Modeling technological innovation performance and its determinants: An aspect of buyer–seller social capital

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ARTICLE INFO

ABSTRACT

This study validates a research model that examines technological innovation performance from the aspect of buyer–seller social capital in business-to-business (B2B) contexts. Drawing on social capital theory, this study postulates that innovation performance is indirectly affected by buyer–seller social capital via the mediation of *commitment to innovation* and *customer knowledge development*. The commitment to innovation also has an influence on customer knowledge development. The model examines the data obtained from high-tech firms' personnel in Taiwan. The study's test results indicate that innovation performance is positively influenced by shared norms and trust through the mediation of customer knowledge development. Accordingly, innovation performance is also positively influenced by social interaction and shared norm through the mediation of the commitment to innovation. Lastly, managerial implications and limitations from the empirical findings are provided.

1. Introduction

Innovation is a new way of doing something or a new thing that is made useful. It may be accomplished through developing new products, reformulating existing ones, and so on [1]. Given a high failure rate of innovation and the high costs associated with innovation development [2], maximizing innovation performance is often an important issue of theoretical and managerial interests. An original driver of innovation performance in business-to-business (B2B) contexts is buyer–seller social capital, which refers to the features of business societies that facilitate the social relationship and cooperation between buyers and sellers in industries (e.g., [3]). Customers (i.e., buyers in B2B settings) have fundamentally changed the dynamics of the market, which has become a forum in which the customers play an active role in the innovation of sellers (e.g., R&D teams) through co-design or co-production [4]. This phenomenon suggests the importance of buyer–seller social capital (e.g., between R&D teams and their buyers in B2B contexts) in the innovation development processes. For example, previous research indicates that customer involvement can substantially serve as a vehicle for sellers' innovation development [5].

Over the last decade or so, the concept of social capital has captured the attention of sociologists (e.g., [3, 6]) and organizational theorists (e.g., [7]) as a way of understanding why people in social communities, organizations, and industry clusters share information and ideas with each other, even when there is no legal obligation or expectations of personal gains from doing so. Social capital is important in building intellectual capital of work groups or organizations [7, 8]. Based on the social capital fostered between customers and innovation developers, an understanding of customer experiences, perception, demand, expectations, and preferences (namely, customer knowledge) can be effectively obtained by the innovation developers such as R&D teams or work groups [2, 9], eventually enhancing the teams' innovation performance [2].

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Even if social capital ultimately leads to improve such outcome as innovation performance, the strength and nature of this association through its potential mediators still remain underexamined. This study proposes two critical mediators, commitment to innovation and customer knowledge development, which fully mediate the relationship between buyer–seller social capital and innovation performance in B2B contexts. For instance, some studies argue a positive relationship between the vendor's levels of customer interaction (i.e., a form of buyer–seller social capital) and the vendor knowledge of the customer (i.e., customer knowledge) [10]. Other studies further indicate that the greater the knowledge possessed by sellers for how customers think of a product (i.e., customer knowledge), the greater the likelihood there will be for a successful new product development (i.e., innovation performance) [10]. Similarly, strong buyer–seller social capital is likely to encourage sellers to fulfill their obligations towards innovation development (i.e., commitment to innovation), consequently enhancing their innovation performance. Collectively, these studies together imply an indirect linkage between social capital and innovation performance via the mediation of customer knowledge development.

Either commitment to innovation or customer knowledge development has been respectively included in previous research as a predictor of innovation processes (e.g., [2, 11, 12]), but none of the previous research has tried to simultaneously take both into account for explaining innovation outcomes in B2B contexts. Without a thorough evaluation about the influence of buyer–seller social capital on innovation performance and the mediators (i.e., commitment and customer knowledge development) in B2B settings, our understanding of these constructs will remain limited, and organizational initiatives directed at building buyer–vendor social capital will remain unjustifiable and therefore based on blind faith. Hence, this study's purpose is to clarify the indirect relationship between buyer–seller social capital and innovation performance via the two mediators, which has not yet been previously explored.

This study differs from previous studies in two important ways. First, while most studies have applied inter-employee social capital to examine performance issues in interorganizational or intraorganizational settings, few have tried to examine in-depth the role of buyer–seller social capital in influencing innovation performance in which the social capital in B2B contexts is fostered beyond the boundary of individual members. This study focuses on the social capital between work teams and their customers (i.e., buyer–seller social capital), substantially complementing previous studies (e.g., individuals' social capital). Understanding buyer–seller social capital is helpful for innovators (i.e., sellers) to leverage such social capital to effectively improve their innovation performance, because today's customers are likely to affect the success or failure of the innovation [4]. Second, previous research related to customer knowledge development (e.g., [2]) has examined its determinants purely from the aspect of organizational in-house action or project characteristics. Nevertheless, it is insufficient for truly understanding customer knowledge development when potential variables related to customers (e.g., buyer–seller social interaction) have not been taken into consideration. This study complements previous research by evaluating the influence of

buyer–seller social capital on customer knowledge development, providing supplementary insights about how to improve the customer knowledge development.

2. Research framework and hypotheses development

Drawing on social capital theory, we propose a model as shown in Fig. 1. In the model, innovation performance is indirectly affected by buyer–seller social capital via the mediation of commitment to innovation and customer knowledge development. The commitment has an influence on customer knowledge development. The rationale for our hypotheses is provided in the following.

A common reason for innovation success is that such innovation accurately reflects buyer expectations, perceptions, needs, and preferences (i.e., a part of customer knowledge) [2]. For example, Amazon's customer knowledge management increases its service innovation ability and performance [13]. Recent literature asserts that customer knowledge is a source of innovation (e.g., [14]), and therefore customer knowledge development is a key to innovation performance. For instance, innovation performance can be improved by market experiments (a characteristic of customer knowledge development) [15].

Customer knowledge development is defined as learning about customer expectations, perceptions, needs, and preferences, which entail lower costs and lower the strategic risk in the launch of innovation [16]. Empirical research indicates that customer knowledge development is essential to the creation of successful innovation [2, 17], it creates potential opportunities for the verification of customer knowledge, and it keeps pace with evolving customer expectations and preferences to ensure that any newly developed innovation can be well accepted in the market after the launch of the innovation [2, 18]. In other words, innovation performance is enhanced by customer knowledge development that improves the knowledge accuracy about customer expectations and preferences. Therefore, the first hypothesis is derived as below.

H1. Customer knowledge development is positively related to innovation performance.

In the global market where sources of competitive advantages can be rapidly imitated by competitors, a commitment to innovation is inevitable to sustain competitive advantages and innovation performance (e.g., [15]). Commitment to innovation refers to employees' duty (i.e., pledge or obligation) to work on innovation. It is a must to have such commitment to facilitate successful innovation in the era of globalization, deregulation, and increasing competition [19]. Due to their commitment to innovation, employees continue to refine their product design or marketing plan, eventually introducing a successful innovation [15]. In other words, the commitment to innovation forces work groups to become externally focused, and thus better innovation performance in the market will be accomplished [20]. For example, many successful high-tech firms such as Acer or 3M emphasize their commitment to innovation while setting their goal of innovation performance. Without strong commitment to innovation, the high-tech firms that count heavily on innovation to succeed are unlikely to survive in a competitive global market today. Therefore, the
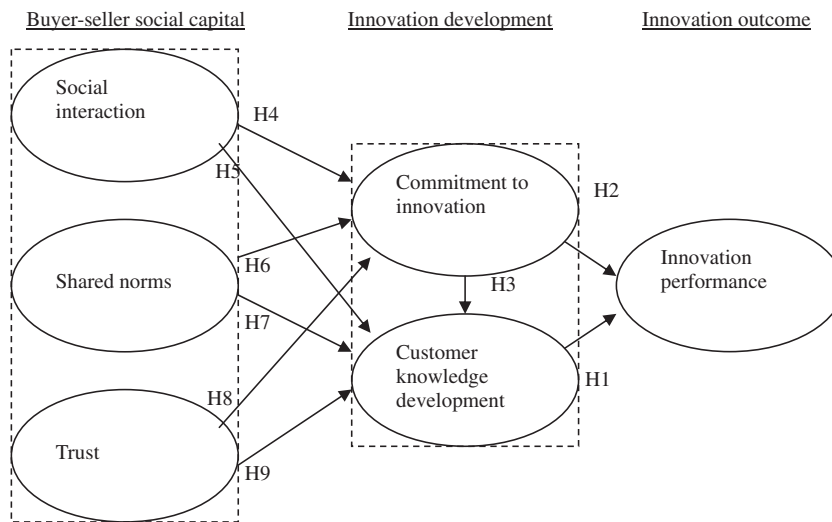
Fig. 1. Research model.

relationship between commitment to innovation and innovation performance is derived as below.

H2. Commitment to innovation is positively related to innovation performance.

For novelty to emerge in the customer knowledge development process, it is essential for the process to be responsive to customer feedback about innovation, and such responsiveness requires strong commitment to innovation [15]. Previous research indicates that great performance on innovation can be primarily achieved by boosting commitment to the innovation [14]. Strong commitment to innovation drives innovators (i.e., sellers) to run "a series of market experiments — introducing a series of prototypes into a variety of market segments" [21, p. 15]. To minimize the risk and maximize learning, those innovators with a strong commitment to innovation are likely to practice customer knowledge development by working intensively with lead customers to understand their latent needs [15]. When employees perceive a strong duty (or pledge) to work on innovation, they become actively motivated to, for example, go through many iterations based on customer feedback prior to launching a new product, learn about customer preferences, and conducting tests of new ideas as thoroughly as possible.

An empirical study by Joshi and Sharma [2] confirms that the greater the project team members' goal is for becoming an innovation leader in the market, the stronger is the positive effect of championing the goal on customer knowledge development. Another study by Lin et al. [22] suggests that enterprise leadership commitment to innovation knowledge helps develop and expand the availability and use of customer knowledge. Strong [23] notes that employees' commitment to innovation for their customers can predict employees' customer orientation, thus strengthening their emphasis on customer knowledge development. Specifically, when an organization has good teamwork capability, it can effectively enhance the team members' commitment and participation in the process of utilizing the innovation knowledge and consequently encourage the

team to develop extensive customer knowledge for access [24]. Since it takes a lot of effort, time, and energy for work groups to obtain useful customer knowledge, successful customer knowledge development is unlikely achieved in the case of low levels of innovation commitment. This is understandable, because innovation is a force of instability, often requiring a long-term commitment and a vision to yield good results [25]. Hence, the commitment to innovation is an important driver in strengthening customer knowledge development, but not vice versa. As a result, the hypothesis between commitment to innovation and customer knowledge development is derived as below.

H3. Commitment to innovation is positively related to customer knowledge development.

2.1. Social capital theory

Social capital refers to "the features of social organizations such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit" [3, p. 67]. Social capital is the invisible glue that holds social relationship more tightly and motivates people to work towards a common, shared goal [6]. The above definition underscores three dimensions of buyer–vendor social capital: (1) social interaction, referring to structural links or interactions between buyers and vendors in social relationship; (2) shared norms, referring to rules and expectations of behaviors between buyers and vendors in a network that define how a community or society will perform; and (3) trust (i.e., customer trust), referring to the strength of social relationships developed between buyers and vendors in the network that is developed through a history of prior interactions among these people and that influences their subsequent behaviors in the network.

People are social beings and they rely on social relationship for support during times of crisis, for sharing joys and frustrations, and for assistance and advice in doing their work. Social capital can be seen as an important resource embedded in a social structure, which is accessed and/or

mobilized in deliberate action [26]. Social capital has been well utilized to explain a variety of pro-social behaviors (such as exchanging customer experiences and sharing customer knowledge) that other forms of capital (e.g., human or financial capital) are unable to clarify [26, 27], indicating the substantial influence of social capital on customer knowledge development. While financial or human capital is developed on the basis of financial assets or particular individuals' ability, buyer–seller social capital resides in the interpersonal fabric of relationships embedded in the social realm among innovation developers and their customers [3, 26, 28]. In organizations, innovation sellers are heavily dependent on the guidance, knowledge, experience, and support of their customers for improving or getting ahead with their innovation. The idea of customer feedback as a "resource" is more important within a buyer–vendor context (than in purely vendors' settings), because sellers' innovation performance often relies on the collective effort of sellers and their customers, as is typical in customer-oriented product development, customization manufacturing planning, and other domains of organizational work. Not all organizations are equivalent in terms of buyer–seller social capital — some organizations are more inclusive than others and consequently develop better customers' relationship, cooperation, and feedback in a timely manner.

2.2. Social interaction

Social capital theory suggests that social interaction (i.e., structural social capital) is accumulated through the interpersonal networks in social communities, which refer to the impersonal configuration (i.e., who you reach and how you reach them) of linkages between sellers and their buyers [29, 30]. Stronger social interaction between sellers and buyers encourages the sellers' commitment to innovation through the relationship by intensifying role interactions (e.g., [31, 32]) and by enhancing the sellers' ability to recognize the importance of the obligation to stick to innovation. Previous research indicates that new products developed via a close buyer–seller partnership (or social interaction) lead to a high level of management commitment to innovation development [33].

Social interaction (i.e., buyer–seller social interaction) between innovation developers (i.e., sellers) and customers encourages sellers' commitment to innovation, since buyer–seller social interaction – which fosters social bonds, friendship, and interpersonal relationship beyond utilitarianism – propels the sellers to create better innovation that they should provide for customers. Previous literature indicates that the commitment to innovation is largely market-driven and responsive to the needs of customers through social interaction between sellers and buyers [34]. Sundbo [35] suggests that innovation is extremely dependent on the employees' commitment to innovation, which can be strengthened via social interaction and involvement between customers and employees. Thus, the hypothesis about social interaction and commitment to innovation can be stated as below

H4. Social interaction positively strengthens the commitment to innovation.

Social interaction between buyers and sellers in an interpersonal social relationship is critical to the development of customer knowledge. Previous literature indicates that frequent buyer–seller interaction is one way by which customer knowledge regarding customer activities, needs, wants, and other information related to potential vendor development of value enhancing products is acquired [10]. Interactions are no longer discrete transactions; instead, they reflect an ongoing knowledge-based process [36]. Collectively, the successful innovation that enhances customer value is achieved by social interaction through the mediation of customer knowledge development (e.g., [18]). Some firms even use the Internet for facilitating social interaction to ultimately develop customer knowledge. For example, Specialized Bicycle Components Inc., a popular bicycle manufacturer, strengthens online social interaction with customers via Internet access, achieving successful customer knowledge development [5]. Social interaction offers a valuable source of information benefits (i.e., knowledge about customers) — that is, "what customers you know" affects "what you know," supporting that social interaction between sellers and buyers reduces the amount of time and investment required to gather information and knowledge [29]. Hence, customer knowledge can be well developed based on good social interaction.

Explaining how firms make breakthrough innovations, Hargadon [37] argues that organizational innovations are rarely the development of something entirely new, but are more often the recombination of materials, components, or ideas already in use in other capacities based on feedbacks of customers. Therefore, the most prolific innovators or sellers are those who are situated in multiple social ties with customers and who can transfer customers' knowledge and proposed solutions in one domain of work to solve problems in another domain that meets customers' needs (e.g., [38]). Contemporary firms such as 3M and Google have achieved remarkable rates of innovation by forging social interactions between employees and their customers with diverse customer knowledge (e.g., customer feedback, experiences, and resources). Thus, the hypothesis related to social interaction and customer knowledge development is developed as below.

H5. Social interaction positively strengthens customer knowledge development.

2.3. Shared norms

Buyers' cognitive capital reflected by shared norms (e.g., codes, language, and narratives) includes the resources making possible shared meanings, connotation, and stories between sellers and buyers. He et al. [39] conclude that people are often dependent on a reliable social relationship based on a set of shared norms. They further state that such a social relationship based on a social capital perspective evolves into even more communications, more exchanges of idea, stories, and narratives among people (i.e., shared norms), and thus people exhibit a stronger commitment towards a specific mission (e.g., innovation) [39]. More specifically, with shared norms, sellers can accurately have empathy about customers' difficulty at using a certain new product. Consequently, the sellers' commitment to innovation can be

effectively lifted, suggesting a positive relationship between shared norms and commitment to innovation.

It is a trend that innovation should be made with the goal of customer orientation in which shared norms are a means to approach the goal. Having strong shared meanings, connotation, and stories between sellers and their buyers (i.e., shared norms) positively stimulates sellers' commitment to innovation. Thus, the next hypothesis is derived as below.

H6. Shared norms positively strengthen the commitment to innovation.

Norms represent expected patterns of buyers' behavior [40]. Such norms can be explicated as specific procedures, routines, or guidelines for innovation developers or sellers to use [40] for developing knowledge about customers. Particularly, engaging in a meaningful exchange (or sharing) that contains common codes, languages, and narratives (i.e., shared norms) helps facilitate certain levels of mutual understanding among the vendors and buyers [7, 28], consequently facilitating customer knowledge development.

By establishing shared norms, emerging exchange partners (i.e., buyers and sellers) start setting the ground rules for a future exchange (e.g., knowledge), developing knowledge about customers [40]. Previous research has found that project teams in a high-tech company can effectively develop innovation through customer knowledge development, because the teams have deep collaboration and dialectical dialog with various customers [41]. When sharing similar norms with customers, the sellers (or innovators) may acquire much more valuable customer knowledge due to clear feedbacks from customers without misunderstanding. Consequently, the next hypothesis can be stated as follows.

H7. Shared norms positively strengthen the customer knowledge development.

2.4. Trust

The relational dimension of social capital is represented here using the trust construct [42]. This study defines trust (or customer trust) as a buyer's willingness to be vulnerable to the actions of the sellers due to beliefs in their benevolence, competence, and integrity (e.g., [43]). As trust can foster more positive attitudes, the development of a trusting culture among buyers and sellers is likely to facilitate the positive attitudes of the sellers to support others and to do their best in the pursuit of customer satisfactions about the innovation (e.g., [44]). Consequently, trust encourages employees' commitment to innovation which creates customer values.

Trust (i.e., customers' trust) is a willingness to rely on an exchange partner (e.g., R&D teams or innovation developers) in whom one has confidence [45]. Previous literature argues that a high level of trust encourages sharing of knowledge and a willingness to commit to collaborative practices such as co-design or co-production of innovation [46, 47]. Trust encourages people to dedicate their efforts to innovation by enhancing personal commitment to the innovation [48]. It was found in a study [49] that buyer–supplier partnerships which build long-term relationships of trust can eventually bring about a greater commitment of suppliers to achieving improved innovation and performance, suggesting a positive relationship between trust and commitment to innovation. Particularly, commitment to innovation expresses the extent to which sellers like to maintain their trusting relationship with customers, suggesting the positive influence of customers' trust on sellers' commitment to innovation. Therefore, we hypothesize the following.

H8. Trust positively encourages commitment to innovation.

Sociologists contend that social capital plays an important role in many aspects of today's society: economic development, civic engagement, innovation, democracy, human capital, and education [6]. Nahapiet and Ghoshal [7] extend this idea to suggest that social capital creates organizational value in the form of intellectual capital or knowledge development. Knowledge, such as that of new products or services, new customers, and their new preferences, is a key input to organizational activities and is often a critical factor for the success or failure of firms in customer knowledge development. Buyer–seller social capital is converted into knowledge development through the processes of combination and exchange [7], which is substantially affected by customers' trust. Without customers' trust, the innovation process that involves integrating externally acquired knowledge from customers to generate new and better solutions to existing innovation is likely to fail, since customers become unwilling to share their needs, experiences, or what they know with those sellers they do not trust.

Getting customers to share their knowledge with their sellers to an ideal level requires hard work to create sustainable trust between the customers and the sellers [50, 51]. Trust encourages efficient communication and increases accessibility, eventually making customers feel they are in closer contact with the sellers. As a result, their willingness to provide what they know or want to share is increased [52]. In other words, increased trust will speed the process of knowledge sharing between customers and their sellers [53], facilitating customer knowledge development. Customers must be able to trust their sellers that the information or feedback they sent to the sellers will be used in an appropriate manner [50].

Access to buyer–seller social capital provides advantages to the extent that trust decreases uncertainty and improves the effectiveness of innovation undertakings (e.g., [8]). Trust has a positive influence on customer knowledge related to, for example, creativity, learning, and cooperative behavior [7, 8]. Consequently, the hypothesis about trust and customers knowledge development is provided below.

H9. Trust positively helps customer knowledge development.

3. Methods

3.1. Subjects and procedures

The research hypotheses described above were empirically tested using a survey of professionals across the R&D groups or project teams of innovation from thirty information technology

(IT) firms in Taiwan [54]. This study chose IT firms, because they represent one of the largest innovation groups in Taiwan. Initially, we invited eight executive MBA students working professionally in IT firms to help with the data collection. Our sample firms were from two well-known science parks in Taipei and Hsinchu and agreed to provide access to their employees for filling out our survey questionnaire. This study surveyed a supervisor (or an employee assigned by the supervisor on his/her behalf) of each R&D team for the purpose of data collection at the data level of teams. For that reason, this study is able to conduct statistical testing for our hypotheses based on team-level analyses. The findings of this study based on such analysis can substantially complement previous literature focusing on individuals' performance [54].

Of the 452 questionnaires distributed to the subjects, 302 usable questionnaires (i.e., each questionnaire from a team) were returned for a response rate of 67%. A good response rate is mainly due to the strong support of our sample firms in which their personnel departments first helped distribute the questionnaires to employees expressing their voluntariness and then traced the status of returned questionnaires. Our sample contains seventy-six managers or supervisors, and these managers or supervisors herein have all worked at their current organization for a year or more. An independent t-test in this study for detecting non-response bias, as suggested by Baruch and Holtom [55], shows an insignificant difference between early and late respondents. To test for the potential bias of common method variance, we conducted Harman's single factor test [56]. In our study, factor analysis extracted six factors explaining 19.41%, 18.43%, 16.89%, 16.54%, 14.58%, and 14.15% of the total variance. The lack of a single dominant factor explaining most of the variance indicates that potential common method bias is not a significant problem in our observed data. In addition to Harman's one-factor test, we also used a marker variable to adjust partial correlation to control for this bias [57]. We chose the tenure of the respondents as a key marker variable, because it is theoretically unrelated to our research constructs herein. After partial correlation adjustment, all significant zero-order correlations remained significant, providing further evidence that common method bias is not serious. Appendix A presents a summary of several measures we used in this study to reduce and detect common method bias.

3.2. Measures

The constructs in this study were measured using Likert scales adapted from existing literature [2, 58–62]. Four steps were employed in choosing measurement items. First, scale items in English from the existing literature were translated into Mandarin Chinese. Second, the translated items were reworded to fit the contexts of innovation and customer knowledge development for R&D personnel by a focus group of five researchers (i.e., three graduate students and two professors) who were well-versed in organizational and innovation research. Third, we conducted two pilot tests with exploratory factor analysis to assess the quality of our measures and improve item readability and clarity. The focus group participants assessed the appropriateness of scale items and dropped them, if necessary, based on the pilot results.

Fourth, the back-translation technique suggested by Reynolds et al. [63] was applied to obtain a high degree of correspondence between the original and back-translated English questionnaires, assuring us that the translation process did not introduce translation biases into our survey questionnaire.

Following the method of Matsuno et al. [60] to view innovation performance in "competitive terms," this study utilized the main competitor's new product performance as a reference point with which to compare the firm's new product performance on profitability, market share, market growth, and market attractiveness, which are common metrics used for measuring innovation performance [2]. As a result, innovation performance was measured using four items modified from Joshi and Sharma [2]. Commitment to innovation was measured using three items modified from Lin [59]. Customer knowledge development was measured using four items drawn and modified from Joshi and Sharma [2]. Social interaction was measured using four items modified from Doney et al. [58]. The four items for measuring shared norms were adapted and modified from Terawatanavong et al. [62]. Finally, trust was measured using four items modified from Sichtmann [61]. Appendix B lists all scale items.

3.3. Data analysis

The actual survey data with a sample size of 302 responses were analyzed via structural equation modeling (SEM) with a two-step approach proposed by Anderson and Gerbing [64] using SAS software. One of the advantages of SEM is its ability to develop latent constructs that are estimated in the model by several measured indicators, each of which is predicted to "tap into" the latent constructs [65–69]. Such an advantage allows the modeler to accurately capture the unreliability of measurement in the research model, which permits the structural relationships among latent constructs to be effectively estimated [65]. The first step (i.e., measurement model testing) performed confirmatory factor analysis (CFA) on all data collected to assess scale reliability and validity. The second step (i.e., structural model testing) examined the structural model for purposes of testing the hypotheses [70, 71]. Both our measurement model testing (step 1) and structural model testing (step 2) are presented respectively as follows.

3.3.1. Step 1: measurement model testing based on CFA

CFA analysis was done on all items corresponding to all six constructs of our research model (i.e., innovation performance, commitment to innovation, customer knowledge development, social interaction, shared norms, and trust). The goodness-of-fit of the hypothesized CFA model was assessed applying a variety of fit metrics, as shown in Table 1. Although the goodness of fit index (GFI) was slightly lower than the recommended value of 0.9, the comparative fit index (CFI), the normed fit index (NFI), and the nonnormed fit index (NNFI) all exceeded 0.90. The normalized chi-square (chi-square/degrees of freedom) of the CFA model was smaller than the recommended value of 3.0, the root mean square residual (RMR) was smaller than 0.05, and the root mean square error of approximation (RMSEA) was smaller than 0.08. These figures reveal that the CFA model tested in this study fits well with the empirical data [72].

Table 1
Standardized loadings and reliabilities.

Construct	Indicators	Standardized loading	AVE	Cronbach's α
Innovation performance	IP1	0.82 (t = 16.46)	0.63	0.86
	IP2	0.74 (t = 14.05)		
	IP3	0.79 (t = 15.56)		
	IP4	0.82 (t = 16.24)		
Commitment to innovation	CTI1	0.80 (t = 15.43)	0.65	0.85
	CTI2	0.77 (t = 14.57)		
	CTI3	0.85 (t = 16.65)		
Customer knowledge development	CKD1	0.81 (t = 16.15)	0.60	0.86
	CKD2	0.83 (t = 16.70)		
	CKD3	0.73 (t = 13.86)		
	CKD4	0.72 (t = 13.71)		
Social interaction	SI1	0.88 (t = 18.65)	0.76	0.91
	SI2	0.92 (t = 19.89)		
	SI3	0.83 (t = 17.04)		
Shared norms	SN1	0.73 (t = 13.82)	0.57	0.84
	SN2	0.82 (t = 16.12)		
	SN3	0.77 (t = 14.88)		
	SN4	0.69 (t = 12.81)		
Trust	TR1	0.82 (t = 16.86)	0.69	0.89
	TR2	0.88 (t = 18.87)		
	TR3	0.89 (t = 18.88)		
	TR4	0.72 (t = 13.97)		

Goodness-of-fit indices (N = 302): $\chi^2_{194} = 436.80$ (p-value < .0001); NNFI = 0.93; NFI = 0.90; CFI = 0.94; GFI = 0.88; RMR = 0.03; RMSEA = 0.07.
Note: An item of the social interaction construct was removed from this model due to its low factor loading.

Convergent validity was assessed by applying the three criteria suggested by Fornell and Larcker [73]. To begin with, the reliabilities for each construct were all larger than 0.70 (see Table 1), satisfying the general requirement of reliability for research instruments. All factor loadings (see Table 1) were statistically significant at p < 0.001 to assure convergent validity of construct [64]. Finally, the average variance extracted (AVE) for all constructs was larger than 0.50, indicating that the measurement items capture sufficient variance in the underlying construct than that attributable to measurement error [73]. In summary, the empirical data collected by this study met all three criteria required to assure convergent validity.

Discriminant validity was assessed in this study using chi-square difference tests based on the Bonferroni method, given that such a method is good in simultaneous pair-wise comparisons for the research constructs. The Bonferroni method is applied to solve the potential problem of multiple comparisons. It is a correction utilized when several dependent or independent statistical tests are being simultaneously conducted. Specifically, a given alpha value (α) may be proper for the comparison of each individual, but it is inappropriate for the entire set of all simultaneous comparisons. By controlling for the experiment-wise error rate at the overall significance level of 0.001, this study used the critical value of $\chi^2(1, 0.001/15) = 15.89$ as the chi-square difference based on Bonferroni method. Chi-square difference statistics for all pairs of constructs exceeded this critical value of 15.89 (see Table 2), thereby supporting discriminant validity in this study's data.

3.3.2. Step 2: structural model testing
After the above CFA is completed, this study performed structural model testing that reflects the hypothesized

associations for purposes of hypotheses testing. To avoid unpredictable bias caused by individuals' age, gender, education, and position level (managers vs. non-managers), this study includes these four variables as control variables in our structural modeling. Table 3 presents the test results of this analysis.

The test results in Table 3 showed that seven out of the nine hypothesized associations in our model were significant. First, customer knowledge development had a significantly positive effect on innovation performance (β = 0.38; p < 0.01), thereby supporting H1. Commitment to innovation had a significantly positive effect on both innovation performance (β = 0.22; p < 0.01) and customer knowledge development (β = 0.34; p < 0.01), respectively supporting H2 and H3. Nevertheless, the relationship between social interaction and commitment to innovation was insignificant, failing to support H4. At the same time, social interaction had a significantly positive influence on customer knowledge development (β = 0.21; p < 0.01), supporting H5. Shared norms had a significantly positive effect on both commitment to innovation (β = 0.38; p < 0.01) and customer knowledge development (β = 0.35; p < 0.01), respectively supporting H6 and H7. Trust had a significantly positive influence on commitment to innovation (β = 0.18; p < 0.0), supporting H8. However, the influence of trust on customer knowledge development is insignificant, thus failing to support H9.

The unsupported H4 and H9 suggest that not all buyer–seller social capital dimensions affect the mediators of innovation development (e.g., customer knowledge development). It is possible that different dimensions of social capital display different weights on commitment to innovation or customer knowledge development, resulting in some

Table 2
Chi-square difference tests for examining discriminant validity.

Construct pair	$\chi^2_{194} = 436.80$ (unconstrained model)	
	χ^2_{195} (constrained model)	χ^2 difference
(Innovation performance, commitment to innovation)	714.43***	277.63
(Innovation performance, CKD)	784.82***	348.02
(Innovation performance, social interaction)	876.01***	439.21
(Innovation performance, shared norms)	766.50***	329.70
(Innovation performance, trust)	922.12***	485.32
(Commitment to innovation, CKD)	650.28***	213.48
(Commitment to innovation, social interaction)	747.66***	310.86
(Commitment to innovation, shared norms)	693.62***	256.82
(Commitment to innovation, trust)	740.12***	303.32
(CKD, social interaction)	770.65***	333.85
(CKD, shared norms)	636.76***	199.96
(CKD, trust)	836.67***	399.87
(Social interaction, shared norms)	643.52***	206.72
(Social interaction, trust)	829.75***	392.95
(Shared norms, trust)	699.12***	262.32

Legend: CKD = customer knowledge development.
*** Significant at the 0.001 overall significance level by using the Bonferroni method.

Table 3
Path coefficients and t value.

Hypothesis	Standardized coefficient	t value
H1: CKD → innovation performance	0.38**	4.73
H2: Commitment to innovation → innovation performance	0.22**	2.74
H3: Commitment to innovation → CKD	0.34**	5.16
H4: Social interaction → commitment to innovation	0.03	0.32
H5: Social interaction → CKD	0.21**	2.68
H6: Shared norms → commitment to innovation	0.38**	3.82
H7: Shared norms → CKD	0.35**	3.93
H8: Trust → commitment to innovation	0.18*	2.20
H9: Trust → CKD	−0.03	−0.38

Note: Age, gender, education, and position level (managers vs. non-managers) are included as control variables in the model, and these control variables show insignificant effects in the model.
Legend: CKD = customer knowledge development.
* $p < 0.05$.
** $p < 0.01$.

insignificant model paths. Nevertheless, the unexpected results for the unsupported hypotheses warrant further study so that the true reasons behind the unsupported hypotheses are not misinterpreted.

To further confirm the indirect effects of buyer–seller social capital on innovation performance, this study conducted a post-hoc analysis based on the suggestion of Baron and Kenney [74] in which we added the direct linkages between three social capital dimensions and innovation performance. The test results presented in Appendix C confirm that all the direct linkages between the three social capital dimensions and innovation performance are insignificant, empirically supporting the indirect relationship between the antecedents and outcome in our model.

4. Discussion

4.1. Implications for research

The study was one of the few to jointly examine the role of buyer–seller social capital and customer knowledge considerations in a single holistic model. As people are social beings, buyer–seller social capital is likely to shape their customer knowledge development and commitment during the stages of innovation, consequently impacting innovation performance. Our empirical analysis demonstrated that when three social capital dimensions are taken into account, the commitment to innovation and customer knowledge development become key mediators in influencing innovation performance, given that there is no direct relationship between social capital and innovation performance. These effects point to a complex and intricate pattern of relationships between buyer–seller social capital and the innovation performance, which may be the subject of more detailed investigations in the near future. Nevertheless, the triplet of buyer–seller social capital, which seems very plausible from logical and empirical perspectives, is not reflected in most contemporary models of innovation performance. This offers a unique opportunity for theory building in this area.

An interesting finding of our study that is not evident from previous studies is the significant and indirect effects of buyer–seller social capital (rather than inter-employee social capital) on innovation performance. Although we found evidence for direct effects of the social capital on commitment to innovation and customer knowledge development, such direct effects may not directly affect innovation performance. Empirical evidence of these indirect effects on innovation performance, as observed in this study, is all the more reason why we should not examine the effects of buyer–seller social capital, commitment, and customer knowledge in isolation, but rather in conjunction within a larger holistic model of innovation performance.

While previous research on buyer–seller relationship has attempted to explain and predict innovation outcomes with the implicit presumption that, for example, social interaction and trust are beneficial for organizational work, our study further examines the nature and magnitude of the specific relationship between buyers and sellers (i.e., social interaction, norms, or trust) and the organizational work (i.e., innovation performance). In summary, our findings demonstrate that commitment to innovation and customer knowledge development play two dominating roles amid buyer–seller social capital and innovation performance, thereby serving as an important bridge between the social capital and innovation performance streams of organizational research.

4.2. Implications for practice

Our analysis demonstrated that innovation performance of knowledge workers can be improved indirectly by facilitating three social capital dimensions between them and their customers via the mediation of commitment to innovation and customer knowledge development. These three-way tracks between social capital and innovation performance through two mediators, albeit unexplored in prior research, present unique challenges for organizational managers interested in improving innovation performance of their employees. Hence, managers must strive to build a culture of fostering buyer–seller social capital within their organizations, by training the organizational members to build social interaction, shared norms, and trust among their customers, while also simultaneously communicating the benefits of commitment to innovation and customer knowledge development to the members. Given the multiplicative nature of the effects of the three social capital dimensions, organizational initiatives that are directed at only building either commitment to innovation or customer knowledge development are more likely to be of limited help in enabling innovation performance, than those that address the three social capital dimensions concurrently.

Second, the relationships between buyer–seller social capital, innovation performance, and their mediators are even more critical and challenging for entrepreneurial (or innovation) organizations where knowledge workers must possess a strong commitment to innovation and employ customer knowledge to create innovation products or services. Many specialized organizational tasks, such as new product design, often cannot be accomplished purely by sellers without knowing what the customers need and thus require the

collective effort and knowledge among knowledge workers and their customers. Specifically, the significant influence of social interaction and shared norms on customer knowledge development (H5 and H7) suggests that management should provide mentoring that sharpens employees' communication skills for serving customers, consequently obtaining better market knowledge from their customers. Accordingly, the significant influence of social norms and trust on commitment to innovation suggests that management should encourage employees to use general vocabulary (rather than terminology) during contact with customers and to engage the responsibility with empathy for any wrongdoing in order to win customer trust in the long run, eventually improving innovation performance.

In conclusion, this study proposed a theoretical model of innovation performance, by integrating the triple perspectives of buyer–seller social capital and their mediating considerations (in the form of commitment to innovation and customer knowledge development). Our hypothesized model was empirically validated using a field survey of professional workers at IT firms in Taiwan. Since relatively few studies exist on buyer–seller social capital and customer knowledge development within a context of innovation, we hope that our research serves as a first step toward building a comprehensive body of knowledge in this area.

4.3. Limitations of the study

As with any empirical study, this study suffers from two major limitations. The first limitation of this study is its generalizability. Due to the highly delimited nature of our subject sample (personnel in IT organizations in Taiwan), inferences drawn from our data may not be fully generalizable to employees in organizations of other types (e.g., financial industry) or those from other countries.

Second, practical empirical considerations relating to field-based data collection restricted the set of variables examined in this study to a cross-sectional study. There may be other predictors of innovation performance, such as organizational climates, firm size, and so on, that may be important yet excluded from this study. Future research should identify these variables and consider their inclusion in empirical models as independent, moderating, or control variables, and also attempt to examine the hypothesized relationships using longitudinal data.

Appendix A. Measures undertaken to reduce common method bias

1. Anonymous survey: This study surveyed respondents without obtaining their names to reduce their suspicion or hesitation for factually filling out our questionnaire. Respondents are assured of complete anonymity in the cover letter, confirming that neither their personal names nor the names of their organizations will be disclosed.
2. Separation of scale items: We originally inserted a few items unrelated to our constructs (e.g., how did they learn in offline settings), neutralizing the social desirability bias of the respondents.
3. Use of a marker variable: This study used tenure of respondents as the marker variable [57] since it is

theoretically unrelated to constructs examined in this study. Tenure (i.e., employees' work years in their organization) is one of the best estimates of common method bias in a dataset [75], because it often has no direct connection with the substantive constructs of interest (e.g., commitment, trust, performance, etc.) and thus has a correlation with at least one of those variables that is close to zero [76]. After partial correlation adjustment, all significant zero-order correlations remained significant. This suggests that common method bias is not a fatal problem in the study.
4. Harman's one factor test: No single factor that accounts for a majority of the variances was found.

Appendix B. Measurement items

Social interaction (5-point likert)
In the process of new product development (NPD),…
SI1. I have developed a strong friendship with my customers.
SI2. The relationship with my customers goes beyond business and often involves social activities together.
SI3. My customers and I enjoy the interaction with each other.
SI4. My customers and I have a socially common bond.
Shared norms (5-point likert)
In the process of NPD,…
SN1. My customers and I are concerned about each other's benefit.
SN2. My customers and I both understand each other with business jargon.
SN3. My customers and I both follow similar business codes and rules.
SN4. My customers and I both easily obtain a consensus after discussion.
Trust (5-point likert)
In the process of NPD,…
TR1. I am responsible to my customers.
TR2. I am considered by our customers a reliable person.
TR3. I am characterized by our customers as being trustworthy.
TR4. My customers would depend on me whenever they required help.
Commitment to innovation (5-point likert)
CTI1. I views R&D as an investment, not an expense.
CTI2. I think learning capability of innovation is considered as a key successful factor (for NPD).
CTI3. I am willing to put in a great deal of effort beyond what is normally expected to obtain the goal of innovation.
Customer knowledge development (5-point likert)
CKD1. I went through lots of iterations based on customer feedback prior to launching the new product (or innovation) in the market.
CKD2. I developed and/or tested lots of new ideas over the course of my NPD process (or innovation).
CKD3. My NPD process (or innovation) involved numerous failed experiments.
CKD4. I learned about customer preferences as I worked with them through the new product iterations (or innovation iterations).

Innovation performance (3-point likert)

Relative to our main competitor's new product, the performance of the new product developed by our firm is:

IP1. (a) Less profitable, (b) about equally profitable, (c) more profitable.

IP2. (a) Has a lower market share, (b) has about the same market share, (c) has a greater market share.

IP3. (a) Has a lower attractiveness to customers, (b) has about the same attractiveness to customers, (c) has a greater attractiveness to customers.

IP4. (a) Has a slower growth rate, (b) has about the same growth rate, (c) has a faster growth rate.

Appendix C. Full mediation tests
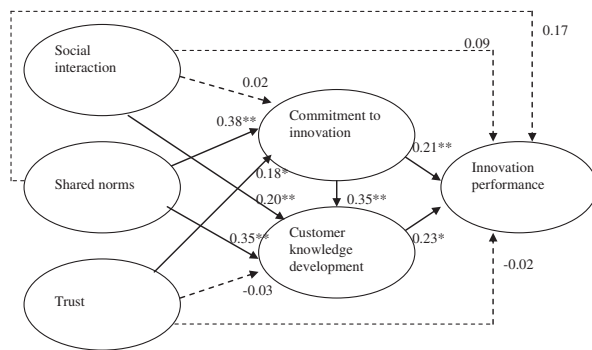
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