J. Eng. Technol. Manage. 33 (2014) 154–173

Contents lists available at ScienceDirect

Journal of Engineering and Technology Management

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

Intellectual capital and new product development

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ARTICLE INFO

Keywords:
Human capital
Organizational capital
Customer capital
New product performance

ABSTRACT

Based on the knowledge-based view, we examined the relationships among various dimensions of intellectual capital, including human capital, organizational capital, and customer capital, and new product performance. Regression analysis was used to test the hypotheses in a sample of 93 firms. The results indicated that human capital and organizational capital are positively related to customer capital which in turn has a positive effect on new product performance. This study contributes to the theoretical development of a conceptual model by examining the mediating role of customer capital in the relation human capital and organizational capital with new product performance. The empirical evidences support our prediction and indicate that human capital and organizational capital can deliver a better new product performance primarily through improving customer capital. Managerial implications and future research directions are discussed.

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http://dx.doi.org/10.1016/j.jengtecman.2014.06.003
0923-4748/

Introduction

Newly introduced products are critical for firms to generate profits, enhance market growth, and sustain advantage in an increasingly competitive environment due to the globalization of markets and continually changing technologies (Chen, 2007; Im and Workman, 2004; Joshi and Sharma, 2004; Sivadas and Dwyer, 2000; Song and Montoya-Weiss, 2001; Song and Parry, 1997; Wu et al., 2008; Wu and Chou, 2007). With new products, firms are better able to respond to evolving market conditions and achieve better performance (Alam, 2002; Chen et al., 2009; Lin and Germain, 2003; Matting et al., 2004; Pil and Leana, 2009; Smith et al., 2005; Subramaniam and Youndt, 2005). The development of innovative products likely depends on the acquisition and utilization of new product-related knowledge in the product development process (Ganesan et al., 2005; Goffin and Koners, 2011; Johnson and Filippini, 2013; Luca and Atuahene-Gima, 2007; Moreau et al., 2001; Schulze and Hoegl, 2006). The knowledge-based view depicts firms as repositories of knowledge and skills (Collins and Smith, 2006; Erickson and Rothberg, 2009; Hsu et al., 2006; Youndt et al., 2004; Johanson et al., 2001). According to this view, intellectual capital, which consists of useful knowledge and skills is a valuable asset and storehouse for firms because of its characteristics of firm-specificity, continuous development, and long-term investment (Martinez-Torres, 2006; Subramaniam and Youndt, 2005; Yang and Lin, 2009).

Previous studies have noted the link between intellectual capital and organizational outcomes (e.g., Bozbura, 2004; Bramhandkar et al., 2007; Chen et al., 2009; Firer and Williams, 2003; Hayton, 2005; Hermans and Kauranen, 2005; Jardon and Martos, 2009; Kamath, 2008; Kim et al., 2012; Wu et al., 2008; Wu and Chou, 2007; Wu and Tsai, 2005; Tan et al., 2007; Yang and Lin, 2009; Youndt et al., 2004; Zeghal and Maaloul, 2010). This association needs to be extended to product innovation (Johnson and Filippini, 2013; Subramaniam and Youndt, 2005; Tsai and Ghoshal, 1998). New product development is a complex, knowledge-intensive activity that can provide not only ideas for product and technology innovations but also solutions to inevitable problems with new product development (Atuahene-Gima and Wei, 2011; Carbonell and Rodriguez-Escudero, 2009; Goffin and Koners, 2011; Mahoney and Pandian, 1992; Marsh and Stock, 2003; Tsai et al., 2011). In the context of new product development, the most effective use of collective knowledge (documented or not) on which firms can build competitive advantage and generate future benefits depends on their intellectual capital (Hsu and Fang, 2009; Nahapiet and Ghoshal, 1998; Pil and Leana, 2009; Subramaniam and Youndt, 2005; Wu et al., 2008; Wu and Chou, 2007; Youndt et al., 2004). Therefore, intellectual capital is likely to affect new product performance based on the knowledge-based view (Atuahene-Gima and Wei, 2011; Bapuji et al., 2011; Kim et al., 2012; Prahalad and Hamel, 1990).

Following the knowledge-based view, intellectual capital provides new product development projects with the technical knowledge to launch successful new products (Hitt et al., 1996; Im and Workman, 2004; Lei et al., 1999; Menguc and Auh, 2010; Olson et al., 1995). The knowledge-based view is one theoretical perspective that allows us to elucidate the potential effects of intellectual capital on new product performance. It suggests that intellectual capital plays an important role in accumulating and utilizing varied knowledge resources and ultimately enhancing new product performance (Bapuji et al., 2011; Chai et al., 2011; Kelley et al., 2011). In this study, we focus on three knowledge resources: human capital, organizational capital, and customer capital.

Innovation-active firms can utilize the knowledge and skills that are not only preserved within the organizational repository but also residing in the minds of the professionals who develop new products (Chen et al., 2009; Drazin and Rao, 2002; Gilson et al., 2005; Hatch and Dyer, 2004; Ittner and Larcker, 1998; Melo et al., 2006; Yang and Lin, 2009; Su and Carney, 2013). Human and organizational capital can be conducive to new product development activities because both allow firms to discover and utilize market intelligence embedded in the customer capital. In other words, firms may leverage the knowledge and skills embedded in the human and non-human capital to incorporate needs and desires of the customers into new products that meet customers' needs and thus increase satisfaction and repeat purchases. As noted above, customer capital may mediate the effects of human capital and organizational capital into new product performance.

To explore the relationship between intellectual capital and new product performance, the theoretical framework of this study is shown in Fig. 1. The framework depicts three dimensions of

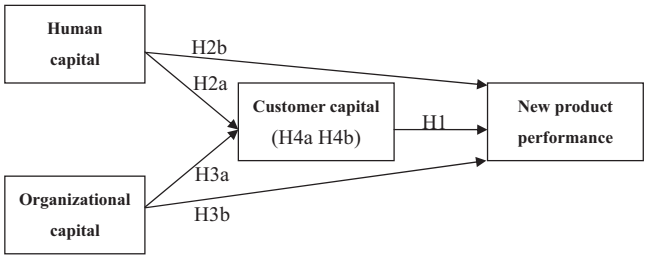

Fig. 1. The theoretical framework and proposed hypotheses.

intellectual capital and shows the ways in which they contribute directly or indirectly, to new product performance. *Customer capital* is defined here as the knowledge residing with customers that allows firms to understand the preferences and latent needs of consumers (Hsu et al., 2006; Hermans and Kauranen, 2005; Matsuo, 2006; Moreau et al., 2001; Nahapiet and Ghoshal, 1998; Schulze and Hoegl, 2006; Wu et al., 2008; Wu and Chou, 2007). In contrast, *human capital* consists of the knowledge and skills that managers and employees possess (Hatch and Dyer, 2004; Martinez-Torres, 2006; Subramaniam and Youndt, 2005; Youndt et al., 1996) while *organizational capital* reflects the knowledge and experience embodied in the organization (Erickson and Rothberg, 2009; Walsh and Ungson, 1991; Youndt et al., 2004). The conceptual framework used in this study is based on the knowledge-based view and it suggests that human and organizational capital both generate the customer capital which influences new product performance. *New product performance* is the degree to which a new product meets financial and market goals at the time of product introduction (Im and Workman, 2004; Johnson and Filippini, 2013; Song and Montoya-Weiss, 2001; Song and Parry, 1997; Tsai et al., 2011).

This article starts with a review of the literature on intellectual capital and new product development from the knowledge-based view. Subsequently, seven sets of hypotheses are proposed, the methodology is described, and the results are presented. Finally, the implications for managers and the limitations of the study are discussed, followed by the suggestion for further.

Research background and hypotheses

Intellectual capital

With the increasing importance of intellectual capital, many scholars have investigated its organizational role. Most of this research focuses on the effect of intellectual capital on organizational performance (e.g., Yang and Lin, 2009; Youndt et al., 2004), business performance (e.g., Jardon and Martos, 2009; Kamath, 2008; Kim et al., 2012; Wu and Chou, 2007), financial returns (e.g., Chu et al., 2006; Hermans and Kauranen, 2005; Reed et al., 2006; Youndt et al., 2004), and value creation (e.g., Bozbura, 2004; Zeghal and Maaloul, 2010). These studies have increased our understanding of the role of intellectual capital in organizations, but this understanding should now be extended to encompass innovations (Subramaniam and Youndt, 2005; Tsai and Ghoshal, 1998). Following this suggestion, some researchers have begun to investigate the effects of intellectual capital on firms' innovation behaviors and outcomes (e.g., Chen et al., 2006, 2009; Hayton, 2005; Su and Carney, 2013; Subramaniam and Youndt, 2005; Wu et al., 2008).

In investigating the effect of intellectual capital on innovative capabilities, Subramaniam and Youndt (2005) used three measures, human capital, organizational capital, and social capital to represent intellectual capital. They found that these types of intellectual capital and the relationships among them influenced incremental and radical innovative capabilities selectively. Human capital was negatively related to radical innovative capability. Organizational capital was positively associated with radical innovative capability. Social capital played a positive role in both types of innovation and interacted with human capital to improve the capacity for radical innovative. Drawing upon the resource-based view, Hayton (2005) investigated the effect of intellectual capital—in terms

of human capital, reputational capital, and intellectual property—on corporate entrepreneurship in new high-tech ventures. The results indicated that the top management team, human capital diversity, and organizational reputation are important determinants of the entrepreneurial performance of such ventures.

Chen et al. (2006) classified intellectual capital as human, structural, and relational, and examined the direct effect of these three dimensions on new product development in an industry context. They found that relational capital was the most important factor, followed by human and structural. Similarly, Wu et al. (2008) examined the effect of intellectual capital on innovations focusing on the moderating effect of social capital and entrepreneurial orientation. They classified intellectual capital as human, structural, and customer. Their results indicated that social capital and entrepreneurial orientation play a quasi-moderating role in the relation between intellectual capital and innovation performance. In the knowledge transfer setting, Chen et al. (2009) used three dimensions of intellectual capital—human, organizational, and relational—to examine their relationships with knowledge transfer of Taiwanese manufacturers. They concluded that relational capital mediated the effects of human and organizational capital on knowledge transfer. In the Kim et al.'s (2012) study, the scope of intellectual capital included human capital, organizational capital and customer capital. According to the authors, human capital indirectly affects business performance through both organizational and customer capital.

In summary, these studies examined the effect of intellectual capital on innovative capability (Subramaniam and Youndt, 2005; Wu et al., 2008), organizational outcome (Hayton, 2005; Kim et al., 2012), new product development (Chen et al., 2006), and knowledge transfer (Chen et al., 2009). In addition, studies have frequently used human and organizational capital while often adding relational or customer capital as the third dimension of intellectual capital. In this study, we examined the role of intellectual capital in new product development projects, emphasizing the influence of customers. Accordingly, we used customer capital, human capital, and organizational capital as the three dimensions of intellectual capital, as they are more germane to customer relations in the context of new product development. An earlier research has been concerned with the direct effect of all dimensions of intellectual capital on firms' innovation behaviors and outcome. We argued, in contrast, that human and organizational capital affect new product performance primarily through customer capital. In the following sections, we present hypotheses to describe the relationships among the dimensions of intellectual capital and new product performance.

The relationship between customer capital and new product performance

New products are an important source of competitive advantage, and they can generate profits, sales, and market growth for innovation-active firms (Chen, 2007; Im and Workman, 2004; Joshi and Sharma, 2004; Shoham et al., 2012; Sivadas and Dwyer, 2000; Song and Montoya-Weiss, 2001; Song and Parry, 1997; Wu and Chou, 2007). Successful new product development activities are often nurtured by the acquisition and utilization of new product-related knowledge (Atuahene-Gima and Wei, 2011; Cooper, 2003; Davenport et al., 2001; Ganesan et al., 2005; Goffin and Koners, 2011; Moreau et al., 2001; Nambisan, 2002). One important source of such product-related knowledge involves the understanding of customer demand and a consumer trend of product characteristics (Dao and Zmud, 2013; Ganesan et al., 2005; Gruner and Homburg, 2000; Lin and Germain, 2003; Matsuo, 2006; Schulze and Hoegl, 2006; Tsai, 2009), and it is likely to be gained from customer capital (Alam, 2002; Ittner and Larcker, 1998; Luca and Atuahene-Gima, 2007; Nambisan, 2002; Skaggs and Youndt, 2004).

Customer capital is the knowledge possessed by customers that allows firms to understand their preferences and latent needs (Hermans and Kauranen, 2005; Hsu et al., 2006; Matsuo, 2006; Moreau et al., 2001; Nahapiet and Ghoshal, 1998; Schulze and Hoegl, 2006; Shoham et al., 2012; Wu et al., 2008; Wu and Chou, 2007; Wu and Tsai, 2005). Identifying buyers' preferences and latent needs and incorporating them into new products development projects is likely to improve market acceptance and increase profit potential rather than inferring customer needs from written survey responses (Dao and Zmud, 2013; Im and Workman, 2004; Ittner and Larcker, 1998; Lin and Germain, 2003; Song and Montoya-Weiss, 2001; Song and Parry, 1997; Tsai, 2009; Verhees and Meulenberg, 2004; Verma and Thompson, 1999). Firms with high customer capital would keep pace with evolving customer

preferences and latent needs to ensure that they understand what consumers want (Atuahene-Gima and Wei, 2011; Griffiths-Hemans and Grover, 2006; Joshi and Sharma, 2004; Matting et al., 2004; Patanakul et al., 2012; Skaggs and Youndt, 2004). The knowledge gained from interactions with customers would facilitate the development of customized and differentiated new products that reflect customer needs, wants, and likes, thereby enhancing performance of new product development (Alam, 2002; Gruner and Homburg, 2000; Hsu et al., 2006; Hsu and Fang, 2009; Matting et al., 2004). In other words, a customer-oriented perspective in the process of new product development is a key element in the success of a new product. Firms with more customer capital gain more customer trust than their competitors do, because the customers enjoy higher value-added service and are more satisfied with and loyal to these firms (Deshpandé et al., 1993; Olson et al., 2005; Song and Montoya-Weiss, 2001; Song and Parry, 1997). Therefore, when a firm acquires customer knowledge, it is more likely to offer new products and services that customers prefer, improving its performance relative to its competitors (Lai, 2007; Menguc et al., 2007).

Accordingly, customer capital in terms of understanding and satisfying consumer preferences and latent needs is expected to contribute positively to new product development. Through customer capital, new product development projects can incorporate market knowledge into the process and implement activities that introduce new products, thus resulting in better new product performance. The following hypothesis is therefore developed.

Hypothesis 1. Customer capital is positively related to new product performance.

The relationships among human capital, customer capital and new product performance

Human capital consists of the knowledge and skills residing in the minds of managers and employees, and although it is a constantly renewable source of firms' innovativeness, it is not reflected in their financial performance (Hatch and Dyer, 2004; Martinez-Torres, 2006; Subramaniam and Youndt, 2005; Youndt et al., 1996). Human capital is possessed by the individuals and not by the organizations unless it is transformed into tangible forms, such as new products (Hayton, 2005; Pil and Leana, 2009; Yang and Lin, 2009). New product development involves the creation of valuable solutions that satisfy customers' preferences and latent needs (Schulze and Hoegl, 2006; Tsai and Ghoshal, 1998). Applying the knowledge-based view in the pursuit of customer satisfaction and value creation helps us clarify that the effectiveness of information exchange and combination process between producers and customers depends on the knowledge and skills of the team members involved in the new product development projects (Alam, 2002; Goffin and Koners, 2011; Matting et al., 2004; Nahapiet and Ghoshal, 1998; Sivadas and Dwyer, 2000; Smith et al., 2005). Therefore, we argue that firms need to accumulate abundant human capital if they want to gather and store market intelligence and customer knowledge during the process of new product development.

When professionals involved in new product development activities know how to interact with customers, they increase the likelihood of information exchange regarding the product innovation ideas (Joshi and Sharma, 2004; Nahapiet and Ghoshal, 1998; Smith et al., 2005) and become more adept at understanding and anticipating customer preferences (Batt, 2002; Joshi and Sharma, 2004; Matting et al., 2004). In addition, highly skilled and experienced professionals are likely to use their knowledge base to diagnose and solve problems (Goffin and Koners, 2011; Hatch and Dyer, 2004; Skaggs and Youndt, 2004; Subramaniam and Youndt, 2005), which can result in more sustained attempts to exchange and share information about product innovation ideas in an effort to learn from customer preferences (Atuahene-Gima and Wei, 2011; Bontis, 1998; Hsu and Fang, 2009; Luca and Atuahene-Gima, 2007; Matting et al., 2004; Selnes and Sallis, 2003). As a result, knowledge and skills that professionals possess promote the exchange of valuable product information between internal professionals and external consumers as well as its use, which, in turn, will generate product ideas that respond to customer preferences.

Accordingly, human capital in the form of knowledge and skills embedded in new product development is expected to contribute positively to customer capital. Through human capital, new product development projects will be able to increase the likelihood of information exchange with

customers, reflect customer preferences, and meet customer needs, thus leading to a higher level of customer capital. Following this line of logic, we developed the following hypothesis.

Hypothesis 2a. Human capital is positively related to customer capital.

The hallmarks of human capital are creative, bright, and highly skilled employees, with expertise in their functional areas, who constitute the predominant source of diverse skills, ideas, and knowledge from the knowledge-based view (Goffin and Koners, 2011; Griffiths-Hemans and Grover, 2006; Subramaniam and Youndt, 2005). The knowledge-based view adopts the assumption of knowledge as a valuable organizational resource and emphasizes the benefits of the knowledge embedded in human capital during the process of new product development, as it allows for sharing different ideas and perspectives (Griffiths-Hemans and Grover, 2006; Su and Carney, 2013; Subramaniam and Youndt, 2005). From the knowledge-based view, new product development projects conducted with bright and skilled participants are likely to reframe problems and generate creative solutions to technology and market problems (Atuahene-Gima and Wei, 2011; Ferrier, 2001; Song and Parry, 1997). Indeed, when the new product development team faces unexpected problems, its performance could benefit from a wider range of viewpoints from the team members. In this respect, the accumulation of human capital among knowledge workers is necessary for pooling individual cognitive ideas and perspectives to solve problems associated with the new product development activities (Bantel and Jackson, 1989; Boone et al., 2004; Olson et al., 1995). Building on this premise, team members and their human capital are crucial for creative solutions, new commercial opportunities, better products, and satisfactory new product development outcomes (Atuahene-Gima and Wei, 2011; Greve, 2003; Griffiths-Hemans and Grover, 2006; Schulze and Hoegl, 2006). This leads to the next hypothesis.

Hypothesis 2b. Human capital is positively related to new product performance.

The relationships among organizational capital, customer capital and new product performance

Organizational capital is reflected in the institutionalized knowledge and codified experience embodied in information systems, organizational structure and organizational culture (Erickson and Rothberg, 2009; Walsh and Ungson, 1991; Youndt et al., 2004). Unlike human capital, organizational capital is embedded in organizations rather than in the minds of employees (Bontis, 1998; Chen et al., 2009; Subramaniam and Youndt, 2005). The knowledge-based view of the firm posits that organizational capital gives firms competitive advantages in leveraging their collection of knowledge obtained from the customers to understand customers' preferences and needs (Chai et al., 2011; Gilson et al., 2005; Golann, 2006; Melo et al., 2006). The propensity to access customer preferences and latent needs is most likely reflected in its customer capital (Hermans and Kauranen, 2005; Hsu et al., 2006; Matsuo, 2006; Moreau et al., 2001; Nahapiet and Ghoshal, 1998; Schulze and Hoegl, 2006; Wu et al., 2008; Wu and Chou, 2007; Wu and Tsai, 2005). Accordingly, organizational capital has an important role in exposing new product development activities to customers, which would increase the capacity to deploy and facilitate customer capital. Organizational capital may allow firms to store and retrieve the knowledge and experience embedded in the information systems, organizational structure and culture during the process of new product development (Hansen et al., 1999; Hayton, 2005; Kelley et al., 2011; Subramaniam and Youndt, 2005; Walsh and Ungson, 1991). Therefore, this study applies the knowledge-based view of the firm to propose that firms need to invest their organizational capital in information systems, organizational structure and culture if they want to gather and store market intelligence and customer knowledge in the new product development activities. Organizational capital in the form of knowledge and skills embodied in the non-human and physical repository such as information systems, organizational structure, and culture makes positive contributions to customer capital. The following hypothesis is developed.

Hypothesis 3a. Organizational capital is positively related to customer capital.

Additionally, organizational capital is likely to affect new product performance (Atuahene-Gima and Wei, 2011; Prahalad and Hamel, 1990). According to the knowledge-based view, organizational

capital provides new product development projects with the technical knowledge to launch successful new products (Hitt et al., 1996; Im and Workman, 2004; Lei et al., 1999; Menguc and Auh, 2010; Olson et al., 1995). The knowledge-based view elucidates the potential effects of organizational capital on new product performance. It suggests that organizational capital plays an important role in appropriating and storing organizational knowledge and, ultimately, in new product performance (Bapuji et al., 2011; Chai et al., 2011; Kelley et al., 2011). The effect of organizational capital on new product performance depends on the way in which knowledge is stored in and appropriated from organization-level repositories, such as information systems, organizational structure and culture (Erickson and Rothberg, 2009; Walsh and Ungson, 1991; Youndt et al., 2004). According to the knowledge-based view, new product development is a knowledge-intensive activity that requires employees to gather and share knowledge. Therefore, organizational capital can contribute to the new product performance and this relationship is captured in the following hypothesis.

Hypothesis 3b. Organizational capital is positively related to new product performance.

The mediating role of customer capital

From the knowledge-based view, human capital and organizational capital promote new product performance by enabling a product team to involve customers in new product development (Carbonell and Rodriguez-Escudero, 2009; Dougherty and Murthy, 2009; Joshi and Sharma, 2004; Kok and Biemans, 2009; Patanakul et al., 2012). In brief, the benefits of new product performance are seen in increased amounts of customer capital. The scant literature on how intellectual capital affects new product performance suggests that customer capital transfers the effects of human capital and organizational capital. In support of this notion, Dougherty and Murthy (2009) argued that the incorporation of high-quality interactions between customers and frontline employees into knowledge-management systems and other technologies (a concept closely related to customer capital) could reveal substantial opportunities for breakthrough products and services. Indeed, a firm whose employees have unique knowledge and skills to improve their understanding of what customers experience in their work would gather product ideas more effectively (Collins and Smith, 2006; Hsu et al., 2006; Kamath, 2008; Nahapiet and Ghoshal, 1998; Pil and Leana, 2009; Sivadas and Dwyer, 2000; Yang and Lin, 2009; Zeghal and Maaloul, 2010). New product development requires employees to commit their time, attention, and effort to collecting knowledge about the preferences and needs of customers. In new product development settings, knowledgeable and skillful employees of the firms need to establish a higher level of customer capital, by identifying consumers' preferences and latent needs (Bontis, 1998; Dao and Zmud, 2013; Hsu and Fang, 2009; Matting et al., 2004; Selnes and Sallis, 2003). The established customer capital would then result in better market acceptance and higher profit potentials from new products, increasing customer satisfaction and loyalty (Batt, 2002; Hatch and Dyer, 2004; Hsu et al., 2006; Ittner and Larcker, 1998; Joshi and Sharma, 2004; Matting et al., 2004; Skaggs and Youndt, 2004; Smith et al., 2005; Subramaniam and Youndt, 2005; Tsai, 2009).

Similarly, customer capital plays a mediating role between organizational capital and new product performance (Cannon and Homburg, 2001; Chen et al., 2006; Gilson et al., 2005; Golann, 2006; Jayachandran et al., 2005; Melo et al., 2006; Mithas et al., 2005; Patanakul et al., 2012; Tsai, 2009; Verhees and Meulenberg, 2004). From the knowledge-based view, effective organizational-level repositories are regarded as supportive infrastructures to achieve better product innovation performance (Chen et al., 2009; Jardon and Martos, 2009; Subramaniam and Youndt, 2005; Yang and Lin, 2009; Rampersad et al., 2012). The increased customer capital brought about by organizational capital promotes higher new product performance. First, new product performance benefits from customer capital because organizational information system might help new product projects gain a coherent picture of customers, store accumulated customer experience, and design products that match the diverse needs of customer segments (Hayton, 2005; Joshi and Sharma, 2004; Youndt et al., 2004). Second, when new product teams need to acquire customer feedback and product-market knowledge, their organizational structure should be informal, decentralized and specialized (Ruekert et al., 1985; Vorhies and Morgan, 2003). A customer-oriented organizational culture encourages

behaviors that explore product innovation opportunities created by emerging customer demand and reduce market uncertainty and potential risks in the process of new product development (Carbonell and Rodriguez-Escudero, 2009; Cooper, 2003; Kelley et al., 2011; Smith et al., 2005). For these reasons, organizational capital generates customer capital, which enhances new product performance.

Human and organizational capitals promote customer capital, which in turn enhances new product performance. Some prior studies implied that new product projects collect and internalize technological and marketing capabilities and deliberately incorporate them into the development of new products (Johnson and Filippini, 2013; Marsh and Stock, 2003; Rampersad et al., 2012; Shoham et al., 2012). Thus, from the process-oriented perspective, customer capital plays a mediating role in the relations among human capital, organizational capital and new product performance. Following this line of reasoning, the following hypotheses are proposed.

Hypothesis 4a. Customer capital fully mediates the relationship between human capital and new product performance.

Hypothesis 4b. Customer capital fully mediates the relationship between organizational capital and new product performance.

Methodology

Data collection and sample

The unit of analysis is the new product development project. The empirical study employed a questionnaire approach designed to collect data for testing the validity of the model and research hypotheses. Variables in the questionnaire included background information, human capital, organizational capital, customer capital, and new product performance. All of the independent and dependent variables were measured using multiple-items. For each item, respondents were asked to indicate the extent to which they agreed along a seven-point Likert-type scale, ranging from 1 = "completely disagree" to 7 = "completely agree". All measures of the variables are listed in the Appendix I.

The population of this study is the top 5000 Taiwanese firms listed in the yearbook published by the China Credit Information Service Incorporation (CCIS), a credit-rating company in Taiwan. A stratified random sampling method was used to divide the population into five non-overlapping groups or strata based on the total assets held by the top 5000 companies in this study. A stratified sample in our survey was randomly selected from five levels of the top 5000 as follows: (a) rankings 1 through 1000; (b) rankings 1001 through 2000; (c) rankings 2001 through 3000; (d) rankings 3001 through 4000; and (e) rankings 4001 through 5000. 100 firms were equally chosen from each stratum for a total of 500 questionnaires distributed. The sample is representative of the Taiwanese population because the sampling frame is generated by a stratified random sampling process based on firm size. Moreover, if a company reported more than one new product development case in the last three years, the company was asked to choose the most significant one. We first contacted the selected firms by telephone in order to get the contact information for managers in charge of the new product development project. Each manager was directly mailed a letter explaining the general purpose of the study, a copy of the questionnaire, and a return envelope. Follow-up letters or emails were sent to appeal for participation three weeks after the first mailing.

Of the 500 questionnaires mailed, 103 responses were received although 10 of them are invalid and incomplete. The remaining 93 valid and complete questionnaires were used for the quantitative analysis, representing a response rate of 18.6%. Although this response rate is not as high as one might wish, it is consistent with other studies on new product development (e.g., Carbonell and Rodriguez-Escudero, 2009). Subsequently, this study assesses the possibility of non-response bias by using an extrapolation method comparing late and early respondents (Armstrong and Overton, 1977). The calculated t-statistics for the number of employees ($t = 0.52$, $p = 0.60$), sales ($t = 0.35$, $p = 0.72$), and firm age ($t = 0.77$, $p = 0.45$) as well as the Chi-square test for industry type ($\chi^2 = 0.07$, $p = 0.79$) were all statistically insignificant, suggesting no significant difference between late and early respondents.

Because measures of intellectual capital and new product performance were provided from the same source, the possibility of common method bias was controlled by using the procedural remedies and statistical tests (Podsakoff et al., 2003). In procedural remedies, we followed the recommendations proposed by Podsakoff et al. (2003) regarding questionnaire design, including psychological separation of predictor and criterion variables and response anonymity. We also conducted post hoc statistical tests and Harman's one-factor test of the influence of common method bias. Significant common method variance would result if one general factor accounts for the majority of covariance in the variables (Podsakoff and Organ, 1986). A principle component factor analysis on the questionnaire measurement items of this study produced four factors with eigenvalues greater than 1, together accounting for 74.1% of the total variance; the first factor accounted for 21.37% of the variance. As a single factor does not emerge and one general factor does not account for most of the variance, common method bias is unlikely to be a serious problem in the data (Carbonell and Rodriguez-Escudero, 2009; Chai et al., 2011; Podsakoff and Organ, 1986).

The characteristics of the sample are described in Table 1, including number of employees, number of years since founding, and industry sector. The response regarding the number of employees, 23.66% of the sample companies employed 200 people or less, 24.73% of the sample companies employed 200 through 500, 10.75% of the sample companies employed 500 through 1000, and 40.86% had more than 1000 employees. In addition, the greatest number of response by number of years since founding was located in the section of 10–20 years (33.3%), with the remainder composed of 10 years or less (10.75%), between 20 and 30 years (24.73%), and over 30 years (31.18%). Furthermore, the sample consisted of 77.42% manufacturers and the remainder composed of other sectors (22.58%).

Measures

Dependent variable

Following prior new product development studies (Im and Workman, 2004; Johnson and Filippini, 2013; Luca and Atuahene-Gima, 2007; Song and Montoya-Weiss, 2001; Song and Parry, 1997; Tsai et al., 2011), we used survey measures to assess the new product performance as objective performance measures are often unavailable or inaccurate for new product development projects. We used a five-item measure, adopted from Im and Workman's (2004) study, to indicate the extent to which firms were satisfied with the achievements in the new product development projects. These five items included two financial items (relative return on investment and relative profitability), two market items (relative market share and relative sales), and one overall assessment item (meeting objective for customer satisfaction) ($\alpha = 0.95$).

Table 1
Profile of the respondent firms.

	Number/percentage	HC	OC	CC	NPD
Number of employees					
<200 (SMEs)	22 (23.66%)	5.05	5.41	5.29	5.05
>200–500	23 (24.73%)	4.85	5.09	4.94	4.95
>500–1000	10 (10.75%)	4.78	4.95	5.03	4.70
>1000	38 (40.86%)	4.94	5.47	5.40	5.24
Number of years since founding					
<10 (new venture)	10 (10.75%)	4.78	5.10	4.89	5.12
>10–20	31 (33.33%)	4.92	5.49	5.20	5.19
>20–30	23 (24.73%)	5.15	5.23	5.16	4.99
>30	29 (31.18%)	4.80	5.24	5.39	4.96
Industry sector					
Manufacture sector	72 (77.42%)	4.97	5.32	5.25	5.13
Other sectors	21 (22.58%)	4.76	5.26	5.09	4.83

Independent variables

Human capital reflects the level of knowledge and skills residing in the minds of the managers and employees (Youndt et al., 1996; Hatch and Dyer, 2004; Martinez-Torres, 2006; Subramaniam and Youndt, 2005). We adopted Subramaniam and Youndt's (2005) five-item scale to assess the extent to which the employees are highly skilled, considered the best in the industry, creative and bright, experts in their jobs, and able to develop new ideas and knowledge (α=0.88).

Organizational capital refers to the levels of institutionalized knowledge and codified experience embodied in the organization-level repository. We used a four-item scale, developed by Subramaniam and Youndt (2005), to assess the extent to which the organization's knowledge and codified experience are stored in information systems, intellectual properties, cultures, and structures and systems (α=0.88).

Customer capital refers to organizational capabilities of market intelligence to understand and satisfy customers' preferences and latent needs (Hermans and Kauranen, 2005; Moreau et al., 2001; Nahapiet and Ghoshal, 1998; Schulze and Hoegl, 2006). Through interactions with customers, firms can gain the market knowledge necessary to facilitate the development of customized and differentiated new products that match customers' needs and wants (Alam, 2002; Gruner and Homburg, 2000; Hsu et al., 2006; Hsu and Fang, 2009; Matting et al., 2004). In addition, a high level of customer capital can make firms more trustworthy to customers, who experience higher value-added service and are more satisfied and loyal to these firms (Deshpandé et al., 1993; Olson et al., 2005; Song and Montoya-Weiss, 2001; Song and Parry, 1997). Accordingly, we measured this construct with a seven-item scale, adapted from Wu and Tsai's (2005) study, to assess the extent of the firm's capabilities in being market-oriented, striving to understand customers' wants and needs, possessing problem-solving ability, providing high value-added service, and maintaining high customer satisfaction, loyalty, and market share (α=0.92).

Control variables

To empirically test the relationships among human capital, organizational capital, customer capital, and new product performance, we controlled several variables—including firm size, firm age, and industry type—that may affect the dependent variable. Firm size and age may influence new product performance as different sizes and ages may exhibit different organizational characteristics and resource deployment (Ganesan et al., 2005; Im and Workman, 2004; Song and Montoya-Weiss, 2001; Song and Parry, 1997; Tsai et al., 2011). In addition, firms in different industries may behave differently in new product development (Schulze and Hoegl, 2006). Therefore, these variables were included as control variables to measure potential effects. Firm size was measured as the natural logarithm of the number of full-time employees while firm age was computed as the number of years from the founding date. Finally, this study controlled the industry type effect by including a dummy variable to indicate whether a firm belonged to the manufacturing industry (coded as 1) or other industry (coded as 0).

Reliabilities and convergent and discriminant validity

We estimated the measurement model of the confirmatory factor analysis for all of the multi-item scales of the dependent and independent variables simultaneously to provide evidence of both internal consistency and convergent validity (Gerbing and Anderson, 1988). All constructs showed satisfactory levels of reliability in terms of the composite reliabilities, ranging from 0.88 to 0.95 (see Appendix I). Convergent validity (i.e., the extent to which different means of measuring a construct agree) can be judged by looking at the item loadings. Each loading for each construct, as shown in Appendix I, was significantly related to its underlying factor, and all of the standardized item loadings were well above the cutoff of 0.50 (Gerbing and Anderson, 1988), thereby supporting convergent validity.

Discriminant validity (i.e., the extent to which a construct differs from others) was assessed for the multi-item dependent and independent scales. We examined the pairwise discriminant validity by merging the constructs into one, and then examined the difference in Chi-square values between the constrained and unconstrained models. The test statistics for each pair were

highly significant ($p<0.05$), suggesting discriminant validity. It was particularly important that discriminant validity be achieved among our constructs for human capital, organizational capital, customer capital, and new product performance. The significant difference in the Chi-square (organizational capital vs. human capital, $\Delta\chi^2=5.9$, $\Delta df=1$, $p<0.05$; organizational capital vs. customer capital, $\Delta\chi^2=68.0$, $\Delta df=1$, $p<0.001$; organizational capital vs. new product performance, $\Delta\chi^2=30.5$, $\Delta df=1$, $p<0.001$; human capital vs. customer capital, $\Delta\chi^2=11.9$, $\Delta df=1$, $p<0.001$; human capital vs. new product performance, $\Delta\chi^2=5.9$, $\Delta df=1$, $p<0.05$; customer capital vs. new product performance, $\Delta\chi^2=48.0$, $\Delta df=1$, $p<0.001$) indicates pairwise discriminant validity of our constructs (Gerbing and Anderson, 1988). We also compared the goodness-of-fit indexes between each constrained and unconstrained model and found the difference to be moderately large, again suggesting sufficient discriminant validity (Bagozzi and Yi, 1988).

Results

The independent variables of human capital, organization capital and customer capital, and dependent variable of new product performance varied widely in all groups of number of employees, number of years since founding, and industry sector. This study used ANOVA to analyze whether there were significant differences of three types of intellectual capital and new product performance among the firm size, firm age and industry sector. The first row of Table 1 showed average organizational capital, customer capital, and new product performance in the companies exceeding 1000 persons were the most in the four groups of firm size, whereas mean human capital in small and medium-sized enterprises (200 persons or less) was better than that of other three groups in firm size. Furthermore, Table 2 showed that there were indeed insignificant differences in human capital, organizational capital, customer capital and new product performance among the four groups of firm age. Similarly, the manufacturing industry did not differ significantly from the non-manufacturing industry in terms of human capital, organizational capital, customer capital, and new product performance according to the ANOVA *F*-test.

This study has attempted to understand the relationships among human capital, organizational capital, customer capital, and new product performance. Table 2 displays the descriptive statistics and correlations of all variables. These 93 projects had an average of 2364 employees, and had mean number of years since founding of 25.32 years. Variance inflation factors (VIFs) were used to examine the effect of multicollinearity. The values of the VIF associated with the predictors ranged from 1.06 to 2.14, indicating they were within acceptable limits (Hair et al., 1998); these data suggest no need for concern with respect to multicollinearity. The theoretical framework and seven empirical hypotheses proposed in this study were previously illustrated in Fig. 1. Structural equation modeling was employed to test the hypotheses. Given the robust results of this analysis, Baron and Kenny's (1986) procedure and Sobel's (1982) test were then conducted on the main sample to confirm the directional and mediated relationships.

Table 2
Means, standard deviations, and correlations.

Variables	Mean	SD	VIF	1	2	3	4	5	6	7
1. Firm age (log)	1.34	0.24	1.11							
2. Industry (dummy)	0.77	0.42	1.08	−0.158*						
3. Number of employees (log)	2.83	0.70	1.06	0.124	−0.143*					
4. Human capital	4.89	0.93	1.77	−0.148*	0.089	0.002	(0.88)			
5. Organizational capital	5.31	0.95	2.08	−0.114	0.025	0.123	0.588**	(0.88)		
6. Customer capital	5.33	0.95	2.14	0.031	0.126	0.100	0.664**	0.588**	(0.92)	
7. New product performance	5.06	1.12		−0.125	0.113	0.115	0.544**	0.565**	0.718**	(0.95)

* Significance (two-tailed) at the 0.05 level.
** Significance (two-tailed) at the 0.01 level.

Table 3
Structural model estimates (N=93).

Description of paths		Hypothesized direction	Hypothesized model	
			Coefficient	t-Value
H1	Customer capital → new product performance	+	0.76	9.40***
H2a	Human capital → customer capital	+	0.29	3.24***
H2b	Human capital → new product performance	+	0.12	1.38
H3a	Organizational capital → customer capital	+	0.49	5.46***
H3b	Organizational capital → new product performance	+	0.11	1.34

*** Significance (two-tailed) at the 0.001 level.

Structural equation modeling

Structural equation modeling (SEM) was conducted to confirm the research model and hypotheses. Table 3 presents the standardized maximum likelihood parameter estimates and their t-statistics for the five directional relationships (Hypotheses 1, 2a, 2b, 3a, and 3b). Fig. 2 illustrates the hypothesized model with the standardized coefficients for the two mediated relationships (Hypotheses 4a and 4b). All coefficients in Fig. 2 are significant at 0.001 and with the hypothesized signs. The values for Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), and root mean square error of approximation (RMSEA) are 2.95, 0.97, 0.85 and 0.14 respectively. The p-value associated with the Chi-square statistics indicated acceptance of the model (p=0.52). Other statistics also suggest a good fit, especially according to the Normed Fit Index (NFI=0.97, recommended by Bentler and Bonett, 1980), the Incremental Fit Index (IFI=0.98), and the Comparative Fit Index (CFI=0.98). All other fit indices with the exception of the AGFI met the .90 criterion. The standardized Root Mean Square Residual (RMR) of 0.05 was also less than the 0.08 criterion. Significant factor loadings for each of the individual construct items indicated convergent validity for each construct. All of these fit statistics indicate a good fit of the data to the proposed structural equation model and, considered together, lend support to the overall validity of the structural equation model.

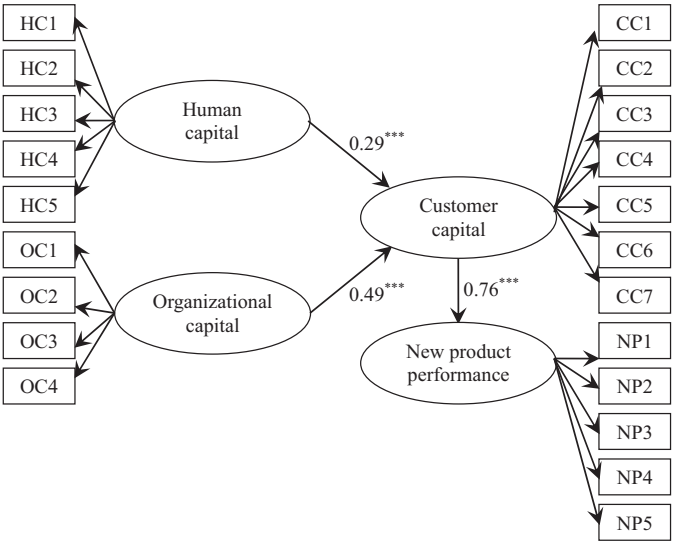

Fig. 2. Estimated coefficients of the research model. *Notes*: $^{*}p \leq 0.05$; $^{**}p \leq 0.01$; $^{***}p \leq 0.001$.

Hypothesis 1 predicts that customer capital positively relates to new product performance; it is supported by the data ($\beta = 0.76$; $p < 0.001$). This result provides empirical evidence to connect the positive relationship between customer capital and new product performance, highlighting the importance of customer capital in the new product development process. The second set of hypotheses examines how human capital would—whether directly or indirectly—affect new product performance primarily through customer capital. Table 3 shows that human capital is positively related to customer capital ($\beta = 0.29$, $p < 0.001$), providing support for Hypothesis 2a. However, in contrast to our prediction, human capital does not have considerable main effects in explaining new product performance ($\beta = 0.12$, $p > 0.05$); thus, Hypothesis 2b is not supported. Likewise, the third set of hypotheses proposes that organizational capital has a direct or indirect effect on new product performance. As evidenced in Table 3, organizational capital contributes more to customer capital ($\beta = 0.49$, $p < 0.001$), but does not considerably affect new product performance ($\beta = 0.11$, $p > 0.05$). In this regard, the empirical findings provide support for Hypothesis 3a, but not Hypothesis 3b. Collectively, Table 3 shows that the mediating effect of customer capital between human capital and new product performance reaches 0.22 (the multiplication of the two parameter estimates 0.29 and 0.76), which is larger than the direct impact of human capital on new product performance (parameter estimate = 0.12). Similarly, the mediating effect of customer capital between organizational capital and new product performance reaches 0.37 (the multiplication of the two parameter estimates 0.49 and 0.76) which is higher than the direct impact of organizational capital on new product performance (parameter estimate = 0.11). The empirical findings provide evidence supporting the role of customer capital in mediating the effects of human capital and organizational capital on new product performance. This suggests that, in this case, human capital and organizational capital are constructive to customer capital, which in turn enhances new product performance. Accordingly, the empirical results generally support Hypotheses 4a and 4b.

Robustness tests

As a consistency check with prior research, SEM methodology was used to analyze the mediated relationships. Furthermore, this study replicated the analysis using the four-step regression procedure that Baron and Kenny (1986) recommended, to explore the robustness of the preceding results given the potential concerns stemming from the small sample size. Table 4 presents the results of regression

Table 4
Results of regression analyses predicting customer capital and new product performance.

Dependent variable	Customer capital		New product performance				Sobel's test
	Model 1a	Model 1b	Model 2a	Model 2b	Model 2c	Model 2d	
Control variables							
Firm age (log)	0.040	0.147	−0.125	−0.034	−0.154*	−0.121	
Industry (dummy)	0.150	0.115	0.114	0.080	0.007	0.012	
Number of employees (log)	0.117	0.037	0.147	0.092	0.063	0.069	
Independent variables							
Human capital		0.311***		0.371***		0.187**	3.21***
Organizational capital		0.491***		0.308***		0.018	4.68***
Mediating variable							
Customer capital					0.716***	0.591***	
Model statistics							
R^2	0.032	0.532	0.045	0.401	0.541	0.565	
F	0.977	19.776***	1.409	11.642***	25.959***	18.580***	
N	93	93	93	93	93	93	

Note. Standardized coefficients are reported.
* Significance (two-tailed) at the 0.05 level.
** Significance (two-tailed) at the 0.01 level.
*** Significance (two-tailed) at the 0.001 level.

analyses predicting the directional and mediated relationships. Model 1a is the base model that includes the control variables. As anticipated, this combination of control variables does not have a significant effect on the dependent variable ($F=0.977$, $R^2=0.032$).

As previously discussed, the coefficient of customer capital in Model 2c is positively and statistically significant for new product performance ($\beta=0.716$, $p<0.001$). This finding indicates that firms would achieve a higher level of new product performance if they passively engage in the pursuit of knowledge residing with customers that allows firms to understand their latent and future needs. Hence, Hypothesis 1 regarding the positive relationship between customer capital and new product performance is supported. In addition, Model 1b in Table 4 captures the direct effects of human capital and organizational capital on customer capital. It is statistically significant ($F=19.776$; $p<0.001$) and explains an additional 50.0% of the variance over what Model 1a alone explains. The coefficients of human capital ($\beta=0.311$, $p<0.001$) and organizational capital ($\beta=0.491$, $p<0.001$) for customer capital are both positive and statistically significant, suggesting that not only highly knowledgeable and skillful employees, but also physical organization-level repositories may improve the performance of new product development process as a whole. Accordingly, we obtained evidence consistent with Hypotheses 2a and 3a, respectively.

Furthermore, we followed Baron and Kenny's (1986) four-step procedure to analyze how customer capital mediates the effects of human capital and organizational capital on new product performance. The first step was to examine the relationship between independent variables and the dependent variable. As shown in Model 2b, both human capital ($\beta=0.371$, $p<0.001$) and organizational capital ($\beta=0.308$, $p<0.001$) are positive and statistically significant for the new product performance. Second, the mediator, customer capital, is regressed on the independent variables. As shown in Model 1b, the effects of both human capital ($\beta=0.311$, $p<0.001$) and organizational capital ($\beta=0.491$, $p<0.001$) are positive and statistically significant on customer capital. The third step is to examine the relationship between the mediator and the dependent variable. Model 2c shows that customer capital has a positive and statistically significant effect on new product performance ($\beta=0.716$, $p<0.001$). Finally, the mediator—namely, customer capital—was included in the model to examine whether it reduces the effects of the antecedents to non-significance. As shown in Model 2d, the coefficient for customer capital factor is positive and statistically significant ($\beta=0.591$, $p<0.001$), indicating the direct effect of customer capital on new product performance. Furthermore, with customer capital included in the equation, the effects of human and organizational capital factors are significantly reduced to non-significance. The regression coefficient for human capital is reduced from 0.371 ($t=3.580$, $p<0.001$) in Model 2b to 0.187 ($t=1.978$, $p>0.05$) in Model 2d; meanwhile the regression coefficient for organizational capital is reduced from 0.308 ($t=2.965$, $p<0.001$) in Model 2b to 0.018 ($t=0.176$, $p>0.05$) in Model 2d. These findings indicate that the inclusion of the customer capital attenuates the effects of human capital and organizational capital on new product performance.

Moreover, Sobel's (1982) test enables the investigation of indirect effects for independent variables of human capital and organizational capital, regardless of the significance of their total effects on the dependent variable of new product performance via the mediators of customer capital in our study. As shown in the final column of Table 4, the Sobel's test z-values of 4.68 for organizational capital and 3.21 for human capital are both statistically significant ($p<0.001$). The results of the Sobel's test provide additional evidence of the significance and strength of the indirectly mediating effects. As previously discussed, human capital and organizational capital are unrelated to new product performance in the preceding SEM model. Testing for mediation for these variables violates Baron and Kenny's (1986) first test condition. However, several early researchers in the field of product innovation have argued that this constraint may be relaxed without hampering the validity of the mediation analysis (see Luca and Atuahene-Gima, 2007; Smith et al., 2005). As previously mentioned, customer capital plays a fully mediating role among human capital, organizational capital, and new product performance. Therefore, the mediation effects proposed in Hypothesis 4a and 4b were fully supported, whereas Hypothesis 3a and 3b did not receive any support. Overall, the results of this study suggest that human capital and organizational

capital have an indirect effect (through customer capital), but no direct effect on new product performance.

Discussion

This study examined the roles of human, organizational, and customer capital, in the new product development projects. Our results empirically support the argument that intellectual capital facilitates new product performance. The three dimensions of intellectual capital have significant effects on new product performance. More specifically, human capital and organizational capital are positively related to customer capital, which is in turn positively related to new product performance. The empirical evidence from the SEM, Baron and Kenny's (1986) procedure, and Sobel's (1982) test support the mediating role of customer capital in the relation among the human capital, organizational capital and new product performance. These findings highlight the critical roles of different aspects of intellectual capital in the development of new products. Human capital has not been found to have a significant association with new product performance. A possible explanation for this result is that although human capital is necessary for firms, it may not be a sufficient condition for firms to achieve advanced new product performance. The prior new product development experience of employees should be considered (e.g., Hoang and Rothaermel, 2010). If employees lack prior experience relevant to the new products, the firm is probably incapable to leverage their resources and capabilities effectively to increase its new product performance. Future research may investigate the unanticipated effect of the employees' prior new product development experience on a firm's new product performance.

The argument that intellectual capital enhances new product performance has found wide acceptance among practitioners. Our study supports this conclusion, but with qualifications. The managerial implications are as follows. First, product innovation projects that improve their new product performance should develop intellectual capital. This notion is justified given the research on the positive effects of intellectual capital on product innovation outcomes. Second, the accumulation of customer capital in the development of new products can explain what customers want, enhancing new product performance resulting from an increase in profits, sales, and market growth. Therefore, the new insights for project managers is that intellectual capital which provides useful knowledge and skills for firms is inherently valuable for new product performance, although it emphasizes customer capital at the expense of human and organizational capital, which may be detrimental to the achievement of the new product projects. Third, our study calls on project managers to recognize the importance of customer capital in transferring the effects of human and organizational capital. In other words, knowledge and skills within human capital (in the form of knowledgeable and skillful employees) and organizational capital can help product innovation projects acquire the knowledge possessed by customers. Accordingly, project managers are fervent adherents of the human capital and organizational capital with respect to the value of gaining customer capital. Finally, this study examines the features of customer knowledge by considering that—although human capital is important—managers need to pay equal attention to organizational capital. The human and non-human dimensions of intellectual capital influence the acquisition of customer capital, which affects new product performance. Moreover, project managers need to encourage new project teams with the human and organizational capital invest their customer capital in new product development activities. In this respect, our empirical findings could guide project managers who may not be able to achieve their intended objectives in new product development without balancing the need for customer capital engendered by the knowledge residing with human capital and organizational capital.

The findings of this study contribute to the development of a conceptual model that would explain the interrelationships among the three dimensions of intellectual capital and new product performance. Little research has been done to examine these interrelationships, which is of significance given the increasing importance of new product development for a firm's competitive advantage. This study, based on the knowledge-based view, presented a conceptual model and

hypothesized the mediating role of customer capital in the relation among human capital, organizational capital, and new product performance.

The second contribution of this study is that offers empirical support for the model's prediction using the data from actual cases. Our study contributes to the literature by empirically examining the mediating role of customer capital in the relation of human and organizational capital with new product performance. Prior studies have recognized the importance of intellectual capital in business performance, financial returns, and knowledge management effectiveness (e.g., Bozbura, 2004; Bramhandkar et al., 2007; Chen et al., 2009; Firer and Williams, 2003; Hayton, 2005; Hermans and Kauranen, 2005; Jardon and Martos, 2009; Kamath, 2008; Kim et al., 2012; Tan et al., 2007; Wu and Chou, 2007; Wu and Tsai, 2005; Wu et al., 2008; Yang and Lin, 2009; Youndt et al., 2004; Zeghal and Maaloul, 2010); however, the role of intellectual capital in new product development has not been investigated empirically. By establishing these important links, this study demonstrates that the use of human and organizational capital explains new product performance; yet, when customer capital was added as a mediator, these positive relationships were attenuated. Thus, we demonstrate that customer capital acts as a mediator through which human and organizational capital benefit new product performance. The findings of this study are therefore based on a much-needed empirical examination of the roles of intellectual capital in the context of new product development.

Conclusions and limitations

The findings of this study should be interpreted with caution in light of several limitations. Although this study posits causal relationships of three types of intellectual capital, the causality may flow in an opposite direction to the proposed causal relation (for example, perhaps customer capital promotes human capital or organizational capital) or it may flow both ways. For example, Bapuji et al. (2011) argue that incumbent firms with a stronger focus on the knowledge residing in customers could be incentivized to build human capital and organizational capital to better absorb external knowledge and respond to customers' needs. However, we rooted our arguments in existing theory and previous results. Future longitudinal research may clarify whether or not these reverse or reciprocal relationships exist. In addition, the low response rate and small sample are another potential concern. However, the sample is rather representative of the population; either *t*-statistics or Chi-square tests indicate that the non-response bias is not a significant issue. In terms of generalizability, the small sample size and low return rate of the survey are potential limitations. This study was an empirical investigation of Taiwanese firms. Potential cultural limitations should be noted. In addition, the main measurement, NPD performance, cannot capture the type of innovation. Future research should explore the issue of intellectual capital and the two types of innovation, including incremental innovation and radical innovation. Moreover, this study is based on self-reported data, which may lead to common method variance, project selection bias and not knowing who completed survey; however, by using the procedural remedies and statistical tests, this was not found to be a significant problem. Future research using objective measures of new product performance that can be independently verified can address this limitation. Finally, the sample may be biased because it excluded firms that might not introduce new products into the mature product markets but might be engaged in the pursuit of product innovations in the early stage of organizational life cycle. Although the empirical analysis has controlled for the firm age, additional research is required to compare the early stage of organizational life cycle companies to the late stage using our conceptual model.

To conclude, intellectual capital is a treasured asset for firms when developing new products for superior competitive advantages. The viewpoints proposed in this study highlight the roles of different aspects of intellectual capital in the development of new products. Human and organizational capital can deliver superior new product performance primarily through customer capital.

Appendix I. Results of confirmatory factor analysis of measures.

Operational measures of construct	Standardized factor loading	*t*-Value
New product performance (Im and Workman, 2004) (α=0.95)		
1. Return on investment in our new product development project is relative high in our industry	0.87	14.97***
2. Profitability in our new product development project is relative high in our industry	0.92	18.14***
3. Market share in our new product development project is relative high in our industry	0.88	15.42***
4. Sales in our new product development project are relative high in our industry	0.88	15.79***
5. Our new project development product can meet objectives for customer satisfaction and technological advancement	0.85	13.57***
Human capital (Subramaniam and Youndt, 2005) (α=0.88)		
1. Our employees are highly skilled	0.68	7.68***
2. Our employees are widely considered the best in our industry	0.65	6.96***
3. Our employees are creative and bright	0.78	9.31***
4. Our employees are experts in their particular jobs and functions	0.84	10.57***
5. Our employees develop new ideas and knowledge	0.84	10.83***
Organizational capital (Subramaniam and Youndt, 2005) (α=0.88)		
1. Our organization uses patents and licenses as a way to store knowledge	0.78	9.29***
2. Much of our organization's knowledge is contained in manuals, databases, etc.	0.91	11.74***
3. Our organization's culture (stories, rituals) contains valuable ideas, ways of doing business, etc.	0.75	8.87***
4. Our organization embeds much of its knowledge and information in structures, systems, and processes	0.78	9.28***
Customer capital (Wu and Tsai, 2005) (α=0.92)		
1. We maintain the most positive value-added service	0.72	9.10***
2. We pride ourselves on being market-oriented	0.78	10.62***
3. We have greatly reduced the time it takes to resolve a customer's problem	0.72	9.21***
4. We capitalize on our customers' wants and needs by continually striving to make them satisfied	0.82	11.94***
5. Our customers are loyal to our company, more so than to any other in the industry	0.88	14.24***
6. We get as much feedback out of our customers as we possibly can under the circumstances	0.84	12.54***
7. Data on customer feedback is disseminated throughout the organization	0.69	8.40***

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