evidence to further their studies. Such a concept is especially important in the context of AM and international business, due to the current lack of empirical evidence (Rayna and Striukova, 2014), and the novelty of the challenges faced by businesses worldwide in adopting said solution. Consistently with the above, we undertook a unique approach to this study by investigating their points of view on the topic and comparing them with what is emphasized in scientific literature.

More precisely, this study derives a set of directions for future research based on the critical comparisons between the perspectives of academia and practice. For instance, a significant stream of future research could explore the disruption of centralization and globalization, and how it is going to affect internalization and global value chains. Scholars could explore the impact of industry sector heterogeneity on AM adoption, compare micro-multinationals to larger companies, and consider cross-cultural perspectives, as further empirical research is needed to better understand this complex, multifaceted phenomenon. A further line of research consists of the exploration of the paradigm of mass customization and value-added production applications. The use of AM for collaborative customer interactions and prototype development, offers opportunities for further research on international partnerships, and the shift in

Table 4
Theoretical and practical takeaways of the study.

Future research directions	Implications for practitioners
How does the disruption of centralization and globalization affect the concepts of internalization and global value chains in the context of Additive Manufacturing (AM) adoption?	The pivotal role of practitioners, managers, and policymakers in transitioning from mass standardized production to mass personalized production
What is the impact of industry sector heterogeneity on the adoption of AM technology, and how does it vary between micro-multinational companies and larger firms?	The challenges and complexities associated with the adoption of AM in international business, including closed-loop control, quality inspections, and workforce skill upgrades
What are the cross-cultural differences in the adoption and utilization of AM, and how do they influence international business strategies?	The recommendation for managers and practitioners to integrate AM into the strategic planning process for customer interactions
How does the implementation of AM for collaborative customer interactions and prototype development impact international partnerships, as well as customer behavior and preferences?	The potential for AM to reshape the value chain from both a logistics and strategic planning perspective
In what ways can AM technology contribute to sustainability and the circular economy by allowing products to be converted into reusable raw materials, and how can this be assessed?	The complexity of the paradigm shift in international business, including its ramifications, concerns, and opportunities

customers behavior and preferences. Finally, an important stream for future research consists in the connection between AM and sustainability, as AM processes can contribute to the circular economy by allowing products to be converted back into reusable raw materials. Additionally, relocating production closer to end customers reduces environmental impact and logistics costs. Research on AM's sustainability impact is in its early stages and requires more attention, focusing on drivers and barriers to sustainable AM adoption, and how they are influenced by location and culture. The above is further corroborated by the study of [Sanguineti et al. \(2023\)](#), who urged more research on the topics of AM technology adoption, global value chains and sustainability. Early results are seemingly promising, as [Choudhary et al. \(2023\)](#) found how AM can be more economical in energy consumption compared to traditional manufacturing, and more sustainable, both environmentally and socially (i.e. showing positive effects on workers' health, safety, and customer satisfaction indicator). [Table 4](#) provides a more structured overview of the implications, separating the theoretical implications, intended primarily as future lines of research, and the practical implications, intended as recommendations for managers and policymakers.

6.2. Limitations of the study

Much like all research, this study comes with a few limitations to be considered. First, our decision to combine professional and scientific sources forced us to take a bird's eye view of the topic, thus potentially missing out on information that would have emerged from focusing on both realities separately. A second limitation comes with our choices in research design. For scientific reliability, we only focused on articles published in peer-reviewed journals, thus excluding conference proceedings, book chapters, and non-peer-reviewed journals from our analyses. Future studies could potentially explore the point of view of the above sources and, as the research stream develops over time, compare the results from a broader sample with the ones featured in the present study.

A further set of limitations is related to the methodology being adopted for the study. More specifically, LDA comes with inherent constraints that must be considered when interpreting the findings. While LDA is well-suited for the analysis of extensive bodies of text, it might not provide the same level of in-depth analysis a qualitative review would provide instead. As a methodological approach, LDA relies heavily on the interpretation of research, thus being exposed to concerns related to potential biases in extraction and analysis, due to the human component. As the field grows in numbers, a future study could replicate our analysis by focusing specifically on academic sources through the means of a systematic review, as to better and more accurately depict key emerging themes, and critical perspectives on the field.

In conclusion, the study addresses the gaps in research regarding the advantages and challenges of AM in international business, consolidating insights from various academic and practitioner sources. Recent convergence suggests potential mutual benefits for academia and industry. The research emphasizes the disruptive potential of AM, affecting aspects like product specialization, production dispersion, and reduced need for specialized training. However, challenges such as financial and cultural barriers, changes to global value chains, and intellectual property risks are also identified. The study reflects on the implications of AM on de-globalization and the strategies of internationally oriented companies, highlighting the weakening interdependence among nations. By comparing perspectives of professionals and scholars through internalization and global value chain theories, the research seeks to bridge the gap between academia and industry. The findings suggest the need for collaborative efforts between public and private stakeholders in the implementation of AM in international business, advocating for a closer alignment between academic and practical perspectives for further theoretical and empirical advancements in the field.

CRediT authorship contribution statement

Elisa Giacosa: Conceptualization, Investigation, Methodology. **Edoardo Crocco:** Data curation, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft. **Jan Kubálek:** Investigation, Writing – review & editing. **Francesca Culasso:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Writing – review & editing.

Declaration of competing interest

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Data availability

Data will be made available on request.

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