

# When Demeter meets Coeus: Dynamic Capabilities and Data Literacy in SMEs

## 1. Introduction

Dynamic capabilities (DC hereafter) are conceptually disaggregated into intrinsic and extrinsic capabilities to sense opportunities; to redeploy and reconfigure the existing resources (Teece, 2007) to seize opportunities systematically and strategically (Teece, Pisano and Shuen, 1997) and to shape the environment (Eisenhardt and Martin 2000). Previous research provides robust evidence to support that a firm's DC, namely its ability to sense and seize internal and external opportunities (Teece, et al., 1997), and the firm's capacity to make necessary resource base adjustment (Farzaneh et al.2022) are critical components of innovative capabilities (Wesley et al.1990; Simon 1985; Wei and Zhao 2014; Wilden et al.2018; Farzaneh et al.2022). Many studies have found that organizations that lack DC do not achieve good innovation outcomes because they are unable to deal with changes in the environment (Khattab, 2017).

Our research promises original contributions. Data literacy (DL hereafter) is a critical factor effecting a firm's DC and innovation capability (IC hereafter) as a result, especially in turbulent and fast-paced environments (Carter 2019; Pothier and Condon 2019; Tabesh et al. 2019; Wang et al. 2019; Jewell et al. 2020; Mikalef et al. 2021). Mikalef et al. (2021) argue that, while DC are well defined in the management literature, there is still a lack of understanding of how data literacy contributes to building DC. In their seminal paper, Zahra et al. (2006) suggest a fruitful area of investigation of whether there is a core dynamic capability skill that is common to all of the various dynamic capabilities the firm develops. We suggest DL capabilities of a firm as one of the core DC skills and we build our DC model, namely DC Scale, accordingly (Bolton, 2016). The DC model conceptualises and quantifies DC from the data literacy perspective (Bolton 2022). Conceptualizing DC as one single model may render it a less meaningful concept (Helfat and Winter 2011) as scarce empirical evidence reveals that individual DC dimensions have different impacts on a range of indicators of firm performance (Huang et al. 2012; Nieves et al. 2016; Singh and Rao 2017; Hernández-Linares et al. 2021) or firms might not necessarily be strong across all DC dimensions (Teece, 2018, p. 44). And therefore, our DC model identifies six distinctive DC dimensions (as stages), and it tests the effect of each dimension separately. Additionally, we measure the overall DC effect through statistical modelling. Innovation capability is the ability of a firm to establish a learning philosophy in which the firm has common standards and beliefs about learning and knowledge that pervade and guide all functional areas toward innovation (Siguaw et al. 2006; Farzaneh et al. 2022). Farzaneh et al. (2022) argue that IC is built through producing positive innovation outcomes and sustaining innovativeness of the firm which requires the firm to accumulate knowledge and capabilities (Li et al., 2020). In this empirical research, we explore *innovations* in 137 firms and test if DC have any impact on those firms' innovation capabilities. We adopt Farzaneh et al.

(2022)'s conceptualisation of IC and calculate IC as a function of innovation continuity and innovation performance of the firm. DC field has been gaining a gradually growing popularity among scholarly, but contributions have been overwhelmingly conceptual, and the scant empirical evidence have been equivocal (Vogel and Güttel, 2013). Zahra et al. (2006) identify two promising territories for empirical investigation. First is the need for empirical evidence to understand substantive and dynamic capabilities and second, DC research within the context of young SMEs. Our research aims to contribute to those territories too. Since our focus is DC and IC relationship, we control for the impact of possible effecting factors such as sector, firm age, firm size and firm performance. Teece et al. (1997) state that the essence of a firm's DC is embedded in organizational processes (p.518) and therefore organisational and process innovation are+ required to support product, service and technology adoption innovations (p.520). To test authors' premise, we create innovation type categories and use innovation type as a moderating variable to measure its moderating effect on DC and IC relationship. This paper studies the DC effect in the SME context because (i) there is still a lack of for empirical evidence in the SME context and (ii) the obstacles and weaknesses that SMEs suffer from, make DC critically important for them (Wang et al. 2011; Hernández-Linares, et al. 2021). Smaller firms may have more flexibility and ability to develop capabilities more quickly (Drnevich and Kriauciunas, 2011) but Hernández-Linares et al. (2021) argue that firm size is positively related to DC efficacy. SMEs' limited size might translate into wider flexibility, adaptability (Wade and Hulland, 2004; Wang et al., 2011) and stronger knowledge generating capabilities (Levy et al. 2003), but they exhibit inabilities in knowledge exploitation. Bolton attributes this inability to SMEs' lack of expertise and experience in the key DC (2022). Further, SMEs have limited resources and capabilities (Drnevich and Kriauciunas 2011; Sawers et al. 2008) and they possess an immanent ineffectiveness in redeploying and reconfiguring resources (Bolton, 2022). And therefore, smaller firms might be unable to create formal scalable and repeatable processes that are routinised and systematised (Caloghirou et al. 2004; Hernández-Linares et al. 2020; Clampit et al. 2022) whilst larger firms can dedicate more resources to develop and change their routines (Schilke, 2017). And therefore, SMEs seem to be more vulnerable to competition (Wang et al. 2011) and environmental changes (Wade and Hulland 2004; Palmié et al. 2016; Park and Kim 2013). The widespread academic approach of measuring firm performance, growth and innovativeness is perceptual judgement (e.g., Engelen et al. 2014; Pavlou and El Sawy, 2011; Ling and Kellermanns 2010). And yet, our analysis (i) is conducted with actual measures of firm performance and innovation, (ii) tests the moderating effect of the innovation type and (iii) controls for the effect of a range of organisational and ecosystem variables (e.g. Camisón and Villar 2009; Miocevic, 2021).

We use the database of SME Productivity & Innovation Centre (PIC hereafter) at Edge Hill University. PIC is part-funded by the European Regional Development Fund to provide innovation support and advisory services to Lancashire and Liverpool City Region based small or medium-sized enterprises (Edge Hill University 2022; PIC 2022). PIC has been collecting qualitative and quantitative primary

data from SMEs since 2018 as a part of the project. Overall, we use data collected from 464 SMEs based across seventeen postcode areas in the Northwest England region. We deducted the number of observations to 137 following a throughout data cleaning process.

The following chapters (i) establishes familiarity with and understanding of current research in the fields; (ii) explains and rationalises the research design; (iii) presents the key results; (iv) delves into the meaning, importance, and relevance of our results and (v) summarises the main points of our research with future recommendations.

## **2. Theory And Hypotheses**

### *Dynamic Capabilities*

Capabilities can be easy to define in theory but quite hard to identify in practice (Strønen, et al., 2017). The term of capabilities is defined as tangible and intangible processes (Akter et al. 2017), which are non-transferable and aim to enhance the productivity of other resources possessed by the firm (Makadok 1999; Morgan et.al 2009). Amit and Schoemaker (1993) argue that capabilities can be functional and rooted in specific areas of the firm. According to Teece et al. (1997), the term of capabilities emphasizes the key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and external organizational slulls, resources, and functional competences to match the requirements of a changing environment (p.515).

Literature distinguishes between ordinary capabilities (OC hereafter) and DC. The term DC is defined the ability to sense new opportunities and threats, seize new opportunities through business model design and strategic investments, and transform or reconfigure existing business models and strategies (Helfat and Raubitschek, 2018). Teece (2014, p. 332) describes OC in terms of technical efficiency in business functions, based on the ability to buy or build learning. The term of OC is used interchangeably with operational capabilities (Winter, 2003) and substantive capabilities (Zahra et al., 2006). Helfat and Winter (2011) use the term of OC and DC to describe first and second order capabilities. Zahra et al. (2006) argues that the effects of DC on firm performance work through OC and depend on the quality of the firm's knowledge base. And therefore authors proposition that the relationship between DC and performance is mediated by the quality of OC and the effect of OC on performance is moderated by organizational knowledge. Since we adopt DL perspective to measure DC, we support the proposition that presumes a relationship between organisational knowledge (as a product of a firm's data literacy capability) and DC. We proposition that if an innovation activity of a firm does not significantly correlated to the firm's DC, then it is correlated to the firm's OC that aim to fix ad-hoc problems or challenges, that are only suited for situated problem solving and therefore they are not dynamic (Strønen, et al., 2017). An OC can be based on a best practice, which is not very difficult to imitate, and aim to do things effectively and efficiently (Strønen, et al., 2017).

Teece (2007) argues that the sensing element of DC includes establishing analytical systems of scanning, searching and exploring activities across markets and technologies. And therefore, sensing is linked to a firm's ability to identify and define problems and opportunities (DC1), ability to establish clear objectives and priorities (DC2) and ability to collect data and evidence and identifying insights (DC3). The seizing element of DC, entails evaluating existing and emerging capabilities, and investing in relevant designs and technologies that are most likely to achieve marketplace acceptance (Wilden, et al., 2013). Transforming or reconfiguration includes continuous alignment and realignment of specific tangible and intangible assets (Katkalo et al. 2010). A firm's ability to seize an opportunity and reconfigure its resources to build DC is linked to the firm's ability to evaluate options for alternative solutions/reconfigurations (DC4), ability to develop optimal solutions, reconfiguration designs and action plans for implementation (DC5) and ability to monitor and evaluate performance against objectives (DC6). Teece also underscores the learning aspect of DC and points out the purpose of DC as to achieve congruence with business opportunities and user needs by learning, based on signature processes that are difficult to imitate (2014).

Many studies have found that firms that lack DC demonstrate poor innovation performance due to their inability to deal with changes in the environment (Khattab 2017). And therefore, DC are underpinned by managerial capabilities to both identify environmental trends and develop business models that address new threats and opportunities (Farzaneh et al., 2022; Lütjen et al. 2019). According to the DC view, top managers or entrepreneurs reconfigure available resources to define a firm's trajectory (Eisenhardt and Martin 2000; Penrose 1959). Teece (2007) argues that DC relate to high level activities that link to management's ability to sense and seize opportunities and to reconfigure assets in response to a changing environment. Al-Aali and Teece (2014, p.106) assert that DC are derived from some combination of top management skills, and the firm's history, values and routines. Eisenhardt and Martin (2000, 1107) also acknowledge that a firm's top managers influence the nature of a firm's competitive advantage through its DC, which depend on the human ability to reconfigure, combine and integrate resources to create appropriate strategies (Teece 2014; Jones et al. 2013; Teece et al. 1997; Van den Bosch et al. 1999). This focus on the action orientation of key managers suggests that they have the potential to imprint particular solutions and trajectories in response to perceived contingencies (Narayanan et al., 2009), and that these solutions are realized at the firm level. This may be either through actions and contributions of employees, and/or through the adoption of new processes and routines (Macpherson et al., 2015). Hence, entrepreneurial management seems to be important for maintaining dynamism in innovation capabilities (Strønen, et al., 2017). Eisenhardt and Martin (2000) position management in a key role and argue that competitive advantage comes from how managers use DC, rather than from the capabilities themselves. Similarly, we recognise the importance of management's ability (as the highest-level strategic decision-maker or the entrepreneurs themselves) in recognising and utilising DC; and we measure DC based on top management's evaluation. Our results

enable us to reinforce two patterns. First, management can capture and utilise the firm's DC for innovation evident in a positive correlation between DC and IC. Second, management can only conceptualise and capture the firm's OC to fix ad-hoc problems or challenges through reactive innovation evident in lack of correlation between DC and IC. For the latter, we might expect innovation through imitation (Hu, 2018), low innovation continuity and success; and low innovation capabilities as a result.

### *Data Literacy*

DL is defined as the ability to read, write and communicate data in context, with an understanding of the data sources and constructs, analytical methods and techniques applied, and the ability to describe the use case application and resulting business value or outcome (Bhargava and D'Ignazio, 2015). DL consists of a knowledge base that allows managers and entrepreneurs to transform raw data into information and actionable knowledge. Mandinach and Gummer (2013, p. 30) conceptualize DL as the ability to understand and use data effectively to inform decisions which involves knowing how to identify, collect, organize, analyse, summarize, and prioritize data and how to identify problems and opportunities, interpret the data, and determine, plan, implement, and monitor courses of action. DL is a firm's data management abilities and the firm's ability to identify sources of data (internally or externally), to develop feasible tools to collect data and the ability to interpret data to inform strategic decision-making. Therefore, DL enables managers/entrepreneurs to transform data into value (Carter 2019; Pothier and Condon 2019; Tabesh et al. 2019; Wang et al. 2019; Jewell et al. 2020). It is claimed that structured adoption of DL skills, such as data analytics, positively affects a firm's DC especially in turbulent and fast-paced environments (Mikalef et al. 2020, Wamba et al. 2017, Mikalef et al. 2021). Teece (2007) argues that the capabilities of sensing, seizing, and transforming are informed by DL. Wesley et al. (1990) connects DL with IC and argue that a firm's DL is critical to its IC. Authors particularly emphasize the importance of the ability to exploit external knowledge that is a critical component of innovative capabilities (p.1). Ability to exploit external knowledge is associated with a firm's absorptive capacity (Oxford, 2021) that is a function of the firm's level of prior related knowledge (Wesley et al., 1990). Wesley et al. (1990) argue that firms with higher levels of AC are more proactive, exploiting opportunities present in the environment whilst firms with a modest AC are reactive, searching for new alternatives in response to a failure or a change in the ecosystem. Acquiring knowledge from external sources and assimilating as well as applying knowledge help the firm improve innovation performance (López-Sáez et al., 2010). Thus, innovation performance and opportunity seizing are strongly linked. The premise of the notion of AC is that the organization needs prior related knowledge to assimilate and use new knowledge. And therefore sustaining innovativeness of a firm, that requires the firm to accumulate knowledge and capabilities (Li et al., 2020), is a product of the self-reinforcing nature of AC (Bower and Hilgard 1981). Prior learning experience may affect subsequent performance and its effect on subsequent learning tasks can be observed in a firm's variety of processes

and abilities such as problem-solving skills and DL capabilities (Pirolli and Anderson 1985; Li et al. 2020). Wesley et al. (1990) claim that a firm's problem solving skills and the firm's learning capabilities are so similar. Similarly we argue that a firm's DL capabilities and AC are similar. DL context might be both internal and external, prior knowledge is crucial to develop better DL capabilities and DL is process oriented whilst AC is more result oriented. In our research, innovation continuity, namely sustaining innovativeness of a firm, demonstrates the firm's ability to learn from previous innovation activities and act upon this learning through further innovations. And therefore, innovation continuity is linked to learning from previous innovation experiences.

The DC parameters (DC Scale), that are adopted and measured in this research, manifest a firm's DL and management capacity, namely its strategic capability, to develop an insightful and accurate assessment of organisational resources, external threats as well as opportunities (Ambrosini and Bowman 2009; Lin and Wu 2019; Teece et al. 1997) for innovation. A strategic capability is a unique ability that is mainly associated with large firms with abundant resources (Prusak 1997; Tsai 2001). SMEs are inherently less strategic, less hierarchical (Teece et al. 2016: 24) and more spontaneous which may facilitate quick adaptations and outperform strategically planned DC and strategic proactive innovations especially in VUCA - volatile, uncertain, complex, and ambiguous (Bennett and Lemoine, 2014) - environments (Teece et al. 2016; Pavlou and El Sawy 2010; Wilhelm et al. 2015). Liao et al. (2003) argue that SMEs can develop a high innovation capability relatively quick, and they are more efficient in recognising DC to overcome the competence traps that lead to organisational inertia (Moradi, et al., 2021). Research shows that firms that engage with proactive strategic innovation are better able to use externally available information (e.g., Tilton 1971; Allen 1977; Mowery 1983; Cohen and Levinthal 1990) and therefore they have a higher level of DL, DC and management capability as a by-product of their innovation investment (Cohen and Levinthal, 1990). On the other hand, firms with lower DL capability engage with little and reactive innovative activity and therefore they are relatively insensitive to external opportunities (Cohen and Levinthal, 1990, p. 132). Reactive innovation is passive (Emerald, 2013, p. 23) and it is developed as a firm's response to an impetus – such as to comply with environmental regulations, to adapt to stakeholders' requests – in the meso and macro ecosystems. And therefore, reactive innovation is less strategic more spontaneous than proactive innovation. Proactive innovation is planned (Galvin, 2018), research-informed, knowledge-based, process oriented (Wu, et al., 2014, p. 109) and shapes the environment (Eisenhardt and Martin 2000).

### *Innovation and Innovation Capabilities*

To meet the demands from new markets, revolutionary changes in technology or new business models, firms need to renew themselves (Chakravarthy and Doz, 1992) and be innovative. There have been a number of theoretical studies of DC (e.g., Eisenhardt & Martin, 2000; Teece et al., 1997; Teece, 2007; Teece, 2014), but one of the key remaining challenges is to understand the relationship between DC and IC (Breznik and Hisrich 2014; Strønen et al. 2017). Teece (2007, p. 1321) describes the role of the

entrepreneur, as an institutional one, who adapts to and also shapes the environment through innovation. Thus, DC sit at the intersection of innovation and entrepreneurial action. Innovation outputs and innovation capabilities refer to an important part of DC. Firms possessing DC have the ability to integrate key capabilities and resources of their firm to successfully stimulate innovation (Strønen, et al., 2017). Innovation requires the acquisition and utilization of new knowledge (Castaneda and Cuellar 2020), knowledge assets in organizations, such as intellectual capital (Farzaneh et al., 2022) and AC (Duodu and Rowlinson, 2019).

DC is the ability to learn from both inside and outside the firm, to integrate new resources with existing ones (Hsu and Wang, 2010; Han and Li 2015). DC enable the firm not only to integrate internal resources with external resources by linking knowledge and capabilities into the firm's operations, but also to absorb new ideas from external sources with the goal of innovation (Qiu et al. 2019). Keskin (2006) reports a positive relationship between learning and innovation capability in SMEs. Strønen et al. (2017)'s research with a university hospital reveals that regardless the outcomes (success or failure), innovation activities facilitate organisational learning that enhances IC of the firm. Their research show that innovation practices underpin IC development through learning about different aspects of innovation management. Hence, we propose that a firm's DL capability determines a significant amount of its IC.

Although previous research provides valuable insights into how DC is linked to innovation, how DL is a linking mechanism to explain DC and innovation relationship is an under researched area especially empirically (Randhawa et al. 2021; Farzaneh et al. 2022). Therefore our DC model throws light on the DL connection between DC and innovation. In this research, IC is measured as a function of innovation continuity and innovation performance. Innovation continuity measures whether an SME has the ability to develop continuous innovations that is measured as the number of innovation projects initiated within the last three years before the PIC intervention. The continuity manifests the extent of evolutionary fitness that depends on how well the DC of a firm match the context within which the organization operates (Helfat et al. 2007) and the learning capacity of the SME (Strønen, et al., 2017). Furthermore, to maintain continuity, the firm must develop different levels of DC and DL based on environmental uncertainty (Darvizeh, 2018, p. 55; Molina et al. 2015) so as to identify changes in the ecosystem. Innovation performance is measured by the degree to which the innovation project met the desired outcomes.

Previous research suggests that the DC and innovation relationship can be moderated by a variety of variables, such as ecosystem factors (Pavlou and El Sawy 2011; Wang et al. 2015), firm age, firm performance, and firm size (Arend, 2014). The moderating role of environment has been in the core of the DC literature (Fainshmidt et al. 2016; Karna et al. 2016). And yet, substantial variability in terms of moderators remains unexplained (Fainshmidt et al. 2016) pointing to the necessary exploration of other factors (Hernández-Linares, et al., 2021).

### *Firm Demographics And Performance*

Previous research reveals that “bigness” (Gooding and Wagner, 1985, p. 462) leads to net economies of scale, increases resources available for organisational use (Gooding and Wagner, 1985) to acquire control over ecosystem entities (Aldrich and Pfeffer 1976; Pfeffer and Salancik 1978), and to attract and retain more productive employees (e.g. Williamson, 1975; Mueller, 1969; Stanford, 1980) and it produces a degree of resource certainty that insures continued productive viability (Gooding and Wagner, 1985). Firm size is vastly measured by the number of employees (e.g., Pugh et al. 1969; Child 1972; Marriott 1949; Glisson and Martin 1980; Kaen et al. 2010; Doucouré and Diagne 2020). Gooding and Wagner claim that the number of employees reflects the degree to which the availability of human resources facilitates performance (1985). Since firm size and DC relationship is not our main focus, we design firm size as a control variable, and adopt the natural logarithm of the number of employees (Menguc and Auh, 2008). In addition to firm size, we control for sector, firm age, profit, and turnover consistent with previous studies (e.g., Cai et al. 2015; Monferrer et al. 2015). DC and innovation relationship can be contingent on firm age (Arend 2013; Clampit et al. 2022; Helfat and Peteraf 2003). Thus, we control for firm age, measured as the number of years between the firm’s establishment and the PIC survey application.

The way resources are deployed is a dynamic process that is aligned with the ecosystem characteristics because DC are context dependent (Cordeiro et al. 2022; Bindra et al. 2020). Especially sector is a strong determinant of resource allocation strategy as certain industries may demand faster, more flexible transformation (Teece, 2014; Teece et al., 1997) than the others. Also, the ability to adapt to changing circumstances in multiple contexts draws on DC (Teece, 2018, p. 47). Previous research reveals correlations between sector and innovation capabilities (Guan and Ma 2003; Keskin 2006; Forsman 2011). And therefore we adopt sector as an ecosystem related variable, and we control its effect too. We adopt a broad industry category of twenty one industry sub-groups (ONS 2023) one of which (Section U) is a group of unidentified industries that cannot be categorised under any of the sub-groups. The industry information was not specified by the participating SMEs. Instead they responded an open ended question asking them to summarise the existing core business activity. Hence, we extracted the industry information from the qualitative raw data as explained in the methodology chapter.

DC influence firm performance in various ways (Teece, 2007). They facilitate strategic alignment with the ecosystem (Zahra et al. 2006), facilitate the reconfiguration of the existing resources for adaptation to the ecosystem (Teece et al., 1997), change the market dynamics (Eisenhardt and Martin, 2000), enhance strategic and cognitive capabilities (Makadok, 2001), improve inter-firm performance (Gudergan et al. 2012; Wilden et al. 2013), improve the agility of organisational responses to the ecosystem (Chmielewski and Paladino 2007; Hitt et al. 2001). Since our focus is not testing the impact of DC on business performance, we control the effect of business performance. PIC measures firm

performance with two variables, namely turnover and profit. We adopt the PIC approach in measuring firm performance.

In the light of above, we explore (i) the types of innovations developed by 137 SMEs, (ii) the effect of DC on IC of the SMEs and (iii) whether innovation type has a moderating effect on the relationship between DC and IC. Figure 1 and Table 1 exhibit the research hypotheses.

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### 3. Methodology

As mentioned previously, the data were collected by PIC throughout 2018, 2019 and 2020. In order to collect quantitative data, a business diagnostic form, that had been designed by PIC, was used. The form enabled PIC to collect a wide range of organisational and ecosystem data from over 460 SMEs. We extracted the relevant data from the PIC database and executed a throughout data cleaning process. The data cleaning process caused a drastic increase in the number of observations from 465 to 137. Consequently we used data collected from 137 SMEs. First, responses were transferred onto Excel spreadsheets. Second, we worked on transferring the data from Excel onto SPSS 25 that was used to analyse the quantitative data.

Qualitative data were collected through interviews with the founders or owners or top managers of the SMEs and through open-ended questions in the business diagnostic form. Participants were asked to identify any recent innovation projects the company engaged in during the past three years (successful and unsuccessful) before the first PIC intervention in 2018. Participants narrated detailed information about their innovation activities such as innovation type, whether or not an innovation met the expected or planned performance targets, results achieved, reasons of failure and factors affecting the innovation activity decision. We worked on qualitative coding with NVivo as well as manually. NVivo is a commonly used software to organize qualitative data (e.g. Ali and Lodhi 2017; Munn and Branch 2018; Nelson 2016; Ulfig 2019). We transferred the data into NVivo for computer aided disassembling, reassembling, coding, interpretation, and theme development. Next, the team worked on the data manually to identify themes and to compare the NVivo generated themes with the manually generated themes to identify inconsistencies. Based on our qualitative data analysis, we identified four *innovation types*, namely, technology adoption (TA), organisational and process innovation (OP), new service or product development (PSD) and strategic (S) innovation. We grouped participants' innovation activities under these innovation type categories. Our qualitative data analysis enabled us to identify five *innovation performance* categories, namely, ongoing, completed, failed, progress, and success. The progress performance outcome was describing an outcome that was positive but below the expected performance level. In this paper we only included the success performance category. Finally we checked the continuity of innovations. Innovation continuity was about whether or not an SME initiated

subsequent innovations within the three years before PIC intervention. We also used ONS (2023) SIC categories to group SMEs under twenty one industry sub-groups. We used NVivo to extract SIC information from the core business activity narratives. Table 2 shows the sector groups.

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With respect to DC measurement, Arend and Bromiley (2009) note that there is not a consensus on how to measure DC and therefore, scholars adopt a variety of proxies extracted from archival data (p. 84). Self-created single or double item measures are common (Døving and Gooderham, 2008). The lack of established scales and a desire to capture discrete subchannels (such as the ability to sense new opportunities vs the ability to capitalise on them) lead to the creation of long formative scales that aggregate DC perceptions across different processes and are adapted to settings on a study-by-study basis (Arend 2013; Kump et al. 2019; Pavlou and El Sawy 2010). And therefore, perceptual judgments are widely used to assess the ability of DC (e.g., Hernández-Linares, et al., 2021). For example: Clampit et al. (2022:408) employed a general three-item Likert-type scale to measure DC with a five-point response format ranging from “disagree” to “agree.” Hernández-Linares et al. (2021: 162) measured DC through using an established Likert-type scale with a fivepoint response format ranging from “strongly disagree” to “strongly agree”. The prevalence of subjective measures of DC (e.g., Real, et al., 2014) is defended to be a more holistic evaluation and to capture more than a single element (Rodríguez et al., 2004). There is also a strong correlation observed between objective and subjective abilities and performance measures (e.g., Dawes 1999; Dess et al. 1984; Ling and Kellermanns 2010). We used the Dynamic Decide Model (Bolton 2018) to measure DC. The model has been used in different subject contexts in the wider literature. For example: Guo (2008) explained the association between managers’ cognitive, knowledge creation and knowledge management capabilities and the effectiveness of their decisions through implementation of the Decide Model. Especially, knowledge management aspect of the model includes the organisational capabilities of knowledge acquisition, conversion and application that are strongly related to DC. Gold et al. (2001) used an extended version of the model to examine the issue of effective knowledge management from the perspective of organisational capabilities (p.186). Our Dynamic Decide Model, namely the DC scale, involved two distinct phases: (1) problem or opportunity analysis and (2) decision making. These two concepts helped frame understanding the problem(s) being addressed or opportunities identified and the factors where decisions need to be made. The Dynamic Decide Model consisted of six focussed activities as DC dimensions (Bolton, 2016). The level of each DC dimension was measured by a six-item Likert-type scale with a five-point response format ranging from “does not present a challenge” to “significant challenge or barrier”. The model is exhibited in Figure 1.

<Figure 1 is here>

We designed IC as the dependent variable. The independent variables were the DC dimensions. The control variables were firm age, firm size, sector, profit and turnover. The research variables are explained in Table 3.

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The term moderating variable refers to a variable that can strengthen, diminish, negate, or otherwise alter the association between independent and dependent variables. Moderating variables can also change the direction of this relationship. Moderating variables are useful because they help explain the links between the independent and dependent variables. Also sometimes referred to as simply moderators, these moderating variables provide additional information regarding the association between two variables in quantitative research by explaining what features can make that association stronger, weaker, or even disappear (Hefner, 2018). We accepted innovation type as the moderating variable. Table 4 exhibit the research variables more in-detail.

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We applied principal component analysis to the DC scale. As a measure of scale reliability, the Cronbach's Alpha ( $\alpha$ ) statistic of 0.708 suggested that the six instruments were internally consistent. The rest of the variables were measured by multiple choice and open-ended questions. The survey data allowed us to evaluate the role of DC with respect to firm performance, growth, and innovation outputs. Self-reported data are deemed reliable as their overall patterns closely match findings from real-time data (Chetty et al. 2020; Clampit et al. 2022).

### *Sample*

PIC collected both quantitative and qualitative data using a survey instrument and through structured interviews which was consistent with recent research on DC in SMEs (Arend, 2013; Lin and Wu et al. 2014). PIC adopted the European Commission's definition of SME. By definition, an SME employs fewer than 250 persons and either have an annual turnover that does not exceed EUR 50 million, or an annual balance sheet not exceeding EUR 43 million (European Commission, 2015). Overall, we used the data collected from 137 SMEs based across seventeen postcode areas in the Northwest England region. The participants were either founders or owners or professional top managers who were directing and controlling SMEs at the highest level.

### *Time Frame*

The PIC data were collected during 2018, 2019 and 2020.

## **4. Findings**

Cañamares et al. (2021) describe reactive innovation as reactive strategies involve responding to external factors such as environmental regulations, pressures and ecological damage. And therefore, the

reactive innovation path does not take into account anticipating regulations or resource constraints that may affect the firm's economic performance but rather defends against problems once they arise. It does not innovate by planning but by innovating in the face of unexpected adversity (Stalmokaitė and Hassler, 2020). Proactive innovation is the opposite. Proactive innovation does anticipate the future by taking action in advance and paying attention to the expected end results for behaviours such as expressing opinions or solving problems (Kiss et al., 2022). Proactive innovation is a competitive advantage as it explains the what and how of innovation strategy (Sheth and Sinfield, 2022). These innovation strategies need a balance between internal and external activities (Kratzer et al., 2017) that come from strategic improvement initiatives of the firm and constraints in the ecosystem respectively (Hofer et al., 2019). Exploitative innovation evaluates a firm's ability to develop products, services, and processes that are competency enhancing. Exploratory innovation measures a firm's ability to develop products, services, and processes that require the acquisition of new knowledge, skills, and competencies (Farzaneh et al., 2022). Our findings reveal that, the innovation projects initiated by SMEs were reactive, therefore passive (Emerald, 2013, p. 23), and exploitative in nature. The participants that PIC interviewed typically imitated someone else's ideas. Imitation is simply replication or borrowing of a competitor's innovation (Teece, et al., 1997). March and Simon (1958: 188) suggest that most innovations result from borrowing rather than invention.

Basen on our qualitative analysis, we identified four innovation type categories that had been adopted by SMEs as explained in Table 5. Technology adoption (TA) and new service or product development (PSD) innovations were more visible and developed through imitation. Strategic (S) and organisational / process (OP) innovations were hidden and trial-and-error innovations. Consequently their impact was difficult to measure with traditional metrics. Trial-and-error was an acting "from the gut" behaviour of the SME that was regarded as one of the most important elements of innovations (Azoulay et al., 2011) and organisational learning (Zahra et al., 2006).

To test our hypotheses, we ran hierarchical multiple regression analysis. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoestaticity. There was no bivariate correlation higher than 0.7 between the independent and control variables which indicated no viloation of the assumption of multicollineairty. We checked the extreme scores for all variables as a part of the data screening process. The outliers were identified through standardised residual plots and replaced with the extreme observations at a reasonable value (Pallant, 2007, p. 154). In order to test the moderation effect of innovation type, we first created a total DC score that was the total value of the six DC items. Next, we created a product term variable (M) for each innovation type category through the compute variable feature of SPSS 25. More specifically the product term variables were technology adoption (DC\*TA), organisational / process (DC\*OP), new service or product development (DC\*PSD) and strategic (D\*S). Correlations were calculated as shown on Table 6.

<Table 6 is here>

The firm demographics and sector control variables were entered into hierarchical multiple regression analysis at Step 1. At Step 2, the firm performance control variables were entered. At Step 3, the independent variables were entered. Finally at Step 4, the product term variables (M) were entered. The  $R^2$  and adjusted  $R^2$  values indicated a significance contribution of Model 4 to the variation of the IC value. The adjusted  $R^2$  value is more precise and it takes the number of variables into account (Westfall and Arias 2020). And therefore we used the adjusted  $R^2$  value in our analysis. Model 1, Model 2 and Model 3 did not show any effect on the innovation capability. Model 4 explained 19 percent of the variance in the innovation capability. Model 4's contribution was statistically significant as the significance of F change was 0.001. The ANOVA table indicated that the model as a whole was significant (See Table 7).

<Table 7 is here>

Next we assessed the contribution of each variable in Model 4. The coefficient analysis revealed that, OP innovation significantly moderated the impact of DC on IC. OP and DC6 were significantly contributing to the final equation.

The moderating variable strengthened the impact of DC6 (ability to monitor and evaluate performance against objectives) on IC just for OP innovations. The full data analysis results can be seen in Table 8.

<Table 8 is here>

## 5. Discussion

Our results revealed no correlation whatsoever between DC and IC in the context of SMEs. Only the product term variable improved the effect of DC (Only DC6) on IC for OP innovations. SMEs copy competitors' technologies, products and services because those type of innovations are visible and their effect as well as feasibility have already been tested. And yet, OP innovations are internal, not explicit in the market and therefore SMEs cannot benchmark but adopt more trial-and-error style to improve internal processes instead. Zahra et al. (2006) claim that trial-and-error facilitates building knowledge, routines, and slack resources in the early states of an SME, but undermines DC as the SME ages. To test authors' claim, we ran a correlation test between the product term variables and business age. The test did not generate any significant correlation between the variables. Hence we conclude that firm age and trial-and-error innovations are not correlated.

Teece et al. (1997) argue that a firm should first restructure the organizational processes (that most likely can support the conventional product/service only) through process innovation before introducing new technologies and product developments. And therefore, radical organizational reengineering is required to support new products developed and technologies adopted. It is striking to find out that, in the process of innovation, SMEs do not engage with their DL capabilities measured with the DC scale.

Only for OP, SMEs use data to monitor and evaluate performance against objectives (DC6). Because there is a lack of opportunity for benchmarking, SMEs need to develop their own evaluation of OP performance. Consequently, they engage with their DL capabilities to design objectives and to monitor and evaluate performance against the objectives.

Ability to innovate indicates the existence of some level of DC of the firm although the innovations are reactive and mostly imitated. What seems like a dysfunction is the inability of top management to utilise the firm's DL capabilities but relying on tacit knowledge and visceral judgement, that is intuitive, when innovating (Google dictionary defines visceral as "based on deep feelings and emotional reactions rather than reason or thought" (2022)). This type of management attitude ignores the intrinsically social and collective nature of organisational learning and therefore undermines developing DL capability and AC. When borrowing innovation ideas as well as performance metrics for those innovations from competitors, DC are not well-targeted and deployed in order to achieve strategic goals. Consequently, SMEs might not gain a performance-related benefits from those innovations. Furthermore, Teece et al. (1997) argue that imitation without understanding the contextual dependence of original performance, the act of imitation is likely to be difficult (Teece, 1976) and fail.

The literature on the distinction between dynamic and substantive capabilities is in its infancy (e.g. Winter 2003; Bratnicka-Myśliwiec et al. 2019; Zhang et al. 2022). Zahra et al. (2006) define a new routine for product development as a new substantive capability, but the ability to change such capabilities is a dynamic capability. In our context, organisational and process innovation (OP) is about changing the existing process routines and reconfiguring the existing resources to generate new capabilities. And therefore it is expected that OP is linked to DC more than the other innovation types. The other innovation types do not show any reconfiguration effort of the existing resources including the business model design to build new organisational capabilities. Instead, they are built upon the existing business model to imitate innovations. Strategic innovation (S) is slightly different.

Evidence supports that the key prerequisite of sustainable competitive advantage through DC is adopting a *strategic* approach in innovation management (Harreld et al. 2007; Strønen et al. 2017) and and therefore it depends on the strategic capability of the firm's management. A strategic capability is a unique ability that is mainly associated with large firms with abundant resources (Prusak 1997; Tsai 2001). SMEs are inherently less strategic, less hierarchical (Teece et al. 2016: 24) and more spontaneous which may facilitate quick adaptations and outperform strategically planned DC and strategic proactive innovations (Bennett and Lemoine, 2014). In our case, strategic innovations are more about obtaining new capabilities through buying. For example, recruiting a new accounting manager, business acquisition or recruiting an external agency to conduct a SWOT analysis of the firm. Although strategic innovation can facilitate DC development, it might not enhance innovation directly as we observe in SMEs. We observe similar spontaneous, centralised, uninformed by data and impulsive responses to the environment in developing strategic innovations. The evidence is top management's lack of

engagement with dynamic capabilities (developed upon their data literacy capabilities) and their overconfidence and representativeness. Overconfidence occurs when entrepreneurs/managers are overly optimistic in their initial assessment of a situation, and they are slow to incorporate additional information about the situation into their assessment (Fischhoff et al. 1977; Alpert and Raiffa 1982) due to their confidence in their existing assumptions and opinions (Phillips and Wright 1977; Russo and Schoemaker 1989). Representativeness exists when the data literacy of a firm is poor. In this situation, decision-makers consistently underestimate the error and unreliability inherent in small samples of data (Payne et al. 1992), when they are willing to generalize from inadequate information (Tversky and Kahneman 1971) and when they make generalizations based on tacit knowledge (Kahneman et al. 1982; Collins 2010, p. 83). Cullen et al. (2023) found out that entrepreneurial orientation undermines a firm's ability to capitalise the firm's dynamic capabilities due to overconfidence and representativeness.

OP innovation is the only innovation type that strengthens the connection between DC and IC and facilitates the firm's engagement with DL, although it is limited with one single DC step that is the firm's ability to monitor and evaluate performance against objectives (DC6). And yet, we do not observe any connection with the firm's DC and the other innovation types. And therefore we conclude that SMEs use their DC to "innovate" new business model designs (namely new organisational and process designs), but they use their substantive capabilities to adopt new technology, to develop new service or product and to design new strategies. This conclusion inevitably causes us to question whether or not there will be any contribution of technology adoption, strategy development and new product service development to long term capacity development of SMEs to adapt to changing environment. We recommend future research to investigate the ways in which substantive capabilities can be transformed into dynamic capabilities to improve innovation capabilities. We also suggest more research on data literacy capabilities especially in the SME context. Ability to identify and utilise exiting data sources is crucial for SMEs to improve their strategic innovations and DC.

## **6. Limitations and Recommendations for Future Research**

Helfat et al. (2007, p. 4) define dynamic capabilities as the capability to purposefully create, extend and modify a firm's resource base. Teece et.al (1997) categorise innovation capabilities as dynamic or non-dynamic. The authors point out the importance of the stability level of the ecosystem conditions as a strong determinat of innovation capabilities. And yet, in order to control the stability factor of the ecosystem, we controlled the effect of the sector. However, this might be a limited approach in controlling the effect of the entire ecosystem.

Although perceptual judgements are widely used to assess the ability of DC (e.g., Hernández-Linares, et al., 2021), it might be a weakness in terms of evaluating the actual DC of a firm. In our research we measured DC based on the strategic decision-maker's perspective. This approach enabled us to identify disfunctionalities such as the management's incapability in identifying DC or capitalising them for

proactive strategic innovation with a stronger effect on long-term capacity and data literacy development. On the other hand, our dependency of management's evaluation might be interpreted as a weakness. Lastly, we defined DC from the DL perspective which might limit DC in a way that disables to capture their overall effect (Tanriverdi and Venkatraman, 2005).

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