Journal of Business Research 118 (2020) 117–128

Contents lists available at ScienceDirect

Journal of Business Research

journal homepage: www.elsevier.com/locate/jbusres

Design thinking for innovation: Composition, consequence, and contingency

Cheryl Nakata[a,*], Jiyoung Hwang[b]

[a] Department of Marketing, Entrepreneurship, Hospitality and Tourism, Bryan School of Business and Economics, University of North Carolina at Greensboro, 348 Bryan Building, 516 Stirling Street, Greensboro, NC 27402, United States

[b] Department of Marketing, Entrepreneurship, Hospitality and Tourism, Bryan School of Business and Economics, University of North Carolina at Greensboro, 379 Bryan Building, 516 Stirling Street, Greensboro, NC 27402, United States

ARTICLE INFO

Keywords:
Design thinking
Innovation
Mindsets and actions
New product and service performance
Market turbulence

ABSTRACT

Design thinking, a design-based approach to solving human problems, is increasingly adopted by firms to develop innovations. However, what design thinking is, how it works, whether it leads to successful new products and services, and if such outcomes depend on market turbulence are unresolved issues. To address these knowledge gaps, we theorize a nomological network of design thinking's composition, consequence, and contingency, and then examine the model through a survey of innovation managers. We conclude that design thinking consists of six inter-related mindsets and actions, strengthens new product and service performance, and has robust effects across levels of market turbulence. Based on one of the first confirmatory studies of design thinking, we draw implications of our findings for innovation theory and practice.

1. Introduction

Design thinking, defined as a design-based approach to solving human problems, is increasingly used for innovation. Firms as diverse as IBM, Google, Pepsico, and Bank of America are applying design thinking to create new products and services aimed at delighting customers and growing sales (Gruber, de Leon, George, & Thompson, 2015). An impetus is managerial discontent with current approaches. Studies show that a small minority of managers are satisfied with their firms' innovation efforts, a sentiment reflecting the fact that as few as ten percent of introduced products and services are successful (Castellion & Markham, 2013; McKinsey, 2015). These circumstances provide reasons to seek fresh ways of inventing. Programs such as the Stanford d-school and consultancies such as IDEO, a global design company, have responded with books, courses, and projects on design thinking as an alternative to traditional innovation methods (Brown, 2008; Kelly & Kelly, 2013).

As design thinking appears on the cusp of broad business adoption, four critical research questions surface: (1) what is design thinking? (2) how does it work, (3) does it lead to innovation success? and (4) if so under which circumstances? Without answers to these questions, firms may be drawn to design thinking as a panacea, but not obtain hoped-for results. Though writings on design thinking are rapidly increasing, they are largely anecdotal or prescriptive in nature, and short on rigorous, research-based insights (Cousins, 2018; Liedtka, 2015). As noted in reviews, a major limitation of this emergent literature is a dearth of confirmatory empirical investigations on design thinking in business settings (Carlgren, Elmquist, & Rauth, 2014; Micheli, Wilner, Bhatti, Mura, & Beverland, 2019).

To date formal research has highlighted design thinking's diverse applications (Beverland, Wilner, & Micheli, 2015; Cooperrider, 2010), underlying principles (Micheli et al., 2019), and ties to organizational capabilities (Elsbach & Stigliani, 2018; Zheng, 2018). Also, structures and resources helpful to design thinking have been identified, such as alliance arrangements (Bouncken, Fredrich, Ritala, & Kraus, 2018), internal reward systems (Behrens & Patzelt, 2018), customer participation (Morgan, Obal, & Anokhin, 2018), and common techniques (Frow, Nenonen, Payne, & Storbacka, 2015; Thomke, 1998).

While illuminating, these works have mostly been conceptual and exploratory, such that the previous four questions have not been systematically addressed (Bagno, Salerno, & da Silva, 2017; Carlgren et al., 2014). To meet these knowledge gaps, our study aims to determine the composition, consequence, and contingency of design thinking in firms by theorizing and empirically testing a research framework. We carry out this study by proposing and confirming a nomological network of design thinking, in order to provide a more coherent portrait of its ontology, dynamics, and effects than before.

Specifically, we hypothesize design thinking's inter-related components, new product-service performance impact, and market turbulence interaction. Meta-analyses indicate performance and turbulence are a

* Corresponding author.
E-mail addresses: ccnakata@uncg.edu (C. Nakata), j_hwang3@uncg.edu (J. Hwang).

https://doi.org/10.1016/j.jbusres.2020.06.038
Received 27 December 2019; Received in revised form 16 June 2020; Accepted 18 June 2020
Available online 30 June 2020
0148-2963/

major outcome and a dependency of innovation, respectively, so we focus on them alongside design thinking (Evanschitzky, Eisend, Calantone, & Jiang, 2012; Henard & Szymanski, 2001). We then test our model through one of the first managerial surveys of design thinking. Our contributions are a new conceptualization of design thinking as a dynamic multi-dimensional construct, confirmation of design thinking's positive performance influence, and determination of its robust effects across varying turbulence levels. Together these contributions offer a more holistic view of design thinking for innovation over prior studies. Hereafter, guided by the four research questions, we present a design thinking conceptualization and set of hypotheses, followed by study methods, findings, and implications.

2. What is design thinking?

2.1. Definition and composition

Design thinking has been variously called a logic, principles, practices, tools, discourse, philosophy, and mental model (e.g., Gruber et al., 2015; Leavy, 2010). Its genesis in design practice and later translation to business management have produced confusion about its ontology (Brown, 2008; Lockwood, 2009). Emblematic is the variety of definitions circulating. As shown in Table 1, which highlights recent business scholarship on design thinking, there is no consensus definition. For example, Zheng (2018, p.738) states it is a "methodology which is driven by design philosophy" with the traits of problem-driven, stakeholder focus, holistic perspective, visualization, experimentation and abductive reasoning, whereas Chen, Benedicktus, Kim, and Shih (2018, p. 176) refer to it as the "implementation of design philosophy into design processes and outputs" with the user centered design technique as its chief feature. Literature reviews observe that a single definition has not been widely accepted (Johansson-Skoldberg, Woodilla, & Cetinkaya, 2013; Liedtka, 2015).

Compounding this problematic polysemy are the differing articulations of design thinking's components. Some practitioners offer design thinking as the five steps of empathize, define, ideate, prototype, and test (Interaction Design Foundation, 2020), while other researchers propose eighteen characteristic tools and attributes (Micheli et al., 2019). Although design thinking is recognized as multi-dimensional, it has eluded a comprehensive yet parsimonious conceptualization, without which empirical research and scholarly knowledge are impeded (Beverland et al., 2015; Johansson-Skoldberg et al., 2013). An analogous situation occurred in the 1980s when market orientation was accepted business nomenclature, but with no shared meaning and understanding. Researchers then theorized its nature, enabling discovery of drivers and outcomes (Kohli & Jaworski, 1990; Narver & Slater, 1990). In the same vein, we aim to advance the literature by addressing the question of what design thinking is.

To build a new, useful, and coherent concept of design thinking we first define it. We do so by identifying core commonalities from extant definitions. As indicated in Table 1, while the exact wording across definitions used in business studies differs, design thinking is often described as an approach that relies on designers' ways of addressing deeply human problems (Brown, 2008; Carlgren, Elmquist, & Rauth, 2016; Liedtka, 2015; Micheli et al., 2019). Some of the most prominent interpretations reflect these qualities, including by IDEO's CEO Tim Brown (2008, p. 86): "a discipline that uses the designer's sensibility and methods to match people's needs with what is…feasible…." To capture the essence of design thinking, we propose the definition of a design-based approach to solving human problems.

Beyond the definition, what constitutes design thinking? The term design thinking is itself informative. It indicates both design and thinking are present. Put another way, there are design tasks and activities alongside design perspectives and thoughts that make up design thinking as a distinctive form of problem solving. This notion is supported in research descriptions of design thinking, where words such as process and implementation indicate actions, and words like logic and philosophy point to thoughts (see Table 1). In addition, both cognitions and activities have been observed in studies (Brenner, Uebernickel, & Abrell, 2016; Johansson-Skoldberg et al., 2013; Seidel & Fixson, 2013). Conceiving of design thinking as mindsets as well as actions also differentiates the approach from traditional innovation methods, which are task-centric or -exclusive (Cooper, 1979). Hence, we posit that design thinking is critically composed of mindsets and actions that together form a multi-plex whole.

2.2. Design thinking mindsets

But which mindsets constitute design thinking? Three are salient in the literature: human centeredness, abductive reasoning, and learning by failing. These mindsets appear as integral to and distinctive of design thinking (Beverland et al., 2015; Cousins, 2018; Lockwood, 2009). First, human centeredness is a focus on the people to be served by the solution. Human centeredness is considered so fundamental to design thinking, that in some circles the fuller name is "human centered design thinking" (Brown, 2008).

This mindset goes beyond customer orientation by empathically seeking to resolve user issues as experienced, including the full range of emotional, embodied, and material events (Beverland et al., 2015; Jaworski & Kohli, 1993). With this mindset, innovations are developed to provide compelling moments to users, not simply be the aggregate result of discrete design choices. The human focus translates customer preferences into memorable and meaningful experiences that become a part of the innovation itself (Gruber et al., 2015; Zheng, 2018).

A second mindset is abductive reasoning, which is challenging what exists in order to invite alternatives. Deductive or inductive logic, which is common in other innovation methods, arrives at answers through careful premise building, usually to evaluate and justify a project or design decision (Cooper, 1979). Abduction by contrast makes creative leaps without tethers to the apparent and feasible in order to imagine possibilities. Based more on assertion than evidence, it continuously asks what might or ought to be rather than what already is, reflecting how designers broach dilemmas (Michlewski, 2008; Liedtka, Ogilvie, & Brozenske, 2019).

Learning by failing, the third mindset, is framing failure as necessary for learning. Daring to fail in order to learn permits arriving sooner at effective solutions. Risk aversion on the other hand delays real answers by searching for safe options that may not satisfy underlying needs (Sandberg & Aarikka-Stenroos, 2014). Instead of careful stepwise reduction of errors by making always appropriate choices, learning by failing recognizes that risk taking–and paradoxically mistakes–can lead to unexpected solutions. This mindset is distinctive in widening the vista of exploration, contrasting with the narrow confines of uncertainty reduction characterizing other routes of innovation (Summers & Scherpereel, 2008).

2.3. Design thinking actions

In terms of design thinking actions, the literature points to diverse activities. These activities collectively form a progression of steps iteratively taken to develop an invention. The proposed number of activities varies, such as the five of empathize, define, ideate, prototype, and test (Interaction Design Foundation, 2020), and the four of answering what is? what if? what wows? and what works? (Liedtka et al., 2019). However, three activities have been identified by researchers as fundamental: understanding the innovation need, generating potential answers, and testing and refining to arrive at the answer (Gruber et al., 2015; Liedtka, 2015; Seidel & Fixson, 2013; Shane & Ulrich, 2004). Interestingly, the same trio is offered by IDEO, a leading practitioner (ideo.com). Consequently, we propose the key activities of design thinking to be these three as well, calling them discovery, ideation, and experimentation, respectively.

Table 1
Recent design thinking (DT) studies in the business literature.

Authors (Year)	Method	Research Topic	Definition of DT	Composition of DT	Consequence of DT	Contingency
Beverland et al. (2015)	Qualitative cases	DT as aid to managing tensions of brand ambidexterity	“inherent logic and practices of designers” (p.590)	“creative and strategic process characterized by…abductive reasoning, iterative thinking and experimentation, holistic perspective and human centeredness” (p.593)	Management of brand consistency and relevance	None
Carlgren et al. (2016)	Qualitative cases	Barriers to implementing DT	“Multidisciplinary, human-centered innovation approach inspired by designers” (p.344)	“set of principles/mindset, practices, and techniques…user focus, problem framing, visualization, experimentation, and diversity” (p.346)	DT Implementation	None
Chen et al. (2018)	Student experiment	Teaching design thinking via design techniques to produce marketing outcomes	“implementation of design philosophy into design processes and outputs” (p.176)	User centered design technique	Perceived usefulness, originality, and value of a student idea using a specific design method	None
Cooperrider (2010)	Conceptual	How corporate strategy and design thinking can come together to solve the most pressing sustainability issues e.g. global poverty	None	None	None	None
Elsbach and Stigliani (2018)	Conceptual	“how design thinking relates to organizational culture” (p.2278)	“an approach to problem solving that uses tools by designers of commercial products, processes, and environments” (p.2274)	Four phases; tools in each e.g. mapping, brainstorming, rapid prototyping; and thinking styles e.g. convergent vs. divergent	Organizational culture	None
Liedtka (2015)	Conceptual	“review of assumptions, principles, and key process tools associated with DT” (p.925)	“bringing designers' principles, approaches, methods and tools to problem solving” (p.926)	Various models of DT as mostly 3 stages and some common tools e.g. collaborative sensemaking and assumption surfacing	Reduced cognitive biases e.g. undervaluing novel ideas and overlooking disconfirming data	None
Micheli et al. (2019)	Conceptual	Review of literature to identify principle attributes and tools/methods and future research	Notes three most commonly used definitions	Nine primary attributes e.g. iteration and eight tools/methods e.g. visualization	None	None
Luotola et al. (2017)	Qualitative cases	Design thinking as a means of arriving at a sales solution	“discipline that uses the designer's sensibility, knowledge, and methodological understanding to match customer's needs to what is technically and economically feasible” (p.62)	Problem identification, designing a sales solution, reaching final sales or certainty	Sales certainty	None
Seidel and Fixson (2013)	Qualitative cases	“How novice multidisciplinary teams use design methods to successfully develop novel concepts?” (p.20)	None	Needfinding, brainstorming, and prototyping	Concept novelty	None
Zheng (2018)	Conceptual	Relation of DT through ambidextrous learning ultimately to ambidextrous innovation	“Methodology driven by design philosophy” (p.738)	Traits of problem-driven, stakeholder focus, holistic and systematic perspective, experimentation, visualization, abductive reasoning	Balance of radical to incremental innovation in a firm portfolio	None

A representative, not comprehensive, list of recent scholarly business articles on design thinking.

Discovery as the first action is aimed at deeply understanding user needs. Such understanding helps create innovations that meet articulated and unarticulated desires. Critically too the understanding can help reformulate a problem, which is especially appropriate for complex or ambiguous projects (Liedtka, 2015; Zheng, 2018). In discovery, a host of techniques can be applied. Ethnography and in-person interviews are popular choices, helpful in eliciting user stories, motivations, and meanings (Beckman & Barry, 2007; Chen et al., 2018). An accompanying task is gaining contextual insights, accounting for the surroundings that often shape human behaviors.

Ideation is the next activity. In this action, new concepts aligned with user requirements are generated, employing visual, interactive forms of brainstorming. Visualization captures imagery or narrative, for example through charts, photos, maps, and drawings, while interaction sparks and builds powerful ideas that would not have been produced independently. Interactions are constructive when participants have different yet complementary perspectives, expertise, and skills (Carlgren et al., 2016; Cousins, 2018). Through ideation, the envelope of possibility is extended by loosening constraints on assumptions and frames.

The third action of experimentation is iteratively testing ideas to determine what works and improving the design before settling on the final form. The action involves rapid prototyping and soliciting stakeholder feedback (Lockwood, 2009). Rapid prototyping is inexpensively and quickly mocking up potential solutions. Learning occurs by making, revising, or discarding low fidelity models in which little time, money and effort are invested. When rapid prototyping is combined with soliciting and applying stakeholder feedback, experimentation acts as a form of hypothesis generation and testing (Carlgren et al., 2016; Cousins, 2018).

3. How does design thinking work?

3.1. Dynamics of mindsets to actions

In the preceding section, we address the knowledge gap on what design thinking is by offering the definition of a design-based approach to solving human problems, and by proposing the conceptualization of two sets of specific mindsets and actions. Now we move to research question of how design thinking works. We do so by first outlining possible relationships among design thinking's six elements. Unlike prior static conceptualizations, we detail the dynamics within design thinking as another contribution to the literature.

We begin by hypothesizing that each mindset influences a specific action. These effects are theorized from innovation studies indicating that cognitions and cognitive styles are significant determinants of innovation activities. Independent cognitions have been found to influence intra-unit learning, and reflective cognitions affect inter-unit learning on innovation projects (Lin & McDonough, 2014), while the tendency to engage in and enjoy thinking is an antecedent of individual innovative behaviors (Wu, Parker, & de Jong, 2014).

A further basis for this mind-action tie are theories of complex human behavior. Innovation is considered such a behavior. The theory of reasoned action and its later expansion as the theory of planned behavior argue that attitudes and intentions precede behaviors (Ajzen, 1985; Fishbein & Ajzen, 1975). These theories have successfully predicted substance abuse, HIV prevention, and other complicated activities (Albarracin, Kumkale, & Johnson, 2004). Similarly, the theory of self-efficacy states that confidence in the ability to perform a behavior affects carrying it out, as shown in many empirical studies (Bandura, 1971; Bandura, Adams, Hardy, & Howells, 1980; Bandura & Locke, 2003). Finally, the theory of implicit intelligence (Dweck, 1999) observes that beliefs, or mindsets, about personal capabilities shape choices. In the growth mindset, individuals who are motivated to learn engage in difficult behaviors at the risk of failure, whereas those with a fixed mindset avoid new challenges that may prove their skills are inadequate (Dweck, 2006). As described by these and related theories, actions cannot be understood in isolation; instead, what is thought influences what is done.

In terms of specific expectations, we hypothesize the mindset of human centeredness is critical for the action of discovery. Human centeredness invites entering fully into people's lives to gather meaningfully human, rather than superficially abstract, insights, often through first-hand observations and open-ended interviewing. In applying this mindset, designers try to fathom the full-range of human experiences (Beverland et al., 2015; Gruber et al., 2015). The mindset requires empathy, or the ability to sense, imagine, and share what others undergo, and provides a key portal to lived experiences (Leonard & Rayport, 1997; Kelly & Kelly, 2013). Human centeredness thus propels discovery, without which insights are contextually detached (Elsbach & Stigliani, 2018; Seidel & Fixson, 2013).

H1: Human centeredness is positively related to discovery.

The second mindset is abductive reasoning. By not accepting the problem as a given, abductive reasoning fuels creativity more than deductive or inductive logic (Beckman & Barry, 2007; Verganti, 2011). A signature trait of designers is adopting the frame of imagined possibility ('what if') instead of objective constraints ('what is') (Leavy, 2010; Liedtka, 2015). Abductive reasoning may especially spur the action of ideation, whereby fresh concepts are generated. Abductive reasoning temporarily suspends the rational analytical thinking that prematurely aborts novel ideas before they are explored (Kelly & Kelly, 2013). The abductive-ideation link is suggested in studies identifying abductive reasoning as an avenue to original ideas, even in resource-strapped settings, thus inspiring innovations out of adaptive bricolage (Bicen & Johnson, 2015), and enabling new configurations of ideas in innovation projects by overcoming mental puzzles, contradictions, and competency traps (Dunne & Dougherty, 2016). Conceivably, abduction fosters ideation by producing multiple views of what might work (Dew, 2007; Zheng, 2018).

H2: Abductive reasoning is positively related to ideation.

Design thinking's mindset of learning by failing accepts each stumble as illuminating the problem to arrive ultimately at an effective answer. In contrast, when a mindset of avoiding mistakes permeates, solutions are by default less innovative (Carlgren et al., 2016). In relation to design thinking actions, the learning-by-failing mindset may support experimentation in particular. A hallmark of design thinking is fast, inexpensive trial-and-error experimentation, such as by assembling rough prototypes and exposing them to stakeholders for feedback (Beckman & Barry, 2007; Beverland et al., 2015). Without a friendly posture toward disconfirmation, experimentation can be indefinitely postponed, foreclosing opportunities to make changes on a timely basis or to abandon a poor idea prior to introduction. The sunk cost fallacy can take over. An unfortunate result is unpromising projects are continued because they are not subjected to validation (Sarangee, Schmidt, & Calantone, 2019). Learning by failing however encourages questioning and testing all concepts.

H3: Learning by failing is positively related to experimentation.

3.2. Dynamics of actions to actions

Along with mindsets fostering actions, a second dynamic within design thinking is actions aiding other actions, specifically of discovery propelling ideation and in turn ideation fostering experimentation. Recursive loops may occur between actions, but the overall thrust is moving from discovery to ideation and finally to experimentation. This sequence has not been theorized and confirmed but implied in the literature (Gruber et al., 2015; Seidel & Fixson, 2013; Liedtka, 2015).

The first action step of discovery is aimed at comprehending users as fully as possible, including subtle motivations, emotions, sensations, and reasonings that underlie wants. Eliciting stories from users through naïve questioning surfaces rich insights, often in tandem with ethnographic observations rather than relying entirely on second-hand accounts (Beckman & Barry, 2007; Chen et al., 2018). Secondary data and surveys are also helpful in identifying important contextual factors, such as market trends, economic realities, and social structures (Beverland et al., 2015; Brown, 2008).

We hypothesize that discovery supports the action step of ideation. It does so by providing the basis to perceive solutions that are situationally appropriate to users. Discovery may in addition inspire and fuel ideation. Compassionately connecting with customers by directly watching, listening, and engaging with them during discovery can strengthen the motivation to come up with a concept that addresses underlying needs (Elsbach & Stigliani, 2018; Seidel & Fixson, 2013). Also given the breadth and complexity of findings, more ideas of greater variety can be produced. Studies suggest that perspective diversity aids ideation by increasing the divergence and even attractiveness of concepts (e.g., Perry-Smith, 2006). Discovery in addition encourages problem reframing, so what began as the given issue may be reformulated to produce a more relevant and significant answer (Beckman & Barry, 2007; Liedtka, 2015).

H4: Discovery is positively related to ideation.

Another linkage among design thinking actions is from ideation to experimentation. By expanding the range and number of options, ideation increases the willingness to evaluate and dispense with weaker choices during experimentation. The cost of nonrecoverable losses, such as in time, money, and manpower spent on an innovation project, is lower with a greater number and assortment of possibilities, encouraging speculative testing through experimentation. Losing a few concepts to validation exercises still leaves plenty more in the hopper. Loss aversion and unproductive behaviors tied to constrained thinking are thereby diminished (Kahneman & Tversky, 1992).

Suggestive of such dynamics are studies on the escalation of commitment in new product development. Studies show that weak projects are continued even in the face of mounting evidence of likely failure, due to the belief that applying resources will turn such projects around, and avoid regretting premature abandonment. Psycho-emotional commitment to such projects also increases over time since there is no easy alternative to turn to (Sarangee et al., 2019; Sarangee, Schmidt, & Wallman, 2013).

Ideation may also promote experimentation by signaling a search for more powerful answers. Risk taking momentum can build during ideation and carry over into experimentation (Beverland et al., 2015; Liedtka, 2015). This momentum further spurs experimentation. As new and not-so-new concepts are further probed, refined, merged, and removed through experimentation, more effective designs can emerge (Zheng, 2018).

H5: Ideation is positively related to experimentation.

4. Does design thinking lead to success?

To address the next research question of whether design thinking leads to success, we theorize a potential consequence of this problem solving approach. Although success is an implied outcome in much of what has been written about design thinking, the evidence is scant since prior research is predominantly conceptual and exploratory. Conceptual studies for example propose that design thinking achieves broad organizational aims such as addressing global sustainability concerns (Cooperrider, 2010), as well as focused goals such as reducing cognitive biases when inventing (Liedtka, 2015). Similarly, exploratory studies using case methods probe several effects, including design thinking's impact on brand consistency, concept novelty, and certainty in the sales process (Beverland et al., 2015; Luotola, Hellstrom, Gustafsson, & Perminova-Harikoski, 2017; Seidel & Fixson, 2013). While illuminating, findings have yet to confirm innovation performance per se improves (see Table 1). Systematic assessments of design thinking from a performative perspective in organizations have been noted as a critical lapse in the literature (Carlgren et al., 2014; Micheli et al., 2019).

One of the most coveted innovation outcomes is new product and service performance as indicated by meta analyses (Henard & Szymanski, 2001; Montoya-Weiss & Calantone, 1994) and individual innovation studies (Chen, Wang, Huang, & Shen, 2016; Morgan et al., 2018). Scholars have a long-standing interest in how different innovation methods determine market and financial results of inventions (Cooper, 1979; Salgado, Sanches da Silva, Mello, & Samaan, 2017; Yu, Jacobs, Chavez, & Feng, 2019). We therefore look at the potential impact of design thinking on new product and service performance, which is the degree to which a new product or service achieves success relative to major competitors in terms of sales, profits, market share, and return on investment (Montoya-Weiss & Calantone, 1994; Page, 1993).

We hypothesize that design thinking makes a positive contribution, specifically that the experimentation action directly enhances new product-service performance. Through making and testing early prototypes, experimentation increases understanding of user requirements as well as of current offerings. As this understanding guides revising designs to improve their functional, aesthetic, and symbolic value, buyer satisfaction with and sales of the finished innovations should grow (Bornemann, Scholer, & Homburg, 2014). Experimentation, particularly the procedure of spotting and rectifying problems, also stimulates improvisation (Eisenhardt & Tabrizi, 1995; Nisula & Kianto, 2016), which can yield cost and time efficiencies and even avert catastrophic errors (Thomke, 1998). Past studies indicate that market and product testing, which subject innovations to real-world evaluation, helps new product performance (Cooper, 1979; Kong, Gang, Fen, & Sun, 2015).

H6: Experimentation is positively related to new product and service performance.

5. Under what condition does design thinking lead to success?

Finally, we address the research question of what condition design thinking's success may depend on, since contingencies have received little to no scholarly attention (Table 1). Design thinking is said to be suitable for shifting and ambiguous innovation needs (Liedtka, 2015; Lockwood, 2009), or ill-defined challenges with no apparent answer (Brown, 2008; Kelly & Kelly, 2013). One circumstance where change and uncertainty elevate, producing ambiguous difficulties, is market turbulence (Murray, Gao, & Kotabe, 2011). Market turbulence refers to the rate of change in the composition and preferences of customers (Jaworski & Kohli, 1993), and is a chief factor in how well innovations are received by buyers (Moorman & Miner, 1997; Sethi & Iqbal, 2008). Therefore, we study market turbulence as a potential contingency of design thinking's impact on performance.

When market turbulence increases, uncertainty around a firm's future revenue and pressures to adapt to unknown demands grow as customer preferences shift (Moorman & Miner, 1997; Jaworski & Kohli, 1993). Under this condition, design thinking may strengthen the impact of experimentation on new product and service performance by speeding identification of and astute adjustments to such market shifts. In particular the experimentation action may help the organization navigate the altering terrain by figuring out how best to adapt an innovation to satisfy a moving target. Research shows that inflexible innovation systems suffer under greater turbulence, resulting in learning failures or non-integration of new information into existing knowledge structures and project plans (Sethi & Iqbal, 2008). Conversely, strong market linking capabilities enable monitoring and absorbing new requirements that improve innovation performance in volatile environments (Chen et al., 2016; Murray et al., 2011). By opening new lines of inquiry and action, experimentation may be more potent when the replication logic under stable circumstances no longer applies, leading to the creation of higher performing innovations (Austin & Devlin, 2003; Liedtka, 2004).

H7: Market turbulence positively moderates the relationship of

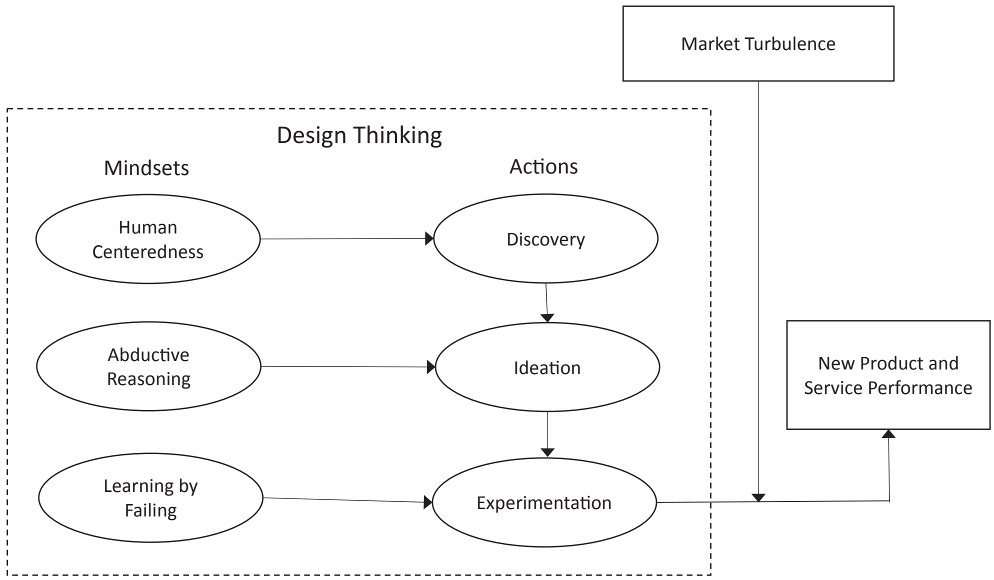

Fig. 1. Conceptual framework.

experimentation to new product and service performance.

The above hypotheses and nomological network are summarized in Fig. 1.

6. Methodology

6.1. Data collection

Data were collected by a market research company through an online survey of a panel of innovation professionals in the U.S. To qualify, participants met the criteria of managing innovation projects, having two or more years of work experience in new product or service development, and being employed in a business unit with annual revenues of $1 million or more. Titles of respondents included chief executive officer, chief innovation officer, director of service development, and product manager. Respondents more often had 3–5 years (34%) or 6–10 years (41%) of new product or service experience. Unit revenues ranged from $1 million to more than $250 million annually, with 22% earning $1 million to $4.9 million, 15% generating $5 million to $9.9 million, 14% receiving $10 million to $24.9 million, and 13% selling $25 million to $49.9 million. Table 2 details these and other sample characteristics.

To capture a variety of industries, the survey was distributed to managers employed in major sectors, including retail, agriculture, construction, manufacturing, transportation, telecommunications, and financial services. Following recommended practices for online surveys, attention filters were incorporated (Hulland, Baumgartner, & Smith, 2018). Respondents who failed to answer correctly all attention questions were removed from the final analysis. Out of 2544 panelists sent the survey, 326 qualified and successfully completed it, a completion rate (12.26%) consistent with recent managerial surveys (Miozzo, Desyllas, Lee, & Miles, 2016; Morgan et al., 2018). Fourteen respondents were removed through standard outlier treatment, resulting in a final sample of 312. To assess non-response bias, early versus late respondents were compared, under the assumption that later respondents approximate non-respondents (Armstrong & Overton, 1977). No significant differences were found between early and late respondents on key firm characteristics such as firm age (χ^2 = 1.15, p = 0.88), firm size (χ^2 = 3.25, p = 0.66) and formalization of new product development (χ^2 = 4.14, p = 0.38), as well as key respondent characteristics such as tenure with the business (χ^2 = 2.99, p = 0.55), and years of new product development experience (χ^2 = 0.12, p = 0.74). We concluded that the likelihood of non-response bias was low.

6.2. Measurement procedures

Building on prior scholarship as elaborated below, we created six measures to reflect the mindsets and actions of design thinking. For new product and service performance, we adapted a previously used measure (Page, 1993), while for market turbulence we adopted an existing scale (Jaworski & Kohli, 1993). In survey instructions, design thinking was defined and respondents were asked to answer questions about the use of design thinking in their strategic business unit (SBU), and if no SBU then for their firm. A test sample of responses indicated adequate measurement validity and reliability. The final sample, excluding the test portion, was subjected to a confirmatory factor analysis (CFA) to formally assess the measurement model. Each measurement item

Table 2
Respondent key characteristics (N = 312).

Firm Industry	%	Firm Revenues	%	Firm Employees	%	Respondent Years Innovation Experiences	%
Agriculture, Forestry, and Fishing	4	$1 - $4.9 million	22	< 20 employees	7	< 2 years	0
Mining	2	$5 - $9.9million	15	20–99 employees	22	3–5 years	34
Construction	16	$10 - $24.9 million	14	100–999 employees	37	6–10 years	41
Manufacturing	16	$25 - $49.9 million	13	1000–2499 employees	17	11–20 years	19
Transport, Comms, Utilities, Sani	12	$50 - $99.9 million	14	2500–5000 employees	9	20 + years	6
Wholesale Trade	4	$100 - $249.9 million	8	5000 + employees	8		
Retail Trade	14	$250 + million	14				
Finance, Insurance, and Real Estate	14						
Other Services	19						

Table 3
AVEs, means, standard deviations, and correlations.

	Mean (SD)	1	2	3	4	5	6	7	8
1. Abductive Reasoning (AR)	5.73 (0.95)	0.82							
2. Discovery (DS)	5.82 (1.01)	0.69	0.87						
3. Experimentation (EX)	5.74 (1.02)	0.67	0.69	0.87					
4. Human Centeredness (HC)	5.79 (0.93)	0.71	0.63	0.55	0.79				
5. Ideation (ID)	5.72 (0.97)	0.74	0.76	0.76	0.64	0.83			
6. Learning by Failing (LF)	5.41 (1.20)	0.70	0.58	0.65	0.52	0.69	0.85		
7. New Product and Service Performance (NPSP)	5.86 (0.83)	0.66	0.54	0.61	0.58	0.57	0.53	0.78	
8. Market Turbulence (MKT)	5.69 (0.93)	0.68	0.59	0.62	0.61	0.66	0.62	0.69	0.71

The diagonals are the squared root of average variance extracted (AVE), and the below are the shared correlations between constructs.

loaded significantly ($p < 0.001$) on its latent construct, with the exception of one item for market turbulence.

Each scale surpassed the 0.70 threshold for Cronbach alpha and 0.60 for composite reliability (Bagozzi & Yi, 1988) as detailed in Appendix A. Thus, convergent validity was established. Furthermore, the AVE values were higher than the shared correlations between constructs (Fornell & Larcker, 1981). With these values and the upper confidential intervals of Heterotrait-Monotrait Ratio smaller than the cutoff 0.90 (Gold, Malhotra & Segars, 2001), discriminant validity was supported. Correlations, means, standard deviations, and AVEs appear in Table 3.

Altogether the results indicated desirable psychometric properties. To assess common method variance, a procedure outlined by Podsakoff et al. (2003) and elaborated in Liang, Saraf, Hu, and Xue (2007) was performed. In a PLS measurement model we included a common method factor using all trait factors' indicators. Each indicator's explained variance was then calculated by principal construct and method factor analyses. The results showed that the average substantively explained variance was 0.68 and the average method-based variance was 0.006 (Liang et al., 2007). Furthermore, the indicator's substantive variances were 114.69 times greater than the method variance (0.68 versus 0.006), and the method factor loadings were insignificant (Appendix B). With this test showing a high ratio of trait-to-method variance, common method variance was deemed unlikely (Liang et al., 2007; Williams, Edwards, & Vandenberg, 2003).

6.3. Measures

6.3.1. Design thinking

Design thinking refers to the design-based approach to solve human problems, and is composed of three mindsets (human centeredness, abductive reasoning, and learning by failing) and three actions (discovery, ideation, experimentation). Six measures capture the multiple dimensions of design thinking, reflecting the extent to which each mindset and action is established or performed in the firm or business unit, from not at all (1) to well (7). Appendix A presents item loadings, Cronbach alphas, and composite reliabilities for the design thinking and other measures.

6.3.2. Design thinking mindsets

For the human centeredness mindset, four items capture the focus on humans when developing innovations, such as "maintaining the human perspective while solving customer problems" (Beverland et al., 2015; Gruber et al., 2015). The four items loaded significantly to produce a measure with a Cronbach alpha of 0.80. The abductive reasoning mindset was reflected in a scale of four items emphasizing possibilities by challenging what already exists (Michlewski, 2008; Liedtka, 2015; Zheng, 2018). All items, such as "asking what-if questions to discover new ideas," loaded significantly, yielding a scale with an alpha of 0.84. Finally, four items form a scale of the learning-by-failing mindset, including "inviting mistakes in order to learn" (Carlgren et al., 2016). All items loaded on one factor, with the resulting Cronbach alpha of 0.88.

6.3.3. Design thinking actions

The discovery action was measured with a 3-item scale on carrying out research to uncover deep unarticulated needs to develop fresh insights on the potential innovation (Beckman & Barry, 2008; Chen et al., 2018). Items such as "seeking to discover new insights on customers through research" all loaded as intended to produce a Cronbach of 0.85. The ideation action was measured with a 4-item scale on generating new ideas (Gruber et al., 2015; Lockwood, 2009). All items were retained in the purification process, producing a Cronbach of 0.86. The experimentation action was scaled with three items on iteratively testing and refining ideas (Gruber et al., 2015; Lockwood, 2009). All items were retained after factor and reliability analyses, resulting in a measure with a Cronbach of 0.85.

6.3.4. New product and service performance

The dependent variable of our model is new product and service performance (Montoya-Weiss & Calantone, 1994; Page, 1993). We expanded the Page (1993) new product performance measure to include services, as services are increasingly considered an important innovation along with products (Martin, Raj, & Ciravegna, 2018). The adapted measure has four items on a 7-point agreement scale assessing the success of new products and services in terms of sales, market share, profits, and return on investment relative to those of competitors'. All items were retained due to significant factor loadings. The scale had a Cronbach of 0.79.

6.3.5. Market turbulence

Market turbulence provides the exogenous contingency in our model (Moorman & Miner, 1997; Jaworski & Kohli, 1993). We adopted a well-validated measure of turbulence from Jaworski and Kohli (1993) that consists of five items, including "In our kind of business, customers' product and service preferences change quite a bit over time." All items but one loaded significantly on the expected factor. For these reasons, the low-loading item was removed, resulting in a measure with four items with a Cronbach alpha of 0.79.

6.3.6. Control variables

For model testing purposes, we included two control variables commonly applied in new product or service development studies: annual revenues and industry. Annual revenues is the dollar amount of sales the prior year, while industry reflects the ten largest standard industrial classifications. Revenue and industry can impact innovation performance, so they were included to shed light on the robustness of the model.

6.4. Hypothesis testing procedures

The hypotheses were examined using PLS-SEM, a recommended method for testing predictive effects, handling complex models, and obtaining high level of statistical power with small to medium sized samples (Chin, 1998; Hair, Hult, Ringle, & Sarstedt, 2017). Though not required in PLS-SEM, model fit was assessed with Standardized Root

Table 4
PLS-SEM hypotheses testing results.

Hypothesis	Path	β	t-value	p-value	Hypothesis Supported/ Not supported
H1	Human Centeredness → Discovery	0.64	13.74	< 0.001	Supported
H2	Abductive Reasoning → Ideation	0.41	6.50	< 0.001	Supported
H3	Learning by Failing → Experimentation	0.24	4.06	< 0.001	Supported
H4	Discovery → Ideation	0.48	6.84	< 0.001	Supported
H5	Ideation → Experimentation	0.60	10.06	< 0.001	Supported
H6	Experimentation → New Product and Service Performance	0.31	4.13	< 0.001	Supported
H7	Market Turbulence X Experimentation → New Product and Service Performance	0.04	0.44	0.67	Not supported

We included two control variables, sales and industry, in the model. Neither control variable was found to influence new product and service performance, with coefficients at β = 0.04 (p = 0.43) and β = 0.03 (p = 0.69) for sales and industry, respectively.
Though not required in PLS-SEM, model fit was assessed with Standardized Root Mean Square Residual (SRMR). The SRMR was 0.057, indicating a good fit with the data (Hu & Bentler, 1999).

Mean Square Residual (SRMR). The SRMR was 0.057, indicating a good fit with the data (Hu & Bentler, 1999). We furthermore estimated multicollinearity. Collinearity indices were below 3, except between the moderator and moderator term as expected. Falling below the threshold of 5, indices indicated no significant multicollinearity issues existed (Belsley, Kuh, & Welsch, 1980). The PLS-SEM results are reported in Table 4.

7. Results

We proposed that the mindsets of design thinking influence the actions, as represented by H1 - H3. We found human centeredness is positively tied to the action of discovery. The results are supported with a significant standardized coefficient (β = 0.64, $p < 0.001$). Thus H1 is evidenced. In the second hypothesis, we theorized that abductive reasoning is linked positively to ideation. The coefficient was significant as well, providing support for H2 (β = 0.41, $p < 0.001$). According to H3, learning by failing is positively associated with experimentation, a relationship that was supported (β = 0.24, $p < 0.001$). Next we proposed in H4 – H5 a sequence of influences among the actions of design thinking. We expected that discovery is positively related to ideation in H4 (β = 0.48, $p < 0.001$). We conclude there is evidence for H4. Thereafter, we predicted ideation to be positively tied to experimentation. The relationship was significant (β = 0.60, $p < 0.001$). Therefore, H5 is supported.

In H6, we theorized a performance consequence, namely that experimentation positively impacts new product and service performance. The result showed the positive impact of experimentation (β = 0.31, $p < 0.001$), supporting H6. Finally, we hypothesized that market turbulence positively moderates the tie between experimentation and new product and service performance (H7). However, the interaction coefficient was not significant (β = 0.04, p = 0.67). A separate multi-group test of interaction between high versus low market turbulence groups determined the difference between groups was likewise non-significant (Δβ = 0.53, p = 0.15). Those results indicated that experimentation contributes to new product and service performance regardless of the level of market turbulence. We later discuss implications of this finding.

7.1. Robustness checks

To determine the robustness of the hypothesized model, we carried out four robustness checks. First, we included two control variables, sales and industry, in the model. Neither control variable was found to influence new product and service performance: for sales (β = 0.04, p = 0.43) and for industry (β = 0.03, p = 0.69). Thus, regardless of firm industry or revenue, the empirical model is stable. Second, we conducted a mediation test of discovery to experimentation through ideation. This mediation was found to be significant (t = 3.28, p = 0.001), confirming the proposed sequence of effects among design thinking actions. Third, we tested an alternative model where each action was directly and positively linked to new product and service performance. However, neither discovery (β = 0.04, p = 0.99) nor ideation (β = 0.03, p = 0.98) had a significant coefficient, indicating that the proposed model where the effects occur from discovery to ideation and finally to experimentation is supported. Fourth, we tested the original model using regression analyses to confirm the PLS results. The regression analyses, available from the authors, were similar to those of PLS-SEM, with all hypothesized relationships significant in the directions predicted and a non-significant interaction between market turbulence with experimentation.

8. Discussion

Our study aims to address the research questions of (1) what is design thinking? (2) how does it work? (3) does it lead to innovation success? and (4) if so under which circumstances? We began our study by defining design thinking and developing a new conceptualization. Thereafter, we formulated hypotheses about how the six components relate to one another, and the ultimate impact on new product and service performance. We also hypothesized the potential moderation of this impact by market turbulence. Next we developed, adapted, or adopted construct measurements, and tested the model through a survey of innovation managers. The model was supported except for the non-significant moderation of market turbulence. Our contributions are a new conceptualization of design thinking as a dynamic multi-dimensional construct, confirmation of design thinking's positive performance outcomes, and determination of its robust effects across varying levels of turbulence. Together these contributions offer a more comprehensive framework or nomological network of design thinking for innovation. Based on these results, we draw several theoretical and managerial implications.

8.1. Theoretical implications

By conceptualizing design thinking as paired sets of mindsets and actions, this study provides a more coherent and parsimonious interpretation of design thinking over prior works. It is coherent in theorizing both mindsets and actions as integral to design thinking, and specifying components such as human centeredness and experimentation. Our conceptualization is also more parsimonious than articulations of design thinking as many possible principles, tools, methods, techniques, and concepts. We do not claim ours is the only way to understand design thinking, but offer it as one articulation especially useful for empirical investigations.

Our study finds certain mindsets influence particular actions, such as abductive reasoning on ideation. We thus contribute a view of design thinking as multi-dimensional and dynamic, accounting for linkages among its constituent parts. This notion is consistent with theories of complex human behavior and past innovation findings (e.g., Fishbein &

Ajzen, 1975; Lin & McDonough, 2014). We elaborate how design thinking is not merely a static list of tools or features, but rather dynamic couplings of mindsets and actions that in tandem create innovations. Both thinking about and performing innovation tasks eventually lead to new product and service performanace. By specifying mind-action connections, we demonstrate that thoughts are crucially linked to tasks. This perspective differs from other innovation frameworks that bypass cognitions to focus solely on activities, a shortcoming lamented in the literature (Castellion & Markham, 2013; Sethi & Iqbal, 2008).

Furthermore, we contribute an enlarged perspective on the innovation process by acknowledging the role of emotions and less rational cognitions. Innovation is typically presented in academic writings as a logical, somewhat mechanical exercise of analyzing and filling user needs (Henard & Szymanski, 2001; Kong, Gang, Feng, & Sun, 2015; Salgado et al., 2017). Yet design thinking is more nuanced, incorporating emotions that can be directed to aid the invention process, such as leveraging compassion (with users) and reducing fear (of failing) (Loch, 2017; Sethi & Iqbal, 2008). Other less rational forms of thinking are activated in design thinking, for example, abductive reasoning to engender creativity (Kelly & Kelly, 2013).

Critically we find that design thinking leads to successful new products and services. This finding confirms the long-held belief that design thinking is value-enhancing for firms. In so doing, it opens up the possibility that other methods tapping into the fuller expanse of human experiences are effective paths for innovation. More immediately, our finding suggests design thinking deserves further examination to detail its mechanisms of impact, including via intermediary outcomes such as team collaboration, new product advantage, and new service innovativeness. Additionally we show the sequential relationships among design thinking actions, such that discovery and ideation are necessary for the experimentation that leads to new product and service success.

Finally, in determining that market turbulence does not moderate the relationship of experimentation with new product and service performance, we shed light on design thinking's applications. Though often described as suitable for difficult, 'wicked' situations (Gruber et al., 2015; Liedtka, 2015), design thinking was found to have a positive impact on performance even when the environment is fairly stable and known. Thus design thinking is sufficiently robust on its own to strengthen innovation outcomes irrespective of the level of market turbulence. This finding is not entirely surprising. Studies have not consistently shown that environmental uncertainty benefits innovation outcomes, sometimes having an impact and other instances not (Evanschitzky et al., 2012).

8.2. Managerial implications

Several managerial implications flow from our study. Because design thinking was found to significantly improve new product and service performance, the chief implication is for firms to implement the approach. As managers search for new ways to reduce high rates of innovation failure, design thinking is worthy of serious consideration. This does not necessarily mean that other ways should be abandoned. It may well be that design thinking is one of several a firm uses, with the selection depending on team expertise, project type, business strategy, and other factors. Alternatively, design thinking may be applied with other approaches, such as agile project management and Stage-gate techniques. Future research may investigate when design thinking may be more effective on its own versus in combination with others.

A second managerial implication is attending to mindsets as well as actions when creating new products and services. Focusing just on actions appears direct and efficient. Innovation is often conceived as a series of tasks to do and check off. Yet without accounting for cognitive biases, the quality of work and resulting new product or service can suffer (Liedtka, 2015; Sethi & Iqbal, 2008). We found actions are determined by mindsets. Ignoring human centeredness, abductive reasoning, and learning by failing weakens discovery, ideation, and experimentation, and in the end jeopardizes innovation success. To ensure the proper mindsets are cultivated, firms will need to provide employee training to instill these ways of thinking, which are not widely practiced in business. Learning by failing for example is discouraged in many organizations (Edmondson, 2011).

A third, related implication reflects the reality that innovation programs are impacted by their surrounding organizational context. If the design thinking mindsets are to take hold, along with the actions, potential incongruencies between design thinking mindsets and the organization's mental frames should be identified, and then efforts made to minimize clashes of logic. Such efforts may include creating a separate unit for design thinking projects, and giving the chief innovation officer an organization-wide design thinking mandate. A separate unit offers time and opportunity to establish and mesh design thinking practices with the rest of the firm. Similarly, appointing a chief innovation officer with a design thinking mandate can direct resources to transform the entire firm around design thinking, removing obstacles and fostering adoption. P&G for example implemented design thinking by establishing the role of a vice president of design strategy and innovation as supported by the CEO, and rolling out design thinking initiatives to thousands of employees worldwide (Leavy, 2010).

This brings us to a fourth and fifth implication around implementation. Since we learned that design thinking is beneficial regardless of sector, revenue, and turbulence, we recommend executing design thinking in a range of industries, firm sales sizes, and changing environments. Nonetheless, other organizational characteristics may matter, such that certain firms stand to gain or lose more from implementing design thinking. The literature suggests that design thinking may conflict with entrenched functional structures and bureaucratic cultures (Carlgren et al., 2016; Rauth, Carlgren, & Elmquist, 2014). It may well be that businesses with longstanding linear, systematized, metric-based processes of innovation will resist design thinking. Therefore our last implication is that design thinking be executed after careful consideration and accommodation of existing structures, cultures, and processes.

8.3. Study limitations and future research

Our study is cross-sectional in nature, and therefore causal relationships cannot be concluded. Longitudinal data to better assess and establish causal links may be incorporated in other studies. Another limitation is that antecedents of design thinking are not known. The role of organizational, managerial, and employee variables, including mental frames and structural factors as suggested above, merit investigation. The findings would help firms enact design thinking and materialize its full benefits. Since ours is an early performative study on design thinking, we prioritized conceptualizing it and determining its direct and moderated impacts. Another line of future inquiry is to consider cultural factors. Learning by failing for example may be resisted in Confucian-based, face-sensitive cultures in Japan and South Korea (Chiou, 2001). We encourage scholars to join us in exploring further the potential of design thinking for innovation.

Appendix A. Measurements

	Items	Item loading	Cronbach's Alpha	Composite reliability
Human Centeredness	a. Empathizing deeply with customers	0.782	0.803	0.871
	b. Being more centered on customer, not business', needs	0.791		
	c. Maintaining the human perspective while solving customer problems	0.845		
	d. Understanding the context of customer needs, such as how customer lives, works.	0.753		
Abductive Reasoning	b. Pushing the boundaries of possible product or service ideas	0.833	0.838	0.892
	c. Going beyond immediately observable solutions	0.826		
	d. Asking "what if" questions to discover new ideas	0.791		
	e. Challenging "what is" or assumed in pursuit of novelty	0.832		
Learning by Failing	a. Inviting mistakes in order to learn	0.868	0.880	0.917
	b. Embracing failures because they lead to new insights	0.880		
	c. Risking failure early and often	0.804		
	d. Believing better solutions come faster by permitting failure	0.877		
Discovery	a. Collecting first-hand data on customers to discover deep needs	0.865	0.852	0.910
	b. Seeking to discover new insights on customers through research	0.888		
	c. Utilizing various methods to make fresh discoveries about customers	0.883		
Ideation	a. Generating new concepts that challenge what's assumed to work	0.864	0.858	0.904
	b. Brainstorming new concepts to meet customers' functional and emotional wants	0.806		
	c. Arriving at fundamentally new concepts by reframing problems	0.849		
	d. Asking questions to ideate new concepts	0.831		
Experimen-tation	a. Iteratively testing ideas to refine and launch new products or services	0.887	0.849	0.908
	b. Repeatedly experimenting while developing new products or services	0.888		
	c. Adjusting new product or service ideas more than once based on customer feedback	0.854		
New Product and Service Performance	a. Sales	0.805	0.787	0.862
	b. Market share	0.763		
	c. Return on investment	0.791		
	d. Profits	0.763		
Market Turbulence	a. In our kind of business, customers' product and service preference change quite a bit over time	0.775	0.788	0.862
	b. Our customers tend to look for new products or services all the time	0.804		
	c. We are witnessing demand for our products and services from customers who never bought them before	0.793		
	d. New customers tend to have product- or service-related needs different from those of our existing customers	0.758		

Appendix B. Common method bias analysis

		Substantive Factor Loading (R1)	$R1^2$	Method Factor Loading (R2)	$R2^2$
Human centeredness	HC1	0.793	0.629	−0.004	0.000
	HC2	0.792	0.627	−0.001	0.000
	HC3	0.837	0.701	0.016	0.000
	HC4	0.751	0.564	−0.012	0.000
Abductive reasoning	AR1	0.712	0.507	0.022	0.000
	AR2	0.877	0.769	−0.051	0.003
	AR3	0.775	0.601	0.021	0.000
	AR4	0.817	0.667	0.009	0.000
Learning by failing	LF1	0.824	0.679	0.050	0.003
	LF2	0.808	0.653	0.085	0.007
	LF3	0.918	0.843	−0.135	0.018
	LF4	0.886	0.785	−0.009	0.000
Discovery	DS1	0.863	0.745	0.001	0.000
	DS2	0.920	0.846	−0.035	0.001
	DS3	0.853	0.728	0.034	0.001
Ideation	ID1	0.669	0.448	0.213	0.045
	ID2	0.791	0.626	0.015	0.000
	ID3	0.999	0.998	−0.165	0.027
	ID4	0.892	0.796	−0.065	0.004
Experimentation	EXPE1	0.858	0.736	0.033	0.001
	EXPE2	0.986	0.972	−0.113	0.013
	EXPE3	0.781	0.610	0.112	0.013
New product and service performance	MKT	0.698	0.487	−0.125	0.016
	Profit	0.880	0.774	−0.125	0.016
	ROI	0.821	0.674	−0.025	0.001
	Sales	0.724	0.524	0.040	0.002
Market Turbulence	MKT1	0.731	0.534	0.070	0.005
	MKT2	0.847	0.717	−0.038	0.001
	MKT3	0.784	0.615	0.022	0.000
	MKT4	0.768	0.590	−0.008	0.000
Average		**0.822**	**0.681**	**−0.006**	**0.006**

References

Albarracin, D., Kumkale, G. T., & Johnson, B. T. (2004). Influences of social power and normative support on condom use decision: A research synthesis. *AIDS Care, 16*, 700–723.

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research, 14*, 396–402.

Austin, R., & Devlin, L. (2003). *Artful making: What managers need to know about how artists work.* Upper Saddle River: Prentice-Hall.

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhland, & J. Beckman (Eds.). *Action-control: From cognitions to behavior* (pp. 11–39). Heidelberg: Springer.

Bagno, R. B., Salerno, M. S., & Oliveira da Silva, D. (2017). Models with graphical representation for innovation management: A literature review. *R&D Management, 47*, 637–653.

Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation modes. *Journal of the Academy of Marketing Science, 16*, 74–94.

Bandura, A. (1971). *Social learning theory.* New York: General Learning Press.

Bandura, A., Adams, N. E., Hardy, A. B., & Howells, G. N. (1980). Test of the generality of self-efficacy theory. *Cognitive Therapy and Research, 4*, 39–66.

Bandura, A., & Locke, E. (2003). Negative self-efficacy and goal effect. *Journal of Applied Psychology, 88*, 87–99.

Beckman, S. L., & Barry, M. (2007). Innovation as a learning process: Embedded design thinking. *California Management Review, 50*, 25–56.

Behrens, J., & Patzelt, H. (2018). Incentives, resources, and combinations of innovation radicalness and innovation speed. *British Journal of Management, 29*, 691–711.

Belsley, D. A., Kuh, E., & Welsch, R. E. (1980). *Regression diagnostics: Identifying influential data and sources of collinearity*. New York: John Wiley.

Beverland, M. B., Wilner, S. S., & Micheli, P. (2015). Reconciling the tension between consistency and relevance: Design thinking as a mechanism for brand ambidexterity. *Journal of the Academy of Marketing Science, 43*, 589–609.

Bicen, P., & Johnson, W. H. A. (2015). Radical innovation with limited resources in high-turbulent markets: The role of lean innovation capability. *Creativity and Innovation Management, 24*, 278–298.

Bornemann, T., Scholer, L., & Homburg, C. (2014). In the eye of the beholder? The effect of product appearance on shareholder value. *Journal of Product Innovation Management, 32*, 704–715.

Bouncken, R. B., Fredrich, V., Ritala, P., & Kraus, S. (2018). Coopetition in new product development alliances: Advantages and tensions for incremental and radical innovation. *British Journal of Management, 29*, 391–410.

Brenner, W., Uebernickel, F., & Abrell, T. (2016). Design thinking as mindset, process, and toolbox: Experiences from research and teaching at the University of St. Gallen. *Design Thinking for Innovation* (pp. 3–21). Switzerland: Springer.

Brown, T. (2008). Design thinking. *Harvard Business Review, 86*, 85–92.

Carlgren, L., Elmquist, M., & Rauth, I. (2014). Design thinking: Exploring values and effects from an innovation capability perspective. *Design Journal, 17*, 403–424.

Carlgren, L., Elmquist, M., & Rauth, I. (2016). The challenges of using design thinking in industry – experiences from five large firms. *Creativity and Innovation Management, 25*, 344–362.

Chen, S., Benedicktus, R., Kim, Y., & Shih, E. (2018). Teaching design thinking in marketing: Linking product design and marketing strategy in a product development class. *Journal of Marketing Education, 40*, 176–187.

Castellion, G., & Markham, S. (2013). New product failure rates: Influence of argumentum ad populum and self-interest. *Journal of Product Innovation Management, 30*, 976–979.

Chen, K. K., Wang, C. H., Huang, S. Z., & Shen, G. C. (2016). Service innovation and new product performance: The influence of market-linking capabilities and market turbulence. *International Journal of Production Economics, 172*, 54–64.

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. In G. A. Marcoulides (Ed.). *Modern methods for business research* (pp. 295–336). Mahwah: LEA.

Chiou, J. S. (2001). Horizontal and vertical individualism and collectivism among college students in the United States, Taiwan, and Argentina. *The Journal of Social Psychology, 141*, 667–678.

Cooper, R. G. (1979). The dimensions of industrial new product success. *Journal of Marketing, 43*, 93–103.

Cooperrider, D. (2010). Managing-as-designing in an era of massive innovation. *The Journal of Corporate Citizenship, 37*, 24–33.

Cousins, B. (2018). Design thinking: Organizational learning in VUCA environments. *Academy of Strategic Management Journal, 17*, 1–18.

Dew, N. (2007). Abduction: A pre-condition for the intelligent design of strategy. *Journal of Business Strategy, 28*, 38–45.

Dunne, D. D., & Dougherty, D. (2016). Abductive reasoning: How innovators navigate the labyrinth of complex product innovation. *Organization Studies, 37*, 131–159.

Dweck, C. S. (1999). *Self-theories: Their role in motivation, personality and development.* Philadelphia: Taylor and Francis/Psychology Press.

Dweck, C. S. (2006). *Mindset.* New York: Random House.

Edmondson, A. C. (2011). Strategies for learning from failure. *Harvard Business Review, 89*, 48–55.

Eisenhardt, K. M., & Tabrizi, B. N. (1995). Accelerating adaptive processes: Product innovation the global computer industry. *Administrative Science Quarterly, 40*, 84–110.

Elsbach, K. D., & Stigliani, I. (2018). Design thinking and organizational culture: A review and framework for future research. *Journal of Management, 44*, 2274–2306.

Evanschitzky, H., Eisend, M., Calantone, R. J., & Jiang, Y. (2012). Success factors of product innovation: An updated meta-analysis. *Journal of Product Innovation Management, 29*(S1), 21–37.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research.* Reading, MA: Addison-Wesley.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*, 39–50.

Frow, P., Nenonen, S., Payne, A., & Storbacka, K. (2015). Managing co-creation design: A strategic approach to innovation. *British Journal of Management, 26*, 463–483.

Gold, A. H., Malhotra, A., &. Segars, A. H. (2001). Knowledge management: An organizational capabilities perspective. Journal of Management Information Systems, 18, 185–214.

Gruber, M., de Leon, N., George, G., & Thompson, P. (2015). From the editors: Managing by design. *Academy of Management Journal, 58*, 1–7.

Hair, J. F., Jr., Hult, G. T. M., Ringle, C., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (PLS-SEM)* (2nd ed.). Thousand Oaks: Sage Publications.

Henard, D. H., & Szymanski, D. M. (2001). Why some new products are more successful than others. *Journal of Marketing Research, 38*, 362–375.

Hu, L. T., & Bentler, P. M. (1999). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods, 3*, 424–453.

Hulland, J., Baumgartner, H., & Smith, K. M. (2018). Marketing survey research best practices: Evidence and recommendations from a review of JAMS articles. *Journal of the Academy of Marketing Science, 46*, 92–108.

IDEO (2020). Design thinking defined. https://designthinking.ideo.com/ Accessed 30 March 2020.

Interaction Design Foundation. (2020). 5 stages in the design thinking process. https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process Accessed 27 March 2020.

Jaworski, B. J., & Kohli, A. K. (1993). Market orientation: Antecedents and consequences. *Journal of Marketing, 57*, 53–70.

Johansson-Skoldberg, U., Woodilla, J., & Cetinkaya, M. (2013). Design thinking: Past, present, and possible futures. *Creativity and Innovation Management, 22*, 121–146.

Kahneman, D., & Tversky, A. (1992). Advance in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty, 5*, 297–323.

Kelly, T., & Kelly, D. (2013). *Creative confidence: Unleashing the creative potential within us all.* New York: Crown Publishing.

Kohli, A. K., & Jaworski, B. J. (1990). Market orientation: The construct, research propositions, and managerial implications. *Journal of Marketing, 54*(2), 1–18.

Kong, T., Gang, L., Feng, T., & Sun, L. (2015). Effects of marketing-manufacturing integration across stages of new product development on performance. *International Journal of Production Research, 53*, 2269–2284.

Leavy, B. (2010). Design thinking—a new mental model of value innovation. *Strategy and Leadership, 38*, 5–14.

Leonard, D., & Rayport, J. F. (1997). Spark innovation through emphatic design. *Harvard Business Review, 75*, 102–113.

Liedtka, J. (2004). Design thinking: The role of hypothesis generation and testing. In R. J. Boland, & F. Collopy (Eds.). *Managing as designing* (pp. 193–197). CA: Stanford Business Books.

Liedtka, J. (2015). Perspective: Linking design thinking with innovation outcomes through cognitive bias reduction. *Journal of Product Innovation Management, 32*, 925–938.

Liedtka, J., Ogilvie, T., & Brozenske, R. (2019). *The designing for growth field book.* New York: Columbia University Press.

Liang, H., Saraf, N., Hu, Q., & Xue, Y. (2007). Assimilation of enterprise systems: The effect of institutional pressures and the mediating role of top management. *MIS Quarterly, 31*, 59–87.

Lin, H. E., & McDonough, E. F. (2014). Cognitive frames, learning mechanisms, and innovation ambidexterity. *Journal of Product Innovation Management, 31*, 170–188.

Loch, C. H. (2017). Creativity and risk taking aren't rational: Behavioral operations in MOT. *Production and Operations Management, 26*, 591–604.

Lockwood, T. (2009). *Design thinking: Integrating innovation, customer experience, and brand value.* New York: Allworth Press.

Luotola, H., Hellstrom, M., Gustafsson, M., & Perminova-Harikoski, O. (2017). Embracing uncertainty in value-based selling by means of design thinking. *Industrial Marketing Management, 65*, 59–75.

Martin, S. L., Raj, R. G. J., & Ciravegna, L. (2018). Service advantage built on service capabilities: An empirical inquiry of international new ventures. *Journal of Business Research, 88*, 371–381.

McKinsey. (2015). Growth and Innovation. https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/how-we-help-clients/growth-and-innovation Accessed 2 April 2018.

Micheli, P., Wilner, S. J. S., Bhatti, S. H., Mura, M., & Beverland, M. B. (2019). Doing design thinking: Conceptual review, synthesis, and research agenda. *Journal of Product Innovation Management, 36*, 124–148.

Miozzo, M., Desyllas, P., Lee, H. F., & Miles, I. (2016). Innovation collaboration and appropriability by knowledge-intensive business firms. *Research Policy, 45*, 1337–1351.

Michlewski, K. (2008). Uncovering design attitude: Inside the culture of designers. *Organization Studies, 29*, 373–392.

Montoya-Weiss, M., & Calantone, R. (1994). Determinants of new product performance: A review and meta-analysis. *Journal of Product Innovation Management, 11*, 397–417.

Moorman, C., & Miner, A. (1997). The impact of organizational memory on new product performance and creativity. *Journal of Marketing Research, 34*, 91–106.

Morgan, T., Obal, M., & Anokhin, S. (2018). Customer participation and new product performance: Towards the understanding of the mechanisms and key contingencies. *Research Policy, 47*, 498–510.

Murray, J. Y., Gao, G. Y., & Kotabe, M. (2011). Market orientation and performance of export ventures: The process through marketing capabilities and competitive advantages. *Journal of the Academy of Marketing Science, 39*, 252–269.

Narver, J. C., &, Slater, S. F. (1990). The effect of a market orientation on business profitability. Journal of Marketing, 54, 20-35.

Nisula, A. M., & Kianto, A. (2016). The antecedents of individual innovative behaviour in temporary group innovation. *Creativity and Innovation Management, 25*, 431–444.

Page, A. L. (1993). Assessing new product development practices and performance: Establishing crucial norms. *Journal of Product Innovation Management, 10*, 273–290.

Perry-Smith, J. E. (2006). Social yet creative: The role of social relationships in facilitating individual creativity. *Academy of Management Journal, 49*, 85–101.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*, 879–903.

Rauth, I., Carlgren, L., & Elmquist, M. (2014). Making it happen: Legitimizing design thinking in large organizations. *Design Management Journal, 9*, 47–60.

Salgado, E. G., Sanches da Silva, C. E., Mello, C. H. P., & Samaan, M. (2017). Critical success factors for new product development in biotechnology companies. *Engineering Management Journal, 29*, 140–153.

Sandberg, B., & Aarikka-Stenroos, L. (2014). What makes it so difficult? A systematic review on barriers to radical innovation. *Industrial Marketing Management, 43*, 1293–1305.

Sarangee, K. R., Schmidt, J. B., & Wallman, J. P. (2013). Clinging to slim chances: The dynamics of anticipating regret when developing new products. *Journal of Product Innovation Management, 30*, 980–993.

Sarangee, K. R., Schmidt, J. B., & Calantone, R. I. (2019). Anticipated regret and escalation of commitment to failing: New product development projects in business markets. *Industrial Marketing Management, 76*, 157–168.

Seidel, V. P., & Fixson, S. K. (2013). Adopting design thinking in novice multidisciplinary teams: The application and limits of design methods and reflexive practices. *Journal of Product Innovation Management, 30*, 19–33.

Sethi, R., & Iqbal, Z. (2008). Stage-gate controls, learning failure, and adverse effect on novel new products. *Journal of Marketing, 72*, 118–134.

Shane, S. A., & Ulrich, K. T. (2004). Technological innovation, product development, and entrepreneurship in management science. *Management Science, 50*, 133–144.

Summers, G. J., & Scherpereel, C. M. (2008). Decision making in product development: Are you outside-in or inside-out? *Management Decision, 46*, 1299–1312.

Thomke, S. H. (1998). Managing experimentation in the design of new products. *Management Science, 44*, 743–762.

Verganti, R. (2011). Designing breakthrough products. *Harvard Business Review, 89*, 114–120.

Williams, L. J., Edwards, J. R., & Vandenberg, R. J. (2003). Recent advances in causal modeling methods for organizational and management research. *Journal of Management, 29*, 903–936.

Wu, C., Parker, S. K., & de Jong, J. P. J. (2014). Need for cognition as an antecedent of individual innovation behavior. *Journal of Management, 40*, 1511–1534.

Yu, W., Jacobs, M. A., Chavez, R., & Feng, M. (2019). Data-driven supply chain orientation and financial performance: The moderating effect of innovation-focused complementary assets. *British Journal of Management, 30*, 299–314.

Zheng, D. L. (2018). Design thinking is ambidextrous. *Management Decision, 56*, 736–756.

Dr. Cheryl Nakata is Joseph M. Bryan Distinguished Professor of Innovation and Professor of Marketing at Bryan School of Business and Economics, University of North Carolina-Greensboro. Her papers have appeared in the *Journal of Marketing, Journal of International Business Studies,* and the *Journal of Product Innovation Management*, among others. Research interests include innovation, marketing strategy, health and well-being, international marketing, and culture.

Dr. Jiyoung Hwang is Associate Professor of Marketing at Bryan School of Business and Economics, University of North Carolina-Greensboro. She holds her Ph.D. in retailing from Ohio State University and M.S. in international retailing from Michigan State University. Her research interests include the impact of conscious capitalism on business and consumers, sharing economy as disruptive innovation, and consumer behaviors regarding AI-services.