

https://dspace.org/

# Dynamic capabilities: axiomatic formation of firms' competitive competencies

**Mushangai, Dandira**

**2023**
Elsevier
https://hdl.handle.net/10539/38377

Downloaded from a DSpace repository. https://dspace.org/

Social Sciences & Humanities Open 8 (2023) 100654

Contents lists available at ScienceDirect

Social Sciences & Humanities Open

journal homepage: www.sciencedirect.com/journal/social-sciences-and-humanities-open

Regular Article

# Dynamic capabilities: Axiomatic formation of firms' competitive competencies

Dandira Mushangai

*Department of Engineering and Technology Management, Graduate School of Technology Management, University of Pretoria, South Africa*

ARTICLE INFO

*Keywords:*
Capabilities
Technology
Innovation
Framework
Competitive advantage

ABSTRACT

The capabilities concept is critical in understanding the competitive competencies of firms. Capabilities allow firms to sense, seize and reconfigure their resources in response to opportunities and threats within their environments. This systematic review reviewed a total of 37 Scopus database-selected peer-reviewed articles on capabilities, technology, innovation, and capability frameworks. The purpose was to identify and discuss firms' capabilities and formation processes and effects on competitive advantages to generate an encompassing framework that overcomes the limited and fragmented nature of current capability frameworks. The study employed thematic content analysis and author-anchored keywords analysis which enabled the identification of several themes regarding capabilities and formation processes. The findings of the study were discussed under the following themes: technological capabilities; supply chain capabilities; networking, collaboration, interactive, coordinating, and alignment capabilities; organisational capabilities; and lastly systems capabilities. The study contributes to enlightening a body of firms' capabilities theories and generated an encompassing interactive capabilities framework to guide researchers in understanding firms' capabilities formation processes. The value of the study to the research community lies in emphasising the multi-level approach (macro; mezzo; firm level) and the virtues of combining tenets from different frameworks for a nuanced understanding of firms' capabilities development. The study will be critical in guiding firms in building their capabilities, particularly the importance of open innovation networks and collaboration in reducing innovation risks and costs. The paper is important to policy makers regarding the institutions facilitating the interaction of international, national and firms level dynamics in propping and propelling firms' capabilities development.

## 1. Introduction

Businesses are increasingly operating in highly complex, volatile, and unpredictable environments. Globalization pressures, global warming and climate change, and the rapidity of technological changes and innovations are challenges within firms' operational environments (Chiang, Kou, & Koo, 2021). The global production orientation towards sustainability demands firms to balance the triple bottom performance of people, planet, and profit (Correia, 2019). The sustainability metrics of a firm are no longer defined solely in economic terms but also the socially and ecologically accepted practices (Moon & Lee, 2023). To thrive amidst uncertainties generated by the augmented requirements of rapidly changing business environments, firms are progressively allocating resources to build and develop their capabilities, especially the capability to innovate (Cassia, Costa, da Silva, & de Oliveira Neto, 2020; Flores, Cherian, & Boër, 2008). The urgency of this is felt more in Africa where local firms are contending in their environments against firms with highly developed capabilities from other regions (Mushangai, 2020).

Globalization pressures and emerging forms of organising production such as global value and supply chains, outsourcing, and off-shoring have exposed local firms to international competition compelling them to seek to build and develop their capabilities to gain or maintain their markets (Auer, Besse, & Meda, 2006; Gereffi, Humphrey, Kaplinsky, & Sturgeon, 2001). Capabilities are not only dependent on factors endogenous to firms but also exogenous factors such as the strength of national systems of innovation and interactions in networks etc. In Gabon, forestry firms failed to participate gainfully in global value chains because of the lack of the requisite production knowledge and skills, mainly a result of a weak national system of innovation which curtailed firms' capabilities development (Mushangai, 2020; Terheggen, 2011).

Production activities and consumption habits are impacted by global warming and climate change. Climate change-induced disasters

*E-mail addresses:* dandira20000@gmail.com, u22033727@tuks.co.za.

https://doi.org/10.1016/j.ssaho.2023.100654
Received 11 March 2023; Received in revised form 7 August 2023; Accepted 21 August 2023
Available online 27 September 2023
2590-2911/© 2023 The Author. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

including recurring droughts, hailstorms, thunderstorms, and windstorms affect crop yields and farmers' productivity (Elahi, Khalid, Tauni, Zhang, & Lirong, 2022; Chakona & Mushangai, 2021). A study by Elahi, Khalid, Tauni, Zhang, & Lirong (2022) in Pakistan indicated climate change-induced hailstorms, thunderstorms, and windstorms are greatly reducing wheat harvests. Climate change has also increased environmental and legal risks regarding farming regulations and environmental practices. In South Africa, commercial forestry is retreating from riparian zones, reducing the plantation hectarage, all with a negative impact on the quantity of production (Chamshama & Nwonwu, 2004), hence the capacity of the plantation forestry base to supply the requisite lumber to maintain production along the value chain in the future. Capabilities are therefore important in determining what is to be done to increase output and the quality of the resource on a reduced land base and in understanding how the dry areas formerly considered unfavourable for commercial forestry can also support the plantation economy (Mushangai, 2020).

Global markets are increasingly influenced by sustainable production principles and shun products unaligned with global production and sustainability standards (Ahmed, 2010). As a climate change mitigation measure, national and international institutions and standards compel firms to lessen carbon fuels consumption, adopt renewable sources (Elahi, 2021) and build smart and ecologically friendly value and supply chains (Schneckenberg & Hamid, 2015). Firms have to build capabilities to comply with national and international standards to maintain their competitive advantages in local and international spheres. Some firms are instituting innovative climate change adaptation measures to reduce the impact on their production activities (Elahi, Khalid, Tauni, Zhang, 2022).

Despite the various technology gaps especially in the least developed countries, the current global environment is characterised by an accelerated pace in the development and adoption of new technologies (Utoikamanu, 2018). Rapid technological change involving the application of big data, the internet of things, robotics, 3D printing, artificial intelligence, machine learning, satellite, biotechnology, nanotechnology and drone technologies, and renewable energy technologies present both opportunities and challenges to firms' production activities (Utoikamanu, 2018). These technologies are critical for the achievement of the Sustainable Development Goals. The challenge here is twofold and pertains to firms' ability to retool, reorient and adopt climate change mitigation strategies (Elahi et al., 2022) and to align activities with global sustainability standards (Mayers, Evans, & Foy, 2001; Koschatzky, 2008). The retooling, reorienting and alignment processes are expensive and require firms to build new skills, evaluate the appropriateness of new technologies on the market, select and absorb new technologies, and protect innovations in rapidly changing environments (Phaal, Farrukh, & Probert, 2004). These changes define the challenges and opportunities regarding the current global business environment and compel firms' managers to make hard decisions concerning resource allocation to address the growing complexity (Phaal et al., 2004).

Existing studies currently focus on particular aspects of firms' transformation from a specific perspective, say technology acquisition from the resource-based view (Poon & MacPherson, 2005), the original equipment manufacturer (OEM) strategy from a global value chain perspective (Chen, Wei, & Hu, 2016) or technological and design capabilities from the capabilities and core competencies theory (Chen et al., 2016). Whilst understanding firms' capabilities from a specific perspective has its strengths regarding depth, it ignores insights and deviations proffered by other perspectives.

Currently, there is a lack of an integrated framework for understanding firms' capabilities development. Regarding supply chain capabilities, Liu, Wei, Liang, Wang, and Wang (2021) noted the lack of a theoretical framework for the organizational efficiency of the smart logistics ecological chain. Concerning technological capabilities, there is a lack of sufficient studies on understanding the diffusion processes in technology adoption (Kumar, Krishnamoorthy, & Kamath, 2020). Technology adoption is a multi-stage and evolutionary process (Coccia & Watts, 2020). However, there is a lack of studies focused on understanding the multi-stage processes in technology adoption. In the field of Business Analytics (BA) Aboelmaged and Mouakket (2020) and Kumar et al. (2020) noted the dearth of process models. Also, regarding technological capabilities and the evolution of technologies, Coccia and Watts (2020) noted that little is known regarding, 'how technologies interact, create and/or improve complex systems in which each component and system can continue to evolve in socio-ecological environments.' Moreover, existing theoretical perspectives on technology diffusion and adoption and capabilities formation and development are fragmented (Frizzo-Barker, Chow-White, Mozafari, & Ha, 2016 cited in Kumar et al., 2020). Aboelmaged and Mouakket (2020) identified over 20 models on technology transfer and adoption and assimilation with reference to big data analytics adoption (BDAD). They noted a lack of studies identifying the determinants of these models and how they are interrelated. Only a few studies (Aboelmaged & Mouakket, 2020; Kumar et al., 2020) have attempted a systematic synthesis of technology diffusion and adoption and capabilities formation and development models. Inan and Bititci (2015) have also noted little research attempting to understand the applicability of capability theories on micro-enterprises. Hence the need for an integrated framework capable of guiding the development of capabilities for both big and small businesses. This SLR seeks to understand firms' capabilities development from different perspectives. The aim is to integrate multiple perspectives to develop a Customised Capabilities Framework to inform firms' capabilities development. The review answers the question: How can firms build and develop their capabilities as the basis of their competitive competencies?

## 2. Capabilities and core competencies

Firms must build their capabilities to gain competitive advantages over other firms. Capabilities refer to the capacity to accomplish certain tasks and activities (Helfat, 2007). These capabilities are practised and honed over time based on learning and knowledge accumulation (Teece, 2007). Capabilities allow firms to adapt to exploit changes in their business environments. They enable firms to absorb, generate or combine existing knowledge elements to embark on new processes to generate new products or take on new functions (Teece, 2007). The firm needs to assemble its resources, both tangible (e.g., land, machines, and capital) and intangible (e.g., reputation; brand equity; knowledge bases and networks), which are part of its capabilities to enhance these competencies through technological, organisational and strategic innovation (Helfat, 2007; Ceglinski, 2020; Mushangai, 2020). Helfat (2007) have argued that "creating, adapting to, and exploiting change is inherently entrepreneurial, for large and small, for old and new …. To survive and prosper under conditions of change, firms must develop the dynamic capabilities to create, extend, and modify how they make their living'' (p.5). Firms must develop the capabilities to absorb new knowledge and technologies to innovate to create rents (Mushangai, 2020).

Teece, Pisano, and Shuen (1997) defined dynamic capabilities as the "firm's ability to integrate, build, and reconfigure its internal and external competencies to address rapidly changing environments.'' The ability of a firm to employ or change its tangible and intangible resources in opening strategic options is a critical capability to improve competitiveness (Helfat, 2007). Eisenhardt and Martin (2000) have taken dynamic capabilities to mean the "firm's processes that use resources … to match and … create market change''. The ability to change the market to respond to external pressures, resource allocation routines, product development routines, mergers and acquisition capabilities, and knowledge transfer and replication routines are all aspects of dynamic capabilities. Zollo and Winter (2002) underlined organisational learning as a source of dynamic capabilities. This is made up of a

learned and stable pattern of collective action through which the organisation methodically generates and modifies its operating routines and procedures for improved efficiency and effectiveness (Zollo & Winter 2002). Since capabilities involve collective action, they are partly social and interactive processes, implying social capacity.

Lazonick (1991; 2022) noted that capabilities are part of an innovative organisation. Innovative firms invest in 'specialised research and development skills and facilities' to generate technological capabilities (Lazonick, 1991). Innovative firms invest in 'specialised marketing skills and facilities to determine the needs of buyers' (Lazonick, 1991). To build organisational capabilities, innovative firms invest in 'managerial skills and bureaucracy'.

Managerial skills and bureaucracy are critical for planning and coordinating development; production; and marketing to develop the productive potential for shaping and controlling the economic environment for the firm's strategic success (Chandler, 1992; Lazonick, 1991; Zang & Li, 2017). The development and utilisation of these productive capabilities are the essences of the innovative enterprise (Lazonick, 2022). Dynamic capabilities can thus take several forms and different functions including marketing, product development, or process development (Zang & Li, 2017).

Chandler (1992) noted the success of managerial enterprises as based on a three-pronged set of investments in manufacturing, marketing, and management to exploit economies of scale, scope and speed (Chandler, 1992). These investments enable a firm to set up an organisational structure composed of low, middle, and top managers to create, coordinate and manage a firm's production, marketing and distribution nationally and internationally and to plan and allocate resources for future activities (Chandler, 1992; Harris & Wood, 2020). Organisational capabilities empower firms to forcefully compete functionally and strategically through efficient production and distribution by introducing improved processes and products stemming from research and development (R&D) (Guo, Li, Zuo, & Chen, 2015; Chandler, 1992).

Organisational capabilities generate sensing capabilities allowing firms effective marketing, product differentiation and access to sources of supply (Liu et al., 2021). The dominance of International Business Machines Corporation (IBM) was rooted in organisational and research capabilities. Massive investments by IBM in research and production, marketing and managerial capabilities leading to the introduction of System 360 in 1964 enabled its domination of the industry - producing hardware and software, computers, servers, storage systems and networking equipment (Chandler, 1992). R&D capabilities are vital but are linked to a firm's organisational capabilities. R&D allows for creative destruction, and successful innovators punish firms whose technologies are superseded and become obsolete (Lipczynski, Wilson, & Goddard, 2017). Mastery of new processes enables a firm to produce at a lower cost than its rivals (Lipczynski et al., 2017). This may enable a firm to capture the market by setting reduced prices its rivals are unable to match thereby creating economic rents. Successful innovators are thus rewarded with market power to become monopoly suppliers of new products. Nevertheless, a firm's dominance is temporary and a firm must guard against complacency as other firms will strive to catch up through technological improvements, new sources of supply or new forms of organisation (Liu et al., 2021). Capabilities should thus be dynamic, practised, honed and upgraded according to market dynamics and changes in operational environments.

Chandler (1992), Lazonick (2022), and Liu et al. (2021) acknowledge the importance of exogenous factors in building the capabilities of firms. Chandler (1992) noted that multinational corporations (MNCs) build their capabilities by exploiting different knowledge types in different geographical markets. However, moving into international markets is based on organisational capabilities and accumulated competitive advantages cultivated in exploiting economies of scale. Lazonick (2022) recognizes the importance of the institutional infrastructure and industrial contexts within which the firm operates. External dynamics partly convey the importance of institutions, how they facilitate or hinder innovation and industrial upgrading (Kim & Eom, 2019) and the formation of interactive capabilities regarding the diffusion and assimilation of technologies from outside sources. Countries still far from the technological frontier must build an institutional ensemble to facilitate innovation and industrial upgrading while encouraging their firms to link up and participate in supply and value chains to enable technology transfers (Gereffi, Humphrey, & Sturgeon, 2005; Zhou, Gao, & Chimhowu, 2019a, 2019b). Dynamic capabilities are critical for they enable firms to sense opportunities and threats, seize opportunities and reconfigure per market dynamics (Teece, 2007). Research-intensive firms can expand and enter into markets related to their distinctive core production and research technologies. They do this by focusing on higher value-added fields and moving into new ones considering their capabilities (Chandler, 1992).

### 2.1. Core competencies

Prahalad and Hamel (1990) introduced the core competencies concept by which they meant 'the collective learning in the organisation, especially how to coordinate diverse production skills and integrate multiple streams of technologies.' Core competencies are a unique combination of technologies, knowledge, and skills of a company that cannot be easily imitated by other companies (Hoskisson, Hitt, & Ireland, 2008). They comprise the firm's unique combination of tangible and intangible resources that make its activities more profitable. These resources may become core competencies or contribute to core competencies if they give a firm a comparative advantage over rivals and allow profitability (Harrison et al., 2008). Core competencies can only be such because they are difficult and costly to copy or imitate, hence their rarity. They differentiate a firm's processes and products in a way that make them non-substitutable because of the competitive advantages accumulated vis-à-vis other firms.

Cegliński (2020), noted a core competence meets all the characteristics of a dynamic capability and vice versa. This means that the differentiation between a dynamic capability and core competency is unclear. Cegliński (2020) argues that strategic intangible resources including capabilities and dynamic capabilities, determine the creation of core competencies. This is a view emanating from the resource-based theory. For resources to become core competencies they have to become the source of competitive advantages regarding their value, scarcity, complexity, invisibility, durability, and appropriability (Ceglinski, 2020). Thus, the literature points to the difficulty of developing core competencies.

## 3. Methods

The review followed the guidelines for structured reviews provided by Kitchenham and Charters (2007). These guidelines cover three main stages which are: planning the review, running the review, and reporting the findings. Within these main stages, Chiang et al. (2021) identified five steps to be taken which are 1. Question formation, 2. Locating the studies. 3. Study selection and evaluation, 4. Analysis and synthesis and 5. Reporting and using the results. These stages and processes differentiate a Systematic Literature Review (SLR) from a Classical Literature Review (CLR). These stages require rigorous planning of the review, with each stage planned to the last detail. Every stage of the systematic review is clearly defined in detail beforehand. This makes all the stages of an SLR methodology transparent and reproducible. Reproducibility helps to establish a greater degree of confidence in the review.

In locating the studies, SLRs employ strict inclusion and exclusion eligibility criteria clarifying the primary studies for the review. This study used the Scopus database to locate and select the relevant studies for the SLR. This search engine was used to search for indexed peer-reviewed articles relating to firms' capabilities. Scopus was chosen because of its interdisciplinary citation focus and global coverage and

exposure to peer-reviewed articles when compared to other engines such as Web of Science and Google Scholar (Harzing & Alakangas, 2016). This helped in achieving a thorough search of all the available data on the topic, with the search criteria and keywords clearly specified and predefined. SLRs are exhaustive, considering every bit of evidence in synthesizing the outcome. The following keywords, capability, capabilities, technology, innovation, and framework were employed to search for published peer-reviewed articles focusing on firms' capabilities development, innovation, and capability frameworks.

The search aimed to obtain the maximum number of relevant articles that have the terms capability/capabilities, technology, innovation and framework in their titles, abstracts, or keywords. The first search employing the terms capability and capabilities produced 146 560 articles. With the inclusion of the term technology (capability, capabilities, technology) in the search string, the second search yielded 12 928 articles. A third search with the addition of the term innovation to the search string (capability, capabilities, technology, innovation) reduced the number of articles to 1258. A further refinement of the search with the addition of the term framework (capability, capabilities, technology, innovation, framework) to obtain more focused articles to answer the research question yielded 62 articles. The exclusion of conference papers and non-English language papers resulted in 37 peer-reviewed articles which informed this SLR.

The SLR processes are different from CLRs in that with CLRs the reviewer usually selects articles through keyword searches in the database and manually determines the relevant papers (Qian, Liu, & Yang, 2018 cited in Aboelmaged & Mouakket, 2020). This exposes the outcome to reviewers' biases, selection and interpretation. CLRs lack thoroughness and fall short of revealing 'hidden structures and properties of research domains.' (Khan, 2013). SLR lessens the limits of CLRs such as the lack of thoroughness, through systematic processes and assessments of literature in a transparent, reliable and replicable way that contributes to inheritable paradigms (Seuring & Gold, 2012 cited in Chiang et al., 2021).

The strength of SLRs' methodology does not mean that they are immune to errors. The reviews can be misleading if data is inappropriately handled or biased as a result of selective appropriation of sources. Biased methodological errors may bring about misrepresentation of outcomes, hence the failure to objectively reflect and report on the subject matter. This study addressed this challenge by establishing a clear eligibility criterion which the reviewer adhered to. The Scopus database employed has an interdisciplinary and global coverage with wide ranging citations, latest peer-reviewed studies and sources (Harzing & Alakangas, 2016).

This study employed keyword analysis and thematic content analysis to make sense of the information from the reviewed articles/studies concerning firms' capabilities development. In some cases, the objectivity of SLRs is limited due to selective reporting. This happens when the reviewer only reports on outcomes that suits his/her interests, hence a biased and misleading interpretation of evidence outcomes on the subject matter. This study was careful to consider and synthesise all views from the reviewed articles concerning the subject matter.

### 3.1. Keyword analysis

Keywords are the 'central poles' of a research article (Su & Lee, 2010). They reflect the subject matter of research articles (Uddin & Khan, 2016). Keywords epitomise authors' thematic understanding of their work within their research field and enable the researchers to discover and research themes, interests, methodologies etc., (Uddin & Khan, 2016). This study collected keywords from the selected 37 articles and examined research topics and themes - emerging and those fading with time.

### 3.2. Thematic content analysis

This involves a thorough reading of the texts, noting down key ideas to become familiar with the content and subject area; identification of the recurring themes; rearrangement of data according to emerging themes and the mapping and interpretation of data. Thematic content analysis has been articulated by Braun and Clarke (2006). The final product of this paper is an exegetical analysis and alignment of themes emerging from both keywords and thematic content analysis.

## 4. Findings and discussion

The findings and discussion sections provide a summary of the studies and a synthesis of all the results. These are discussed under the following themes: Technological capabilities; Supply and value chain capabilities; Networking, Collaborative, Interactive, Coordinating and Alignment Capabilities; Organisational capabilities and lastly System capabilities and the proposed framework.

### 4.1. Technological capabilities

Technology is 'the effective and efficient application of the accumulated know-how, knowledge, skills, and expertise that will result in the input of value-added products, processes and services.' (Du Pre, 2010). A firm's technological capabilities pertain to its ability to effectively use technological knowledge (Kim, 1999). Organisational performance and innovativeness are determined by the level of interaction between human capital and technology (Marchiori, Rodrigues, Popadiuk, & Mainardes, 2022). Several keywords highlighted in reviewed articles point to the centrality of technology and technological capabilities in building a firm's competitive competencies. Some of these keywords point to distinctive technologies and their functions, and others to processes in accessing technologies hence capacity building or enhancing processes. Among the identified keywords are technological capability (Zang & Li, 2017); technology adoption (Kumar et al., 2020); collaborative technologies (Schneckenberg, Truong, & Mazloomi, 2015); technology transfer (Fu, Pietrobelli, & Soete, 2011); Technology-organisation-environment framework (TOE) (Kim, Hebeler, Yoon, & Davis, 2018), information communication technology (ICT) (Chiang et al., 2021), digitalization, digital transformation, industry 4.0 (Annarelli, Battistella, Nonino, Parida, & Pessot, 2021); big data analytics (Aboelmaged & Mouakket, 2020); business analytics (Kumar et al., 2020), Resource- Based View (RBV) (Poon & MacPherson, 2005) etc. These keywords denote the centrality of technology in firms' transformation.

Terms such as technology transfers and technology adoption point to the how part of building technological capabilities. Most firms are far from the technological frontier, lacking the ability to produce their technologies, hence the need to adopt technologies. Scholars have identified issues regarding perceived usefulness, perceived ease of use, organisational innovativeness and data capabilities as some of the factors affecting an organisation's adoption of technology (Kim et al., 2018). Moreover, because of 'technological complexity' and 'technological dynamics' it is impossible for firms to produce or have all the knowledge and technologies required to maintain their competitive competencies (Bergek, Jacobsson, Hekkert, & Smith, 2010). Technological complexity implies the impossibility of firms possessing internally all the knowledge required for innovation (Bergek, et al., 2010). Technological dynamics imply that knowledge is dynamic and always changing in complex ways that cannot be comprehended in all dimensions by a firm (Bergek, et al., 2010). The concepts of technology adoption and technology transfer speak of the need for market intelligence regarding new technologies for adoption by firms to improve or maintain their core competencies. This calls for the need for firms and nations as systems to develop strategic intelligence infrastructure for discernment of technological interactions and opportunities, their

possible applications, and strategies for their actualisation. Firms have to develop the ability to evaluate and consider their core/host/general technologies with the capability to accommodate several other technologies and applications in the transformation of the firm's functions, processes, and products. This will allow firms to comprehend, 'how technologies interact, create and/or improve complex systems in which each component and system can continue to evolve in socio-ecological environments' (Coccia & Watts, 2020). This understanding will enable firms to maximise technological benefits by developing the criterion for assessing and choosing core technologies with the capacity to accommodate other technologies in ways that allow technological co-evolution and systems transformation.

#### 4.1.1. The technological transformation of firms

Zhou, Ping and Chimhowu (2019) noted that firm transformation occurs in three interrelated areas. These are: 1. technological capability/operation layer, 2) open innovation layer, and 3) actor-network layer. Transformation happens when a firm upgrades its operation mode and improves its skills in activities such as design, product development, branding and marketing (Kadarusman, 2010; Marchiori et al., 2022; Zang & Li, 2017). The stated activities are enhanced by technology applications and imply the importance of design, engineering, entrepreneurship and management (DEEM) skills. Chu (2009) noted the remarkable transformation of firms achieved by Chinese, South Korean, and Taiwanese firms based on building technological capabilities (Zhou et al., 2019a, 2019b). In their transformation process, South Korean firms developed their technological capabilities (Zhou et al., 2019a, 2019b). The Taiwanese firms transformed into Original Brand Manufacturers (OBM) based on creating the required capabilities (ibid). Zhou and Wu (2010a, 2010b) considered technological capability a critical element in product innovation.

Transformation happens through innovation hinged on knowledge accumulation and capability-building processes (Teece, 2007). Capabilities are an intangible asset in product development, a critical source of a firm's competitive advantages. Miao, Song, Lee, and Jin (2018) emphasised the firms' endogenous dynamics as critical in knowledge accumulation and capability-building processes. This is a case of closed innovation emphasising a firm's internal rather than external resources in capabilities development. Miao et al. (2018) East Asian firm-level studies specifically focused on firms' strategic choices in understanding technological capabilities.

However, Zhou et al. (2019a, 2019b) noted the importance of an integrated approach including exogenous factors on firms' technological capabilities. In their study of Rural Enterprises in China, they combined the capabilities view (Teece et al., 1997) and the actor-network theory to demonstrate the possibility by latecomers to leverage ICTs to transform and catch up through indigenous efforts in global value chains. ICTs enabled these enterprises to form supportive actor networks to leverage open innovation (Kim & Eom, 2019). Bergek et al. (2010), encourage firms to stay competitive by taking advantage of external opportunities to interact with foreign firms and learn towards knowledge frontiers, especially product knowledge and production skills. Technology assimilation goes with skills development hence the importance of national skills systems and systems of innovation to spur the innovative capabilities of firms (Borsi, 2021; Flores-Amador, 2014).

Chen et al. (2016) employed dynamic capabilities and global value chain perspectives focusing on technological and design capabilities to comprehend OEM survival strategies in global value chains. The localisation of knowledge learnt from global firms by local firms participating in global value chains leads to the development of indigenous firms' capabilities (Chew, Watanabe, & Tou, 2011). Eng and Spickett-Jones (2009) highlight cases of transformation from OEM to Original Design Manufacturers (ODM) and then to OBM with a competitive advantage based on product design, proprietary technology and brand equity (Zhou et al., 2019a, 2019b).

To improve the rate of returns in global value chains, firms in developing countries have to acquire design and branding capabilities (Zhou et al., 2019a, 2019b). The Resource- Based View (RBV) seeks to understand organisations' transformation based on asset accumulation. Thus, Poon and MacPherson (2005) employed the RBV to understand the role of technology acquisition in the transformation of Korean and Taiwanese firms in the USA. The need to acquire relevant technologies compels firms to build interactive capabilities as the basis for effective and profitable interaction with external players. Approaches stressing the role of exogenous factors acknowledge the importance of interactions to realise technological capabilities. Accordingly, Bergek et al. (2010), noted that technological knowledge is generated by interactive learning, and it takes the form of 'distributed' knowledge bases among different types of economic agents who must interact if it is to be applied. The interactive nature of technological knowledge means that firms have to build networking, collaborative, interactive, coordinating and alignment capabilities. This requires social skills which enable individuals to form linkages, work in a team and "induce cooperation among actors in an organisation or any other field" (Fligstein & McAdam, 2012). Developing interactive capabilities is critical as firms with higher levels of digital technology implementation can introduce more radical product innovations which yield higher returns (Blichfeldt & Faullant, 2021).

Technology adoption is a complex process that goes through various stages such as evaluation, adoption and assimilation (Kumar et al., 2020). Despite the importance of technologies such as Big Data (BD) and Business Analytics (BA) in understanding customer insights, improving decision-making, and automating business processes, improving customer experience, customising products, in transforming a business' analytical capabilities into a strategic position to enhance a firm's performance and develop a competitive advantage, many firms fail to apply or to derive benefits from BA and BD (Annarelli et al., 2021; Aboelmaged & Mouakket, 2020; Kumar et al., 2020). Firms fail to benefit from BA and BD mainly because of the lack of analytical skills by domain employees and the lack of domain knowledge among analytics professionals (Kim, et al., 2018). Bose (2009) identified organisational support, implementation of advanced analytics, regulatory environment and data privacy, technology skill gaps, and data availability as significant challenges in BA adoption (Kumar et al., 2020). However, current theoretical perspectives on BA adoption are still fragmented and there are only a few studies focused on comprehending diffusion processes (Aboelmaged & Mouakket, 2020; Atuahene, Kanjanabootra, & Gajendran, 2018). Scholars have noted the absence of studies explaining interactional relationships and the various stages of BA using different theoretical lenses (Kumar et al., 2020; Atuahene et al., 2018). Regarding sustainability capabilities, firms are concerned about technology applications to reduce wastage and improve supply chain efficiency and effectiveness by building smart logistics ecological chains (Liu et al., 2021). Sustainability capabilities concerning eco-innovation are a critical intangible resource enabling businesses to meet clients' expectations and maintain competitive advantages and business sustainability (Fernando, Jabbour, & Wah, 2019).

### 4.2. Supply chain (SC) capabilities

Supply chain management has become a critical source of value for many firms. Supply chains comprise suppliers, manufacturers, distributors and customers and the linkages and connexions between them (Liu et al., 2021). This network also includes the suppliers of complementary products/services, competitors, universities, research institutions, industry associations, regulatory agencies and government agencies (Liu et al., 2021).

Sustainable supply chain capabilities are based on a collaborative division of labour with network actors taking specialised responsibilities and creating value to achieve network goals (Chiang et al., 2021). Stevens and Johnson (2016) regards integration and collaboration as the key constructs concerning the supply chain capability (Chiang et al.,

2021). The coordination and management of supply chain logistics and information flows integrate the supply chain (Barut, Faisst, & Kanet, 2002 cited in Liu et al., 2021). The keywords: risk management, buyer-supplier relationship (Afraz, Bhatti, Ferraris, & Couturier, 2021) sustainable supply chain management (SSCM) and supply chain integration (Chiang et al., 2021) and organisational efficiency (Schneckenberg & Hamid 2015) speak to processes of chain integration for greater efficiency and effectiveness. These terms and concepts imply the need for networking, cooperation and collaboration. Supply chain integration encompasses the alignment, linkage and coordination of information flow, organisational knowledge, employee capability, business processes, and strategies across all points of the SC (Afraz et al., 2021; Stevens & Johnson, 2016 in Chiang et al., 2021). Integration improves collaboration between companies in a network and reduces environmental uncertainties (Lin, 2014 cited in Cassia et al., 2020). This integration accelerates efficient and effective flows of finance, products, information, and knowledge to meet customer requirements (Afraz et al., 2021). A good supply chain is thus hinged on interactive capabilities for cooperative relationships.

However, supply chain actors have to cultivate mutual trust and commitment with suppliers. Mutual trust tightens network actors' relationships which reduces information asymmetries, enabling the sharing of cost-reducing information (Chiang et al., 2021; Afraz et al., 2021). The inclusion of sectoral intermediaries such as research institutions and industry associations points to the importance of knowledge generation and university-industry interactions in addressing specific industrial issues. Further, government agencies and regulatory agencies spur supply chain innovations by monitoring, and enforcing institutions and standards to ensure compliance (Moon & Lee, 2023). The existence of various network players points to interactive capabilities as the basis for supply chain management capabilities. Interactive capabilities imply the capacity to form effective linkages with other organisations and use existing competencies to learn through interaction (von Tunzelmann & Wang, 2003).

Further, keywords like sustainable supply chain management (SSCM) (Chiang et al., 2021), supply chain innovation, and competitive advantage (Afraz, et al., 2021) point to the need for supply chains to address sustainability concerns concerning the carbon footprint through reverse logistics. Since production standards now consider sustainability issues, the legitimacy of firms' activities is partly linked to reducing the environmental impact of their production activities through lessening the demand for materials by recycling materials (Adhikari & Momaya, 2021; Zoo, de Vries, & Lee, 2017). This requires firms to develop adaptive and sensing capabilities. Because of adaptive and sensing capabilities, LG Electronics complies with international regulations on hazardous substances including the Restriction of Hazardous Substances (RoHS) and Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) (Moon & Lee, 2023). LGE has operated a supply chain green management program, Green Program Plus, to monitor hazardous substances in their supply chain (Moon & Lee, 2023). Chiang et al. (2021) realised the importance of reverse logistics to reduce environmental impact by using the residual value of consumed products. Paula, Campos, Pagani, Guarnieri, and Kaviani (2019) suggested that reverse logistics should be considered throughout the product lifecycle to minimise the environmental impact of product design, storage, delivery and recycling (Chiang et al., 2021). Sustainability capabilities are a competitive asset especially now that customers consider sustainability issues particularly the chain of custody in their consumption activities (Adhikari & Momaya, 2021). Social and environmental issues have thus become important antecedents for product innovation (Munoz--Pascual, Curado & Galende, 2019).

Further, keywords like a smart-logistics ecological chain, technological innovation capability (Schneckenberg & Hamid 2015), and supply chain innovation (Afraz et al., 2021) point to technological applications as critical in building supply chain capabilities. It is the application of smart technologies that differentiate smart logistics ecological chains from traditional supply chains. Interactive capabilities including networking, coordination, integration etc., constitute an ensemble of capabilities required in building smart-logistics ecological chains. Smart logistics differ from traditional supply chains because they rely on a variety of technologies for rapid, efficient and accurate responses to the changing customers' needs (Liu et al., 2021). Innovative technologies such as human machines, cloud computing and the internet, interconnect the elements of an ecological supply chain (Liu et al., 2021). Moreover, the service capability of smart logistics ecological chains is different from that of traditional transportation and warehousing. Smart logistics ecological chains depend on big data and innovative technologies to provide customers with complex and more integrated types of services. These capabilities are built and honed by responding proficiently to internal and external environments. The internet has also enabled e-commerce and online shopping (Zang & Li, 2017). There is room for improving e-supply chain innovations to enable fast service and efficient management of multiple channels to satisfy online shopping (Daugherty, Bolumole, & Grawe, 2019 cited in Chiang et al., 2021).

### *4.3. Networking, collaborative, interactive, coordinating and alignment capabilities*

Integration is critical for national economic development. The integration of an industrial system or a skills system facilitates interaction between the components of a system of innovation as the basis for collaboration, partnerships, and networks, enabling the sharing of knowledge and the application of technologies. Integrative interactions are hinged on the recognition that learning within individual firms and a network of firms alongside other organisations comprises the new basis for competitiveness and growth in the global economy (Bergek et al., 2010; Schneckenberg et al., 2015). Collaborating with other firms and actors in networks aids learning (Colli, Stingl, & Waehrens, 2022). The lack of integration in a sector hinders collaboration in learning, hence the diffusion of knowledge and technologies. Without considering factors that affect the organisational efficiency of the system for efficient and low-cost logistics services, constructing a smart logistics ecological chain is impossible (Liu et al., 2021). Innovative and integrative technologies facilitate interactions among stakeholders in smart logistics supply chains (Annarelli et al., 2021; Atuahene et al., 2018).

Regarding knowledge generation and transfers, MacLaughlin and Scott (2010) noted the importance of learning by interacting and shared learning processes among stakeholders, manufacturers, industry associations, universities, and users. This kind of cooperation is based on dissimilar resource advantages and interests of diverse subjects (Matsumae & Nagai, 2017 cited in Hong and Lin (2022). It enables the pooling of resources and reduces information asymmetries, market distortions and transaction costs hence collective organisational and network efficiency (Mushangai, 2020). In the triple helix of industry, academia and government, universities provide rich R&D resources, equipment and talent and facilitate firms' access to university research and discoveries (Mushangai, 2020). By cooperating with the industry, universities secure funding for graduate students, lab equipment and insights regarding the implications of their research. This cooperative model can increase the innovation levels and competitive advantages of enterprises. In China, the turnover of granted patents and technology contracts increased by 31.9 and 35.32 times from 2001 to 2020 respectively because of the entrenchment of collaborative relationships (Scandura, 2016 cited in Hong & Lin, 2022). These collaborative industrial capabilities promote national and regional innovation and the reform of national systems of innovation.

Within the integrative learning framework, MacLaughlin and Scott (2010) noted how skills and efficiencies are gained over time in manufacturing through a combination of practical experience and trial and error (i.e., learning by doing groups). This is a reference to the importance of tacit knowledge which is sticky and cannot be transferred

in the same way as codified knowledge from colleges and universities. Innovation in a firm is mainly a result of incremental processes and product innovation hinged on the doing, using and interacting (DUI) mode of innovation (Jensen, Johnson, Lorenz, & Lundvall, 2007). At an industrial level, this can be promoted through industrial clusters. Clusters as localised innovation networks allow for interactive learning to take place (Liu et al., 2021). Proximity in clusters enables firms to learn from each other through observation, comparing and imitation. In their investigation of how SMEs in one of the poorest regions in eastern China entered a competitive market, Huang, Zhang, and Zhu (2008) noted clustering was critical in deepening the division of labour in the production process and made it possible for SMEs to enter the industry by focusing on a narrowly defined stage of production (Zhou et al., 2019a, 2019b).

Zhou et al. (2019a, 2019b) study of firms' transformation in China indicates the criticality of networking, collaboration and interactive capabilities for firms to acquire the knowledge, skills and technologies required for upgrading. The usual upgrading route is from the Original Equipment Manufacturer to Original Design Manufacturer and then Original Brand Manufacturer (Mitsuhashi, 2006). OEM firms produce products under another firm's brand name. ODMs operate like OEMs but also design their clients' products. An OBM produces and sells products with its brand (Mitsuhashi, 2006). Because of networking capabilities, firms in Hong Kong were able to optimise the value-creation process and increase profit levels by investing in manufacturers run by their relatives in mainland China (Zhou et al., 2019a, 2019b). This enabled them to build research and development capabilities. Joint ventures with Chinese firms enabled Hong Kong firms to acquire capabilities to transform from OEMs to OBMs.

Singaporean firms transformed from OEMs to OBMs by relying on foreign direct investments (Brown, 1998 cited in Zhou et al., 2019a, 2019b). Also in China, the liberal economic reforms starting in the 1980s opened Chinese firms' access to foreign markets, capital, and technologies (Gao & Yu, 2010 cited in Zhou et al., 2019a, 2019b). Chinese OEM firms' networks grew as MNCs relied on them to access the Chinese market. In these interactive processes, the Chinese firms acquired capabilities that empowered them to burst out of the low-end OEM cul-de-sacs. For instance, Lenovo merged with IBM's personal computers division and acquired design capabilities (Luo & Chang, 2011 cited in Zhou et al., 2019a, 2019b). Konka, which started as an OEM contractor, successfully upgraded its capabilities to produce branded products for the Chinese domestic market. Konka grew to become a major player in consumer electronics (Lee, Jee, & Eun, 2011 cited in Zhou et al., 2019a, 2019b).

In Guangdong near Hong Kong and Fuji near Taiwan, China's liberal reforms attracted foreign investments (Berger & Lester, 1997). The reforms enabled the provinces to develop close relations with overseas markets and attract foreign investments (Zhou et al., 2019a, 2019b). These interactive processes permitted local firms to participate in global value chains and to be subjected to rigorous international standards concerning scale, scope, speed and sustainability economies. OEMs upgrade and transform to ODM and OBM and catch up in global value chains by acquiring key product knowledge and production skills from firms in/from knowledge-rich countries (Mitsuhashi, 2006).

Knowledge acquisition, transfers and profiting from external knowledge and innovations are critical activities capacitating firms' decision-making processes to sustain competitive advantages in rapidly changing markets. These interactions improve an enterprise's Absorptive Capacity (AC) to detect new knowledge, identify its value and use it at all levels (Aboelmaged & Mouakket, 2020). AC is a dynamic capability vital in identifying and evaluating the potential value of external knowledge and its assimilation as a firm's asset (Zahra & George, 2002). Interactions with external actors compel local firms to develop sensing, seizing and reconfiguring capacities by coordinating internal resources and aligning with external resources to adapt new modes of operation (OEM to OBM). According to Teece (2007), sensing opportunities, seizing opportunities, and the reconfiguration and recombination of competitive assets are firm-level capacities that combine to form dynamic capabilities which sustain superior performance in rapidly changing environments (Schneckenberg et al., 2015).

Interactive collaborative relationships in networks with external stakeholders and competitors are an essential dynamic capability for open innovation (Liu et al., 2021; Cassia et al., 2020). Open innovation relies on interactive collaborative relationships which expose participating firms to external knowledge, innovation and drivers of change (Cassia, et al., 2020; Teece, 2007). Open innovation is critical in building the capabilities of firms with limited resources. It reduces the money and time spent on R&D processes by leveraging the knowledge, creative potential and workforce of external actors (Newton et al., 2010 in Keinz & Marhold, 2021). However, open innovation requires firms to understand absorptive capacity. This dynamic capability is generated by the managerial and knowledge-based routines in a firm (Lichtenthaler & Lichtenthaler, 2009 cited in Schneckenberg et al., 2015). It is a capability required even in intra-firm knowledge transfers concerning the interactive and absorptive capacity of a firm's subunits (Aboelmaged & Mouakket, 2020).

Nonetheless, challenges exist in networks and hinder open innovation, particularly for start-ups. Most start-ups begin from a position of sufferance and asymmetrical power dynamics in networks of collaborators inhibit upgrading by small enterprises (Mitsuhashi, 2006). Disadvantaged firms confront challenges related to the lack of resources, risk of technology misappropriation, lack of credibility and market reputation when adopting open innovation practices. These challenges can be addressed partly by building strong national systems of innovation that enforce standards and support SMEs' skills acquisition to improve their ability to evaluate, adopt and assimilate technologies (Zoo et al., 2017; Goedhuys & Srholec, 2015). This would enhance SMEs' organisational capabilities.

### 4.4. Organisational capabilities

According to Porter (1981), organisational resources critical in the implementation of strategies constitute the axioms of a firm's strength (Kumar et al., 2020). Organisational resources and capabilities are mainly a result of learning and knowledge accumulation (Teece et al., 2000). Since the 1990s the dynamics of firms' competition have radically been changed by globalisation and the rise of the knowledge economy. The knowledge economy is focused on scientific knowledge as the primary source of value creation (Kahin & Foray, 2006). Globalisation and the growth in knowledge generation, dissemination and application since the 1990s as facilitated by ICTs increased the speed of corporate innovations and accelerated product life cycles to meet ever-changing customer partialities thereby impacting firms' diversification strategies (Kahin & Foray, 2006).

Innovation capabilities are largely founded upon the creation and combination of knowledge (Schneckenberg et al., 2015) and MNCs are able to tap into and combine knowledge from various sources across the globe. Innovative organisations are more dependent on high-level scientific and technological knowledge whose sources are geographically dispersed across the globe (Chandler, 1992; Teece, 2000). Competitive advantages in dynamic environments require organisations to constantly apply their stocks of integrated knowledge to keep ahead of other firms. Successful knowledge management and organisational learning practices are therefore vital for efficient corporate innovation performance enabling a firm to leverage successful new products and service offerings in the markets (Schneckenberg, Truong & Mazloomi, 2015). Concerning knowledge as the basis of innovative capabilities, firms have to develop intra-firm interactive capabilities embedded in individuals, teams or business units to enable knowledge flows through the entire organisation (Begerk et al., 2010; Goedhuys & Srholec, 2015; Marchiori et al., 2022). These flows foster organisational learning and integration and enhance the organisation's absorptive capacity to adapt

to changing environments. Effective organisational management facilitates knowledge sharing among employees as individuals and in business units.

Knowledge sharing in an organisation especially MNCs is made difficult by the geographical dispersion of business units (Schneckenberg et al., 2015). This challenge makes it difficult to achieve the top management's vision of a knowledge-sharing culture in an organisation. The knowledge management and sharing processes of an organisation are embedded in organisational and managerial structures, systems, processes and procedures which constitute the micro-foundations of a firm's capabilities (Teece et al., 1997). Innovation largely results from interaction and interdependencies between micro-foundations (Schneckenberg et al., 2015). Scholars are thus investing in locating and understanding the origins, creation and development, and reproduction and management of collective constructs such as routines and capabilities as sources of dynamic capabilities (Schneckenberg et al., 2015). The Knowledge-Based-View (Teece, 2000) regards the main purpose of the firm as coordinating and combining knowledge.

The interest in understanding the link between knowledge and firms' organisational capabilities has led to three main streams of literature. These are 1. Organisational Learning Literature (OGL) 2. Knowledge Management Literature (KML), and 3. Literature integrating OGL and KML. These 3 strands are discussed below.

#### 4.4.1. *Organisational Learning Literature*

Organisational learning approaches are interested in how firms create, retain, and transfer knowledge. Knowledge is a result of individual learning and is embedded in individuals but also stored in several repositories. Since individuals are the primary source of knowledge, the challenge for an organisation concerns the transfer of the individual's knowledge to the organisation (Argote & Ingram, 2000 cited in Schneckenberg et al., 2015).

OGL regards learning as critical for organisations to transform and adjust their knowledge and processes for functional, process or product innovations. Through interactions, the newly acquired knowledge is integrated into the firm's organisational culture and network, and stored in organisational processes and technologies (Schneckenberg et al., 2015). This strand identifies the stickiness of knowledge (especially tacit knowledge); the embeddedness of knowledge in individuals and business units; the lack of prior learning in receiver units; and the lack of motivation on the transferring part as the main challenges regarding knowledge flows. OGL lacks explanatory power regarding the conditions and contexts allowing for efficient knowledge creation, sharing, and application (Schneckenberg et al., 2015).

#### 4.4.2. *Knowledge Management Literature*

Regarding knowledge as a corporate resource, KML enquires into contexts and conditions, allowing for the combination, recombination and coordination of knowledge assets for efficient application (Grant, 1996). KML is mainly concerned with organisational knowledge retention and preventing organisational loss of memory. The literature articulates how to renew and upgrade individual and team memory (Schneckenberg et al., 2015). KML is technology-oriented, focusing on developing technological systems for storing, exchanging and retrieving an organisation's information and knowledge. (Schneckenberg et al., 2015).

KML's technological orientation is two pronged, that is a focus on integrative technologies and on interactive technologies. Integrative technological solutions are systems that enable the storage and retrieval of information and knowledge. These systems facilitate management strategies by enabling the accessibility of previous lessons and best practices to all in the organisation (Schneckenberg et al., 2015). The interactive aspects of KML focus on applications which enable the users to network, interact, exchange and collaborate in knowledge management platforms (Schneckenberg et al., 2015). The emphasis is on knowledge sharing and integration, hence the need for collaboration within and across organisational boundaries in 'communities of practice' (Brown & Duguid, 2001; Wenger & Snyder, 2000) in addressing issues of common interest. Interactive technologies are transforming firms and communities of practice enabling stakeholders to interact and share irrespective of geographic dispersion. In these interactive processes, inimitable tacit capabilities and competencies are built and developed, enabling firms to operate in newly diversified fields of the economy.

Integrative and interactive technologies are aspects of innovative capabilities which enable a firm to absorb new products, employ new technologies, and to configure and reconfigure organisational resources regarding market conditions (Lin, 2014 in Cassia et al., 2020). Their interaction with human resources forms the basis of the socio-technical approaches to innovation. KML has contributed to designing and implementing systems for the storage, easy retrieval, and sharing of knowledge and information in organisations. KML does not extend to consider the micro foundations of capabilities such as organisational routines.

The limitations of OGL and KML have led to a strand of literature focusing on the micro-foundations of firms' dynamic capabilities. This literature combines tenets from OGL and KML to explain the development of strategic *routines* and capabilities enabling rapid responses by firms to maintain competitive advantages in changing environments (Schneckenberg et al., 2015). But why routines?

Routines are a crucial collective organisational stratagem to develop cognition (Amin & Cohendet, 2000). Routines enable firms to reproduce action sequences stored in localised or distributed forms. They are an aspect of organisational memory embodying successful solutions to past problems (Aboelmageda & Mouakket, 2020). The solutions constitute an asset to be retrieved and implemented whenever the organisation is confronted by a similar problem. Routines are however contextually tied and difficult to transfer. They can only be retrieved for collective action in particular contexts (Amin & Cohendet, 2000).

Although managerial and knowledge-based routines are considered the process elements of absorptive capacity as a dynamic capability (Teece, 2007), when institutionalised are difficult to change and can become the source of organisational apathy or lock-ins. Nevertheless, routines can be changed through experimentation and learning because learning changes and modifies knowledge (Amin & Cohendet, 2000). This is a requirement for continuous learning within a firm to develop new skills to explore and exploit knowledge and opportunities for the benefit of the organisational learning environment. Interactions between and within firms involve the exchange of knowledge, skills and experiences of their employees, critical in strengthening firms' routines (Cassia et al., 2020). Learning creates a dynamic allowing firm to develop sensing capabilities to identify threats and opportunities and seize opportunities and reconfigure their resources in responding to emergencies in the operational environment. This is critical because in a globalised economy, the greatest value added in production is increasingly a result of scientific knowledge application and the ability to absorb new technologies and work organisational techniques, to introduce new functions, processes and products (Chiang et al., 2021; Bergek et al., 2010).

### 4.5. *Systems' capabilities*

Strong systems of innovation are critical for national economic development. Systems of innovation are made up of skills and knowledge-producing organisations (theory), institutions (policy) and firms (practice). The focus is on integration, coordination and interaction of people in the organs forming these three components in skills production, knowledge generation, transfer and application to improve organisational productivity in building national economies. Skills and education systems are at the centre of systems of innovation. Education is the foundation of social capabilities (Abramovitz, 1986 cited in Goedhuys & Srholec, 2015). Skills systems generate the requisite skills

required by firms to spur their innovation activities. The availability of research infrastructure like universities, universities of technology, TVET colleges, R&D labs and a pool of researchers in the labour force, reduces costs and uncertainties associated with firms' innovative activities (Goedhuys & Srholec, 2015). The quality of national research institutions is therefore critical in the development of local firms' capabilities (Zhou et al., 2019a, 2019b; Fu et al., 2011). Strengthening systems of innovation can narrow the productivity gap between domestic and foreign firms as local firms' absorptive capabilities depend on enabling domestic technological infrastructure (Goedhuys & Srholec, 2015). Systems' capabilities are also crucial for technology foresight in an economic system (Hassanzadeh, Namdarian, Majidpour, & Elahi, 2015). This is critical in discerning technological trends.

#### 4.5.1. Institutions

Institutions are critical for economic activities because 'governance matters' (Kaufmann, Kraay, & Mastruzzi, 2009). Institutions are defined as the laws, regulations, and other cognitive, cultural, or socio-structural constraints in the context of the government and constraints regarding individuals or organisation's economic activities (Lassinanttil, Bergvall-Kåreborn, & Ståhlbröst, 2014 cited in Kim and Eom, 2018). The quality of governance regarding effectiveness, voice, and accountability; political stability and peace; regulatory quality; rule of law; and control of corruption, all affect business environments and firms' decisions (Goedhuys & Srholec, 2015). Governments are critical in formulating and enforcing regulations, production standards, arbitration and the resolution of disputes within an economic system. Institutions guide firms' economic activities. For example, IRP institutions guide the sharing of intellectual property between partners in collaborative research activities.

Standards institutions may compel firms to upgrade their production activities to ensure compliance. Institutions influence firms' operational environments and moderate technological innovations in ways that reduce moral hazards by compelling firms to be ethical. For example, institutions governing genetically modified organisms or the handling of nuclear substances compel firms to regard environmental laws. A disregard for institutions and ethics may result in organisations getting banned or losing licences to operate. Organisational actors comply with institutions to acquire legitimacy in their fields (Kim & Eom, 2019; Zoo et al., 2017). Interaction between the regulators and firms increases firms' legitimacy, risk management capabilities, and knowledge of regulatory frameworks (Alaassar, Mention, & Aas, 2020). Limited interactions negatively affect both the regulators and the regulated due to lowered trust and discrepancies in underlying goals and expectations (Alaassar et al., 2020). Thus, a firm's innovation activities cannot be purely understood in terms of independent decision-making at the firm level (as implied by Miao et al., 2018) as the firm's options are determined by environmental factors and collaborative patterns, regulatory systems and customary practices that influence how innovations occur (Bergek et al., 2010). Institutions compel firms to build and develop compliance capabilities to legitimise their activities.

#### 4.5.2. Interactions

The strength of the systems of innovation approach is hinged on interactions in knowledge generation, technology transfers and application (Flores-Amador, 2014; Flores et al. (2008), Fu et al., 2011). National systems of innovation encourage interactions between the government, firms and skills organisations in addressing the skills and technological needs of firms (Goedhuys & Srholec, 2015). The Triple Helix concept denotes interactions between the government, industry, and knowledge and skills organisations, interactions critical in building the capabilities of organisations (Borsi, 2021). Interactions and human relationships are the glue, holding together the economic system. Brokers and technology transfer intermediaries (TTI) facilitate interactive relationships by scouting for relevant technologies nationally and internationally, facilitating networks, partnerships, collaboration and deal-making and technology transfers (Palaco, Kim, Park, & Rho, 2022). Their role in a system of innovation is critical in assisting organisations to identify, select, acquire and exploit relevant technologies. Effective national systems facilitate interactions with the international community, allowing local firms and organisations to tap into international knowledge and technology (Zhou et al., 2019a, 2019b; Gachino, 2010).

The emphasis on interactions is hinged on the emerging understanding that firms do not innovate in isolation but interact with other organisations in the system at regional, sectoral, national, and supranational levels. Thus, innovation can no longer be the privilege of a mastermind discoverer operating alone in isolation but a multi-actor activity in a system of innovation. Interactions and networks are the reasoning behind industrial clusters such as industrial parks, processing zones etc. The interactive dynamics of firms' capabilities formation call for an encompassing interactive capabilities framework. Below is a type of such framework.

## 5. The proposed model framework

A deduced framework in Fig. 1 acknowledges interactions at all levels - the macro, mezzo and micro firm-level in understanding the firms' capabilities development and the importance of feedback loops in generating knowledge. The macro-supranational level is critical in understanding international trends and drivers of change, the role of FDI and MNCs in knowledge and technology diffusion, and international standards monitored and enforced by global organisations (Zoo et al., 2017). Local firms have to interact with global players in international networks like global value chains to acquire knowledge and technologies to meet global production standards (Adhikari & Momaya, 2021; Zoo et al., 2017). The mezzo national environment is critical regarding investments in R&D and skills development, infrastructure development, standards, ethics and institutions, and establishing intermediaries, networks, and industrial clusters to encourage learning and capability building.

The national system is also important in creating a business environment that attracts foreign investments and in promoting sustainable development (e.g., through fighting corruption; violence etc.). Firm-level dynamics (interactive capabilities - internal and external learning, integrative and coordination capabilities; absorptive capabilities; adaptive capabilities; innovative capabilities; compliance capabilities) are still critical and firms have to invest in organisational learning, and knowledge management to build their absorptive capabilities, interactive capabilities, integrative capabilities and innovative capabilities.

## 6. Conclusion

This paper reviewed the literature on firms' capabilities, identifying several capabilities and answering the question: How can firms build and develop their capabilities as the basis of their competitive competencies? It discussed many capabilities of firms and the processes by which they are developed such as interaction in local and global networks and value chains, mergers and acquisitions, skills development within the national skills systems, and FDI. The paper considers both factors endogenous and exogenous to the firm as critical in capabilities building and development.

The paper took note of the frameworks that are currently employed in understanding and developing firms' capabilities. Among these are the actor-network theory, the dynamic capabilities framework, the diffusion of innovation theory, the Resource-Based View and the Technology-Organisation-Environment Framework. These frameworks are critical but limited to specific views regarding firms' capabilities formation. This paper was generative and produced a prototype of firms' capabilities framework which seeks to overcome the limited and fragmented nature of the current frameworks by emphasising interactions at global, national and firm levels as the basis for knowledge and

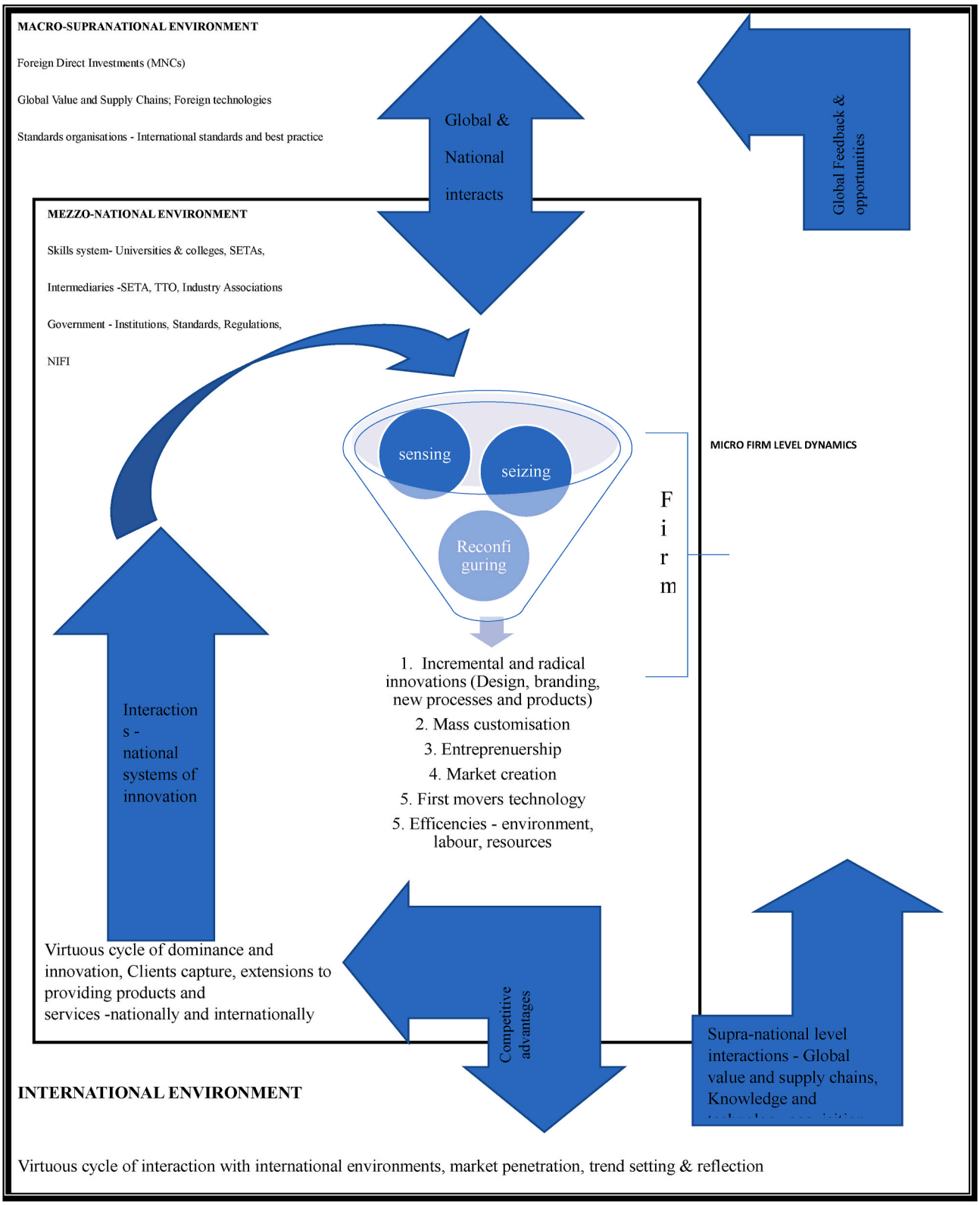



**Fig. 1.** Capabilities framework model.

technology flows critical in firms' capabilities development. The prototype is hinged on interactions, collaboration, and networks as conceptions guiding capabilities' formation processes at the supra-national macro levels, the mezzo-national levels and the micro-firm levels. This framework will be applied to test its validity. The feedback mechanism from the application processes will enhance its explanatory power as a dynamic capabilities' framework.

Future research should however focus on empirical studies on building and validating frameworks emphasising macro, mezzo, and firm-level dynamics in building capabilities for competitiveness of nations and firms. Since most of the frameworks neglect SMEs' capabilities development, future studies should also focus on applying this new

interactive framework to validate its facilitative role in building SMEs' social capital and participation in open innovation networks. Further, studies would be required to understand how systems of innovation may be employed in understanding technological interactions and the evolution of technologies within an economy.

## Declaration of competing interest

My researches interests are in development studies, development economics, systems of innovation, post school education studies, economic history. Currently I am researching on capabilities formation of firms in the South African engineered wood construction sector.

## Acknowledgement

The study was funded by the Department of Research and Innovation (University of Pretoria) and York Timbers - South Africa.

## References

Aboelmaged, M., & Mouakket, S. (2020). Influencing models and determinants in big data analytics research: A bibliometric analysis. *Information Processing & Management, 57*(4). https://DOI:10.1016%2fj.ipm.2020.102234.

Abramovitz, M. (1986). Catching up, forging ahead, and falling behind. *The Journal of Economic History, 46*(2), 386–406.

Adhikari, P., & Momaya, K. S. (2021). Innovation capabilities, environmentally sustainable practices and export competitiveness: An exploratory study of firms from India. *International Journal of Innovation and Technology Management, 18*(6). https://DOI:10.1142/S0219877021500035.

Afraz, M. F., Bhatti, S. H., Ferraris, A., & Couturier, J. (2021). The impact of supply chain innovation on competitive advantage in the construction industry: Evidence from a moderated multi-mediation model. *Technological Forecasting and Social Change, 162*. https://DOI:10.1016/j.techfore.2020.120370.

Ahmed, N. M. (2010). *A user's guide to crisis of civilisation: And how to save it*. London and New York: Pluto Press.

Alaassar, A., Mention, A. L., & Aas, T. H. (2020). Exploring how social interactions influence regulators and innovators: The case of regulatory sandboxes. *Technological Forecasting and Social Change, 160*. https://DOI:10.1016/j.techfore.2020.120257.

Amin, A., & Cohendet, P. (2000). Organisational learning and governance through embedded practices. *Journal of Management & Governance, 4*, 93–116.

Annarelli, A., Battistella, C., Nonino, F., Parida, V., & Pessot, E. (2021). Literature review on digitalization capabilities: Co-Citation analysis of antecedents, conceptualization and consequences. *Technological Forecasting and Social Change, 166*. https://DOI:10.1016/j.techfore.2021.120635.

Argote, L., & Ingram, P. (2000). Knowledge transfer: A basis for competitive advantage in firms. *Organizational Behavior and Human Decision Processes, 82*(1), 150–169.

Atuahene, B. T., Kanjanabootra, S., & Gajendran, T. (2018). Towards an integrated framework of big data capabilities in the construction industry: A systematic literature review. In *Proceeding of the 34th annual ARCOM conference, ARCOM 2018* (pp. 547–556). https://www.scopus.com/inward/record.uri?eid=2-s2.0-85055652067.

Auer, P., Besse, G., & Meda, D. (2006). Offshoring and the internationalization of employment: Introduction. In P. Auer, G. Besse, & D. Meda (Eds.), *Offshoring and the internationalization of employment: A challenge for a fair globalization?* (pp. 1–17). International Institute for Labour Studies (ILO).

Barut, M., Faisst, W., & Kanet, J. J. (2002). Measuring supply chain coupling: An information system perspective. *European Journal of Purchasing & Supply Management, 8*(3), 161–171.

Bergek, A., Jacobsson, S., Hekkert, M., & Smith, K. (2010). Functionality of innovation systems as a rationale for and guide to innovation policy. In E. Smits, S. Kuhlmann, & P. Shapira (Eds.), *The theory and practice of innovation policy* (pp. 115–144). Edward Elgar Publishing, Inc.

Berger, S., & Lester, R. K. (1997). *Made by Hong Kong*. Oxford, UK: Oxford University Press.

Blichfeldt, H., & Faullant, R. (2021). Performance effects of digital technology adoption and product & service innovation: A process-industry perspective. *Technovation, 105*(7). https://DOI:10.1016/j.technovation.2021.102275.

Borsi, B. (2021). The balanced state of application-oriented public research and technology organisations. *Science and Public Policy, 48*(5), 612–629. https://DOI:10.1093/scipol/scaa071.

Bose, R. (2009). Advanced analytics: Opportunities and challenges. *Industrial Management & Data Systems, 109*(2), 155–172.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://DOI:10.1191/1478088706qp063oa.

Brown, R. (1998). Electronics foreign direct investment in Singapore: a study of local linkages in "Winchester City". *European Business Review, 98*(4), 196–210.

Brown, J. S., & Duguid, P. (2001). Knowledge and organization: A social-practice perspective. *Organisation Science, 12*(2), 198–213.

Cassia, A. R., Costa, I., da Silva, V. H. C., & de Oliveira Neto, G. C. (2020). Systematic literature review for the development of a conceptual model on the relationship between knowledge sharing, information technology infrastructure and innovative capability. *Technology Analysis and Strategic Management, 32*(7), 801–821. https://DOI:10.1080/09537325.2020.1714026.

Ceglinski, P. (2020). The relations between dynamic capabilities and core competencies on the case of polish companies. *Administrative Sciences, 10*(48). https://DOI:10.3390/admsci10030048.

Chakona, G., & Mushangai, D. (2021). Understanding the food crises in southern Africa and the ways of transitioning the food systems to combat hunger. In *Working paper. Centre for researching education and labour – university of the witwatersrand/ environmental research learning centre – rhodes university*. https://figshare.com/articles/book/Understanding_the_food_crises_in_southern_Africa_and_the_ways_of_transitioning_the_food_systems_to_combat_hunger_pdf/21681176.

Chamshama, S. A. O., & Nwonwu, F. O. C. (2004). *Forest plantations in sub-saharan Africa. A report prepared for the project: Lessons learnt on sustainable forest management in Africa*. FAO.

Chandler, A. D., Jr. (1992). Managerial enterprise and competitive capabilities. *Business History, 34*(1), 11–41. https://DOI:10.1080/0007679920000000.

Chen, D., Wei, W., & Hu, D. (2016). Survival strategy of OEM companies: A case study of the Chinese toy industry. *International Journal of Operations & Production Management, 36*(9), 1065–1088.

Chew, M. Y. C., Watanabe, C., & Tou, Y. (2011). The challenges in Singapore NEWater development: Co-Evolutionary development for innovation and industry evolution. *Technology in Society, 33*(3–4), 200–211. https://DOI:10.1016/j.techsoc.2011.06.001.

Chiang, C. T., Kou, T. C., & Koo, T. L. (2021). A systematic literature review of the it-based supply chain management system: Towards a sustainable supply chain management model. *Sustainability, 13*(5), 1–18. https://DOI:10.3390/su13052547.

Chu, W.-W. (2009). Can Taiwan's second movers upgrade via branding? *Research Policy, 38*(6), 1054–1065. https://doi.org/10.1016/J.2008.12.014

Coccia, M., & Watts, J. (2020). A theory of the evolution of technology: Technological parasitism and the implications for innovation management. *Journal of Engineering and Technology Management, 55*, Article 101552.

Colli, M., Stingl, V., & Waehrens, B. V. (2022). Making or breaking the business case of digital transformation initiatives: The key role of learnings. *Journal of Manufacturing Technology Management, 33*(1), 41–60. https://DOI:10.1108/JMTM-08-2020-0330.

Correia, M. S. (2019). Sustainability: An overview of the triple bottom line and sustainability implementation. *International Journal of Strategic Engineering, 2*(1), 29–38.

Daugherty, P. J., Bolumole, Y., & Grawe, S. J. (2019). The new age of customer impatience: An agenda for reawakening logistics customer service research. *International Journal of Physical Distribution & Logistics Management, 49*, 4–32.

Du Pre, R. (2010). Universities of technology in the context of the South African higher education landscape. *Kagisano, 7*.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal*, (21), 1105–1121.

Elahi, E., Khalid, Z., Tauni, M. Z., & Zhang, H. (2022a). Understanding farmers' intention and willingness to install renewable energy technology: A solution to reduce the environmental emissions of agriculture. *Applied Energy, 129*, Article 118459. https://doi.org/10.1016/japenergy.2021.118459

Elahi, E., Khalid, Z., Tauni, M. Z., Zhang, H., & Lirong, X. (2022b). Extreme weather events risk to crop-production and the adaptation of innovative management strategies to mitigate the risk: A retrospective survey of rural Punjab, Pakistan. *Technovation, 117*, Article 102255. https://doi.org/10.1016/j.technovation.2021.102255

Eng, T. Y., & Spickett-Jones, J. G. (2009). An investigation of marketing capabilities and upgrading performance of manufacturers in mainland China and Hong Kong. *Journal of World Business, 44*(4), 463–475. https://doi.org/10.1016/j.jwb.2009.01.002

Fernando, Y., Jabbour, C. J., & Wah, W. X. (2019). Pursuing green growth in technology firms through the connections between environmental innovation and sustainable business performance: Does service capability matter? *Resources, Conservation and Recycling, 141*, 8–20. https://DOI:10.1016/j.resconrec.2018.09.031.

Fligstein, N., & McAdam, D. (2012). *A theory of Fields*. New York: Oxford University Press.

Flores-Amador, J. (2014). Systems of innovation and the adoption of biotechnologies: The case of Mexico. *International Journal of Biotechnology, 13*(1–3), 120–136. https://DOI:10.1504/IJBT.2014.059644.

Flores, M., Cherian, M., & Boër, C. (2008). Towards a sustainable innovation framework to assess new Indo-Swiss collaboration scenarios. *IFIP International Federation for Information Processing*, (283), 555–566. https://DOI:10.1007/978-0-387-84837-2_57.

Frizzo-Barker, J., Chow-White, P. A., Mozafari, M., & Ha, D. (2016). An empirical study of the rise of big data in business scholarship. *International Journal of Information Management, 36*(3), 403–413.

Fu, X., Pietrobelli, C., & Soete, L. (2011). The role of foreign technology and indigenous innovation in the emerging economies: Technological change and catching-up. *World Development, 39*(7), 1204–1212. https://DOI:10.1016/j.worlddev.2010.05.009.

Gachino, G. G. (2010). Technological spillovers from multinational presence: Towards a conceptual framework. *Progress in Development Studies, 10*(3), 193–210. https://DOI:10.1177/146499340901000301.

Gao, P., & Yu, J. (2010). Has China caught up in IT? *Communications of the ACM, 53*(8), 30–32. https://doi.org/10.1145/1787234.1787245

Gereffi, G., Humphrey, J., Kaplinsky, R., & Sturgeon, T. J. (2001). Introduction: Globalization, value chains and development. *IDS Bulletin, 33*(3), 1–8.

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of International Political Economy, 12*(1), 78–104. https://DOI:10.1080/09692290500049805.

Goedhuys, M., & Srholec, M. (2015). Technological capabilities, institutions and firm productivity: A multilevel study. *European Journal of Development Research, 27*(1), 122–139. https://DOI:10.1057/ejdr.2014.32.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*, 109–122.

Guo, A., Li, Y., Zuo, Z., & Chen, G. (2015). Influence of organizational elements on manufacturing firms' service-enhancement: An empirical study based on Chinese ICT industry. *Technology in Society*, (43), 183–190. https://DOI:10.1016/j.techsoc.2015.07.003.

Harris, M., & Wood, G. (2020). Ambidextrous working in health and social care services: A configurational view. *Long Range Planning, 53*(6). https://DOI:10.1016/j.lrp.2020.102051.

Harzing, A.-W., & Alakangas, S. (2016). Google scholar, Scopus and the Web of science: A longitudinal and cross-disciplinary comparison. *Scientometrics, 106*(2), 787–804. https://doi.org/10.1007/s11192-015-1798-9

Hassanzadeh, A., Namdarian, L., Majidpour, M., & Elahi, S. (2015). Developing a model to evaluate the impacts of science, technology and innovation foresight on policy-making (2015). *Technology Analysis and Strategic Management, 27*(4), 437–460. https://DOI:10.1080/09537325.2015.1007035.

Helfat, C. (2007). *Dynamic capabilities: Understanding strategic change in organizations*. Blackwell Publishing.

Hong, L., & Lin, L. (2022). Evaluation of interest balance of low-carbon collaborative innovation subjects. *Mathematical Problems in Engineering*. https://doi.org/10.1155/2022/8270712, 2022.

Hoskisson, R. E., Hitt, M. A., & Ireland, R. D. (2008). Competing for advantage. *South-Western/Thomson Learning*.

Huang, Z., Zhang, X., & Zhu, Y. (2008). The role of clustering in rural industrialization: A case study of wenzhou's footwear industry. *China Economic Review, 19*(3), 409–420. https://doi.org/10.1016/j.chieco.2007.11.001

Inan, G. G., & Bititci, U. S. (2015). Understanding organizational capabilities and dynamic capabilities in the context of micro enterprises: A research agenda. *Procedia - Social and Behavioral Sciences, 210*, 310–319.

Jensen, M. B., Johnson, B., Lorenz, E., & Lundvall, B. A. (2007). Forms of knowledge and modes of innovation. *Research Policy, 36*(5), 680–693. https://doi:10.1016/j.respol.2007.01.006.

Kadarusman, Y. (2010). *Global value chains and technological capabilities: Analysing the dynamics of Indonesia's garments and electronics manufacturers. PhD dissertation*. Manchester, UK: The University of Manchester.

Kahin, B., & Foray, D. (2006). *Advancing knowledge and the knowledge economy*. Boston, MA: MIT Press.

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2009). Governance matters VIII: Aggregate and individual governance indicators, 1996-2008. In *World Bank policy research working paper No. 4978*. Available at: SSRN: https://ssrn.com/abstract=1424591.

Keinz, P., & Marhold, K. (2021). Technological competence leveraging projects via intermediaries: Viable means to outbound open innovation and mediated capability building? *International Journal of Project Management, 39*(2), 196–208. https://DOI:10.1016/j.ijproman.2020.10.006.

Khan, G. F. (2013). Social media-based systems: An emerging area of information systems research and practice. *Scientometrics*, 159–180.

Kim, L. (1999). Building technological capability for industrialization: Analytical frameworks and Korea's experience. *Industrial and Corporate Change, 8*(1), 111–136. https://doi.org/10.1093/icc/8.1.111

Kim, J. H., & Eom, S. J. (2019). The managerial dimension of open data success: Focusing on the open data initiatives in Korean Terms and conditions. *Sustainability, 11*(23). https://DOI:10.3390/su11236758.

Kim, D. J., Hebeler, J., Yoon, V., & Davis, F. (2018). Exploring determinants of semantic Web technology adoption from IT professionals' perspective: Industry competition, organization innovativeness, and data management capability. *Computers in Human Behavior, 86*, 18–33. https://DOI:10.1016/j.chb.2018.04.014.

Kitchenham, B., & Charters, S. (2007). Guidelines for performing systematic literature reviews in software engineering. Technical report, EBSE Technical Report EBSE-2007-01 https://www.cs.auckland.ac.nz/~norsaremah/2007%20Guidelines%20for%20performing%20SLR%20in%20SE%20v2.3.pdf.

Kumar, A., Krishnamoorthy, B., & Kamath, D. B. (2020). Key themes for multi-stage business analytics adoption in organizations. *Asia Pacific Journal of Information Systems, 30*(2), 397–419. https://DOI:10.14329/apjis.2020.30.2.397.

Lassinanttil, J., Bergvall-Kåreborn, B., & Ståhlbröst, A. (2014). Shaping local open data initiatives: Politics and implications. *Journal of Theoretical and Applied Electronic Commerce Research, 9*(2), 17–33. https://DOI:10.4067/S0718-18762014000200003.

Lazonick, W. (1991). The innovative business and transaction cost theory. In W. Lazonick (Ed.), *Business organization and the myth of the market economy* (pp. 191–229). Cambridge University Press.

Lazonick, W. (2022). Investing in innovation: A policy framework for attaining sustainable prosperity in the United States william Lazonick. Institute for new economic thinking, working paper No. 182 march 30th, 2022 https://DOI.org/10.36687/inetwp182.

Lee, K., Jee, M., & Eun, J. H. (2011). Assessing China's economic catch-up at the firm level and beyond: Washington consensus, East Asian consensus and the Beijing model. *Industry & Innovation, 18*(5), 487–507. https://Doi:10.1080/13662716.2011.583463.

Lichtenthaler, U., & Lichtenthaler, E. (2009). A capability-based framework for open innovation: Complementing absorptive capacity. *Journal of Management Studies, 46*(8), 1315–1338. https://Doi.org1o.1111/j.1467-6485.2009.0054.x.

Lin, H. (2014). The impact of socialization mechanisms and technological innovation capabilities on partnership quality and supply chain integration. *Information Systems and e-Business Management, 12*(2), 285–306.

Lipczynski, J., Wilson, J. O. S., & Goddard, J. (2017). *Industrial organisation: Competition, strategy, policy* (3rd ed.). Prentice Hall.

Liu, W., Wei, S., Liang, Y., Wang, D., & Wang, J. (2021). Influencing factors on organizational efficiency of smart logistics ecological chain: A multi-case study in China. *Industrial Management and Data Systems, 121*(3), 545–566. https://DOI:10.1108/IMDS-06-2020-0371.

Luo, C. M., & Chang, H. F. (2011). SME competitive strategy: Learning from Taiwan's ODM industry. *Business Strategy Series, 12*(3), 107–114.

MacLaughlin, D., & Scott, S. (2010). *Overcoming latecomer disadvantage through learning processes: Taiwan's venture into wind power*. Environment Development and Sustainability. https://DOI:10.1007/s10668-009-9202-7.

Marchiori, D. M., Rodrigues, R. G., Popadiuk, S., & Mainardes, E. W. (2022). The relationship between human capital, information technology capability, innovativeness and organizational performance: An integrated approach. *Technological Forecasting and Social Change, 177*. https://DOI:10.1016/j.techfore.2022.121526.

Matsumae, A., & Nagai, Y. (2017). Formation of inter-subjectivity as a basis of sustainable collaborative innovation. *Research into Design for Communities, 1*, 633–642.

Mayers, J., Evans, J., & Foy, T. (2001). *Raising the stakes: Impacts of privatization, certification and partnerships in South African forestry. Instruments for sustainable private sector forestry series*. International Institute for Environment and Development.

Miao, Y., Song, J., Lee, K., & Jin, J. (2018). Technological catch-up by East Asian firms: Trends, issues, and future research agenda. *Asia Pacific Journal of Management, 35*(3), 639–669.

Mitsuhashi, K. (2006). *The furniture value chain from Thailand to Japan: Upgrading and the roles of buyers*. Doctor of Philosophy Thesis. University of Sussex.

Moon, S., & Lee, H. (2023). Shaping a circular economy in the digital tv industry: Focusing on ecopreneurship through the lens of Terms and conditions Privacy policy. *Sustainability, 13*(9). https://DOI:10.3390/su13094865.

Muñoz-Pascual, L., Curado, C., & Galende, J. (2019). The triple bottom line on sustainable product innovation performance in SMEs: A mixed methods approach. *Sustainability, 11*(6). https://DOI:10.3390/su11061689.

Mushangai, D. (2020). *Exploring challenges in the interaction of forestry-related institutions in the employment of R&D in the South African forestry sector*. University of the Witwatersrand. https://hdl.handle.net/10539/30042.

Newton, W. P., Stone, K., Dent, G. A., Shaheen, N. J., Byerley, J., Gilliland, K. O., et al. (2010). The university of North Carolina at Chapel Hill school of medicine. *Academic Medicine, 85*(9). https://DOI:10.1097/ACM.0bo13e3181ea36cd.

Palaco, I., Kim, S. K., Park, M. J., & Rho, J. J. (2022). Exploring capabilities of international technology transfer intermediaries between emerging and developed countries. *The Journal of Technology Transfer, 47*(1), 307–335. https://DOI:10.1007/s10961-021-09849-2.

Paula, I. C. D., Campos, E. A. R. D., Pagani, R. N., Guarnieri, P., & Kaviani, M. A. (2019). Are collaboration and trust sources for innovation in the reverse logistics? Insights from a systematic literature review. *Supply Chain Management an International Journal, 25*, 176–222.

Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2004). A framework for supporting the management of technological knowledge. *International Journal of Technology Management, 27*(1).

Poon, J. P. H., & MacPherson, A. (2005). Technology acquisition among Korean and Taiwanese firms in the United States. *International Business Review, 14*(5), 559–575.

Porter, M. E. (1981). The contributions of industrial organization to strategic management. *Academy of Management Review, 6*(4), 609–620.

Prahalad, C. K., & Hamel, G. (1990). *The core competence of the corporation. Harvard Business Review. (May-June 1990)* (pp. 79–81).

Qian, X., Liu, W., & Yang, J. (2018). Game theory analysis of technology adoption timing and pricing decision in supply chain system under asymmetric Nash equilibrium. *Journal of Intelligent and Fuzzy Systems, 35*(3), 3101–3111.

Scandura, A. (2016). University-industry collaboration and firms' R&D effort. *Research Policy, 45*(9), 1907–1922.

Schneckenberg, D., Truong, Y., & Mazloomi, H. (2015). Microfoundations of innovative capabilities: The leverage of collaborative technologies on organizational learning and knowledge management in a multinational corporation. *Technological Forecasting and Social Change, 100*, 356–368. https://DOI:10.1016/j.techfore.2015.08.008.

Seuring, S., & Gold, S. (2012). Conducting content-analysis based literature reviews in supply chain management. *Supply Chain Management an International Journal, 17*, 544–555.

Stevens, G. C., & Johnson, M. (2016). Integrating the supply chain . . . 25 years on. *International Journal of Physical Distribution & Logistics Management, 46*, 19–42.

Su, H. N., & Lee, P. C. (2010). Mapping knowledge structure by keyword co-occurrence: A first look at journal papers in technology foresight. *Scientometrics, 85*(1), 65–79. https://doi.org/10.1007/s11192-010-0259-8

Teece, D. J. (2000). Strategies for managing knowledge assets: The role of firm structure and industrial contex. *Long Range Planning: International Journal of Strategic Management, 33*(1), 35–54. https://doi.org/10.1016/s0024-6301(99)00117-x

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*, 1319–1350. https://doi:10.1002/smj.640.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533. http://links.jstor.

org/sici?sici=01432095%28199708%2918%3A7%3C509%3ADCASM%3E 2.0.CO%3B2-%23.
Terheggen, A. (2011). *The tropical timber industry in Gabon: A forward linkages approach to industrialization. MMCP discussion paper No.10*. Town: University of Cape.
von Tunzelmann, N., & Wang, Q. (2003). An evolutionary view of dynamic capabilities. *Economie Appliquee, 56*(3), 33–64.
Uddin, S., & Khan, A. (2016). The impact of author-selected keywords on citation counts. *Journal of Informetrics, 10*, 1166–1177. https://doi.org/10.1016/j.joi.2016.10.004
Utoikamanu, F. (2018). *Closing the technology gap in least developed countries. The UN chronicle: New technologies: Where to? No 3&4*. LV.
Wenger, E., & Snyder, W. M. (2000). Communities of practice: The organizational frontier. *Harvard Business Review, 78*(1), 139–146.
Zahra, S. A., & George, G. (2002). AC: A review and reconceptualization, and extension. *Academy of Management Review, 27*(2), 185–203.
Zang, J., & Li, Y. (2017). Technology capabilities, marketing capabilities and innovation ambidexterity. *Technology Analysis and Strategic Management, 29*(1), 23–37. https://DOI:10.1080/09537325.2016.1194972.
Zhou, Q., Gao, P., & Chimhowu, A. (2019a). ICTs in the transformation of rural enterprises in China: A multi-layer perspective. *Technological Forecasting and Social Change, 145*, 12–23. https://DOI:10.1016/j.techfore.2019.04.026.
Zhou, Q., Gao, P., & Chimhowu, A. (2019b). ICTs in the transformation of rural enterprises in China: A multi-layer perspective. *Technological Forecasting and Social Change, 145*, 12–23. https://doi.org/10.1016/j.techfore.2019.04.026, 2019.
Zhou, K. Z., & Wu, F. (2010a). Technological capability, strategic flexibility, and product innovation. *Strategic Management Journal, 31*(5), 547–561.
Zhou, K. Z., & Wu, F. (2010b). Technological capabilities, strategic flexibility, and product innovation. *Strategic Management Journal, 31*, 547–561.
Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organisation Science, 13*, 339–351.
Zoo, H., de Vries, H. J., & Lee, H. (2017). Interplay of innovation and standardization: Exploring the relevance in developing countries. *Technological Forecasting and Social Change, 118*, 334–348. https://DOI:10.1016/j.techfore.2017.02.033.