R&D MANAGEMENT

Blind faith or hard evidence? Exploring the indirect performance impact of design thinking practices in R&D

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Design thinking has recently been the subject of considerable attention from academics and practitioners. In management discourse, design thinking is a creative and human-centred problem-solving approach based on designers' practices, used mainly in the pursuit of product, service and process innovation. Despite being increasingly promoted and adopted as an approach to innovation, we know little about whether and how design thinking influences firm performance. Drawing upon the resource-based view of the firm and dynamic capability theory, this paper answers these questions via a two-study approach in the context of R&D. Study 1 explores the perceived performance impact of design thinking in a descriptive way. Study 2 investigates the mediating role of organizational innovative capability in design thinking and organizational innovative performance relationship. The results from these two studies shed light on design thinking's performance impact. In addition, they add evidentiary support to the contention that design-thinking practices applied in R&D help develop organizational innovative capability, which in turn increases organizational innovative performance. This research adds welcome evidentiary support to the contention that design thinking practices, applied in R&D, help develop organizational innovative capability, which in turn increases organizational innovative performance. Our study offers a theory-based and actionable approach which explains the underlying mechanism through which a firm can boost its innovation performance by the adoption of design thinking.

1. Introduction

Design thinking, with its emphasis on human-centredness and experimentation, is an emerging approach and practice in the innovation field, specifically, in the area of new product development (Mootee, 2013; Carlgren et al., 2016b; Bagno and Salerno, 2017; Micheli et al., 2019; Knight and Daymond, 2020; Magistretti et al., 2021a, 2021b). It has been used widely by organizations to pursue product, service and process innovation such as GE, Microsoft, SAP, Pepsi, P&G, Philips, GSK, and Airbnb (Curedale, 2016) as well as Bank of America and Google (Nakata and Hwang, 2020). The PwC (2017) innovation benchmark study found 59% of surveyed firms were using design thinking to manage innovation projects.

Meanwhile, academic interest in design thinking has also been growing. This is evidenced by

both published books explaining design thinking (Brown, 2009; Martin, 2009; Liedtka and Ogilvie, 2011; Mootee, 2013; Curedale, 2016) and the growing number of academic articles, published in top academic management journals, including the *Academy of Management Journal* (Gruber et al., 2015), *Journal of Product Innovation Management* (Castellion, 2010; Seidel and Fixson, 2013; Liedtka, 2015; Micheli and Perks, 2018; Micheli et al., 2019; Nagaraj et al., 2020; Magistretti et al., 2021a; Auernhammer and Roth, 2021), *R&D Management* (Auernhammer, 2020; Magistretti et al., 2021b) and business management journals including the *Harvard Business Review* (Kolko, 2015; Bason and Austin, 2019) and a recent special issue of the *California Management Review* (edited by Pitsis et al., 2020). The recent spate of acquisitions of design agencies by the major consulting firms is also seen as evidence of this increasing attention (Dell'Era et al., 2020).

Design thinking's growing momentum is driven by organizations' interest in innovation (Dewett, 2007; Carlgren et al., 2016a). Innovation is widely acknowledged to be key to organizations' competitive advantage. The fact that as few as 10% of new products and services are successful (Castellion and Markham, 2013) means that many firms are dissatisfied with current approaches (Nakata and Hwang, 2020). Magistretti et al. (2021b, p. 2) note that most failures occur in the development process of R&D. How to increase the innovative performance for new R&D projects has become the major challenge for many firms (Wang, 2017).

Increasingly organizations are using design approaches to innovate their innovation process in R&D management (Robbins and O'Gorman, 2015) and as a potential panacea in times of uncertainty and disruption (Björklund et al., 2020).

This sustained and growing interest has propelled design thinking from being merely an innovation buzzword to a highly regarded and widely applied set of practices (Micheli et al., 2019). Despite the growing interest, we still know little about whether design thinking actually results in superior innovation performance and, if so, how it happens (Roth et al., 2020). Many of the existing papers on design thinking are conceptual and exploratory (Bagno et al., 2017; Nagaraj et al., 2020; Nakata and Hwang, 2020), entrenched in practice (Magistretti et al., 2021a) or anecdotal and prescriptive (Liedtka, 2015; Cousins, 2018). A few very recent studies have started to examine the impact of design thinking on innovation (Meinel et al., 2020; Nakata and Hwang, 2020). These studies mainly examine the direct or conditional impact of design thinking on specific innovation outcomes. Understanding *how* design thinking contributes to firm innovation is both theoretically and empirically important. Theoretically, as a new topic or domain; how and why design thinking influences firm performance needs to be better understood in order to move this field forward. For example, such research could help to open the black box between design thinking and firm outcomes. Scholars increasingly call for empirical evidence for the successful use of design thinking (Carlgren et al., 2016a; Micheli et al., 2019). However, research to date points to a 'lack of a body of research that demonstrates systematically design thinking's ability to deliver value' (Liedtka, 2020, p. 78). Without evidence of its efficacy within R&D, it would be easy for design thinking to be 'dismissed as hype or a fad' (Johansson-Sköldberg and Woodilla, 2013, p. 121).

This study investigates *whether* and *how* the adoption of design thinking boosts organizations' innovation performance, thus advancing our understanding of the effectiveness of design thinking for organizational innovation. Drawing upon the resource-based view (RBV) of the firm (Barney, 1991) and dynamic capability theory (Teece and Pisano, 1997), this paper answers these questions via a two-study approach. Study 1 is an exploratory one focusing on the perceived performance impact of design thinking. Study 2 is designed to examine the indirect performance impact of design thinking. It tests a proposed mediation model that design thinking increases organizational innovative performance via the mediating role of organizational innovative capability. The results from two studies support the contention that design thinking improves organizational innovative performance. This effect occurs via the mediating role of organizational innovative capability.

The research context for this study is R&D. Two main factors drove our decision to focus on this population. Firstly, R&D is typically thought to be the engine of innovation (Ciborra and Patriotta, 1998) and a cornerstone of competitive advantage for firms (Andersén and Ljungkvist, 2021). The precise nature of the relationship between R&D and either product innovation or firm performance remains unclear (Heij et al., 2020), which makes the setting of particular interest to innovation researchers. Secondly, prior research reported that many R&D projects tend to fail because creativity is stifled through too much control and formal planning (Stockstrom and Herstatt, 2008). Design thinking is increasingly seen as a means to enhance the innovativeness of R&D (Magistretti et al., 2021b). Consequently, more organizations are adopting design thinking into their R&D departments (Curedale, 2016). Therefore, more research is needed to understand the performance

impact of incorporating design-thinking practices in R&D settings (Appleyard and Enders, 2020).

By examining both direct and indirect impact of design thinking on firm innovative performance, this study makes three major contributions to the design thinking, innovation and R&D management literature. Firstly, this study contributes to the growing debate around the value and impact of design thinking within R&D management. It does so by theorizing and finding evidence for the performance impact of design thinking. Secondly, this study investigates how design thinking works. It is proposed the adoption of design-thinking practices increases firm innovative capability which, in turn, improves organizational innovative performance; the so called, practices-capabilities-performance linkage model. By identifying this unique linkage model in design thinking in R&D, this study advances our understanding of how design thinking boosts innovation in organizations. Thirdly, this research extends existing research in design thinking by adopting a quantitative research method and conducting a two-study approach. Doing so answers several calls for quantitative research in this field (Carlgren et al., 2016a; Bagno et al., 2017; Micheli et al., 2019; Nakata and Hwang, 2020).

2. Theoretical background and hypotheses development

2.1. Design thinking: definition and development

Innovation is at the top of the corporate agenda (Subramaniam and Youndt, 2005; Fu, 2015; Andersén and Ljungkvist, 2021) but failure rates are worryingly high in NPD (Nakata and Hwang, 2020). Managers understand that organizations that fail to innovate will simply become obsolete (Drakeman and Oraiopoulos, 2020). Some estimates suggest that as few as 10% of .new products introduced are successful (Castellion and Markham, 2013). As a consequence, traditional innovation methods are ceding ground to more collaborative models. One such model, design thinking, has been widely advocated in management practice particularly in contexts of high complexity and uncertainty (Brown, 2009; Martin, 2009; Kolko, 2015; Auernhammer, 2020). Many organizations have turned to design thinking in search of breakthrough or radical innovation which has become the holy grail for corporate growth (Alexander and Van Knippenberg, 2014). Dell'Era et al. (2020, p. 324) contend that 'design thinking is booming'. In the literature, the most often cited definition of design thinking is Brown (2009, p. 86), which describes design thinking as '*a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity*'.

There are two main sources attributed to the origins of design thinking. One stream comes from design theory, referred to as *designerly* thinking which describes the academic construction of professional designers' practice (Rittel and Webber, 1973; Cross, 1982; Rowe, 1987; Buchanan, 2001). *Designerly* thinking acknowledges that solutions are influenced by the designer's subjective experience and emphasizes a human-centred and a *fail early* mindset. Designerly thinking connects theory with practice from a design perspective and is anchored in the academic field of design (Johansson-Sköldberg et al., 2013). The second stream in the evolution of design thinking, is managerial discourse (Carlgren et al., 2016a) which is primarily promoted by practitioners (Johansson-Sköldberg et al., 2013). Here, design thinking offers a structured methodology (Auernhammer and Roth, 2021) for new product and service development which begins with ethnographic research to develop empathy with, and derive often surprising and, ideally, actionable insights about users. It then proceeds to ideation and brainstorming to explore possible solutions for improving the user experience, and refines concepts through an iterative process of prototyping as a fast and effective source of communication and learning among stakeholders (Brown, 2009; Seidel and Fixson, 2013; Micheli et al., 2019; Nagaraj et al., 2020).

Design thinking has been regarded as an umbrella construct (Micheli et al., 2019; Auernhammer and Roth, 2021). As Ritala and Schneider (2020) point out, it is challenging to operationalize and measure umbrella constructs in innovation management research because they are mostly intangible. In a meta-review, Micheli et al. (2019) open their important contribution to the understanding of design thinking by describing it as a widely applied set of practices. They identify eight design-thinking tools and practices. They include brainstorming and idea-generation techniques, visualization of ideas and/or concepts, prototyping, field experiments, ethnographic user research, customer segmentation and customer persona's, journey maps, and mind mapping, which have used by other studies (Seidel and Fixson, 2013; Carlgren et al., 2016a; Liedtka, 2017). Some practices are not completely new and overlap with existing innovation frameworks such as agile and lean management. Similarly, Nakata and Hwang (2020) frame

their study of design thinking by conceptualizing its practice as a set of actions. Roth et al. (2020) 'conceptualize design thinking as a set of practices that can be applied in innovation projects' (p. 668). Dong and Garbuio (2016) note that most scholarship on design thinking tends to emphasize design thinking as a replicable process and a set of tools. Equally, Auernhammer and Roth (2021, p. 2) note that design thinking is 'conceptualised as a process or a set of activities'. Based on the above analysis, this paper operationalizes design thinking as a set of practices.

2.2. The performance impact of design thinking

A number of disciplines or domains have claimed the performance impact of design thinking, including strategy (Liedtka and Kaplan, 2019; Knight et al., 2020); entrepreneurship (Patel and Mehta, 2017); marketing (Beverland and Wilner, 2015); and business value creation (Brown, 2009). Despite such extensive claims, empirical evidence on the performance impact of design thinking is very limited (Roth et al., 2020). Increasing attention has been drawn to understand whether design thinking contributes to firm innovation. For example, Wattanasupachoke's (2012) quantitative study of design thinking which surveyed business CEOs in Thailand measured design thinking as a set of practices and found a positive relationship between design thinking and firm innovativeness and also firm performance. Similarly, Nagaraj et al. (2020) and Nakata and Hwang (2020) examine the impact of design thinking on product innovation.

Consistent with existing research, this study argues that design thinking practices contribute to organizational innovative performance, specifically, in the area of new product/service development within R&D settings. Based on the resource-based view of firms (RBV, Barney, 1991), organizations need to have valuable, rare, imperfectly imitable, and non-substitutable resources to gain competitive advantage. Design thinking practices focus on generating new knowledge, new possibilities, ideas and solutions to meet users' needs (Brown, 2009; Seidel and Fixson, 2013; Micheli et al., 2019; Nagaraj et al., 2020). These novel and useful new possibilities form the basis for the design of new business models (Reymen et al., 2017). Such new knowledge, ideas and solutions in design thinking form intellectual capital resources in organizations, which are valuable and firm-specific resource which helps firms to innovate (Nahapiet and Ghoshal, 1998; Subramaniam and Youndt, 2005; Fu et al., 2017).

Design thinking is human-centred. The ethnographic user research, customer segmentation and customer persona's, journey maps, mind mapping, and co-creation with customers approaches enable organizations to better understand customer needs, and to be able to develop new products and services that meet them. Design thinking emphasizes a fail *early* mindset. It allows design professionals to generate new ideas and continuously improve the feasibility of these new ideas by brainstorming, visualizing ideas and/or concepts, prototyping, and by conducting field experiments to test their assumptions. Doing so leads to a more innovative performance in organizations in areas such as new service, product, process development. Empirically, Nagaraj et al. (2020) find team design thinking contributes to product innovativeness in familiar contexts and helps overcome inertia in teams. Nakata and Hwang (2020), in their survey of innovation professionals, reveal that design thinking leads to successful new products and services and is value enhancing for firms. Meinel et al. (2020) adopt an experimental design among innovation teams and find that design thinking outperforms traditional approaches in terms of feasibility, specificity and relevance of concepts generated. Therefore, we propose a positive relationship between the use of design thinking practices in R&D and organizational innovative performance.

Hypothesis 1 Design thinking practices are positively associated with organizational innovative performance.

2.3. The mediating effect of organizational innovative capability

Based on the above analysis, design thinking enables organizations to generate new knowledge and ideas which are valuable resources for organizations. Merely having the resources is not sufficient: they need to be effectively used and leveraged to help organizations achieve higher performance (Sirmon and Hitt, 2007). The uses and leverage of resources, argued by dynamic capabilities theory (Teece et al., 1997) emphasize the active development, deployment and utilization of organizational resources. Kurtmollaiev et al. (2018b, p. 184) noted that to study the impact of design thinking would require a theoretical approach that '*similar to design thinking, is multidisciplinary, acknowledges the instability of environments and focuses on opportunity*

Figure 1. Theoretical model.

identification, innovation and renewal'. Dynamic capabilities were found to be a particularly relevant candidate as it is concerned with purposeful and systematic activities of creating and modifying organizational resources, routines and competencies (Helfat and Martin, 2015). Dynamic capabilities enable firms to address constant changes in the environment by continually reconfiguring competencies and resources (Liedtka, 2020) or as Magistretti et al. (2021a, p. 3) call it 'doing the right thing at the right time'. However, criticisms of the dynamic capabilities concept exist in relation to its conceptual vagueness and tautology (Kraatz and Zajac, 2001). The framework has been described as abstract, intractable, and complex (Wang and Senaratne, 2015). As a result, several different kinds of dynamic capabilities have been explored to represent dynamic capability, e.g., absorptive capacity (Chang et al., 2013), organizational ambidexterity (Patel and Messersmith, 2013), marketing capability in new product development (Bruni and Verona, 2009), organizational uses of resources (Fu et al., 2017), and sensing capability (Dong et al., 2016). These dynamic capabilities are responses to the requirement for change or responses to new opportunities (Ferreira and Coelho, 2020). In existing research, organizational innovative capability has been claimed to be a type of dynamic capital. For example, Slater and Mohr (2014, p. 553) state that the capacity to innovate is a 'dynamic capability…that enables the organisation to maintain alignment with rapidly evolving customer needs in high velocity environments'. Similarly, Dixon and Meyer (2014) conceptualize innovation capability as a form of dynamic capability. This study follows such research and proposes organizational innovative capability as a type of dynamic capability in researching how design thinking influences firm innovative performance.

In this study, design thinking is argued to contribute to organizational innovative performance. Design thinking practices provide organizations with valuable resources such as new knowledge, and strong social capital both within the firm, and between it and its customers. Thus, design thinking practices have the capacity to create organizational innovative capability by identifying opportunities and reconfiguring resources to exploit them (Liedtka, 2018). Design thinking integrates the technical and consumer perspectives within R&D; it weaves together different disciplinary standpoints; and it is collaborative and, with its fail early philosophy, explores multiple options earlier in the innovation process (Magistretti et al., 2021a). Empirically, design thinking has been linked with ambidexterity (Zheng, 2018). Other studies have shown the impact of design thinking on organizational innovative capability. For example, using a quasi-experimental field study with a control group, Kurtmollaiev et al. (2018b) find that team leaders with design thinking training can better develop team dynamic capabilities such as sensing, seizing and transforming capabilities, leading to team innovation output. In an organization context, Kurtmollaiev et al. (2018a) conduct a very rich case study of one of the world's major telecommunication companies which undertook a series of service design initiatives. Based on the longitudinal, qualitative data, they found that the service design, which leans heavily on design thinking, not only positively influences the new service development performance but also promotes significant changes in the organizational mindset and routines, which leads to the development of organizational innovative capability.

Based on the above review, we expect a positive relationship between design thinking practices and organizational innovative capability. Organizational innovative capability has been found to improve organizational innovative performance such as new service/product development and innovation process improvement (Cooper and Kleinschmidt, 1987). We argue that design thinking improves a firm's innovative capability which in turn improves its performance in delivering successful, competitive and tangible innovation outcomes. Therefore, the mediating role of organizational innovative capability in the relationship between design-thinking practices and organizational innovative performance is proposed as below.

> **Hypothesis 2** Organizational innovative capability mediates the relationship between Design-thinking practices and organizational innovative performance.

Figure 1 presents the theoretical model linking design-thinking practices, innovative capability and performance.

3. Research method and results

Two studies (one explorative and the other confirmative) were conducted to answer the research questions on whether design thinking impacts organizational performance, as well as why and how. Study 1 was an explorative study which investigated R&D professionals' opinions about the performance impact of design thinking. To extend Study 1, Study 2 surveyed R&D professionals based in Ireland and used established scales to measure design thinking, organizational innovative capability, and performance. Study 2 tested the hypotheses for the design thinking - performance relationship, and the mediating role of organizational innovative capability in this relationship.

3.1. Study 1: an explorative study of design thinking

3.1.1. Sampling procedure and sample profile

An online survey was sent via the Industry Research & Development Group (IRDG) to their 1806 member organizations. The IRDG is an industry-led and independent industry representative group for manufacturing and services companies involved in research, development and innovation in Ireland. IRDG represents all sectors of industry including electronics, software & telecommunications (ICT), financial services, food, software, engineering, healthcare & life sciences, plastics and utilities. Their members are the R&D representatives from the member organizations.

In total 129 respondents were received with 127 valid responses. Among the respondents, 39% were from small firms with less than 50 staff, 32% were from medium-sized firms with more than 50 and less than 250 staff; and 29% were from large firms with more than 250 staff. In terms of industries, 35% were from manufacturing, 19% were from ICT, 5% were from pharmaceutical companies, 18% were from professional service industries such as accounting, law and financial services, and the rest (23%) were from other service sectors such as retail, tourism, non-profit, and hospitality etc.

Due to the confidential and anonymous nature of the survey, we could not examine the sample representativeness via checking the non-response bias by comparing contextual variables from the respondents to the non-respondents (Wilcox and Bellenger, 1994). We adopted one commonly used method by comparing firm size and industry from the early respondents to the later respondents who are seen as less willing to participate at the first place and may share similar characteristics with non-respondents (e.g., Fu et al., 2017). The early responses are those who returned the survey after the first mailing. The late responses are those who returned the survey after later mailings. The results showed no significant differences between early and late respondents on firm size (t =.80, *n.s.*) or industry (F = 8.54, *n.s.*).

Table 1. Organizational performance driven by design thinking

Organizational performance outcomes driven by design thinking	Yes
Doing smarter new product/service development	78%
Improving our innovation process overall	63%
Making the firm more user-centred	59%
Getting the voice of the customer into the process	56%
Co-creating and engaging with customers	53%

3.1.2. Measurements

Business performance driven by design thinking

Participants were asked about how they think design thinking contributes to their business. A list of business performance outcomes was provided to participants to choose. Example items included providing better customer service, smarter new product/service development, making the firm more user-centred, developing a digital strategy and having better overall alignment, collaboration and knowledge transfer. Responses were based on a binary scale (1 = yes, 0 = no).

3.1.3. Analyses and results

Study 1 was designed to explore the perceived performance impact of design thinking. It was an explorative study. We used mainly descriptive analysis, i.e., the frequency. Table 1 presents the results for R&D professionals' perceptions of their firm performance based on the use of design thinking. Such performance is consistently perceived as strong. For example, 79% of respondents indicated that design thinking drives new product/service development. Over half indicates that design thinking helps improve innovation process (63%), enable user-centred ideas (59%), get the voice of the customer into the process (56%) and co-create and engage with customers (53%). These results indicate that respondents perceive that design thinking drives organizational outcomes in innovation and customer relationships.

3.2. Study 2: an empirical test of the performance impact of design thinking

Study 1 was explorative and descriptive in nature. Based on the direct response on perceived business impact of design thinking, Study 1 revealed some evidence for the performance impact of design thinking. However, strong evidence for such impact had not been established, nor did the indirect impact via organizational innovative capability. Therefore, we designed Study 2 to build further on the findings of Study 1 as well as to test the hypotheses proposed in this research. Study 2 surveyed R&D professionals based in Ireland and used established scales to measure design thinking, organizational innovative capability, and performance. Detailed information on research design, analysis and results was provided below.

3.2.1. Sampling procedure and sample profile

To generate a representative sample, the research team contacted the IRDG again to distribute an online survey to all of its member organizations. The survey was pilot tested among a few R&D professionals and with the managers at IRDG who had experience in R&D management. Their feedback was positive, and some comments related to the wording and the order of questions were accepted in the survey. The survey link was shared with 1806 R&D professionals representing 1806 firms in Ireland. After reminders, in total, 128 responses were received with 127 valid responses (7%). The test results showed no significant differences between early and late respondents on firm size ($t = .48$, *n.s.*) or industry ($F = 4.57$, *n.s.*), suggesting no serious concerns on the sample representativeness. Both studies received similar number of responses. Due to the confidentiality and anonymity, we could not check if the two samples were the same. We did run difference test between two samples and found no significant difference ($t = 1.66$, *n.s.* for firm size; and $F = 2.95$, *n.s.* for industry). These results suggest no concerns about the sample and its representativeness.

Among the respondents, 39% were from small firms, 26% were from medium-sized firms; and 35% were from large firms. In terms of industries, 28% were from manufacturing, 17% were from ICT, 10% were from pharmaceutical companies, 19% were from professional service industries such as accounting, law and financial services, and the rest (26%) were from other service sectors such as retails, tourism, non-profit, and hospitality etc.

3.2.2. Measurements

Dependent variable – organizational innovative performance

Firm innovation is complex and fuzzy to measure (Caridi-Zahavi and Carmeli, 2016). Some scholars use objective measures such as the number of patents (Henderson and Clark, 1990) and the percentage of revenue from innovation (Fu et al., 2015). Other scholars use reflective and comparative scales for firm performance via a number of performance indicators (Delaney and Huselid, 1996). Existing research shows the significant correlation between the objective and reflective performance measures (Wall et al., 2004; Singh and Darwish, 2016).

Given the debate on which type of firm performance indicators should be used, the choice is largely based on the study context and access. This study involved firms with different sizes across different industries. A general and reflective firm performance measurement would be more appropriate, than a narrow and specific one, for this sample. Based on reviewing current literature, two items were adopted from existing research in innovation focusing on (1) new products/services (Aragón-Correa and García-Morales, 2007); and (2) new process (Black and Lynch, 2004). Customers are very important in new product/service development, and they have been regarded as an important component of innovation (Prugl and Schreier, 2006; Buenechea-Elberdin et al., 2018; Schweitzer and Palmié, 2018). Therefore, two items related to customers, i.e., user-centric and getting customer input to innovation, were used in measuring organizational innovative performance.

Respondents were asked to indicate their organizational innovative performance compared to their competitors based on a three-point Likert scale from 1 = weaker to 3 = better. In this study, we chose a three-point Likert scale based on the feedback from the pilot test with R&D professionals as well as support with existing use of 3-point to measure innovation (Wagner, 2010). We are aware of the debate on either five- or seven-point scale (Cummins and Gullone, 2000), or even more point scale (e.g., 10 in Dawes, 2008) used to capture respondents' opinions and attitudes. Based on the fact that fewer points in a scale seem less confusing and can help to increase response rate (Babakus and Mangold, 1992) as well as feedback from the pilot group, we adopted the three-point scale. The alpha coefficient was 0.67, which, although relatively low, is acceptable (Taber, 2018).

Mediating variable – organizational innovative capability

Six items were adopted from Subramaniam and Youndt (2005) to measure organizational

Table 2. Fit statistics from measurement model comparison

Models	χ^2	df	CFI	RMSEA	SRMR	$\Delta\chi^2$	Δdf
Full measurement model	126.80	83	0.91	0.07	0.08		
Model A[1]	284.54	89	0.59	0.13	0.12	157.74***	6
Model B[2]	194.97	89	0.78	0.10	0.09	67.74***	6
Model C[3]	279.68	89	0.60	0.13	0.12	152.88***	6
Model D[4] (Harman Single Factor Test)	313.84	90	0.53	0.14	0.12	187.04***	7

$N = 126$, *** $P < .001$; χ^2 = chi-square discrepancy; df = degrees of freedom; CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; $\Delta\chi^2$ = difference in chi-square, Δdf = difference in degrees of freedom. All models are compared to the full measurement model.
[1]Design thinking and organizational innovative capability combined into a single factor.
[2]Organizational innovative capability and organizational innovative performance combined into a single factor.
[3]Design thinking and organizational innovative performance combined into one factor.
[4]All factors combined into a single factor.

innovative capability. Respondents were asked to indicate their organizational innovative capability compared to their competitors based on a three-point Likert scale from 1 = weaker to 3 = better. Example items included: 'Relative to your main competitors, how good is your organization at innovations that reinforce your prevailing product/service lines', and 'innovations that fundamentally change your prevailing products/services'. The original scale was used as two variables, i.e., the incremental and radical innovation capabilities (Subramaniam and Youndt, 2005). This study theorizes organizational innovative capability as a higher-order construct. Empirically, we ran both exploratory (EFA) and confirmatory (CFA) factor analyses to example the factor structure of innovative capability in the present research context. An EFA with the principal axis factoring and oblique rotation method was conducted. All six items were loaded onto one factor with eigenvalue of 3.65 and 60% variance. The factor loadings were higher than 0.68. CFA was conducted with a second-order construct (innovative capability) with two factors with corresponding items loaded on them (radical and incremental innovative capabilities) in Mplus (Muthen and Muthen, 2012). The results showed a good model fitness (χ^2/[df] = 11.50/7 = 1.64, $P < .05$, CFI = 0.99, RMSEA = 0.07 and SRMR = 0.03). Therefore, innovative capability was operationalized as one construct. The alpha coefficient was 0.86 for organizational innovative capability, indicating high consistency of this construct.

Independent variable – design-thinking practices

To the best knowledge of the authors, there has not been an agreed measure for design thinking. Recently, Micheli et al. (2019) have conducted a systematic review of design thinking literature where they identified eight design thinking tools and practices. These eight were used in this study including brainstorming and idea generation techniques, visualization of ideas and/or concepts, prototyping, field experiments, ethnographic user research, customer segmentation and customer persona's, journey maps, and mind mapping. In addition, one item found in Study 1 on co-creating with customers was added into the measurement. Respondents were asked to indicate how often these design-thinking tools have been used in their organization. Responses were based on a three-point Likert scale ranging from 1 = rarely to 3 = often. The Cronbach's alpha was 0.78 for design thinking practices.

Control variables

Both firm size and industry were controlled in the analysis due to its potential impact on the usage of design thinking and firm performance. Firm size was coded via three categories (1 = small, 2 = medium and 3 = large). Industry was coded via 5 categories (1 = manufacturing, 2 = ICT, 3 = pharmaceutical, 4 = professional service, and 5 = other services). Four dummy variables were created for industries.

3.2.3. Results

In order to check the discriminant validity of all study variables, we conducted CFA. A full measurement model was initially tested where all indicators were allowed to load onto their respective factors and all factors were allowed to correlate. The full measurement model (threefactors) yielded good model fit (χ^2/[df] = 126.80/83 = 1.53, $P <$ .001, CFI = 0.91, RMSEA = 0.07 and SRMR = 0.08). Since all data were collected from a single source, we checked for the possibility of common method bias and by carrying out a series of CFA. Sequential χ^2 difference tests were then carried out and the full measurement model was compared to four alternative nested models as shown in Table 2. The table shows that compared to each of the alternative models, the full measurement model (threefactors) yielded the best fit.

Table 3. Descriptive statistics and correlations of study 2 variables

Variables	Mean	SD	1	2	3	4	5	6	7	8
1. Organizational innovative performance	2.32	0.46								
2. Organizational innovative capability	2.24	0.49	0.61**							
3. Design-thinking practices	2.04	0.43	0.34**	0.25**						
4. Firm size	1.96	0.86	−0.20*	−0.11	0.08					
5. Manufacturing industry	0.28	0.45	−0.03	0.00	−0.18	0.17				
6. ICT industry	0.17	0.37	−0.04	−0.04	−0.04	−0.01	−0.28**			
7. Pharmaceutical industry	0.10	0.30	0.10	0.08	0	−0.14	−0.21*	−0.15		
8. Professional service industry	0.19	0.40	0.08	−0.06	0.21*	0.03	−0.31**	−0.22*	−0.16	
9. Other industries	0.26	0.44	−0.08	0.04	0.03	−0.10	−0.37**	−0.26**	−0.20*	−0.29**

N = 92–126 (pairwise deletion method).
**P < .01,
*P < .05.

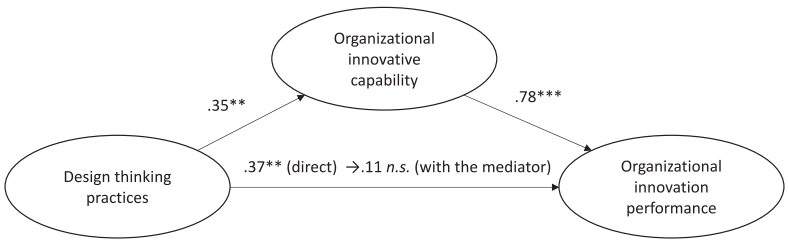
Table 3 presents the descriptive statistics of core study variables including their mean, standard deviation, and correlations. The structural equation modelling analysis was conducted on the key variables including control variables indicated good model fit (χ^2/[df] = 246.75/152 = 1.62, P < .001, CFI = 0.90, RMSEA = 0.08 and SRMR = 0.08). Figure 2 presents the results.

Results in Figure 2 show that the direct standardized coefficient of design thinking practices on organizational innovative performance was positive and significant (β = 0.37, P < .01). Therefore, Hypothesis 1 which proposed a positive relationship between design thinking practices and organizational innovative performance was supported.

Hypothesis 2 proposed that the organizational innovative capability would mediate the relationship between design thinking and organizational innovative performance. We followed the three steps recommended by Hayes (2013). As shown in Figure 2, the independent variable of design thinking was found to be positively associated with the mediator of organizational innovative capability (β = 0.35, P < .01). The mediator, organizational innovative capability, was found to be positively linked to the dependent variable of organizational innovative performance (β = 0.78, P < .001). The indirect effect of dependent variable of organizational innovative performance on the independent variable of design thinking practices via the mediator of organizational innovative capability was 0.55 (P < .05), with a 95% of confidence interval between 0.05 and 1.05, not covering 0. Therefore, Hypothesis 2 was supported.

4. Discussion

The aim of this study was to investigate whether, and how, adopting the design-thinking practices in R&D management actually boosts organizational innovative performance. This research conducted two studies involving R&D professionals. The first explorative study found that the adoption of design-thinking practices are important for driving business performance. The second confirmative study found that design-thinking practices help to develop organizational innovative capability, which in turn, increases organizational innovative performance, the so called practice-capability-performance linkage model. By identifying this linkable model, this research provides both theoretical and evidentiary support for a better understanding how design-thinking practices actually work to help drive successful innovation in R&D



Control variables	Organizational innovative capability	Organizational innovation performance
Firm size	-.20†	-.19†
Dummy industry (manufacturing)	.07	.15
Dummy industry (ICT)	-.03	.04
Dummy industry (pharmaceutical)	.05	.18†
Dummy industry (professional service)	-.11	.22*

Figure 2. SEM results. *Note:* $^{***}P < .001$, $^{**}P < .01$, $^{*}P < .05$, $!P < .10$.

settings. Several implications for R&D management emerge from our study.

4.1. Theoretical contributions

Our study contributes to the growing debate around the value and impact of design thinking within R&D settings (Appleyard et al., 2020; Magistretti et al., 2021b) and provides convincing evidence in support of its use in R&D management. Magistretti et al. (2021a) observed that although design thinking is gaining traction with both practitioners and academics as a means to boost the innovation performance within R&D, most studies are embedded in practice, relating to specific cases, and there remains a lack of theory-driven research. This paper helps fill the theoretical and empirical void around the efficacy of design thinking specifically within the R&D setting and answers the fundamental question of whether these practices actually work and, if so, through what mechanism. This evidence is timely as design thinking is enjoying significant growth in interest in both the research and practitioner community (Dell'Era et al., 2020; Auernhammer and Roth, 2021).

Within the innovation literature, new product and service development commands a high level of attention owing to the impact it can have on firm performance and competitiveness (Sharma and Martin, 2018). While claims of design thinking's popularity are easy to make; evidence of its performance impact within R&D is harder to find and normally comes in the form of case studies and user stories (Nagaraj et al., 2020). Micheli et al. (2019) suggested a key area for future research of design thinking should be to establish the '*effect of design thinking on organizational performance*' (p. 19). This research answers that call by providing welcome evidence of the efficacy of design-thinking practices in boosting innovation performance within R&D. Specifically, this research found that the adoption of design-thinking practices in R&D, contributes to organizational innovative performance. Our findings are consistent with recent studies on the performance impact of design thinking (Meinel et al., 2020; Nagaraj et al., 2020; Nakata and Hwang, 2020).

Equally importantly, this research integrates the RBV (Barney, 1991) and dynamic capability theory (Teece et al., 1997) to understand the underlying mechanism through which design thinking contributes to firm innovative performance. Dynamic capability theory had been considered a good fit for design thinking (Helfat and Martin, 2015) and the relationship between them has been further illuminated by Magistretti et al. (2021a). By formalizing the link with dynamic capabilities, we add to the canon of theory-based research into design thinking. The mediating role of organizational innovative capability was theorized and confirmed. From a theory-building perspective, specifying and testing intervening mechanisms are important in promoting a cumulative science of organizations (Shapira, 2011).

Understanding the 'missing organizational linkages' is needed where researchers specify clear logic for the intervening factors expected to occur in order to influence organizational performance (Goodman, 2000). By identifying this linkage model of practice-capability-performance linkage model, this research provides both theoretical and evidentiary support for a better understanding how design-thinking practices actually work to help drive successful innovation within organizations.

Finally, prior research on design thinking has called for quantitative studies to explore the efficacy of this approach for new product and service development (Liedtka, 2015; Micheli et al., 2019; Roth et al., 2020). Scholars have noted that the lack of theory is preventing the critical evaluation and advancement of design thinking as an innovation management practice (Auernhammer and Roth, 2021). In response to this, we empirically capture, in one of the first studies of its kind, the application and impact of design thinking in organizations. In this way, our quantitative study contributes to the design thinking conversation by providing empirical evidence that supports prior conceptual and exploratory (Rauth and Carlgren, 2014; Bagno et al., 2017; Nakata and Hwang, 2020) or anecdotal and prescriptive research (Liedtka, 2015; Cousins, 2018) about the efficacy of design thinking. In addition, this research contributes to design thinking, innovation and R&D management literature by adopting both exploratory and confirmatory research designs, adding rigour to our research method, which advances our understanding of innovation practices within R&D. Many of the most cited academic articles on design thinking are written by practitioners and advocates who produce checklists with little theoretical development (Micheli et al., 2019). They have been mainly focused on one, or a limited number of qualitative case studies (Kurtmollaiev et al., 2018b) or quasi-experiment method (Kurtmollaiev et al., 2018a). In terms of R&D management, this research builds on the insights of Appleyard et al. (2020) and offers more confidence to R&D professionals and departments in deciding whether or not to adopt design-thinking practices.

4.2. Implications for practice

This study offers a number of insights for practitioners in R&D as well as, more generally, for managers in innovation-active firms. Firstly, we adopt a system perspective to investigate how design-thinking practices, used together, positively influence firm innovative performance. These design-thinking practices have been identified in a number of studies (Seidel and Fixson, 2013; Liedtka, 2015; Micheli et al., 2019). They include ethnographic research; personas; journey maps; brainstorming; mind maps; visualization; prototyping and experiments. Collectively, they capture the creative and human-centred nature and the process of understanding users' needs, working with multiple stakeholders to generate ideas, prototyping and experimenting and testing these ideas. This study finds that this particular combination of design-thinking practices to be effective in practice to boost innovation performance. We thus recommend organizations, particularly R&D-related departments, to adopt these design-thinking practices.

In parallel, this research has found the performance impact of design-thinking practices as well as the mediating role of organizational innovative capability. This practices-capability-performance linkage model could be used as a self-diagnosis tool for organizations. For example, organizations could work with researchers to benchmark their innovative capability and performance to better understand their strengths and to identify space for improvement. If an organization is performing poorly on innovation metrics, it could review usage of the design-thinking practices which will help to improve the innovative capability. While numerous general innovation audits or scorecards exist (Björkdahl and Holmén, 2016), there is no current survey instrument to benchmark use of design-thinking practices.

4.3. Limitations and future research

This study has some limitations. First, this research adopts a two-study approach involving both explorative and confirmative studies to answer the research questions. Both studies are quantitative in nature. Due to the limitations in quantitative research design, this study is limited in its capacity to provide in-depth insights on questions such as how and why organizations adopt design thinking. Future research could employ mixed method including interviews with design-thinking users to answer these questions. Other limitations in the research method include relatively small sample size, data collection from single source, low response rate, single country and cross-sectional design which limits us from testing the casualty and generalizability. Future research may choose to broaden the sample size, involve global participants, and adopt longitudinal research design to better assess and establish causal links in further studies.

In the survey design, this study adopted a three-point Likert scale in measuring respondents' views. Increasing attention has been drawn by researchers on the number of point scales used in management research. For example, Cummins and Gullone (2000) suggest seven as a good number of points. Dawes (2008) states, 'a 10-point scale format will produce slightly lower scores compared to the scores generated from 5-point or 7-point formats' (Dawes, 2008, p. 7). We call for future management research to more rigorously examine the difference by using different points Likert scale.

A further potential limitation is the operationalization of design thinking as a set of practices. As

shown in our review, there has not been an agreed measure for design thinking. This study measured design thinking using the practice-view which is consistent with existing studies (Beverland et al., 2015; Carlgren et al., 2016a; Kurtmollaiev et al., 2018a; Nagaraj et al., 2020; Nakata and Hwang, 2020). Nevertheless, a wider view of design thinking comprises a mindset, a philosophy, a set of rules and attributes in addition to a set of tools (Micheli et al., 2019). Recent scholarship has begun to question whether design thinking can be implemented simply by the use of a set of tools without the creation of an environment of psychological freedom and safety (Auernhammer and Roth, 2021). Future research may be able to define design thinking more expansively and find appropriate impact metrics for other, broader views of and organizational contexts for design thinking.

Lastly, this research applied dynamic capability theory to understand the indirect impact of design thinking on firm performance. In particular, this study theorized and confirmed that organizational innovative capability, as an indicator of organizational dynamic capabilities, mediates the design thinking and organizational innovative performance link. It is acknowledged that other organizational dynamic capabilities such as transforming capability exist. Questions such as whether design thinking has an impact on general organizational dynamic capability would also be worthwhile to investigate.

5. Conclusion

This study identifies a linkage model of design thinking practices-innovative capability-innovative performance. It offers a theory-based and actionable approach regarding why and how a firm can influence its performance through the adoption of design-thinking practices and leverage their innovative capability in formulating and developing innovation. Organizations in search of a proven method to help them navigate the precarious process of innovation in R&D can now engage in design thinking with considerable confidence. Future research is encouraged to continue to unveil how and when design thinking affects innovation performance in R&D active firms.

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