iasdr 2021 [WITH DESIGN]

PolyU Design
School of Design
The Hong Kong Polytechnic University
5–9 December 2021

Two Perspectives on Design Management Capability and Design Awareness: Design Leaders and Top Managers

[Keep this empty for blind peer review] Author's Last Name, Author's First Name*[a]; Second Author's Last Name, Second Author's First Name[b]; Third Author's Last Name, Third Author's First Name[b] [IASDR Author Name]

[a] **[Keep this empty for blind peer review]** Affiliation Organisation Name, City, Country [IASDR Affiliation]
[b] **[Keep this empty for blind peer review]** Affiliation Organisation Name, City, Country
* **[Keep this empty for blind peer review]** The corresponding author e-mail address here

Since it emerged in the 1950s, the concept of *design management* has evolved from managing design projects or organisations to the core element of strategy. With design management capability, a corporation can deploy design resources adequately and flexibly. Although models of assessing design management capability and the possible relationship between it and design awareness have been studied sufficiently in previous research, the exact relationship has never been explicitly clarified and verified. Furthermore, design awareness is always associated with top managers or other non-design managers, while in most cases, design management capability is related to design leaders. Few studies have extended design awareness to design leaders or design management capability to top managers. To fill in this gap, a survey of design leaders and top managers in 200 established firms was conducted. This research contributes to design management theory in the four following respects: 1) identifying design awareness as an independent factor apart from design management capability, 2) confirming the moderator role of design awareness between design management capability and product innovation, 3) defining two independent systems of design awareness and design management capability of design leaders and top managers and 4) reporting no cross-valued awareness between design leaders and top managers in the current frame of design management capability.

Keywords: design awareness; design management capability; product innovation; design leader; top manager

1 Introduction

As an intersection field of design and management, the scope, content and involved role of design management has continued to evolve since its emergence in the late 1950s (Farr, 1966; Kotler & Rath, 1984; Lorenz, 1987; Topalian, 1980). With the development of design management concepts, its contribution to business growth has also been defined as a crucial way of establishing competitive advantages and strategic flexibility (Acklin, 2010; Bruce et al., 1999; Chiva & Alegre, 2007, 2009; Kotler & Rath, 1984). These were achieved through design management capability (DMC), which refers to the capacity to deploy design resources adequately and dynamically (Acklin, 2010, 2013; Fernández-Mesa et al., 2013) to establish the dynamic capability of an organisation (Acklin, 2013; Teece, 1998; Teece et al., 1997).

To further understand the content of design management and apply it in practice, a series of studies on the skill set of DMC in an organisation or of a design leader (DL) have been conducted since the late 1990s (Dickson et al., 1995; Jevnaker & Bruce, 1998; Kootstra, 2009). It is further extended to DMC's contribution to product innovation (Fernández-Mesa et al., 2012) and business performance (Best et al., 2010; Chiva-Gómez et al., 2004). Based on these studies, the design awareness (DA) of top managers (TMs) is recognised as a crucial factor in improving DMC in an organisation (Song et al., 2010) or a key factor of DMC (Dickson et al., 1995). Furthermore, the different viewpoints of the benefit or potential value contributed by design according to TMs, DLs and whole organisations have also been shown (Heskett & Liu, 2012; Topaloğlu & Er, 2017). However, there are two main research gaps in previous studies. First, the relationship between DA and DMC is not clear. Whether DA is an external or internal factor of DMC is a research gap to be filled. Second, since DA is related to TMs and DMC is relevant to DLs, there may be two independent systems of DA and DMC of DLs and TMs. This needs to be clarified. To fill the gap, a conceptual model was proposed in this research. In it, the moderator effect of DA on the relationship between DMC and product innovation performance (PIP) was stated. It was further studied from two perspectives—those of DLs and TMs. As a result, the DLs and TMs of 200 firms were surveyed through a questionnaire according to our proposed conceptual model. Finally, we identified the findings of four aspects: 1) Good DA generates a higher impact on product innovation by DMC than those with lower DW; 2) DA could be viewed as an independent factor from DMC; 3) DLs and TMs represent two independent systems of DA and DMC, and 4) there is no cross-valued awareness between DLs and TMs in the current frame of DMC and DA.

2 Literature review

2.1 Design management capability

To link the theory of design management with industrial practice, the DMC framework was studied and developed in the past decade via two streams—academic research and industrial exploration (Table 1). In the academic research stream, initiated from the 1980s, most of the studies were focussed on auditing design management in a process (Dumas & Mintzberg, 1989) or an organisation (Bruce & Morris, 1994) and exploring the frame of DMC (Chiva & Alegre, 2004; Dickson et al., 1995; Jevnaker, 2000; Heskett & Liu, 2012; Manzakoğlu & Er, 2018; Moultrie, Clarkson, & Probert, 2007; Topaloğlu & Er, 2017). Among them, some frames of DMC were developed based on a literature review or discussing previous studies, instead of empirical research (e.g. Dumas & Mintzberg, 1989; Manzakoğlu & Er, 2018; Storvang et al., 2014; Topaloğlu & Er, 2017). Only a few were developed with empirical research and reported with a systematic structure based on case studies (e.g.

Jevnaker, 2000; Moultrie, Clarkson, & Probert, 2007), or quantitative surveys (e.g. Dickson et al., 1995; Heskett & Liu, 2012). Comparing all the reported frames, it was determined that the one developed based on a quantitative survey by Dickson et al. (1995) is the representative frame of DMC with an independent system.

2.2 The contribution of design management to product innovation performance

The concept of product innovation varies as a process or a result to evaluate performance. As a process, product innovation has been viewed from three perspectives—portfolio management of the product (Cooper et al., 1999; Killen et al., 2008), formalisation of the process (Chiesa & Masella, 1996; Cooper & Kleinschmidt, 1995; Tatikonda & Rosenthal, 2000) and organisation of product innovation and its relationship with other functional organisation (Cohen & Klepper, 1996).

Based on the *Design Management Skills* reported by Dickson et al. (1995), a series of studies was conducted to indicate the positive relationship between DMC and organisational learning capability (Fernández-Mesa et al., 2012), design function organisation (Chiva & Alegre, 2007), design investment (Chiva & Alegre, 2009) and PIP (Fernández-Mesa et al., 2012). This indicates that DMC could directly or indirectly contribute to PIP. Meanwhile, its relationship with design organisation and design investment could be explained as different roles of design in new product development (NPD) process, such as functional specialism, part of a multifunctional team or NPD process leader (Perks et al., 2005).

2.3 The moderating effect of design awareness

DA shows the awareness of the benefit or potential value contributed by design. Different terms may be used for this concept, such as design attitude (Boland & Collopy, 2004), design sensitivity (Kotler & Rath, 1984) and culture for design (Design Council, 1999). In previous studies, the subject of design 'awareness' has generally been conducted from two sides—external and internal. The external side generally refers to a consumer's DA and an individual's ability to recognise attributes that have been created in an object with an instrumental and symbolic purpose (Arboleda & Alonso, 2014). The internal side included TMs' DA and the attitudes toward design throughout an organisation (Design Council, 1999; Heskett & Liu, 2012). The latter is the DA in the scope of DMC defined in our research.

DA is either a factor of DMC or an independent factor contributing to it. In previous studies, DA was shown in a number of frameworks of DMC as a critical factor, such as the *Design Management Staircase* developed by Design Management Europe (Kootstra, 2009) and the *Design Atlas Audit Framework* by the British Design Council (1999). With these frameworks, a management team could apply a product development process with a holistic view (Conley, 2004), enhance their capability of dealing with dynamic issues (Jevnaker, 1998) and initiate product innovation through empathy (Brown, 2008). In other cases, DA could be an independent factor contributing to design management effectiveness through including design in decision making and applying design thinking in various forms of design work (Kotler & Rath, 1984). As a result, the relationship between DA and DMC is confused. This is the first research gap we defined. Based on this, our first research question is formulated as follows: *Can DA be viewed as an external factor of DMC, and does it play a moderator role between DMC and innovation performance?*

In the research under discussion, to investigate the relationship between DA, DMC and PIP, both a TM's design 'awareness' and a DL's DA of their 'value' were taken into consideration. The

perspectives of the DL and TM were studied in the context of both DA and DMC. As a consequence, a conceptual model was proposed in this study, and a quantitative methodology was used to validate it (Figure 1).

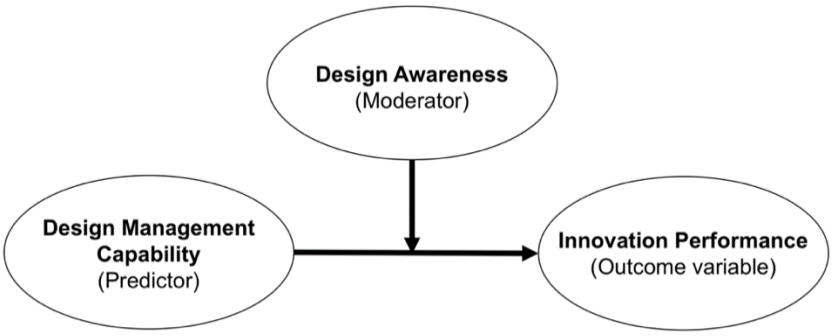

Figure 1. The conceptual model with the hypothesised moderation effect of design awareness (DA).

2.4 Design leaders and top managers

Concerning the two roles, both DLs and TMs should have their DMC to contribute strategy, innovation and change management (Acklin & Fust, 2014). For DA, the discussion usually involves the TM, functional manager and organisation instead of the designer, design team and DL.

1. Design leaders: Design management capability and design awareness

In this research, the term DL includes various titles, such as design manager, team leader, design director and head of the design centre. It refers to the top leader of the design function in a business organisation. DLs not only manage the design team and function in an organisation but also communicate design internally and externally.

In previous studies, DMC has generally been discussed at the organisational level (Cooper & Press, 1995; Design Council, 1999; Dumas & Mintzberg, 1989; Kotler & Rath 1984; Manzakoğlu & Er, 2018; Ramlau & Melander, 2004; Topaloğlu & Er, 2017). A few studies have particularly emphasised the role of DL in DMC, such as the Competency Model for Designers by the NEDO Garment and Textile Sector Group (1993) about the design capability of professional designers and capability of design champion by Jevnaker (2000) for DLs in an organisation, with certain capability related to design management. For DA of DLs, it is rarely studied, since it is assumed that they have sufficient DA. This implies that, in terms of DMC and DA of DLs, no systematic study has been performed.

2. Top managers: Design management capability and design awareness

In this research, TM refers to the head of a business organisation, although such individuals may have various titles, such as chief executive officer (CEO) and general manager. In previous studies, the DMC and DA of an organisation are always mixed up with that of the TM. For example, the Design Management Skills reported by Dickson et al. (1995) are based on a survey of CEOs. However, the result is reported as the skillset of an organisation.

DA is generally discussed within the role of non-design professionals and TMs. Gorb and Dumas (1987) proposed the ‘silent design’ concept to identify the design management done by non-design managers in an organisation. Song has conducted a series of studies on the role of CEOs in design management (Song et al., 2010). The difference between DA of TM and the whole organisation is

first identified by Heskett and Liu (2012) as two scales of the DA factor to evaluate the way of managing design.

From the perspective of TM, DA is an independent and external factor from DMC. However, this has not been clarified in previous studies. In this instance, we define the research gaps, noting that there has been no systematic study on DA and DMC of DLs and TMs. To fill the second research gap, we propose the following research question: *Do TMs and* DL*s have different perspectives of DA and design management?*

2.5 The conceptual model from two perspectives

Taking the two perspectives of DA and DMC from DLs and TMs into consideration, the proposed conceptual model was modified based on the following main hypothesis:

DA acts as the moderator variable between DLs' and TMs' DMC and PIP.

This hypothesis can be broken down into four hypotheses, including the two roles of DL and TM (Figure 2):

Hypothesis 1*.* The DL's DA acts as the moderator variable for the relationship between their DMC and their view of PIP.

Hypothesis 2. The TM's DA acts as the moderator variable for the relationship between the DL's DMC and PIP.

Hypothesis 3. The DL's DA acts as the moderator variable for the relationship between the TM's DMC and TM's PIP.

Hypothesis 4. The TM's DA acts as the moderator variable for the relationship between their DMC and view of PIP.

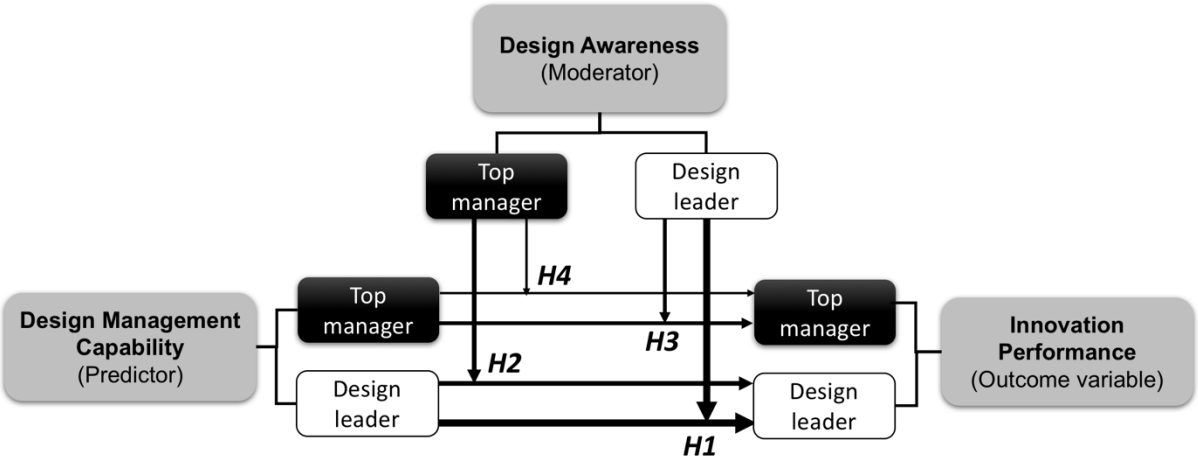

Figure 2. Concept model of the four hypotheses.

Hypotheses 1 and 4 aim to verify the contribution of the DL's or TM's DMC to product innovation performance with their DA as the moderator. If these hypotheses are supported, it implies that both DL and TM have their DMC, which could contribute to innovation performance and be enhanced by their DA.

Hypotheses 2 and 3 aim to indicate the inter-reorganisation between DLs and TMs. The consider whether TMs could be fully aware of the DMC of DLs; such awareness would enhance the contribution of DL's DMC to innovation performance. The same is true of the DL's DA working on the TM's DMC. Once these two hypotheses are supported, it indicates that the DA of one role will enhance the contribution of another role to innovation performance.

3 Method

3.1 Data collection

Our research hypotheses were tested on manufacturing industries in Mainland China, which is largely globalised. The Chinese manufacturing industries have a significant role in the transformation of the nation from a manufacturing giant into a world manufacturing power guided by the 'Made in China 2025' initiative (Li, 2017), a first 10-year plan for remedying China's manufacturing problems with a comprehensive upgrading of the sector and emphasis on seeking innovation-driven development, applying intelligent technologies, strengthening foundations and pursuing green development (Liu et al., 2018). With this vision, Innovation Design was proposed and defined as a driving force of product, process and business model innovation. Instead of extending the concepts of industrial design, the origins of which were generated in an industrial economy based on mass production (Gardien et al., 2014), Innovation Design represents the role and value of design in the new era of the knowledge economy. For the Chinese manufacturers at this stage, DA, DMC and PIP are the key issues in upgrading their innovation capability.

The survey was directed to a pre-recruited, non-probabilistic sample (Couper, 2000) consisting of 300 potential respondents. To ensure a high response level, the questionnaires were sent to the firms through various channels, primarily email, phone calls and face-to-face interviews. As a result, the total number of qualified responses was 200. In each firm, one questionnaire was completed by the DL and the other by the TM. The questionnaires covered the same factors of DA, DMC and PIP.

3.2 The samples

In this case, samples were selected according to the three following criteria: 1) belonging to typical product categories in the manufacturing industry, 2) experience with using design and 3) having a DL in the current organisation. Of the 200 firms surveyed, several categories are of relevance. In terms of design in business types, 7% were in the original equipment manufacturing (OEM), 17% in the original design manufacturing (ODM), 47% in the original brand management (OBM), and 29% in the original strategy management (OSM); regarding the number of employees, 6% had fewer than 10 employees, 30% had 10–50 employees, 12% had 50–100 employees, 13.5% had 100–200 employees, 15.5% had 200–1000 employees and 26.5% had more than 1000 employees.

The TMs in this sample had an average age of 41.26 years (standard deviation [SD] = 8.68); 20.5% were female, the average organisational tenure was 8.53 years (SD = 6.70) and 79.5% of them had obtained a bachelor's degree or higher qualification. The DLs in this sample had an average age of 34.89 years (SD = 6.51); 21% were female, the average organisational tenure was 5.67 years (SD = 5.07) and 96.5% of them had obtained a bachelor degree or higher qualification.

3.3 Measures

DMC was measured using the scale with 16 items reported by Dickson et al. (1995). These items were applied using a 7-point Likert scale (see Appendix). For *DA*, the *Design Management Staircase*

(Kootstra, 2009) measurement scale of awareness was used in the analysis. A four-level scale of DA was applied according to the four levels of design management in the staircase. *PIP* was measured using the scale reported in the *Oslo Manual* by the Organisation for Economic Co-operation and Development (OECD, 2005).

4 Results

Table 1 displays the means, standard deviations, and correlations among the variables. To test the hypotheses, hierarchical regression analysis was used. To minimise a potential multicollinearity issue, all three main variables were centred prior to forming interaction terms (Aiken et al., 1991).

Table 1. Means, Standard Deviations, Correlations and Measure Reliabilities

Variable	M	SD	1	2	3	4	5	6
1. DMC (TM)	5.13	1.03	—					
2. DMC (DL)	5.23	.98	.110	—				
3. DA (TM)	3.03	.61	.385**	.032	—			
4. DA (DL)	3.03	.53	-.072	.477**		—		
5. PIP (TM)	5.06	1.02	.679**	.131	.319**	-.026	—	
6. PIP (DL)	5.07	1.13	-.005	.622**	-.003	.461**	.086	—

Notes:

1) *N* = 200. *p < .05. **p < .01.

2) DMC: Design management capability, DA: design awareness, TM: top manager, DL: design leader, product innovation performance

The hypotheses were tested using hierarchical regression analysis following Baron and Kenny's (1986) method using SPSS 20.0. First, the independent variable and moderator were put into the regression model to predict the dependent variable (Innovation reported by DLs/Innovation reported by TMs). In the second step, the interaction term of the independent variable and moderator were added to the regression model to predict the same dependent variable. The moderating effect could be supported if the coefficient of the interaction term was statistically significant. Table 2 shows the hierarchical regression results for innovation reported by DLs and TMs.

Table 2. Hierarchical Regression Results for Innovation Reported by the Design Leader (DL) and Top Manager (TM)

	Innovation reported by DL								**Innovation reported by TM**							
	Model 1		**Model 2**		**Model 3**		**Model 4**		**Model 5**		**Model 6**		**Model 7**		**Model 8**	
	β	*t*	β	*t*	β	*t*	β	*t*	β	*t*	β	*t*	β	*t*	β	*t*
Independent variable																
DMC of DL	.520***	8.436	.548***	8.783	.623**	11.157	.975**	3.098								
DMC of TM									.681***	13.001	.458	1.408	.653***	11.576	.125	0.496
Moderator																
DW of DL	.213**	3.459	.230***	3.740					.023	.437	-.182	-.606				
DW of TM					-.023	-.404	.36	1.055					.068	1.207	-.443	-1.8
Interaction terms																
DMC_DL * DW_DL			.124*	2.189												

DMC_DL * DW_TM							-.532	-1.137							
DMC_TM * DW_DL											.073	.106			
DMC_TM * DW_TM														.872*	2.141
R^2	.422		.436		.387		.391		.462		.463		.466	.478	
R^2 change			.014*				.004				.001			.012*	

Notes:

1) *p < .05; **p < .01; ***p < .001.

2) H1: Model 1 + Model 2; H2: Model 7 + Model 8; H3: Model 5 + Model 6; H4: Model 3 + Model 4

3) DMC: Design management capability; DW: Design awareness.

Hypothesis 1 predicted that DLs' DA acts as the moderator variable for the relationship between a DL's DMC and their view of PIP. As shown in Model 2 in Table 2, the interaction term of DMC of DL and DW of DL was significantly related to Innovation reported by TMs (β = .124, p < .05). The R^2 value also increased significantly after the interaction term was included in the regression model (ΔR^2 = .014, p < .05). Thus, hypothesis 1 was supported. To further understand the details of the moderating effect, the interaction effect was plotted based on the values ±1 SD from the mean value of DW for DLs (Figure 3). Figure 4 shows that the positive relationship between the DMC of DLs and innovation reported by DLs was more significant when the DW of DLs was high than when the DW of DLs was low.

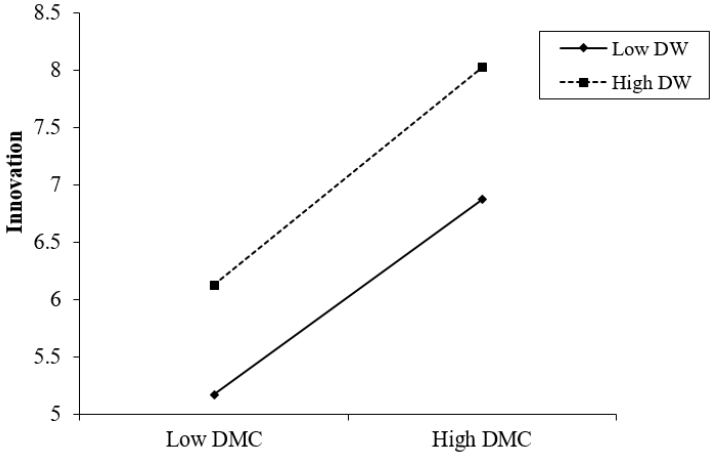

Figure 4. Interactive effects of design leaders' (DLs') design management capability (DMC), design awareness (DA) and product innovation performance (PIP).

Hypothesis 2 predicted that a TM's DA acts as the moderating variable for the relationship between a DL's DMC and their view of PIP. As shown in Model 4 in Table 3, the interaction term of DMC of DL and DW of TM was not significantly related to Innovation reported by DLs (β = -.532, n.s.). The R^2 value was not significantly increased compared with Model 3 (ΔR^2 = .004, n.s.). Thus, hypothesis 2 was not supported.

Hypothesis 3 predicted that a DL's DA acts as the moderating variable for the relationship between a TM's DMC and the TM's PIP. This hypothesis was tested using Models 5 and 6 (Table 3). As may be seen from Model 6 in Table 3, the interaction term of DMC of TM and DW of DL was not significantly related to Innovation reported by TMs (β = .073, n.s.). The R^2 value was not significantly increased compared with Model 5 (ΔR^2 = .001, n.s.). Thus, hypothesis 3 was not supported.

Hypothesis 4 predicted that a TM's DA acts as the moderating variable for the relationship between a TM's DMC and their view of PIP. As shown in Model 8 in Table 3, the interaction term of DMC of TM and DW of TM was significantly related to Innovation as reported by TMs (β = .872, $p < .05$). The R^2 value also increased significantly after the interaction term was incorporated into the regression model (ΔR^2 = .012, $p < .05$). Thus, hypothesis 4 was supported. To further uncover the details of the moderating effect, the interaction effect was plotted based on the values plus and minus 1 SD from the mean value of DW of TM (Figure 4). Figure 5 shows that the positive relationship between the DMC of a TM and innovation reported by TMs was more significant when the DA of the TM was high than it was when the DA of the TM was low.

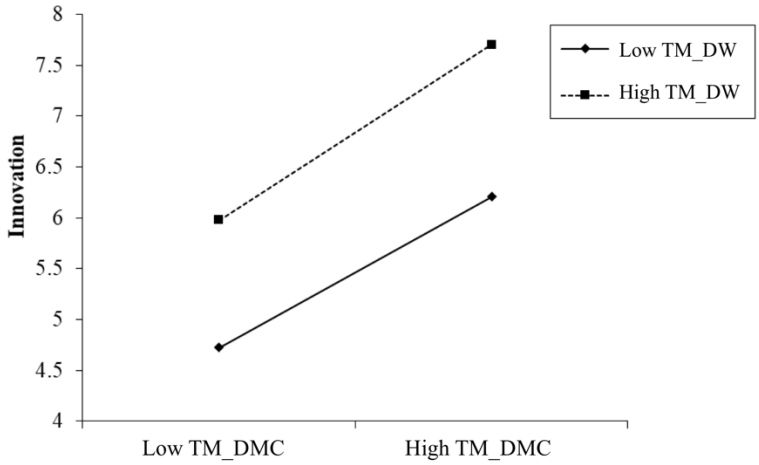

Figure 5. Interactive effects of top managers' (TMs') design management capability (DMC), design awareness (DA) and product innovation performance (PIP).

5 Discussion

5.1 Good design awareness generates a higher impact on product innovation by design management capability

The moderating effect of DA on DMC and product innovation was examined. In the test of hypothesis 1, a DL's DMC was found to be positively associated with their view of PIP, and their DA moderated this association. From the perspective of a TM, hypothesis 4 indicated the same result. This means that DMC contributes to PIP, while DA could enhance performance as an interactive factor from both the perspectives of DLs and TMs. Although this relationship has been mentioned in previous studies (Alegre-Vidal et al., 2013; Fernández-Mesa, 2013), it is verified systematically for the first time in this research. This answers the question of why a firm should invest in improving DA and clarifies the relationship between DA and PIP.

With the supported *hypotheses 1 and 4*, the moderator role of DA between DMC and innovation performance has been verified. On the one hand, the result supports the positive relationship between DA and DMC. On the other, it indicates that the effect of DMC on innovation performance

could be enhanced by increased DA. Furthermore, it clarifies that DA could be an independent variable, departing from DMC. This fills the first research gap and answers the research question. It will support design practice with the reasons for improving DA.

5.2 Two systems of design management capability: Design leader and top manager

Besides confirming DA as an independent factor from DMC, the independent perspectives of DL and TM were also explored and reported in this research. The supported hypotheses 1 and 4 indicated that, within each perspective, the hypothesised conceptual model was supported. This implied that DLs and TMs have distinct DMCs and DAs. Both contribute to better innovation performance. With this result, the following were reported: 1) the subject of DA could be divided into the differing spheres represented by DL and TM; 2) the viewpoint of DMC could also be separated into two, specifically, DL and TM; 3) in the two independent systems, the findings in the last section is valid.

5.3 No cross-value between design leaders and top managers

Cross-valued awareness is lacking between DLs and TMs. The intersection of the two value systems, those of DLs and TMs, was studied in this research with hypotheses 2 and 3. However, the results did not support the hypothesised conceptual model. The unsupported relationship implied that TMs' design 'awareness' and DL's DA of their 'value' are two independent and separate systems at this stage. There is no interaction between the two value systems. In practice, this means that, even if TMs have good DA, it may not lead to better DMC of DLs and better innovation performance as outcomes. Similarly, DLs' good DA may not result in improved DMC of TMs.

6 Conclusion

Design management is crucial for business growth since it contributes to both competitive advantages and strategic flexibility (Acklin, 2010; Bruce et al., 1999; Chiva & Alegre, 2007, 2009; Kotler & Rath, 1984). DMC refers to the capacity to deploy design resources in an adequate and dynamic way (Acklin, 2010, 2013; Fernández-Mesa et al., 2013), as well as to contribute to the dynamic capability of an organisation (Acklin, 2013; Teece et al., 1997). Models of assessing design capability and design management have been explored and reported since the 1980s. These models were popularly applied in diagnosing the DMC of a firm or guiding policymaking through assessing design capability in an industry. However, the role and relationship of DA and DMC is not clear. In some models, DA is part of DMC, while in other research, an interactive relationship between them is proposed. This is the research gap we defined. Moreover, concerning the design management mode, the distinguished role of TM and DL was proposed without further description and definition (Acklin & Fust, 2014). This is another research gap that triggered our research motivation.

Based on the identified gaps, this research was undertaken to explore the role of DA in enhancing DMC and PIP and to explore the performance of DA in the above relationships from two perspectives, those of DLs and TMs, as well as to validate the proposed relationship. Through a survey of 200 firms with their DLs and TMs, the hypothesised moderator role of DA for DMC and product innovation was supported. This implied that DA could be an independent factor beyond DMC; better DA could enhance DMC and lead to better performance of product innovation. Moreover, DA and DMC could be viewed from two independent perspectives, those of DLs and TMs, which also represent two different value systems of design in business practice; the two perspectives do not intersect. The research findings contributed to a systematic and holistic view of DMC and its relationship with DA.

The research is a pilot study on DMC and DA from the perspectives of DL and TM. With the defined relationship and perspective, the content of DLs' DA and DMC, as well as TMs' DA and DMC, could be further explored in the near future.

Acknowledgements. After being accepted, authors can put their acknowledgements here before the references. Acknowledgements can include information about grants, awards, or other types of funding that you have received to support your research. [IASDR_Acknowledgement]

References

Acklin, C. (2010). Design-driven innovation process model. *Design Management Journal*, *5*(1), 50–60.

Acklin, C. (2013). Design management absorption model: A framework to describe and measure the absorption process of design knowledge by SMEs with little or no prior design experience. *Creativity and Innovation Management*, 22(2), 147–160.

Acklin, C., & Fust, A. (2014). *Towards a dynamic mode of design management and beyond* [Paper presentation]. 19th DMI: Academic Design Management Conference; Design Management in an Era of Disruption, London, United Kingdom.

Ahopelto, J. (2002). *Design management as a strategic instrument.* Universitas Wasaensis.

Aiken, L. S., West, S. G., & Reno, R. R. (1991). *Multiple regression: Testing and interpreting interactions*. Sage.

Alegre, J., Sengupta, K., & Lapiedra, R. (2013). Knowledge management and innovation performance in a high-tech SMEs industry. *International Small Business Journal*, *31*(4), 454–470.

Arboleda, A. M., & Alonso, J. C. (2014). Design awareness and purchase intention: An item response theory approach. *Academia Revista Latinoamericana de Administración*, *27*(1), 138–155.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173.

Best, K., Kootstra, G., & Murphy, D. (2010). Design management and business in Europe: A closer look. *Design Management Review*, *21*(2), 26–35. https://doi.org/10.1111/j.19487169.2010. 00062.x

Blaich, R., & Blaich, J. (1993). *Product design and corporate strategy: Managing the connection for competitive advantage*. McGraw-Hill.

Boland, R. J., Jr., & Collopy, F. (2004). *Managing as Designing*, Stanford University Press.

Borja de Mozota, B. (2003). Design management: Using design to build brand value and corporate innovation. Simon and Schuster.

Brown, T. (2008). Design thinking. *Harvard Business Review*, *86*(6), 84.

Bruce, M., & Bessant, J. R. (2002). *Design in business: Strategic innovation through design.* Pearson Education.

Bruce, M., Cooper, R., & Vazquez, D. (1999). Effective design management for small businesses. *Design Studies*, *20*(3), 297–315.

Bruce, M., & Morris, B. (1994). Managing external design professionals in the product development process. *Technovation*, *14*(9), 585–599.

Chiesa, V., & Masella, C. (1996). Searching for an effective measure of R&D performance. *Management Decision*, *34*(7), 49–57.

Chiva, R., & Alegre, J. (2007). Linking design management skills and design function organization: An empirical study of Spanish and Italian ceramic tile producers. *Technovation*, *27*(10), 616–627.

Chiva, R., & Alegre, J. (2009). Investment in design and firm performance: The mediating role of design management. *Journal of Product Innovation Management*, *26*(4), 424-440.

Chiva, R., & Alegre, J. (2004). Design management approaches in the Spanish ceramic sector: a comparative case study. *International Journal of Product Development*, *1*(2). doi:10.1504/ijpd.2004.005703

Chiva-Gómez, R., Alegre-Vidal, J., & Lapiedra-Alcamí, R. (2004). A model of product design management in the Spanish ceramic sector. *European Journal of Innovation Management*, *7*(2), 150–161.

Chiva-Gómez, R., Camisón-Zornoza, C., & Lapiedra-Alcamí, R. (2003). Organizational learning and product design management: Towards a theoretical model. *The Learning Organization*, *10*(3), 167–184.

Cohen, W. M., & Klepper, S. (1996). Firm size and the nature of innovation within industries: The case of process and product R&D. *Review of Economics and Statistics*, *78*(2), 232–243.

Conley, C. V. (2004). Contextual research for new product development. In *The PDMA handbook of new product development* (pp. 228–248).

Cooper, R., & Press, M. (1995). *A guide to successful design management: The design agenda*. John Wiley & Sons.
Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (1999). New product portfolio management: Practices and performance. *Journal of Product Innovation Management*, *16*(4), 333–351.
Cooper, R. G., & Kleinschmidt, E. J. (1995). Benchmarking the firm's critical success factors in new product development. *Journal of Product Innovation Management*, *12*(5), 374–391.
Couper, M. P. (2000). Web surveys: A review of issues and approaches. *Public Opinion Quarterly*, *64*(4), 464–494.
Design Council (1999). *The bigger picture: Design atlas*. Council of Industrial Design, UK.
Dickson, P., Schneier, W., Lawrence, P., & Hytry, R. (1995). Managing design in small high-growth companies. *Journal of Product Innovation Management*, *12*(5), 12.
Dumas, A., & Mintzberg, H. (1989). Managing design designing management. *Design Management Journal (Former Series)*, *1*(1), 37–43.
Farr, M. (1966). *Design management*. Hodder and Stoughton.
Fernández-Mesa, A., Alegre-Vidal, J., Chiva-Gómez, R., & Gutiérrez-Gracia, A. (2012). *Design management capabilities: Its mediating role between OLC and innovation performance in SMEs* [Paper presentation]. DRUID Academy 2012, University of Cambridge/The Moeller Centre.
Fernández-Mesa, A., Alegre-Vidal, J., Chiva-Gómez, R., & Gutiérrez-Gracia, A. (2013). Design management capability and product innovation in SMEs. *Management Decision*, *51*(3), 547–565.
Gardien, P., Djajadiningrat, T., Hummels, C., & Brombacher, A. (2014). Changing your hammer: The implications of paradigmatic innovation for design practice. *International Journal of Design*, *8*(2), 119–139.
Gemser, G., & Leenders, M. A. A. M. (2001). How integrating industrial design in the product development process impacts on company performance. *Journal of Product Innovation Management*, *18*(1), 28–38.
Gorb, P. (1990). Design as a corporate weapon. In P. Gorb (Ed.), *Design management* (pp. 62–94). Architecture Design and Technology Press.
Gorb, P., & Dumas, A. (1987). Silent design. *Design studies*, *8*(3), 150–156.
Hertenstein, J. H., Platt, M. B., & Veryzer, R. W. (2005). The impact of industrial design effectiveness on corporate financial performance. *Journal of Product Innovation Management*, *22*(1), 3–21.
Heskett, J., & Liu, X. (2012). Models of developing design capacity: Perspective from China. In E. Bohemia, J. Liedtka, & A. Rieple (Eds.), *Proceedings of the DMI 2012 International Research Conference* (pp. 225–238).
Jevnaker, B. H. (1998). Building up organizational capabilities in design. *Management of Design Alliances: Sustaining Competitive Advantage*, *13*.
Jevnaker, B. H. (2000). Championing design: Perspectives on design capabilities. *Design Management Journal Academic Review*, *1*(1), 25–39.
Jevnaker, B. H., & Bruce, M. (1998). Design alliances: The hidden assets in management of strategic innovation. *The Design Journal*, *1*(1), 24–40.
Killen, C. P., Hunt, R. A., & Kleinschmidt, E. J. (2008). Project portfolio management for product innovation. *International Journal of Quality & Reliability Management*, *25*(1), 24–38.
Kootstra, G. L. (2009). *The incorporation of design management in today's business practices: An analysis of design management practices in Europe. Design Management.* ADMIRE Programme.
Kotler, P., & Alexander Rath, G. (1984). Design: A powerful but neglected strategic tool. *Journal of Business Strategy*, *5*(2), 16–21.
Li, J. (2017). Analyzing 'Made in China 2025' under the background of 'Industry 4.0'. In *Proceedings of the 23rd International Conference on Industrial Engineering and Engineering Management 2016* (pp. 169–171). Atlantis Press.
Liu, S. X., Liu, H., & Zhang, Y. (2018). The new role of design in innovation: A policy perspective from China. *The Design Journal*, *21*(1), 37–58.
Lorenz, C. (1987). *The design dimension: The new competitive weapon for business*. Blackwell.
Lorenz, C. (1994). Harnessing design as a strategic resource. *Long Range Planning*, *27*(5), 73–84.
Manzakoğlu, B. T., & Er, Ö. (2018). Design management capability framework in global value chains: Integrating the functional upgrading theory from OEM to ODM and OBM. *The Design Journal*, *21*(1), 139–161.
Moultrie, J., Clarkson, P. J., & Probert, D. (2007). Development of a design audit tool for SMEs. *Journal of Product Innovation Management*, *24*(4), 335–368.
Moultrie, J., Nilsson, M., Dissel, M., Haner, U. E., Janssen, S., & Van der Lugt, R. (2007). Innovation spaces: Towards a framework for understanding the role of the physical environment in innovation. *Creativity and Innovation Management*, *16*(1), 53–65.

NEDO ‘Competencies that discriminate outstanding designers’ NEDO Garment and Textile Sector Group.
(1993). *Best practice in design and development.* PE International.
Organisation for Economic Co-operation and Development. (1996). The knowledge-based
economy. *Organization for Economic Cooperation and Development,* OEeD, OECD, 2:1-46.
Perks, H., Cooper, R., & Jones, C. (2005). Characterizing the role of design in new product development: An empirically derived taxonomy. *Journal of Product Innovation Management*, *22*(2), 111–127.
Ramlau, U. & Melander, C. (2004). In Denmark, design tops the agenda. *Design Management Journal*, *15*(4):48–54.
Sexton, D. L., & Bowman, N. (1985). The entrepreneur: A capable executive and more. *Journal of Business Venturing*, *1*(1), 129–140.
Smith, B. (1977, March). The morality and management of design. *Journal of Royal Society of Arts*, 193–210.
Song, M. J., Nam, K. Y., & Chung, K. W. (2010). The chief executive’s influence on corporate design management activities. *Design Management Journal*, 5(1), 61–71.
Storvang, P., Jensen, S., & Christensen, P. R. (2014). Innovation through design: A framework for design capacity in a Danish context. *Design Management Journal*, *9*(1), 9–22.
Tatikonda, M. V., & Rosenthal, S. R. (2000). Successful execution of product development projects: Balancing firmness and flexibility in the innovation process. *Journal of Operations Management*, *18*(4), 401–425.
Teece, D. J. (1998). Capturing value from knowledge assets: The new economy, markets for know-how, and intangible assets. *California Management Review*, *40*(3), 55–79.
Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509–533.
Topalian, A. (1980). *The management of design projects*. Associated Business Press.
Topaloğlu, F., & Er, Ö. (2017). Discussing a new direction for design management through a new design management audit framework. *The Design Journal*, *20*(Supp. 1), S502–S521.
Walsh, V., Roy, E., Bruce, M., & Potter, S. (1992). *Winning by design: Technology, product design, and international competitiveness*. Blackwell.
Willcock, J. (1981, April). The design triangle. *Designer*, 7–8.
Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review*, *27*(2), 185–203.