Towards agility in international high-tech SMEs: Exploring key drivers and main outcomes of dynamic capabilities

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Abstract

In the era of digitalisation, agility is considered a crucial factor for the successful operations of small and medium businesses in the intricate international markets. That is, this research aims to explore and evaluate the drivers that foster agility in international high-tech small and medium-sized enterprises (SMEs). In this regard, building on dynamic capabilities, a total of nine capabilities have been identified that assist high-tech SMEs to become agile in their cross-border activities. Taking advantage of an expert-based method, we relied on Multi-Criteria Decision-Making (MCDM) approach to synthesise the opinion of six Italian international entrepreneurs (experts). In doing so, Grey DEcision-MAking Trial and Evaluation Laboratory (G-DEMATEL) method has been employed to investigate the cause-effect relationship between capabilities and propose conceptual frameworks for agility in international high-tech SMEs. This is followed by the DEMATEL based Analytical Network Process (DANP) to assess the importance and ranking of explored factors. Consequently, the research proposes several theoretical and practical contributions.

Keywords: Agility, Entrepreneurial internationalisation, Dynamic capabilities, High-tech SMEs, G-DEMATEL, DANP

1. Introduction

In the intricate global business environment, agility has been seen as a crucial success factor for firms by giving innovativeness and competitive advantage (Teece et al., 2016). Agility is particularly important for international firms that operate in different contexts with diverse characteristics (Fourné et al., 2014). In this regard, entrepreneurial SMEs that intent to internationalise imminently and in the early stages of their operations are being challenged by the uncertainty due to not only smallness, newness, and resource constraints but also because of the complexity that exists in the global operations (Hagen et al., 2019). Although such small enterprises are deemed to be vulnerable, the international entrepreneurship research highlights that firms like international new ventures (INVs) or born globals (BGs) have significant potential to expand their cross-border operations fast and early (McDougall-Covin et

al., 2003; Tuomisalo and Leppäaho, 2019). That is, agility enables international SMEs to develop capabilities and set strategies to gain a competitive advantage against their slow internationalising rivals.

The contextual differences forced international firms to reconsider their scenario planning, strategy and vision by building on the latest technologies (Bodwell and Chermack, 2010; Vecchiato, 2015). On the other hand, the constant technological evolution more necessitates international SMEs to become agile (Christofi et al., 2021; Jean et al., 2020). Being explored in various fields such as business strategy and technology, supply chain management, sustainable production management (Doz, 2020; Tseng and Lin, 2011), agility is referred to a set of characteristics (e.g., organisational resilience, innovativeness, sustainability, and adaptability) that assist international ventures to make wiser business decisions in the era of digitalisation (Holbeche, 2018; Rezaei et al., 2021; Ribeiro-Soriano et al., 2018). Thus, to obtain such characteristics and become agile, international SMEs need to obtain or develop new capabilities such as decision-making, networking and knowledge management (Millar et al., 2018).

Literature has disentangled the determinants of entrepreneurial internationalisation from various perspectives. For instance, at the individual level, extant research explored entrepreneur's tendency and vision toward internationalisation (e.g., Dimitratos et al., 2016; Zucchella et al., 2007), while firm-level studies investigated characteristics such as strategy considerations and business models (e.g., Autio, 2017; Hagen and Zucchella, 2014), at institution-based research considered the external triggers like cultural and societal differences (e.g., Jafari Sadeghi et al., 2019; Peng et al., 2008). However, there is limited empirical research to investigate the extent to which SMEs leverage agility in their international operations. Agility was initially introduced by Brown and Agnew in 1982 to the business context to discuss the firms' ability to react to changes rapidly (Walter, 2021). However, more recent literature argues that agility is not a sole characteristic, rather it includes a set of capabilities and drivers (Vinodh et al., 2012). Similarly, we argue that agility is crucial for high-tech SMEs to expand internationally whereas surprisingly there has been little attention on what are the main drivers and key outcomes of agility. In this regard, Teece et al. (2016) highlight that firms can leverage dynamic capabilities to become agile more efficiently. Therefore, this research builds on the wealth of dynamic capabilities along

with agility-based dynamic capabilities and is set to explore and examine drivers of agility in international high-tech SMEs. The relative research questions proposed for this examination are: “What are the pertinent capabilities relevant to organisational agility in international high-tech SMEs?” and “Among explored capabilities, what are the causation and effectuation relationships that boost agility in small internationalisers”

To address its research objectives, this paper utilises a multi-layer uncertain decision-making approach. Measuring the relationship and importance of the identified criteria and factors has been emanated based on expert’s opinion and linguistic variables. Moreover, to consider the uncertainty in the MCDM approach the grey numbers and operators have been employed amongst other possible approaches including fuzzy, hesitant fuzzy, etc. Furthermore, a combined G-DEMATEL and ANP known as GDANP has been implemented to first analyse the relationship amongst the identified capabilities towards organisational agility in international SMEs and then measure their importance. Therefore, the current research contributes to the body of knowledge by exploring agility in the field of international entrepreneurship, in which, out of nine identified capabilities, five factors (e.g., technological, innovation capabilities) belong to the causation logic and four factors (e.g., flexibility, speed) found to refer to effectuation logic. This led to proposing a framework that reflects the interrelationship among drivers of agility in small internationalisers. Finally, regarding practical contribution, this study sheds the light on the crucial role of SME’s central decision-makers and suggests that they can provide short-term and long-run solutions towards the agility of their small firms by employing the latest technology and investing in their own R&D activities.

In the remainder of the paper, we review the literature to explore the important dynamic capabilities that are considered for the agility of international high-tech SMEs. Then, the employed MCDM method to identify the causation and effectuation, as well as their rankings (importance), will be explained. Further, we explain the findings of the research and its theoretical and practical contributions. Eventually, the final section concludes the research and argues the research limitations and proposes future studies.

2. Literature review

2.1. Organisational agility in international high-tech firms

According to Singh et al. (2013) and Baškarada and Koronios (2018), the origin of agility can be affiliated with Jack Welch's (CEO of General Electric) indication of "speed, agility, and simplicity" in his interview with Harvard Business Review. Teece et al. (2016) define agility as the firm's capacity to quickly but effectively redirect and redeploy its resources to respond to internal and external changes. Literature considered agility from various perspectives. For example, portfolio agility is the capability of organisations to transfer resources between business quickly and effectively among business entities, and operational agility assists firms to identify and seize opportunities within their current business model, whereas strategic agility refers to firms' capability to explore and exploit both internal and external opportunities (Mensah et al., 2021; Sull, 2010). In particular, strategic agility helps firms to sense strategic information within the firm, and go beyond the organisational boundaries to identify and seize potential opportunities (Heiligtag et al., 2015; Riahi Dorcheh et al., 2021).

When it comes to cross-border activities, strategic agility assists, in particular, entrepreneurial SMEs to deal with the intricate global business environment and mitigate its high level of uncertainty and risk (Sarasvathy, 2001; Jafari-Sadeghi 2021). It enables SMEs to provide an appropriate response to the volatile circumstances, contributing to better international performance and sustainable long-term growth (Hagen et al., 2019). In this regard, Griffith and Hoppner (2013) highlight that strategic agility is crucial for international small firms (such as international new ventures) to get aligned with the existing dynamic international market and not to become looser in the fierce global competition. As such, international SMEs not only can cope with unforeseen challenges but also are able to take advantage of cross-border opportunities with surprise and speed and get ready for growth (Cegarra-Navarro et al., 2016; Nemkova, 2017). In this vein, technology can play as a catalyst through providing IT solutions and technological innovations (Karimi-Alaghehband and Rivard, 2019; Sukumar et al., 2021). Indeed, international high-tech SMEs leverage advanced technologies to create a platform for agility and gaining new capabilities to promptly

adapt to radical changes in the environment and penetrate niche markets (Sia et al., 2008).

The origin of dynamic capabilities returns to Teece et al. (1997) as it has been referred to a set of different capabilities that explain the extent to which firms create, exploit, and reconfigure (either internal or external) knowledge to agilely address the intricate variations in the business environment. That is, such firms are more likely to satisfy customers' needs and adapt to constantly changing technologies that lead to longer-term survival and growth in national and international markets (Teece, 2007). In this vein, Shams et al. (2021) argue that dynamic capabilities can be considered as a portfolio that includes several crucial managerial and organisational capabilities that enable ventures to promptly anticipate and shape their business environment and obtain agility. Furthermore, Mudalige et al. (2019) emphasise that individual and firm-level capabilities play a vital role in increasing agility in SMEs internationalisation. Particularly for the international operations of SMEs, they can build on their capabilities to become agile. In this regard, Baškarada and Koronios (2018) build on the wealth of dynamic capabilities to highlight that agility can be achieved through leveraging both first-order capabilities (e.g., strategic decision making and product development processes) and second-order capabilities such as effectiveness and efficiency. Indeed dynamic capabilities contribute to the entrepreneurial and evolutionary fitness of firms as well as their innovativeness, which is necessary for shaping and adapting to unpredictable organisational and environmental changes (Teece, 2007). Therefore, dynamic capabilities assist to enhance the agility of entrepreneurial SMEs, particularly for their operations in and expansion to international markets. In this regard, in transitional economies which try to float from a centrally planned economy to a market economy, Nyamrunda and Freeman (2021) revealed that dynamic capabilities alongside trust can escalate the organisational agility in international SMEs.

2.2. The underpinning dynamic capabilities

Several dynamic capabilities underpin organisational agility. To start with, one of the most promising capabilities that small firms can acquire to become agile is technological capabilities (Škare and Soriano, 2021). For instance, Akhtar et al. (2018) argue that the latest technologies such as the Internet of Things (IoT) devices can significantly assist modern ventures to become agile through building higher

connectivity and better progressive operations. The emergence and application of new technologies provide SMEs with the time and process flexibilities to gain business advantages in the international market expansion (Jafari-Sadeghi et al., 2021b). In this regard, the literature confirms that information technology contributes to higher agility particularly in uncertain environments and contexts like international markets (Melián-Alzola et al., 2020; Tallon et al., 2019). The inherent flexibility gained by new technologies constitutes new ways of resource deployment for international SMEs, which is crucial to exploit business opportunities (Ravichandran, 2018; Sadeghi and Biancone, 2018). Indeed, developing technological capabilities assists small enterprises in the coordination of internal and external resources that contributes to becoming an agile organisation (Roberts and Grover, 2012). Although emerging technologies may be available in the market, yet SMEs need to enhance their capabilities to effectively utilise them.

Moreover, the extent to which the latest technologies are correctly employed in the current operations of the firms can be explained by their innovation capabilities. Innovation capabilities (which is also known as an intangible resource) refers to the knowledge and ability of human resources that constitute the creation of new processes or products and services which is required by the market (Dabić et al., 2021; Demartini and Beretta, 2020; Santoro et al., 2018). Danneels (2002) and Sukumar et al. (2020) confirm that compared to less innovative organisations, innovative firms are more likely to employ their technological resources and use them as a competitive advantage. Innovative SMEs leverage technology to reconsider different perspectives of their operations and business models to transform into an agile organisation (Jafari-Sadeghi et al., 2021a; Rindova and Kotha, 2001). Literature highlights that innovativeness assists micro and small businesses to agilely respond to environmental changes (Dabić et al., 2021; Thrassou et al., 2018). Meanwhile, compared to large firms, it should be noted that SMEs innovate quite differently through R&D alliances, licensing-in, or taking advantage of employees' technical expertise (Santoro et al., 2019; Scuotto et al., 2017).

Further, in their process to become an agile organisation, high tech SMEs can build on their knowledge management capabilities while dealing with evolutionary national and international business environments (Cegarra-Navarro et al., 2016; Jafari-Sadeghi et al., 2020). For instance, international firms obtain knowledge from either

outside through external observation, evaluation and partnership or inside of the firm as a result of accumulated expertise and experience (Gutiérrez et al., 2015; Rezaei et al., 2020). As such, knowledge management practices such as knowledge creation, acquisition, transfer, etc. can lead to shared understanding and common language as well as higher responsiveness and transparency within a small organisation (Hock-Doepgen et al., 2020; Jordão and Novas, 2017). Hence, particularly for SMEs, the higher retrieval of pertinent knowledge, the more agility competencies, and the better reaction to uncertain global markets. This is in line with the result of Haider and Kayani (2020) who argued that knowledge management has a positive influence on firm performance and plays a crucial role in organisational agility, particularly for new regulatory procedures.

Another crucial player for small firms to become agile is networking plays, which refers to a relational set of networks that gives organisations access to an external source of information and knowledge and help them build strong interfirm ties, which help to imminent flexibility and responsiveness (Garousi Mokhtarzadeh et al., 2021; Wincent et al., 2010). Finding international partners enable small businesses to imminently and reliably acquire competencies and knowledge, and become agile due to the good positioning in the strategic network core (Ahmadi and Ershadi, 2021; Kurniawan et al., 2020). In this regard, networking capabilities give small businesses an opportunity to meet their international objectives through overcoming the scarcity of their inherent resources and creating flexibility and a profound impact on the collaborative performance (Ray et al., 2004; Sheehan and Foss, 2007). This allows firms to take advantage of various agile competitive advantages including cost leadership, higher efficiency and productivity, and better responding to customers' demands and needs (Liu and Yang, 2020).

Furthermore, managerial initiatives and innovations have been seen as another player for organisational agility (Rindova and Kotha, 2001). Karimi and Walter (2021) build on the nexus of digital entrepreneurship and argue that managers' cognitive capabilities to envision, identify and exploit business opportunities in an international context can pertain to the venture's agility. Therefore, particularly for high-tech small enterprises, the central decision-makers and top managers design evaluation mechanisms as well as the operationalisation processes of organisational agility (Boudlaie et al., 2020; Liang et al., 2007). In fact, their contribution to organisational

agility is not only the identification of the organisational need for innovation but also the allocation of the required resources and capabilities as well as preparation of a welcoming context for the relative implementation (Reuber et al., 2011). When it comes to international operations, the capabilities of top management (e.g., entrepreneurs in SMEs) help to take advantage of proactive and agile vision, which is vital for the survival and growth of their firms in the turbulent global market environment (Al Omoush et al., 2018). In this regard, Al-Omoush (2020) highlights that the managerial capabilities lead to enhancement of organisational agility high tech SME as a consequence of flexible and prompt decision-making towards business solutions and dynamics. As such, agility explains how fast and with what quality the decision-making processes assist small firms to align their organisational response to the ongoing changes in customers' needs, level of competition, access to resources as well as international business opportunities and challenges (Kock and Georg Gemünden, 2016). Thus, the faster and more appropriate decisions to make by managers of the firm, the more agility in national and international operations. This stresses the decision-making capabilities as driven by the manager's cognitive behaviour and significantly constitute the organisational agility of techno-small enterprises (Karimi and Walter, 2021).

2.3. Agility-based dynamic capabilities

Considered as important drivers of organisational agility, flexibility, responsiveness, and quickness are considered as agility capabilities (Abdelilah et al., 2018) that small firms need to obtain to become successful in their international expansion (Al-Mudimigh et al., 2004; Gao et al., 2020; Prange, 2016). For instance, Agarwal et al., (2006) highlight that one of the most influential factors that lead firms can become agile is their capability to create positive synergy by leveraging different types of flexibilities within their organisation. In this vein, flexibility can be internal (manufacturing or product flexibility) or external which deals with environmental determinants such as political and legal risk (Swafford et al., 2008). The former is highly inspired by technology and refers to the firm's capabilities and operation strategies while the latter combines the technology with engineering, infrastructure, and design to react against business objectives (Bernardes and Hanna, 2009). Indeed, flexibility is associated with efficiency and adaption to environmental changes and is deemed to assist international firms in better dealing with the constantly evolving

global competition (Christofi et al., 2021). Although flexibility is a crucial element of organisational agility, firms need to embrace responsiveness in facing ever-changing contexts (Ezcan et al., 2020).

When going globally, international stakeholders demand higher levels of responsiveness, which creates intense competition among firms (Pagell, 2004; Reichhart and Holweg, 2007). Responsiveness can be described as a firm's reactive or proactive capability to "identify, respond to and recover from" internal and external changes (Feng et al., 2010). Thus, Tseng and Lin (2011) argue that to become agile, firms need to be responsive to not only national and international stakeholders but also to their human resources, business processes and strategies as well as infrastructure and technology. In this vein, speed is important since agility stresses the processes of exploration and exploitation of business opportunities with speed and imminent surprise (Sambamurthy et al., 2003; Tahmasebifard et al., 2017). In international business venturing, speed is deemed to have a determining role in gaining international performance. For instance, Cheng et al. (2020) and Demir et al. (2021) argue that the speed of internationalisation is an undeniable element of organisational agility, which helps SMEs in pursuit of success in cross-border markets.

All in all, the review of the literature suggests a total number of nine capabilities that contribute to the agility of international high-tech SMEs. Six dynamic capabilities include *technological capabilities*, *innovation capabilities*, *knowledge management capabilities*, *networking capabilities*, *managerial capabilities*, *decision-making capabilities*. Also, three agility capabilities are *flexibility*, *responsiveness*, and *speed*.

3. Methodology

To evaluate the main capabilities that drive the agility in international high-tech SMEs, three main steps have been designed which include identification, data gathering, and data analysis. In the first stage, after an in-depth literature review, the main dynamic and agility capabilities of international firms have been extracted. In the second stage, based on the identified capabilities, the importance and relationship between them are evaluated based on expert opinions from executive managers. Ultimately, in the last stage, a multi-layer decision-making approach by combining DEMATEL and ANP has been scheduled and employed to determine the relationship and the importance of the capabilities toward agility. To consider uncertainty in the designed decision-making

approach, grey values and operators have been employed. In Figure 1, the considered framework is illustrated, and each stage and step are presented in detail.

Please insert **Figure 1** here

3.1. Stage 1. Capabilities toward agility

As discussed in the literature review section, we identified a total number of nine capabilities that have interaction with the agility of international high-tech SMEs. Table 1 summarises the identified capabilities while providing a sample of references explored.

Please insert **Table 1** here

3.2. Stage 2. Data gathering

After extracting capabilities in Table 1, to assess and prioritise them, required data has been gathered. As the selected drivers are qualitative and records and statistics regarding them were not accessible, expert's opinions have been collected to rank the capabilities and drivers. As the results of this study significantly rely on the expert's opinion, several criteria and thresholds for expert selection have been considered as follows:

- Age. Minimum 30s
- Education. Minimum Bachelors
- Job Position. Minimum department-level manager
- Working experience. Minimum of five years
- Industry sector. Manufacturing or service-oriented sector

Hence, an invitation email has been sent to thirty-three international entrepreneurs. As result, we received fifteen responses (45.4%), in which a total number of six cases (18.2%) accepted to participate in this research. Therefore, the researcher set up an individual online appointment with each participant to complete the questionnaire. In the MCDM era, the number of experts could vary between 3 to 15 (Amoozad Mahdiraji

et al., 2020a; 2021 Beheshti et al., 2016); therefore, the number of experts is acceptable. The expert profile is illustrated in Table 2.

Please insert **Table 2** here

As this research has employed MCDM methods (specifically G-DEMATEL and DANP), an appropriate questionnaire has been designed for data gathering. In the designed questionnaire, the experts were asked to evaluate the direct effect of agility capabilities on each other via email. As quantitative records are not usable, the experts have answered each question using linguistic variables including seven terms in a Likert spectrum. A total number of 72 questions have been answered each indicating the effect of agility capability (i) on (j) measured by the expert (p) known as Z_{ij}^{p}. The data gathered from the questionnaire were transferred to the square matrix (9*9) with an empty (zero) main diagonal (as the effect of each capability on itself is meaningless).

3.3. Stage 3. Phase 1. G-DEMATEL

As the main objective of this research is to analyse the relationship amongst the capabilities that boost the agility in international high-tech SMEs, a multi-layer MCDM approach has been designed and implemented. In the MCDM era, a wide range of methods are available to address different research objectives, such as (1) measuring the weight or importance of criteria/factors by best-worst method (BWM) (e.g., Mahdiraji et al., 2019; van de Kaa et al., 2018), analytical hierarchical process (AHP), ANP (e.g., Chen and Lin, 2018), etc. (2) sorting and ranking alternatives to solve problems by Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (e.g., Carayannis et al., 2018), ELimination Et Choix Traduisant la REalité (ELECTRE) (e.g., Amoozad Mahdiraji et al., 2020b), Preference Ranking Organisation METHod for Enrichment of Evaluations (PROMETHEE) (e.g., Andreopoulou et al., 2018), etc. (3) analysing the cause and effect relationship among the factors by Decision making trial and evaluation laboratory (DEMATEL) (e.g., Yadegaridehkordi et al., 2018), etc. In this research, the cause and effect relationship amongst the capabilities and also measuring the importance of each capability toward enhancing the agility in international organisations are going to be investigated, Hence, a hybrid

approach has been scheduled to address these objectives via combining the DEMATEL with ANP, known as DANP method. DEMATEL provides a clear methodology to illustrate the cause and effect relationship amongst the capabilities and ANP can benefit from the created network to measure the importance of each capability toward higher agility in international organisations.

Living in an unpredictable world with the least assurance of information validity requires a solution for decision-making under this circumstance. Many classical and modern uncertainty approaches have been developed since the 1980s. For classical approaches, grey system or interval values (Beheshti et al., 2016), fuzzy sets (Amoozad Mahdiraji et al., 2020a), etc. are amongst the most popular ones. For the modern category, interval-valued intuitionistic fuzzy (IVIF) (Mahmoudi et al., 2019), hesitant fuzzy linguistic term sets (HFLTs) (Hajiagha et al., 2018), etc. have been implemented in many uncertain circumstances by many scholars. In the 1980s, the grey system was introduced to scholars by Julong (1989) to provide a framework for overcoming problems related to vague data decision-making situations. Since then, it has been highly employed in different areas of science, such as agriculture, economics, medicine, or management (Amoozad Mahdiraji et al., 2016). In the rest of this section, as the authors have implemented a grey decision-making approach, a brief explanation of the main notations and operations of grey systems is proposed. Every grey number has an upper and lower bound to demonstrate the range of uncertainty in providing information from experts. The grey number ($\otimes X$) is shown as $\otimes X = \left[\, \underline{x}, \overline{x} \,\right]$where ($\overline{x}$) is the high range and ($\underline{x}$) is the lower range of the grey number, respectively. The following equations from (1) to (4) illustrate the main operators of grey numbers for basic mathematical functions.

$$\otimes X_1 + \otimes X_2 = \left[\, \underline{x_1} + \underline{x_2}, \overline{x_1} + \overline{x_2} \,\right] \tag{1}$$

$$\otimes X_1 - \otimes X_2 = \left[\, \underline{x_1} - \underline{x_2}, \overline{x_1} - \overline{x_2} \,\right] \tag{2}$$

$$\otimes X_1 \times \otimes X_2 = \left[\min\left(\underline{x_1}.\underline{x_2}, \underline{x_2}.\overline{x_1}, \underline{x_1}.\overline{x_2}, \overline{x_1}.\overline{x_2}\right), \max\left(\underline{x_1}.\underline{x_2}, \underline{x_2}.\overline{x_1}, \underline{x_1}.\overline{x_2}, \overline{x_1}.\overline{x_2}\right)\right] \tag{3}$$

$$\otimes X_1 \div \otimes X_2 = \left[\underline{x_1}.\overline{x_1}\right] \times \left[\frac{1}{\underline{x_2}}, \frac{1}{\overline{x_2}}\right] \tag{4}$$

An efficient problem-solving solution in the grey environment is to use the grey aggregation methodologies. The scholars have recommended transferring grey

values to crisp numbers (Garousi Mokhtarzadeh et al., 2020). The three-step Converting Fuzzy Data into Crisp Scores (CFCS) methodology is among the most populated approaches to reach crisp values (Wu and Lee, 2007). These steps are illustrated in equations (5) to (9).

(1) Normalising the initial values ($\tilde{x}_{ij}^{p}$).

$$\underline{\otimes}\tilde{x}_{ij}^{p} = \left[\underline{\otimes}x_{ij}^{p} - min_j \underline{\otimes}x_{ij}^{p}\right]/\triangle_{min}^{max} \quad (5)$$

$$\overline{\otimes}\ \tilde{x}_{ij}^{p} = \left[\overline{\otimes}\ x_{ij}^{p} - min_j\ \overline{\otimes}\ x_{ij}^{p}\right]/\triangle_{min}^{max} \quad (6)$$

Where

$$\triangle_{min}^{max} = min_j\ \overline{\otimes}\ x_{ij}^{p} - min_j x_{ij}^{p} \quad (7)$$

(2) Determining the total normalised crisp value (Y_{ij}^{p}).

$$Y_{ij}^{p} = \frac{(\underline{\otimes}\ x_{ij}^{p}\left(1 - \underline{\otimes}\ x_{ij}^{p}\right) + (\overline{\otimes}\ x_{ij}^{p} \times \overline{\otimes}\ x_{ij}^{p}))}{1 - \underline{\otimes}\ x_{ij}^{p} + \overline{\otimes}\ x_{ij}^{p}} \quad (8)$$

(3) Calculate the Crisp number (Z_{ij}^{p}) as follows.

$$Z_{ij}^{p} = min_j \underline{\otimes}x_{ij}^{p} + Y_{ij}^{p}.\triangle_{min}^{max} \quad (9)$$

Subsequently, the average Z_{ij}^{p} is calculated and transferred to the DEMATEL matrix. The merit of the DEMATEL approach is its capability to visualise the intricate relationship between metrics using diagrams. This method was first used by Fontela and Gabus (1973) to plot the strength of the relationship between different components and has been widely used in different areas of science (Garousi Mokhtarzadeh et al., 2021). In the DEMATEL matrix, measures are set in a pairwise direct relation for comparison and evaluation. In the next step, the influence matrix is constructed through the normalised direct-relation matrix. Following the total relation matrix, a cause/effect graph emerges between different factors in the matrix. In other words, the grey DEMATEL (G-DEMATEL) approach is translated via the following steps (Fu et al., 2012).

(1) Linguistic variables are transferred to grey values, and the influence comparison scale for criterion is defined. In this research, a seven scale Likert

questionnaire has been used to gather expert's opinions regarding agile capabilities including *strongly ineffective, ineffective, nearly ineffective, neither effective nor ineffective, nearly effective, effective, and strongly effective.* These linguistic terms are transferred to interval or grey values via [0.1,0.2], [0.2,0.3], [0.3,0.4], [0.4,0.5], [0.5,0.7], [0.7,0.9], [0.9,1] interval numbers, relatively.

(2) The grey pairwise influence relationship $n \times n$ matrix is formulated and using the CFCS method equations (5) to (9), the grey values are transformed into crisp components. The average Z_{ij} matrix is constructed as below where *p* denotes the number of experts.

$$Z_{ij} = \frac{1}{p}(Z_{ij}^1 + Z_{ij}^2 + \cdots + Z_{ij}^p) \tag{10}$$

(3) Next, the normalised direct-relation matrix is formulated using equations (11) and (12) where *s* presents the normalisation coefficient and *N* denotes the normalisation matrix.

$$s = Min\left\{\frac{1}{max_{1\le i\le n}\sum_j^n z_{ij}}, \frac{1}{max_{1\le j\le n}\sum_i^n z_{ij}}\right\} \quad ; \quad \forall_{ij} = 1,2,\dots,n \tag{11}$$

$$N = s \times Z_{ij} \tag{12}$$

(4) Construction of the total relation matrix (T) emanates via equation (13).

$$T = N + N^2 + N^2 + \cdots = \sum_{i=1}^{\infty} N^i = N \times (I - N)^{-1} \tag{13}$$

(5) For each row and column, the sum is calculated. The results (R_i) and (D_j) represent the direct and indirect effect of each component (i, j) via equations (14) and (15) where t_{ij} values are emanated from the total relation matrix.

$$R_i = \sum_{j=1}^{n} t_{ij} \quad ; \quad \forall i \tag{14}$$

$$D_j = \sum_{i=1}^{n} t_{ij} \quad ; \quad \forall i \tag{15}$$

(6) The net effect (E_i) and the overall prominence (P_i) is calculated from the following expressions.

$$P_i = \{R_i + D_j | i = j\} \quad (16)$$

$$E_i = \{R_i - D_j | i = j\} \quad (17)$$

The maximum value of (P_i) determines the highest impact of the corresponding criteria on overall relationships. The positive or negative (E_i) value shows the cause or reliable nature of the criterion on the decision-making matrix (Tzeng *et al*., 2007). Positive E_i denotes the causes and negative values show the effects (Garg, 2021). Values for P_i reveals the importance of each capability. From two perspectives, some recent developments have been designed by scholars in the DEMATEL method including (1) combining the DEMATEL method with other approaches such as DEMATEL-ANFIS (adaptive neuro-fuzzy inference system or adaptive network-based fuzzy inference system) (e.g., Yadegaridehkordi et al., 2018), DEMATEL-ANP (e.g., Chen and Lin, 2018), PCA-ISM-DEMATEL (Principle component analysis and Interpretive structural modelling) (e.g., Rajput and Singh, 2019), etc. (2) using uncertainty rules and operators in the DEMATEL method such as Fuzzy DEMATEL (e.g., Tseng et al., 2019), Grey/Interval DEMATEL (e.g. Mubarik et al., 2021), Hesitant Fuzzy DEMATEL (e.g., Liu et al., 2019), etc. Considering the uncertainty of the environment and to insert the uncertainty in the decision-making process, grey values have been employed in the DEMATEL method in this research to analyse the relationship between different capabilities of agility. By applying this method, the cause and effect capabilities and their relationships are extracted and illustrated. Moreover, in this research methods including DEMATEL with ANP and ISM have been integrated in a fashion order.

3.4. Stage 4. Phase 2. DANP

Over the past decades, scholars have implemented multicriteria decision-making (MCDM) approaches to various managerial problems (Amoozad Mahdiraji et al., 2020a). A group of MCDM approaches, such as DANP, mainly focus on assessing the criterion rank based on expert opinion. Unlike classical statistical factor analysis, the main advantage of these methods is their focus on the interdependent relationship between criteria in cases (Li et al., 2021). Although the ANP method developed by Hsu et al., (2012) overcame the drawbacks of the classic Analytical Hierarchical

Process (AHP), this method assumes equal weights for the criterion. Hence, Tzeng et al., (2007) designed DANP to combine the ANP and DEMATEL models into a single structure. A study by Chen and Lin (2018) is employed to illustrate the DANP process steps via equations (18) to (20). This method has also been widely used by many scholars in different areas including society, location, information technology, etc. (Li et al., 2021).

(1) Normalised C^H matrix is obtained by dividing every row in G_{ij} by the sum of the row (S_i) where G_{ij} denotes the input decision matrix emanated from the DEMATEL analysis in the previous step.

$$C^H = \begin{bmatrix} G_{11} & \dots & G_{1m} \\ G_{i1} & \dots & G_{1m} \\ G_{m1} & \dots & G_{mm} \end{bmatrix} \begin{matrix} S_1 \\ S_i \\ S_m \end{matrix} \quad (18)$$

Where $S_i = \sum_{j=m}^{1} G_{ij}$

(2) To obtain the unweighted supermatrix, the C^H is transposed as below where F^m denotes the transposed normalised matrix.

$$F^m = (C^H)' = \begin{bmatrix} H_{11} & \dots & H_{1m} \\ H_{i1} & \dots & H_{1m} \\ H_{m1} & \dots & H_{mm} \end{bmatrix} \quad (19)$$

(3) In this step, if a matrix consists of categories and subcategories, the weighted supermatrix (W^{limit}) is calculated and then the influence of each factor is summarised. However, in the following research, several agile capabilities factors are evaluated. Therefore, by limiting the supermatrix the overall priority is calculated as below.

$$W^{limit} = \lim_{k \to \infty} (C^{H'})^k \quad (20)$$

The obtained results from the W^{limit} produces the DANP influential weights. These weights are sorted to achieve the rank of each agile capability in this investigation.

4. Results and discussion

To meet its objectives, this research is set to explore the cause-effect capabilities towards the agility of international high-tech SMEs. It is also aimed to investigate the importance of identified factors and propose a framework of their interrelationship.

To start with, the average of the answers to the collected questionnaires was converted to numerical grey values. Using (7), the delta value is computed, and the normalised matrix is assembled. Therefore, according to (8), normalised crisp values are obtained. At the final step of converting grey numbers to crisp values, Z_{ij}^{p} for each cell is calculated and presented in Table 3.

Please insert **Table 3** here

As mentioned earlier in (11), (12), and (13), the total relation matrix should be formulated. Thus, the sum of each row is calculated, and the maximum value is obtained, respectively. Then, a unit matrix is subtracted from the normalised matrix. According to (13), the total relation matrix is computed as Table 4.

Please insert **Table 4** here

The green cells illustrate the acceptable cause-effect relationships between the capabilities with a value higher than the threshold. The threshold value is the average of all cells in the TRM, 0.557 in this research. To evaluate the strength and the impact range of each criterion, the (R_i) and (D_j) values are calculated in Table 4. The overall prominence (14) and net effect (15) equations are computed afterwards. As can be seen from Table 4, the maximum value of the overall prominence shows the most influential factor among other drivers. Similarly, the positive values of the net effect mean that these factors affect the whole matrix. Conversely, the negative value depicts the factor being influenced by other elements.

Please insert **Table 5** here

As shown in Table 5, red cells in the third column demonstrate the effects (negative values) and the green cells (positive values) reveal the causes. Moreover, the fourth column values demonstrate the importance of each capability, which has been normalised in the last column.

Please insert **Figure 2** here

Moreover, Figure 2 reveals the cause-effect and importance of capabilities that deal with the agility of international high-tech SMEs. The cause factors can be found above the horizontal line (positive Pi values) while the effect factors are below it (negative Pi values). Besides, the more important drivers with higher priority are positioned at the left-hand side of the figure. Therefore, the findings of this research suggest that technological capabilities (TEC), innovation capabilities (INNC), knowledge management capabilities (KNWC), networking capabilities (NETC), and managerial capabilities (MNGC) are cause factors. It means that high-tech SMEs can leverage these capabilities to gain agilities in their cross-border operations. On the other hand, decision-making capabilities (DMC), responsiveness (RES), flexibility (FLX), speed (SPD) are effect factors. This explains that agility assists small ventures to be fast, responsive, flexible, and more capable in making international market expansion decisions.

The analysis of cause-effect analysis suggests that among cause capabilities, innovation (INNC) and technology (TEC) have the highest importance and drive the organisation toward agility with the highest intensity while knowledge management capabilities (KNWC) are among the less influential drivers. As regards effect factors, for international SMEs, flexibility (FLX), and speed (SPD) are the most important obtained capabilities due to agility, whereas decision-making (DMC) is the least significant factor.

Given that SMEs are normally suffering from restricted resources such as financial and human, they can build on their innovation to obtain agility in the international context. In this vein, Rialp-Criado and Komochkova (2017) highlight that innovation and initiatives align SMEs capabilities with their immediate environment, subsequently better international performance. As such they might offer new goods and services to meet international market demand (product innovation) (Querbach et al., 2020) or make steady and continuous improvements in workflow efficiency to reduce the average production costs (process innovation) (Freixanet et al., 2020). Moreover, the findings of this research highlight the significant function of technology and digital tools as a second important capability for the internationalisation of small enterprises. In this

vein, firms can develop new technologies through a research and development process (R&D). However, for SMEs, R&D is an expensive strategy that can be undertaken for long-term objectives. Alternatively, such firms can purchase a licence for external technology. By this virtue, the catalytic effect of technology licencing can minimise their operational costs and time, which assist them to become agile. Furthermore, the low ranking of knowledge management capability confirms that, compared to big firms, SMEs are less dependent on managing the circulation of the knowledge within their organisation. Being small and technology-intensive has already equipped SMEs with knowledge in their entire organisation, leading to less focus on knowledge management.

On the other hand, the results of the cause-effect analysis revealed that flexibility is the most important characteristic for the international activities of small businesses. Hagen et al. (2019) argue that the dynamism and complexity of international markets along with their newness and foreignness to the market, SMEs more vulnerable and fragile. This stresses the importance of their flexibility to deal with the rapid changes and address the unknown in the new business environment. Hence, agility not only gives them the ability to adapt to the changes via leveraging technology but also prepares them to deal with various cultural and political systems. Further, the second important impact of agility on SMEs is giving them the speed to adapt and grow in international markets faster than their rivals. To present a more discussable figure from the G-DEMATEL method and to scrutinise the cause-effect relationship among the agile capabilities, the following rules have been set from ISM (Rajput and Singh, 2019).

1- In classical DEMATEL, the average value of all cells in the TRM matrix is considered as threshold value; however, in this research to extract the strong relationships between capabilities toward organisational agility, the threshold has been set 60% or 0.6. As a hybrid ISM-DEMATEL has been used to analyse the relationships among the capabilities, the threshold value for acceptable correlation between causes and effects has been considered 0.6. Hence, for the correlations greater or equal to 60%, the cause-effect has been accepted for further process.
2- In case, capability A impacts on B, and B impacts on C, then capability A affects C.

3- In case, capability A impacts B and C, and B impacts C, then the direct effect from A to C has been eliminated.

Considering the abovementioned guidelines, the TRM has been modified and a new cause-effect table has resulted. In this vein, the results of cause and effect analysis led to the identification of interrelationships among explored factors. Therefore, Table 4 has been pictured via VENSIM software and the result is presented in Figure 3.

Please insert **Figure 3** here

According to Figure 3, among nine factors, managerial capabilities (MNGC) is connected to all other factors. This stresses the function of entrepreneurs and central decision-makers in the internationalisation of small businesses as discussed by international entrepreneurship literature (Loane, 2005; Oviatt and McDougall-Covin, 2005). This contrasts with larger multi-national enterprises, in which the management team or board of directors has the power of decision-making (Bhuian et al., 2005). In small and medium ventures, the international entrepreneurial founder or/and the owner are often willing to be the first person and to be in charge of making decisions for internationalising of the firm. Similarly, managerial capabilities are among the most interconnected factors that lead contribute to the agility of international high-tech SMEs. Literature confirms that managerial capabilities is the core characteristics that impact on every processes of dynamism, flexibly, and agility of small firms (Al-Omoush, 2020). Furthermore, among effect factors, speed (SPD) is impacted by managerial capabilities (MNGC) while flexibility (FLX) shows the highest received influence from cause factors.

The results obtained in the total relation matrix are set in the DANP approach to sort the drivers in each category. By transposing the matrix and repeating steps four times, the results are achieved as in Table 6. Moreover, to illustrate the robustness of the weights of each criterion, a comparison between the weights emanated from G-DEMATEL and DANP has been presented. As is clear, the weights emanated from the DANP method are not changing significantly, demonstrating the robustness of engendered results.

Please insert **Table 6** here

4.1. Theoretical contributions and practical implications

The findings of this paper provide several important additions to the agility research, thus contributing to theory and practice. From the theoretical point of view, our paper makes the following contributions. To begin with, this is among pioneer studies that contribute to the scant research on exploring agility in the field of international entrepreneurship. In opposite to the prior research exploring agility in large and longer-established firms such as Multinational Enterprises (MNEs) (e.g., Pereira et al., 2018), the contribution of this research focuses on small ventures that aim to exploit international business opportunities. This is particularly crucial for high-tech SMEs since they have several restrictions such as limited resources as well as the lack of experience and knowledge that make them fragile in global markets (Ratten et al., 2016; Sadeghi and Biancone, 2018; Sukumar et al., 2020) whereas agility assists them to overcome these challenge and look for international growth.

Furthermore, we argue that agility is not a stand-alone characteristic but a set of capabilities that help SMEs remain internationally competitive in the era of disruptive technologies. Hence, through the lens of dynamic capabilities, we complement and enrich the extant research by exploring and evaluating nine factors (six dynamic capabilities and three agility-based dynamic capabilities) that deal with the agility of young and small internationalisers. More importantly, we extend this line of research and demonstrate that identified factors are not discrete, highlighting that there is a non-linear relationship among them. That is, this paper goes beyond common hypothesis testing in the field and builds on expert-based methods to disentangle the interrelationship among capabilities. In this regard, our research contributed to the causation versus effectuation modes debate. Although prior studies have partially investigated the causation and effectuation logic (e.g., Nemkova, 2017), the current research explicitly explores how dynamic and agility-based dynamic capabilities interact in order to make SMEs agile. The findings suggest five causal and four effectual factors, in which technological, innovation capabilities (causation logic) and flexibility, speed (effectuation logic) are the main capabilities of agility in SME

internationalisers. Our causation versus effectuation analysis is important for the conceptualisation of agility in the international entrepreneurship literature since it constituted to propose our distinct conceptual framework. This framework assists researchers in their hypothesis development and further exploration of agile international entrepreneurship.

Moreover, regarding the practical implications, we highlight that entrepreneurial internationalisers need to leverage dynamic and agility-based dynamic capabilities as looking globally. When firms are small, resources are limited, the market is new and unknown, agility can enable them to overcome their challenges (Hagen et al., 2019) and simultaneously identify and exploit long-term business opportunities and seek survival and growth in international markets. In the first instance, being agile enables SMEs to begin with an idea, try it and monitor the stakeholder reaction to make prompt decisions either to develop or stop it. In this vein, our findings suggest that such firms need to expand their current operations and make necessary innovative initiatives in their processes and products respectively. In doing so, SMEs can employ the latest technology as a short-term solution or build on their R&D activities which contribute to the longer-term advantages. On the other hand, our findings stress the role of the top management (e.g., founders, owners, managers, other central decision-makers) team and highlight that, being more open to high risk and/or last-second challenges, SME managers can leverage the knowledge advantages to become flexible and quickly responsive to the volatile changes in global markets.

5. Conclusion

This research builds on the wealth of organisations' dynamic capabilities to organisational agility in international high-tech SMEs. In doing so, we relied on an expert-based approach and employed the MCDM approach to synthesise the specialised opinions and thoughts of six Italian international entrepreneurs. Therefore, we applied the G-DEMATEL method to disentangle the cause-effect relationship among nine capabilities of international high-tech SMEs and explore a conceptual framework. Moreover, through a DANP analysis, we assessed the importance and ranking of explored factors.

5.1. *Limitations* and future research

Our research acknowledges the different limitations which may pave avenues for further studies. First, to address its objectives, this research took advantage of dynamic capabilities and identified nine general dimensions of agility in high-tech firms. However, future research may go beyond these nine dimensions and investigate organisational agility based on new organisational capabilities (Kane et al., 2015) or the reconfiguration of the firm's unique resources (Doz and Kosonen, 2010). Second, although we built our research on small ventures that leverage the latest technologies (high-tech SMEs) to go internationally, we call on scholars to expand our findings in other types of firms such as born-globals. Third, from the geographical perspectives, the data for this research has been taken from SMEs in Italy. However, future studies can explore other locations to compare how differently SMEs employ agility in their international entrepreneurial journey.

Fourth, this study employs an expert-based method, recruiting a total number of six international entrepreneurs. The choice of international entrepreneurs assures for contacting the most knowledgeable person, which attests to the accuracy of responses (Sadeghi et al., 2019). As such, the data collection has been done through a self-reporting process, in which participants reflected their thoughts on the specialised questionnaire following their experience, preferability and perception of the phenomena. However, personal reflection can cause an increased likelihood of being biased for their desirable responses. We, therefore, invite other studies to confirm the findings of this research by employing a larger sample targeting central decision-makers of international high-tech SMEs in order to test our findings in a broader context. Future research can also employ empirical analyses and target a broader sample to verify the validity and generalisability of the proposed interrelationship framework.

Finally, from the methodological point of view, as this manuscript deals with Grey systems to consider the uncertainty, in future researches, other scholars should investigate other uncertainty approaches such as fuzzy, hesitant fuzzy sets (HFs), intuitionistic fuzzy set (IFs), etc. and compare their results with the conceptual framework of this research. Moreover, instead of combining ANP with DEMATEL, other decision-making approaches such as Best-Worst-Method (BWM),

simultaneously evaluation of criteria and alternative (SECA), etc. are applicable to measure the importance of capability of agility in international organisations. Furthermore, instead of analysing the relationship of the capabilities via MCDM, the system dynamics approach could also be a productive alternative to this aim.

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