



27 EISIC – 2024

Nexus of Digitalization and Internationalization: A Review of DDCs in International Business Strategy

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Abstract

As the global landscape undergoes profound transformations driven by digitalization, the imperative for businesses to cultivate digital dynamic capabilities (DDCs) has become paramount. DDCs serve as linchpins for leveraging digital technologies, fostering organizational agility, innovation, and facilitating internationalization endeavors. Despite their pivotal role, a consensus on the precise definition and conceptual framework of DDCs for internationalization remains elusive. This paper seeks to bridge this gap by conducting a comprehensive review of the extant literature on DDCs, with the aim of elucidating and conceptualizing this critical construct. Through a synthesis of diverse perspectives, this study aims to establish a coherent framework for understanding DDCs. The findings emphasize the indispensable role of DDCs in enabling firms to navigate the intricacies of digital business environments characterized by uncertainty, rapid changes, and relentless innovation. Moreover, DDCs play a pivotal role in bolstering international competitiveness, enhancing international performance, and accelerating the speed of internationalization. By addressing these research inquiries, this study enriches the academic discourse on digital transformation, internationalization, and strategic management, offering valuable insights for future research endeavors and practical applications in the realm of digitalization and DDCs.

Keywords: dynamic capabilities, digital dynamic capabilities, digitalization, digital transformation, internationalization

1. Introduction

With the rapid advancement of digital technology, digitalization has become the core driving force for global economic and social transformation. Digitalization involves harnessing digital opportunities, utilizing digital technologies to transform a firm's business model, and enriching its processes of value creation (Lähteenmäki, Nätti, & Saraniemi, 2022). The convergence of various emerging technologies centered around data, such as big data, artificial intelligence (AI), and the internet of things (IoT), is driving radical transformations in firms' systems, processes, management methods, and workforce (Nambisan, 2017; Reuber & Fischer, 2011). For instance, these technologies are reducing operating costs and enhancing interactions among ecosystem stakeholders, including customers, partners, suppliers, and distributors. These nascent digital technologies are playing an increasingly critical role in company growth. They are driving the realization of digital transformation (DT) (Liu et al., 2011) and accelerating the digitalization process through deep integration with industrial economies (Yoo, Henfridsson, & Lyytinen, 2010; Wang et al., 2022).

Digital transformation holds particular significance, especially in today's dynamic business environments characterized by uncertainty, frequent change, and complexity (Brandon-Jones & Knoppen, 2018). Moreover, the substantial uncertainty and ambiguity surrounding AI and big data technologies (Nambisan, 2017) often impede companies undergoing DT from developing effective solutions to address the challenges and opportunities presented by these technologies, thereby hindering the realization of their true value (Magistretti, Pham & Dell'Era, 2021; Verganti & Öberg, 2013). Consequently, firms frequently encounter significant challenges in effectively driving this transformation. El Sawy et al. (2020) identify a major obstacle to digital transformation as the lack of digital experience among senior leadership teams. Additionally, risks such as data security breaches, insufficient interoperability with existing systems, and inadequate control mechanisms can hinder the adoption of digital technologies (Schwertner, 2017). Effectively advancing digital transformation requires instilling a sense of urgency among management and devising a coherent strategy (Fitzgerald et al., 2014). Therefore, firms need to develop new capabilities to navigate the uncertainties of dynamic environments and digital technologies, underscoring the importance of scholarly research on dynamic capabilities (DCs).

Dynamic capabilities refer to the ability of firms to dynamically create and combine resources to perceive, seize, and reconfigure opportunities during transformations (Teece, 2007). Previous academic research has focused on understanding how to appropriately utilize digital technologies to design digital solutions, aiming for their adoption and acceptance by human agents (Danneels & Frattini, 2018). Some scholars have examined information technology (IT) capabilities from the perspective of DCs, focusing on technical issues such as technology investment, the development of new technological capabilities, and the ownership of complementary assets necessary for leveraging their innovations in the commercial market (Tripsas, 1997). They have proposed high-level frameworks of dynamic IT capability (Schilke, Hu & Helfat, 2018; Li & Chan, 2019; Khin, 2019; Božič & Dimovski, 2019; Van & Versendaal, 2021), as

well as distinctions between lower-order technical DCs and higher-order DCs (Božič & Dimovski, 2019; Li & Chan, 2019; Wang & Ahmed, 2007; Zheng, Zhang & Du, 2011). However, the definitions of IT capability and digital capability differ. IT capability is described as “the relative capabilities that help an organization create technical and market knowledge and facilitate intra-organizational communication flow” (Song, Nason & Di Benedetto, 2008). In contrast, digital capability encompasses more than just information and communication flows. It refers to a firm’s ability to leverage digital technologies to create value in their business activities. DCs leverage digital technologies to support various business operations (Chakravarty, Grewal & Sambamurthy, 2013; Queiroz et al., 2018; Wheeler, 2002). However, there still exist research gaps in the study of DDCs.

Warner and Wäger (2019), within the context of strategic change, have articulated a framework emphasizing the necessity for senior executives to cultivate a comprehensive set of digital sensing, seizing, and transformation capabilities. This framework is designed to effectively facilitate digital transformation through the lens of DCs. By adopting these capabilities, executives can better navigate and leverage the complexities of digital environments to drive organizational change and innovation. These capabilities are crucial for firms to maintain competitiveness and achieve sustainable development in the digital era. However, there is currently no clear consensus on the definition of DDCs. Most academic studies have referenced and extended Warner and Wäger’s (2019) delineation of “DCs for digital transformation,” alternatively termed DDCs, with few scholars offering nuanced interpretations and alternative perspectives. In this context, this paper seeks to explore the multifaceted nature of DDCs, delving into differing viewpoints and definitions to offer a comprehensive understanding of this crucial concept.

RQ 1: How are DDCs defined and conceptualized, and what are the key components and interpretations offered by scholars?

Furthermore, internationalization and digitization have evolved into collaborative efforts. Previous research acknowledges the positive impact of digitalization on internationalization (Coviello, Kano & Liesch, 2017; Brouthers, Geisser & Rothlauf, 2018). Digitization has eliminated geographical barriers between countries and global cities, fostering the formation of international user communities, democratizing global consumption, and enhancing communication (Schmitt & Baldegger, 2020). The increasing integration and utilization of digital technologies provide significant impetus for enterprises’ internationalization efforts, including small and medium-sized enterprises (SMEs) (Etemad, Wilkinson & Dana, 2010). Despite the nascent role of emerging digital tools, platforms, infrastructures, and resulting digital entrepreneurial ecosystems in accelerating the internationalization process (Gabrielsson, Raatikainen & Julkunen, 2022), many enterprises still heavily rely on digital technologies to support their internationalization strategies, enabling real-time information exchange, rapid adaptation to customer needs, and cost reduction (Luo, Zhao & Du, 2005).

Just as digitization operates within an uncertain environment (Nambisan, 2017),

enterprises face escalating uncertainties in their international endeavors (Luo & Hassan, 2009; Autio, George & Alexy, 2011; Johanson & Vahlne, 2017; Liesch, Welch & Buckley, 2011). Therefore, the perspective of DCs is crucial for explaining the internationalization process (Johanson & Vahlne, 2011) and constitutes a critical determinant of internationalization success (Kuuluvainen, 2012). While existing research, exemplified by studies on internationalization, underscores the critical role of DCs in international marketing strategy and management (Zahra, Petricevic & Luo, 2022; Scuotto et al., 2022; Ding & Chen, 2023), as well as in accelerating the internationalization process (Chebbi et al., 2023; Yang & Stoian, 2024; Zakery & Saremi, 2024), and influencing SMEs internationalization (Mudalige, 2015; Chebbi et al., 2023; Ali, Hao & Aijuan, 2020), significant research gaps persist concerning the impact of DCs on internationalization within the context of DT.

Therefore, this study specifically analyzes the impact of DDCs on internationalization. It draws upon literature exploring internationalization from the perspective of DCs and the impact of digitalization on internationalization. Distinguishing itself from prior research, the study aims to elucidate how these capabilities facilitate the adaptation of internationalization strategies in response to digital disruptions and competitive pressures. The findings explore how these DCs, within the context of DT, act as a bridge through digital technology, thereby establishing a new relationship between DCs and internationalization. By thoroughly exploring these research inquiries, this paper aims to enrich the academic discourse on DT and strategic management in international business, offering valuable insights for future research endeavors and practical applications related to digitalization and DDCs.

RQ 2: What role do DDCs play in the internationalization process of enterprises?

The exponential proliferation of knowledge within business research, coupled with its interdisciplinary and fragmented nature, poses formidable challenges in keeping abreast of the latest advancements and comprehensively evaluating collective evidence within specific areas of inquiry. This underscores the significance of literature reviews in contemporary academic research (Snyder, 2019). Literature reviews also serve as valuable tools for theory development (Baumeister & Leary, 1997; Torraco, 2005), with seminal works such as those by Palmatier, Houston and Hulland (2018) providing guidelines for publishing review papers in esteemed journals like the Journal of the Academy of Marketing Science. Therefore, this paper undertakes a comprehensive review of a plethora of literature pertaining to DCs, digital capabilities, DDCs, and internationalization to address the research questions posed. The findings of this review indicate that DCs within digital transformation are considered DDCs, encompassing core elements such as digital sensing, digital seizing, and digital transforming (Warner and Wäger, 2019). The review explores the different roles of DDCs in internationalization, including international performance, the speed of internationalization, and innovation. This study significantly contributes to the understanding of DDCs and their implications for internationalization. Moreover, it lays the groundwork for future empirical research endeavors and offers insights into the development of enterprise DDCs and internationalization strategies.

The paper proceeds as follows. The subsequent section begins with the conceptual framework, emphasizing the DCs theory and aiming to elucidate this concept through a comprehensive review and analysis of existing literature. Following this, the section delves into the concept of DDCs, examining their role in the internationalization process. This analysis seeks to enhance the understanding of DDCs definitions and frameworks within the current body of literature and underscore their implications in enterprises' internationalization. The fourth section provides the conclusion, discusses the study's limitations, and proposes directions for future research.

2. Conceptual Framework

2.1 Dynamic Capability Theory (DCT)

Dynamic capability (DC) have emerged as a pivotal concept in management studies (Barreto, 2010) since first introduced by Teece in 1997. They involve the integration, development, and rearrangement of internal and external resources to adapt to changing conditions (Teece, Pisano & Shuen, 1997, p. 516; Winter, 2003; Cepeda & Vera, 2007). The concept of DCs was developed to enhance the resource-based view (RBV), which considers enterprises as collections of unique resources and emphasizes the heterogeneity among enterprises due to their distinct resources and capabilities (Barney, 1991; Grant, 1991). It focuses on an organization's ability to modify its resource base (Eisenhardt & Martin, 2000; Teece, Pisano & Shuen, 1997). Additionally, the knowledge-based view (KBV) was integrated into the study of DCs. This integration highlights the critical role of organizations in articulating and applying different types of knowledge through processes of transfer, replication, integration, and coordination (Galunic & Rodan, 1998; Grant, 1996; Kogut & Zander, 1992).

In elaborating on the types of DCs, Eisenhardt and Martin (2000) expanded the framework initially proposed by Teece, Pisano, and Shuen (1997) to include the categories of acquiring and releasing capabilities. DCs play a crucial role in managing the evolution of a enterprises' core competencies, thereby enhancing its adaptability to environmental changes (Griffith & Harvey, 2001, p. 597; Winter, 2003, p. 991; Helfat & Winter, 2011; Teece & Leih, 2016). They are considered a sustainable source of competitive advantage, particularly in Schumpeterian environments characterized by rapid change (Lee, Lee & Rho, 2002, p. 734). Unlike operational capabilities, which maintain the status quo, DCs are driven by innovation and are essential for sustaining long-term competitive advantage (Zollo & Winter, 2002, p. 340; Ambrosini & Bowman, 2009; Pavlou & El Sawy, 2011; Zahra, Sapienza & Davidsson, 2006).

According to Helfat and Peteraf (2003, p. 999), while DCs may not directly impact a enterprises' output, they indirectly contribute to its performance by influencing operational capabilities. These capabilities encompass not only the skills managers use to build, integrate, and reconfigure organizational resources and competencies (Adner & Helfat, 2003, p. 1012) but also the ability to adjust a enterprises' resources and routines according to the vision of its key decision-makers (Zahra, Sapienza & Davidsson, 2006, p. 918). Helfat et al. (2009, p. 4) emphasized that DCs include the ability to perform tasks in the most minimally acceptable manner. These capabilities

provide enterprises with the essential flexibility needed to adapt to uncertain and evolving environments, thereby facilitating the development of innovations in products, processes, and management practices (Singh, Oberoi & Ahuja, 2013). Additionally, some scholars note that DCs can be leveraged not only in turbulent environments but also in stable settings to maintain a competitive edge (Helfat & Winter, 2011; Eisenhardt & Martin, 2000).

Teece (2014) conceptualizes DCs through three core activities: sensing, seizing and reconfiguring (SSR). Sensing involves identifying and assessing opportunities, emphasizing activities such as scanning, creation, learning, and interpretation (Teece, 2007). Seizing focuses on mobilizing resources to capture value from identified opportunities, highlighting the importance of swift decision-making and business model innovation (Schoemaker, Heaton & Teece, 2018). Reconfiguring, or transforming, encompasses rearranging resources and capabilities to address or initiate market and environmental changes, ensuring organizational agility and competitiveness (Teece, 2014; Fainshmidt et al., 2016). Organizations with transforming capabilities actively foster an agile, entrepreneurial mindset and cultivate extensive external networks (Day & Schoemaker, 2016).

Dynamic capabilities have been explored extensively by scholars from various perspectives (Eisenhardt & Martin, 2000; Zollo & Winter, 2002; Helfat & Peteraf, 2003; Zott, 2003; Winter, 2003; Zahra, Sapienza & Davidsson, 2006; Teece, 2007; Helfat et al., 2009; Cepeda & Vera, 2007). Originating in and evolving from strategic management, DCs have increasingly been examined in relation to diverse aspects and potential applications across different fields, complicating their definition further. The pivotal role of DCs in developing and renewing digital technology competencies has been emphasized (Easterby-Smith & Prieto, 2008; Eisenhardt & Martin, 2000; Teece, Pisano, & Shuen, 1997), driving significant expansion in academic research within the digitalization context. Research in this domain has primarily focused on sensing opportunities, seizing them, and transformative processes (Teece, 2007; Yeow et al., 2018; Warner & Wäger, 2019), forming a foundational theoretical framework for investigating DDCs.

Moreover, DCs encompass a range of competencies, including internationalization (Kor & Mahoney, 2005; Filatotchev & Piesse, 2009; Chakrabarty & Wang, 2012; Pinho & Prange, 2016; Vithessonthi & Racela, 2016) and innovation (Filatotchev & Piesse, 2009; Chakrabarty & Wang, 2012; O’Cass & Sok, 2012; Singh, Oberoi & Ahuja, 2013). This extension of DCs research underscores their critical importance in diverse strategic contexts, such as innovation management and international business (Bogers et al., 2019). The significance of DCs in the context of digital transformation holds profound implications for research in international business.

2.2 Digital Transformation and Digital Capabilities

Digital transformation refers to the process by which companies employ digital technologies to create new business models that enhance value creation and capture (Verhoef et al., 2019). This transformation involves SSR digital challenges into

opportunities, impacting business processes, operational routines, and organizational capabilities (Li et al., 2018). It enables enterprises to engage more deeply with customers and fosters innovations in business models (Amit & Zott, 2001; Aspara et al., 2013; Chesbrough, 2010; Khanagha, Volberda & Oshri, 2014; Wirtz, Schilke & Ullrich, 2010). Vial (2019) elaborates on digital transformation as fundamental changes in organizational activities and processes driven by digital disruptions. These changes necessitate strategic responses from enterprises to adjust value creation paths amid structural changes and organizational challenges. Beyond traditional IT roles, DT redefines a company's value proposition (Zhou & Li, 2010), which is crucial for enterprises pursuing early internationalization (Lee, Falahat & Sia, 2019). Businesses drive this transformation by influencing value creation processes, organizational tasks (Verhoef et al., 2021; Liu, Chen & Chou, 2011), and cultural dimensions (Warner & Wäger, 2019) to gain competitive advantages.

In response to the imperative of digital transformation, more companies are leveraging digital technology to drive transformative processes and develop sustainable digital capabilities (Zhen et al., 2021; Yu, Wang & Moon, 2022). According to Pan, Pan & Lim (2015), digital capabilities encompass a flexible IT infrastructure and information management capabilities, crucial for addressing rapid technological changes and uncertainties. The concept of digital capabilities is increasingly emphasized as enterprises seek to harness digital technologies for value creation (Zhen et al., 2021). Enterprises with robust digital capabilities optimize processes, develop new products or services, and strengthen partnerships within their networks (Pagani & Pardo, 2017). Companies recognize the necessity of adapting to digital challenges through activities, strategies, and routines (Loureiro, Ferreira & Simoes, 2021).

2.3 Internationalization

Internationalization refers to the extension of business activities beyond national borders (Chen, 2014; Hitt, Hoskisson & Kim, 1997). In the 1970s and early 1980s, motives for internationalization were categorized into three types: market-seeking, resource-seeking, and efficiency-seeking (Erdener & Shapiro, 2005). Dunning (1998) later expanded this concept by including strategic asset-seeking as a fundamental aspect of internationalization motives. This process is widely recognized for progressively strengthening organizational commitments to international markets (Johanson & Vahlne, 2017; Welch & Luostarinen, 1988), enabling enterprises to gain a larger share of transnational exchanges compared to their domestic operations and mitigating regulatory impacts on these flows (Zweig, 2002). In the era of economic globalization, integrating into international markets has become crucial for enterprises seeking sustainable competitive advantages (Barkema & Vermeulen, 1998; Zahra, Ireland & Hitt, 2000). Internationalization is a critical strategy for enterprises to overcome innovation bottlenecks and achieve substantial growth, especially amidst various innovation challenges and pressures (Papanastassiou, Pearce & Zanfei, 2020; Hitt, Hoskisson & Kim, 1997; Luo & Tung, 2007).

However, the international environment is increasingly fraught with uncertainty (Luo

& Hassan, 2009). Internationalization strategies involve gradually expanding into new markets and allocating human resources while navigating uncontrollable technological factors (Teece, 2007; Teece & Shuen, 1997). Managing such strategies involves handling complex information, which can lead to additional costs and reduced profits (Silverman, 2004). Moreover, entering new countries or markets exposes enterprises to challenges such as staffing, procurement, and establishing production facilities, which can hinder their international endeavors.

From the RBV perspective, internationalization enables enterprises to acquire new technologies, skilled talent, and other critical resources, thereby enhancing value creation and appreciation (Wu et al., 2019). As enterprises gain deeper insights into digital technologies, they perceive lower levels of environmental uncertainty in foreign markets, accelerating their export activities (Noroozi, Mobarekeh, & Zadeh, 2010) and improving their export performance (Oura, Zilber, & Lopes, 2016). With increased proficiency in digital technologies, enterprises optimize decision-making processes and accelerate their internationalization efforts earlier (Neubert, 2018), thereby strengthening their competitive advantage.

3. Literature Review

3.1 Digital Dynamic Capabilities

In today's volatile business environment, characterized by evolving customer preferences, shifting industry boundaries, rapid technological advancements, and emerging global competition, organizations are increasingly compelled to develop DCs that leverage the potential of digital technologies for digital transformation (Chakravarty, Grewal & Sambamurthy, 2013; Queiroz et al., 2018; Wheeler, 2002). The framework of DCs has evolved significantly with the rise of disruptive digital competitors, changing consumer behaviors, and innovative technologies (Warner & Wäger, 2019). Mendonça et al. (2018) highlighted the significant contributions of digital technologies such as IoT, big data, and AI to the microfoundations of DCs, emphasizing the performance benefits of Big Data in seizing opportunities through a quantitative approach. This study demonstrated the tangible benefits of integrating digital technologies with traditional DCs. This framework now provides a comprehensive view that encompasses technology, organizational practices, and environmental factors (Steininger et al., 2022), enabling enterprises to adapt and effectively navigate the constant changes driven by digital advancements (Warner & Wäger, 2019).

Warner and Wäger (2019) made a seminal contribution by identifying specific routines for SSR routines of DCs as crucial for DT. They defined the three core components of DDCs as digital sensing, digital seizing, and digital transforming capabilities and proposed a process model with nine microfoundations, emphasizing the need for enterprises to harmonize internal capabilities with external opportunities in the digital landscape, revealing key contingency factors that facilitate or hinder the development of DDCs (Warner & Wäger, 2019).

Digital sensing capabilities encompass digital scouting, scenario planning, and fostering a digital mindset (Warner & Wäger, 2019). Digital scouting involves identifying digital opportunities, while scenario planning interprets signals to formulate digital strategies for future scenarios (Berbel-Vera, Palanca & Gonzalez-Sanchez, 2022). Cultivating a digital mindset involves nurturing a digital and entrepreneurial ethos and developing a long-term digital vision (Mazumder & Garg, 2021). Sensing capabilities are crucial across all organizational levels, not limited to top management (Teece, 2007). Organizations must build digital sensing capabilities to grasp unexpected developments in a fluctuating business environment and proactively manage change (Jacobi and Brenner, 2018; Warner & Wäger, 2019).

According to Warner and Wäger (2019), digital seizing capabilities are divided into three sub-capabilities: strategic agility, balancing digital portfolios, and rapid prototyping. Strategic agility is essential for utilizing the newest technology or service and fending off threats (Ellström et al., 2021). These capabilities are closely related to the development of an actual digital strategy (Herold et al., 2023). New digital technologies such as cloud computing and social media have revolutionized seizing capabilities by accelerating product launches, enhancing customer centricity, and scaling operations at minimal costs (Warner & Wäger, 2019).

In addition to sensing and seizing capabilities, transforming capabilities are crucial for executing effective digital strategies and leveraging strategic changes (Bharadwaj et al., 2013; Karimi and Walter, 2015; Teece & Linden, 2017). Digital transformation capabilities encompass navigating innovation ecosystems, restructuring internal frameworks, and enhancing digital maturity (Warner & Wäger, 2019). Engaging in innovation ecosystems and fostering collaborative partnerships are critical for navigating these environments (Tronvoll et al., 2020). Flexible leadership, strategies, and business models enable organizations to adjust their internal structures as needed (Warner & Wäger, 2019), potentially involving decentralizing business units and establishing autonomous subsidiaries (Errida & Lotfi, 2021). Digital maturity reflects an organization’s readiness and willingness to adopt digital solutions (Kan et al., 2017). Achieving digital maturity requires balancing internal digital expertise with external digital talent (Tronvoll et al., 2020).

Warner and Wäger’s (2019) exploration of microfoundations relevant to digital transformation and strategies, particularly in examining incumbents, has established a foundational framework. Subsequent scholars have expanded upon and supplemented this framework, forming the basis for much of the subsequent research across different domains (Table 1).

Year	Author(s)	Definition and/or Main Content	Key Innovations
2018	Mendonça et al.	Demonstrated that digital technologies (IoT, Big Data and AI), contributed to the three microfoundations of DCs (Teece, 2007).	Utilized a quantitative approach and emphasized the Big Data’s performance in the seizing microfoundation.

2019	Warner & Wäger	Identified SSR routines crucial for DT and proposed a process model with nine microfoundations. Emphasized the need for enterprises to align internal capabilities with external opportunities in the digital landscape.	Explored how incumbents in traditional industries build DDCs and identified key contingency factors.
2021	Ellström et al.	Identified six specific routines crucial for DDCs: cross-industrial digital sensing, inside-out digital infrastructure sensing, digital strategy development, enterprise boundary determination, decomposition of DT into projects, and creation of unified digital infrastructure.	Provided detailed routines for SSR in DT for small and medium-sized family enterprises (SMFEs).
2021	Alkhamery et al.	Explored the role of DCs (sensing, learning, and integration capabilities) (Teece 2007) in enhancing readiness for digital business transformation.	Proposed a new model for digital transformation readiness (DTR). Examined the mediation role of DCs in reconfiguring operational capabilities within a enterpro.
2022	Ghosh et al.	Proposed digital transformation capability (DTC). Developed DDCs based on DTC, highlighting SSR.	Expanded on the DDCs proposed by Warner and Wäger (2019) to include cultural/mindset transformation.
2022	Yu, Wang & Moon	Developed DDCs based on DTC, highlighting sensing, organizing, and restructuring.	Explored the relationship between strategic orientation, DTC, and operational performance.
2022	Čirjevskis	Based on the DDCs proposed by Warner and Wäger (2019), constructed a conceptual model that includes coupled open innovation with collaborative partners, alliance formation phases, DDCs, and their micro-foundations.	Explored coupled open innovation for digital servitization in grocery retail from the perspective of DDCs.
2022	Shen, Zhang & Liu	Adopted the concept of DDCs proposed by Warner & Wäger (2019) and developed a conceptual model based on framework of resource–capability–performance.	Conducted quantitative analysis to explore the mediating role of DDCs between digital technology adoption and DT performance.
2022	Miguel et al.	Indicated that sensing, seizing, and innovation capabilities were appropriately grouped into DCs. The generation of DCs through DT influences customer satisfaction.	Focused on the automotive industry and its components.
2022	Wohlleber et al.	Combined the DCs (sensing, seizing, and transforming capabilities) (Teece, 2007) with DT efforts, providing valuable insights for decision-makers in port authorities, carriers, and freight forwarders.	Highlighted strategic agility, innovation ecosystems, and the redesign of organizational structures as the most vital second-order concepts for succeeding in DT in MCS.
2023	Daradkeh et al.	Incorporated digital customer orientation into Warner and Wäger (2019) framework as another	Focused on the importance of strategically creating and

	crucial DCs factor.	maintaining customer value in DT.
2024	Saeedikiya, Salunke & Kowalkiewicz Explored SSR capabilities for DT, integrating prior research on DDCs (Warner and Wäger, 2019; Ellström et al., 2021; Chirumalla, 2021).	Focused on SMEs in mobility sector.

Table 1: Development and Extension of DDCs Framework by Warner and Wäger (2019)

Building on Warner and Wäger’s (2019) insights, Ellström et al. (2021) also identified the SSR routines within DCs that are crucial for enabling digital transformation. They conducted an exploratory analysis incorporating insights from medium-sized firms undergoing digital transformation and further detailed six specific routines crucial for digital transformation, including cross-industrial digital sensing, inside-out digital infrastructure sensing, digital strategy development, enterprise boundary determination, decomposition of digital transformation into projects, and creation of unified digital infrastructure. Alkhamery et al. (2021) explored the role of sensing, learning, and integration capabilities (Teece, 2007), rather than SSR, in enhancing readiness for digital business transformation. They proposed a new model for digital transformation readiness and examined the mediating role of DCs in reconfiguring operational capabilities within enterprises.

Ghosh et al. (2022) introduced the concept of DTC, viewing its development through the lens of DCT. They focused on the digital SSR of enterprise resources and expanded on Warner and Wäger’s (2019) framework by integrating cultural and mindset transformation. Their integrated framework illustrates how these capabilities manifest through strategic sensing, rapid prototyping, organizational restructuring, business model transformation, and cultural/mindset shifts. Similarly, Yu, Wang, and Moon (2022) developed dimensions of DTC within the DCT framework, emphasizing sensing, organizing, and restructuring as core elements. They explored the relationship between strategic orientation, DTC, and operational performance.

Building on Warner and Wäger’s (2019) framework of DDCs, Čirjevskis (2022) formulated a conceptual model that integrates coupled open innovation among collaborative partners, phases of alliance formation, dynamic digital capabilities, and their microfoundations. Čirjevskis (2022) further explored coupled open innovation in digital servitization within the grocery retail context, focusing on the perspective of DDCs. Shen, Zhang, and Liu (2022) applied Warner and Wäger’s (2019) DDCs framework to develop a conceptual model linking resource capability to performance through quantitative analysis. They investigated the mediating role of DDCs between digital technology adoption and DT performance. Miguel et al. (2022) emphasized the aggregation of sensing, seizing, and innovation capabilities into DCs, underscoring their impact on customer satisfaction within the automotive industry. Additionally, Wohlleber et al. (2022) integrated sensing, seizing, and transforming capabilities (Teece, 2007) with DT efforts, offering valuable insights for decision-makers in port authorities, carriers, and freight forwarders. They highlighted strategic agility, innovation

ecosystems, and the redesign of organizational structures as crucial second-order concepts for achieving success in DT within MCS.

Extending the discussion, Daradkeh et al. (2023) integrated digital customer orientation into Warner and Wäger's (2019) framework as a critical factor of DDCs. Their focus was on refining strategies to consistently create customer value in digital transformation. In a related vein, Saedikiya et al. (2024) explored SSR capabilities for DT, building on prior research on DDCs (Warner & Wäger, 2019; Ellström et al., 2021; Chirumalla, 2021) within SMEs in the mobility sector.

Furthermore, different perspectives emerge in the study of DDCs in digital transformation (Table 2), which emphasize how these capabilities manifest throughout the transformation process and identify the most critical aspects. These studies typically delve into various dimensions of the relationship and importance of DCs in DT, covering diverse topics.

Year	Author(s)	Definition and/or Main Content	Key Innovations
2020	Weritz, Braojos & Matute	Identified six DCs as relevant DCs during DT: absorptive capacity, agility and flexibility, cross-functional collaboration, innovation capability, market orientation, and relational capability.	Conducted a multiple-industry case study analysis of eight successful companies.
2021	Matarazzo et al.	Identified the digitally-based DCs essential for DT, emphasizing the importance of sensing and learning capabilities as catalysts for this process.	Examined the impact of DT on customer value creation in the context of SMEs operating in the Made in Italy sectors.
2021	Chirumalla	Identified DCs that facilitate the transformation of an enterprise from traditional process innovation to digitally-enabled process innovation. Developed a framework, comprising 19 DCs in total: 8 related to traditional process innovation and 11 related to digitally-enabled process innovation.	Adopted a multiple case study design in two steel manufacturing firms.
2021	Suluk, & Kammerlander	Identified three combinations of enablers and barriers that support or hinder the development of DCs, thereby accelerating or impeding the advancement of the DT process.	Divided DT into three stages and revealed the triggering factors for each stage and the DCs required throughout the transformation process.
2022	Khurana, Dutta & Ghura	Highlighted the evolving roles of the three primary DCs: sensing, seizing, and transforming. Digital technologies provide opportunities for transformation, while crises lead to the emergence of resilience capabilities as a second-order DC.	Focused on the resilience capabilities in DT of SMEs during crises.
2023	Christofi et al.	Explored the impact of strategic leaders' entrepreneurial persistence on digital transformation and BMI. Examined the role of market-sensing DC.	Employed a quantitative approach to analyze how the market-sensing DC positively moderates the

			mediating impact of digital technologies on the direct effects of entrepreneurial persistence on BMI.
2023	Herold et al.	Introduced and defined DPT. Provided an overview of nine microfoundations required for DPT by adopting the DC lens.	Highlight the strategic options procurement leaders can use when strategizing about adopting combinations of digital technologies.
2023	Yang et al.	Proposed a theoretical framework for multistage DT to drive low-carbon technology innovation (LCTI) in manufacturing firms, closely linked to three DCs.	Proposed a novel driving mechanism, which differs from existing literature limited to superficial mediating mechanisms.
2023	Renz & Hilbig	Adapted the DCs foundations, creating a theoretical approach for DT.	Focused on how educational institutions have responded to the changing environmental conditions during the COVID-19 pandemic.
2023	Mele et al.	Focused knowledge-based DCs for DT.	Literature review
2024	Qi et al.	Clarified the relationship among ambidextrous knowledge accumulation, DC and manufacturing DT, highlighting DCs as vital drivers of DT.	Segmented DCs into alliance management capability and new product development capability. Explored their role in DT.
2024	Abdurrahman, Gustomo & Prasetio	Integrated DC with the TOE framework to investigate DT and innovation.	Examined how applying DCs based on the TOE framework to digital banking transformation can enhance performance outcomes through DT.
2024	Kowalski et al.	Proposed a framework of DCs (digital SSR) and their microfoundations to assess the opportunities and challenges related to DT.	Developed new theoretical constructs to uncover microfoundations, barriers, and enablers of DDCs.
2024	Leso et al.	Proposed a framework for DDCs, covering five thematic areas of action: designing and managing transformation, fostering digital value propositions, participating in digital business ecosystems, systematizing structural changes, and supporting enabling factors.	Integrated DC theory with the digital maturity perspective.

Table 2: Different Perspectives on DDCs (Manifestation and Critical Dimensions)

Weritz, Braojos, and Matute (2020) made a significant contribution by identifying six key DCs: absorptive capacity, agility and flexibility, cross-functional collaboration, innovation capability, market orientation, and relational capability. Their multi-industry case study analysis illustrates how these capabilities drive DT initiatives. Matarazzo et al. (2021) highlighted the critical importance of sensing and learning capabilities as fundamental drivers of digital transformation, particularly in SMEs within the Made in

Italy sectors, focusing on enhancing customer value creation. Chirumalla (2021) focused on the transition from traditional to digitally-enabled process innovation in steel manufacturing firms, proposing a comprehensive framework of 19 DCs essential for navigating this transformation. Soluk and Kammerlander (2022) explored the enabling factors and barriers influencing DC development, identifying specific triggers and essential DCs tailored to different stages of the transformation journey. Khurana, Dutta & Ghura (2022) discussed the evolving roles of sensing, seizing, and transforming capabilities in leveraging digital technologies for transformative opportunities, emphasizing the emergence of resilience capabilities as crucial second-order DCs, particularly in response to crises.

Recent studies continued to build on these foundations. Christofi et al. (2023) examined the impact of strategic leaders' entrepreneurial persistence on DT and business model innovation (BMI), highlighting the moderating role of market-sensing DCs. Herold et al. (2023) introduced digital procurement transformation (DPT), outlining nine essential microfoundations through a DC lens. Yang et al. (2023) proposed a theoretical framework for multistage DT driving LCTI in manufacturing firms, linking it to three key DCs and presenting a novel driving mechanism. Renz and Hilbig (2023) adapted DC foundations to develop a theoretical approach for DT, focusing on educational institutions' responses to COVID-19 challenges. Mele et al. (2023) conducted a literature review on knowledge-based DCs for DT.

Further contributions include Qi et al. (2024), who clarified the relationship among ambidextrous knowledge accumulation, DCs, and manufacturing DT, establishing DCs as critical drivers. Abdurrahman et al. (2024) integrated DC with the TOE framework to explore DT and innovation, demonstrating positive performance outcomes. Kowalski et al. (2024) proposed a framework focusing on digital SSR capabilities and their microfoundations, introducing theoretical constructs to uncover barriers and enablers of DDCs.

Leso et al. (2024) contributed an additional DT framework, emphasizing actions such as designing and managing transformation, fostering digital value propositions, engaging in digital business ecosystems, systematizing structural changes, and supporting enabling factors. Their integration of DCT with digital maturity perspectives complements previous studies by emphasizing practical implementation strategies for navigating digital landscapes and fostering organizational excellence in DT.

3.2 DDCs in internationalization

In the field of internationalization, digitalization has emerged as a pivotal strategy for enterprises seeking to expand their global market share and leverage international markets (Elia et al., 2021). Contemporary digitalization encompasses the adoption of new digital technologies such as mobile technology, artificial intelligence, cloud computing, blockchain, and the IoT. The ability to utilize these digital technologies to support marketing strategies at various stages of the internationalization process is

crucial (Katsikeas, Leonidou & Zeriti, 2019).

Warner and Wäger’s (2019) framework on DDCs integrates insights into the evolution of digitalization, providing a structured approach that aids in understanding the complex dynamics of digital transformation in an international context. Therefore, their theoretical framework serves as the basis for exploring the impact of DDCs on the internationalization process in this section. This framework includes digital sensing, digital seizing, and digital transformation capabilities, which play a critical role in facilitating internationalization by influencing business processes across multiple dimensions (Figure 1).

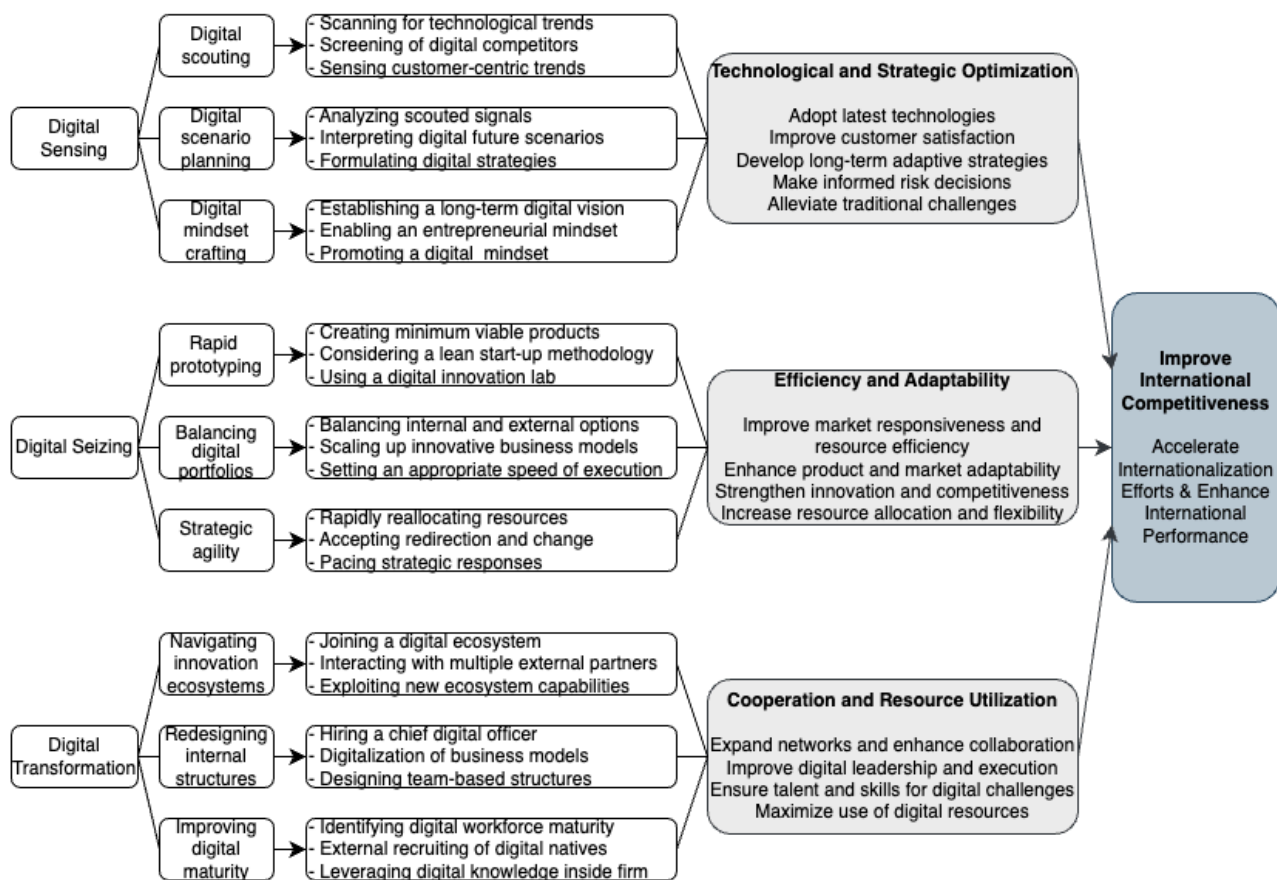


Figure 1: Impacts of DDCs (Warner & Wäger, 2019) in Internationalization

First, digital sensing capabilities are instrumental in optimizing technology and strategy within firms. Digital scouting, which involves scanning technological trends, screening digital competitors, and sensing customer-centric trends, enables companies to rapidly identify and leverage emerging technologies and trends in global markets (Warner & Wäger, 2019). This process allows firms to adjust their products and services to meet the specific demands of diverse international markets (Tseng & Johnsen, 2011). A keen awareness of market and technological trends positions companies advantageously in

global markets (Tseng & Johnsen, 2011; Houghton & Winklhofer, 2004). The adoption of new digital technologies significantly enhances a company's ability to utilize foreign assets, overcome language barriers, and adapt to complex business environments, thereby reducing barriers to market information acquisition and facilitating cross-border communication, which accelerates the identification of new market opportunities (Watson et al., 2018). Advanced digital capabilities also foster an environment conducive to early and rapid international expansion (Johanson & Vahlne, 2017), thereby improving international performance (Vadana et al., 2019; Chen et al., 2019; Alshboul et al., 2022).

Technological platforms, analytical tools, and big data collection methods enhance firms' understanding of customer preferences, attitudes, habits, and interests, which aids in customizing strategies for targeting, positioning, and communication across different countries. This dynamic environment promotes digital entrepreneurship, which is crucial for driving international expansion efforts (Gabrielsson, Raatikainen & Julkunen, 2022). Deploying digital technologies in emerging markets enhances innovation potential, enabling firms to meet diverse global consumer demands and gain a competitive edge (Lee & Falahat, 2019).

Digital scenario planning, which involves analyzing scouted signals, interpreting future digital scenarios, and formulating corresponding digital strategies (Warner & Wäger, 2019), enables firms to set forward-looking strategies and maintain long-term adaptability. This capability helps firms make informed decisions amidst market volatility and reduces the time to enter new markets. Digital mindset crafting supports continuous digital transformation by establishing a long-term digital vision, fostering an entrepreneurial spirit, and promoting a digital mindset. Advanced digital awareness and presence can alleviate traditional challenges associated with firm size and the constraints on financial and human resources in internationalization (Tseng & Johnsen, 2011; Houghton & Winklhofer, 2004; Tarutė & Gatautis, 2014; Mathews & Healy, 2008; Rebecca & Fischer, 2011). This digital mindset lays a solid foundation for digital transformation, effectively guiding the internationalization process.

Second, digital seizing capabilities enhance a firm's efficiency and adaptability. Rapid prototyping allows companies to create minimum viable products (MVPs), adopt lean startup methodologies, and utilize digital innovation labs to quickly test and iterate new products (Warner & Wäger, 2019), thereby improving market response speed and product-market fit. Balancing digital investment portfolios involves balancing internal and external options, scaling innovative business models, and setting appropriate execution speeds. Effective management of digital investments enhances resource allocation efficiency and operational flexibility (Vadana et al., 2019). Strategic agility enables firms to rapidly reallocate resources, embrace changes, and adjust strategic response rhythms, maintaining consistent strategic direction and continuous innovation momentum in rapidly changing market environments (Alshboul et al., 2022), thereby enhancing market competitiveness.

Digital innovation drives technological advancement within firms. It reshapes

distribution and production channels (Coviello, Kano & Leisch, 2017; Brouthers et al., 2018, 2016) and is transforming the management of geographically dispersed value chains (Strange & Zucchella, 2017). However, adopting new digital technologies may initially increase operational costs, outweighing the benefits of internationalization and leading to performance declines (Cassetta et al., 2020). Therefore, balancing internal and external options is crucial, especially for SMEs, which often face resource constraints (Giotopoulos et al., 2017). This balance promotes the formation of innovative business models, enabling firms to reduce operational and transaction costs in international markets, achieve economies of scale and scope, and diversify risks (Johnston et al., 2018; Wasterlund, 2020). Over time, as firms optimize their internationalization efforts and achieve better performance outcomes, the benefits outweigh the costs, presenting a U-shaped relationship between internationalization and performance (Hsu, Lien & Chen, 2015; Wang, Zhang & Xia, 2020).

Additionally, internationalization theories such as the Uppsala model (Johanson & Vahlne, 2015, 2017) and the Helsinki model (Luostarinen, 1979; Welch & Luostarinen, 1988) emphasize the importance of environmental factors in the speed of internationalization (Neubert, 2022). Strategic agility enables firms to flexibly respond to uncertain market conditions, accelerating their internationalization process (Vadana et al., 2019) and swiftly adjusting strategies to sustain growth and achieve long-term success.

Third, DTC helps firms enhance cooperation and resource utilization. Companies must develop internal digital capabilities and collaborate with external experts and partners to access the latest digital technologies and knowledge (Tronvoll et al., 2020). Engaging in digital ecosystems, interacting with multiple external partners, and exploiting new ecosystem capabilities (Warner & Wäger, 2019) enable firms to expand business networks and enhance cooperative abilities. Redesigning internal structures involves hiring a Chief Digital Officer (CDO), digitalizing business models, and designing team-based structures. These structural adjustments improve digital leadership and strategic execution capabilities, ensuring that firms possess the necessary talent and skills to address digital challenges (Tronvoll et al., 2020).

Improving digital maturity through identifying digital workforce maturity, externally recruiting digital natives, and leveraging digital knowledge within the firm (Warner & Wäger, 2019) maximizes the utilization of existing digital resources. These capabilities equip firms with greater adaptability, allowing them to enter and operate in international markets more swiftly (Tronvoll et al., 2020). Continuous development and application of digital technologies enable firms to act faster than competitors, reducing mistakes, delays, and customer dissatisfaction, as well as information asymmetries (Yamin & Sinkovics, 2006), thereby maintaining a leading position in global competition (Elia et al., 2021; Lee & Falahat, 2019).

4. Conclusion and Agenda for Future Research

This paper contributes to the academic discourse on digital transformation and internationalization by reviewing the relevant literature on DDCs. It highlights current

gaps in understanding DDCs. As emphasized by El Sawy et al. (2020), digital technologies act as catalysts for internationalization by breaking down geographical barriers and facilitating the formation of international user communities. However, the path to digital transformation is fraught with challenges. Organizations must navigate the complexity of integrating digital technologies with existing systems (Schwertner, 2017). Effective DT necessitates clear strategic planning and cultivating urgency within management (Fitzgerald et al., 2014). This aligns with the DCs perspective, asserting that firms must develop new capabilities to manage uncertainty and leverage digital technologies for competitive advantage (Teece, 2007).

Most scholars define DDCs by establishing core components: SSR. Warner & Wäger (2019) have notably influenced this discourse by providing a robust framework that has been repeatedly validated and extended in subsequent research. As elucidated by Warner and Wäger (2019), DDCs refer to the capabilities required by firms during digital transformation, delineating nine subdivisions of DDCs in this context. They outline digital sensing capabilities, encompassing digital scouting, scenario planning, and fostering a digital mindset. Digital seizing capabilities are subdivided into strategic agility, balancing digital portfolios, and rapid prototyping. DTC includes navigating innovation ecosystems, restructuring internal frameworks, and enhancing digital maturity. These capabilities enable companies to adapt to the turbulence of the digital era characterized by rapidly changing consumer preferences and technological advancements (Chakravarty, Grewal & Sambamurthy, 2013; Queiroz et al., 2018). The consistent theme across these studies is the pivotal role of DDCs in helping businesses navigate and thrive in the digital age, emphasizing the complexity and strategic necessity within today's dynamic digital environment.

Multiple authors have also contributed unique insights and understandings of DDCs. Despite this, achieving a concise yet comprehensive definition remains elusive, and there is still no consensus on its conceptualization. Nevertheless, it is evident from the literature that DDCs are inherently linked to strategic management, and extensive exploration has demonstrated their relationships with broader organizational aspects.

Additionally, the findings underscore the indispensable role of DDCs in enabling companies to navigate the complexities of the digital business environment and facilitate their internationalization. There is a close interplay between digitalization and internationalization: digitalization provides new tools and means for internationalization, while internationalization brings new markets and opportunities for digitalization. Companies need to consider both aspects simultaneously and achieve synergies when formulating their strategies. When entering new international markets, firms must leverage DDCs, which are not only pivotal drivers in the process of digital transformation for enterprises but also critical factors in achieving successful internationalization strategies. These capabilities enable companies to adapt more swiftly to global market changes, enhance innovation capacity, and improve operational efficiency, thereby maintaining a leading position in fierce global competition.

This study faced several limitations and challenges. Firstly, the scope of the literature

review was limited. Despite our efforts to cover major academic resources and literature databases, some studies or emerging fields may have been overlooked. Secondly, there is no unified operational definition and measurement method for DDCs. Different researchers may have varied understandings and definitions, potentially affecting the consistency and comparability of research results. Thirdly, this study primarily relied on secondary data from existing literature rather than field research or primary data collection, which may introduce some inferential and hypothetical elements regarding the application of DDCs in actual companies.

Based on the findings and limitations of this study, future research can further explore and expand in several directions. Different industries face unique challenges and opportunities in digital transformation and internationalization strategies. Future research could focus on specific industries to analyze the impact mechanisms and pathways of DDCs on the internationalization of companies in those sectors. Additionally, field research or case studies could verify the actual effects and applications of DDCs in various types of companies and market environments. The interaction between DDCs and traditional business models also warrants examination. As companies strive to balance operational efficiency and innovative business models, understanding whether DDCs complement or substitute existing capabilities is crucial. Furthermore, considering cultural diversity in the context of globalization, future research could compare the understanding and application strategies of DDCs across companies from different countries or regions, exploring their applicability and influencing factors in cross-cultural environments.

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