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The Effects of a CEO's Technical Background and Cross-functional Coordination on Technological Innovation Performance: The Mediating Role of Technological Innovation Orientation

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ABSTRACT

The major purpose of this research is to provide a refined understanding of the effects of a CEO's technically oriented functional background and cross-functional coordination on the firm's technological innovation performance by including as a mediating variable in the research model the construct of technological innovation orientation which has been recently identified as an important factor affecting the firm's technological innovation performance. Strategic management and innovation research has suggested managerial functional background as a crucial factor affecting the successful innovation outcomes. Nevertheless, no empirical analysis has been conducted on the relationship between CEOs' or top managers' functional backgrounds and the organizational innovation performance. One plausible reason for the absence of prior research empirically examining the relationship between managerial functional background and innovation performance may be that the research has failed to identify some intervening mechanism through which managers' relevant functional backgrounds influence the firm's innovation outcomes. Cross-functional coordination has been frequently recognized as a crucial driver for the firm's successful technological or product innovation performance. Yet, previous empirical research has provided a limited support for the direct positive impact of cross-functional coordination on such innovation performance. Research has shown that that cross-functional coordination may not be sufficient on its own to generate the firm's superior technological or product innovation performance due to some inherent adverse effects it brings about. Given lack of extant empirical research exploring relevant mediating mechanisms that may link cross-functional coordination with firm innovation performance, the controversy regarding the direct impact of cross-functional coordination on innovation performance remains unsettled.

In an effort to fill up the aforementioned gaps or deficiencies in previous studies, the present research proposed and empirically tested a conceptual research model and hypotheses in which a CEO's technically oriented functional background and cross-functional coordination affect the firm's technological innovation performance, directly and indirectly, via technological innovation orientation. Technological innovation orientation represents an organizational culture conceptualized as an organization-wide direction of thinking toward creating or adopting new ideas, products, services, or processes. Analysis of a sample of 87 small and medium-sized enterprises (SMEs) in the Korean IT industry revealed that technological innovation orientation fully and positively mediated the relationship between the firm's technological innovation performance and a CEO's technically oriented functional background and cross-functional coordination, respectively. Both a CEO's technically oriented functional background and cross-functional coordination did not have significant direct effects on the firm's technological innovation performance when technological innovation orientation was controlled in the model. Theoretical and practical implications for the results of this research were discussed.

Keywords: CEO Technical Background; Cross-functional Coordination; Technological Innovation Orientation; Technological Innovation Performance; Mediating Effect

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I . Introduction

Technological innovation has become a crucial source of competitive advantage and growth for most of the firms in today's dynamic and globally competitive market. Technological innovation represents the creation or adoption of new knowledge or ideas regarding product, service or process development (Damanpour, 1991; Tushman & Anderson, 1986). Especially, successful product or service development through technological innovation is considered an important means whereby small and medium enterprises (SMEs), faced with a greater pressure in securing their competitiveness in the global market as well as the domestic market, achieve their survival and economic growth (Radas & Božić, 2009; Wijayanti, Wahyono, & Rozaq, 2016) and a force enabling the SMEs to reconstitute the established market dominated by the large firms (Christensen, Anthony, & Roth, 2004). Due to such a pivotal role of technological innovation in enhancing the firm's competitive edge, it has been a critical issue to both academic researchers and business practitioners to identify relevant factors contributing to successful technological innovation performance. Although many variables may influence technological innovation performance, this research focuses on the effects of a CEO's technically oriented functional background and cross-functional coordination on the firm's technological innovation performance by including as a mediating variable in the research model the construct of technological innovation orientation which has been recently identified as an important factor affecting the firm's technological innovation performance (Moon, 2013).

Strategic management and innovation research has suggested managerial background characteristics as a crucial factor in accounting for a firm's innovation outcomes. The link between managerial functional backgrounds and innovation outcomes is grounded on the central premise of upper echelons perspective (Hambrick & Mason, 1984) that managerial background characteristics such as age, education, and functional track shape the cognitive bases and values of managers

and have a significant effect on their strategic actions and resultant performance outcomes. Drawing on the upper echelons perspective, a considerable number of prior studies empirically examined the relationships between managerial characteristics such as leadership styles, personalities and education level and firm performance in the context of innovation (Camelo, Fernández-Alles, & Hernández, 2010; Chen et al., 2014; García-Granero et al., 2015; Nadkarni & Chen, 2014). Yet, to date no empirical investigation has been conducted on the relationship between managerial functional background and the organizational innovation performance. One potential reason for the absence of previous research to investigate the link between managerial functional background and innovation performance may be that the research failed to identify some relevant mediating mechanism through which such managerial functional background leads to organizational innovation outcome.

Cross-functional coordination has been frequently recognized as a critical factor for successful technological innovation or new product development (e.g., De Clercq, Thongpapanl, & Dimov, 2011; Song & Montoya-Weiss, 2001; Song, Montoya-Weiss, & Schmidt, 1997; Stock, Totzaur, & Zacharias, 2013; Troy, Hirunyawipada, & Paswan, 2008). Cross-functional coordination refers to the extent of interaction, communication, information sharing, and joint involvement across diverse organizational functions such as R&D, production, and marketing (Song & Montoya-Weiss, 2001; Troy et al., 2008). A large body of literature has demonstrated that cross-functional coordination positively influences new product success or technological innovation performance owing to the virtues it generates like increased sharing of market information, improved interaction and communication and high flexibility in organizational structure (Chen, Li, & Lin, 2013; De Clercq et al., 2011; Song et al., 1997; Song & Montoya-Weiss, 2001; Song & Parry, 1997; Stock et al., 2013; Troy et al., 2008). On the other hand, a substantial amount of research suggested that since cross-functional coordination generates some potential adverse effects such as interpersonal conflicts and low employee commitment, cross-functional alone

may not be sufficient to lead to successful new product development or technological innovation (De Clercq et al., 2011; De Luca & Atuahene-Gima, 2007; Sethi, 2000a, 2000b; Tassarolo, 2007; Xie, Song, & Stringfellow, 2003). Accordingly, in order for cross-functional coordination to lead to the successful technological innovation performance, the firm needs some intermediate mechanism to minimize the detrimental effects that may occur in cross-functional process and to realize in full the benefits cross-functional coordination brings about. Although a few prior studies suggested and empirically demonstrated some variables such as slack resources (Chen, Li, & Lin, 2010) and knowledge integration mechanisms (De Luca & Atuahene-Gima, 2007) as partially or fully mediating the relationship between cross-functional coordination and new product development or innovation performance, there has been still lack of extant empirical research exploring some relevant intervening mechanisms through which cross-functional coordination affects the firm's technological innovation performance. Thus, given lack of extant empirical research exploring relevant mediating mechanisms that may link cross-functional coordination to firm innovation performance, the debate regarding the direct impact of cross-functional coordination on innovation performance remains unresolved.

In order to fill up the aforementioned gaps or deficiencies in previous studies, the present research proposed and empirically examined a conceptual research model and hypotheses in which a CEO's technically oriented functional background and cross-functional coordination affect the firm's technological innovation performance, directly and indirectly, via technological innovation orientation. Technological

innovation orientation represents an organizational culture conceptualized as an organization-wide direction of thinking toward creating or adopting new ideas, products, services, or processes (Moon, 2013). Despite its theoretical and practical importance, the role of technological innovation orientation in the organizational performance has been rarely investigated in extant research. Thus, it will be able to make a valuable contribution to strategic management and innovation research to systematically analyze the contingency relationships between both a CEO's technical background and cross-functional coordination and technological innovation performance using technological innovation orientation as a mediating mechanism. Figure 1 schematically represents the overall conceptual model and associated hypotheses of the present research. The proposed model and hypotheses was empirically tested based on a sample of small and medium-sized enterprises (SMEs) in the Korean IT industry

II. Literature Review and Hypotheses

A. A CEO's technical background and technological innovation performance

Strategic management and innovation research has identified managerial background characteristics as a crucial factor influencing a firm's innovation outcomes. The link between managerial functional backgrounds and innovation outcomes is based on the central notion of upper echelons perspective that managerial characteristics such as age, education, and functional track build up the cognitive frameworks

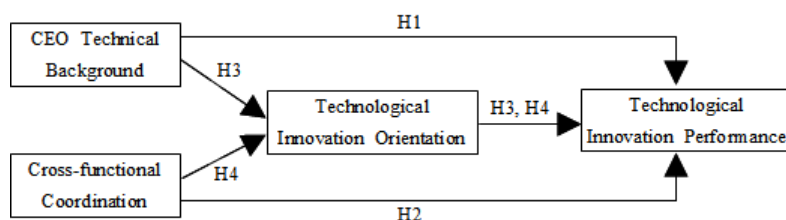


Figure 1. The Conceptual Mode and Hypotheses of the Study

and values of managers and affect their strategic actions and the resultant organizational performance. Based on the upper echelons perspective, some prior research empirically examined the relationships between managerial characteristics such as leadership styles, personalities, and education level and firm performance in the context of innovation (Camelo et al., 2010; Chen et al., 2014; García-Granero et al., 2015; Nadkarni & Chen, 2014). However, extant empirical research has failed to empirically examine the relationship between managerial functional background and innovation performance. This is quite surprising, if we consider it has been a prevalent theme of research in strategic management field to investigate the impact of managerial functional background on the strategic choices and performance outcomes. Thus, it will make a considerable theoretical contribution to strategic management and innovation research to provide an empirical examination of the impact of a CEO's functional background on firm performance in the context of technological innovation.

Functional background is considered as an important indicator of top managers' cognitive biases and their specialized knowledge and skills that play a central role in steering the firm's strategic direction and enabling the firm to effectively implementing the strategy it pursues (Rajagopalan & Datta, 1996). Innovation research has emphasized the importance of top managers' relevant functional background in implementing the organizational innovation. For example, Hoffman and Hegarty (1993) suggested that top managers' externally-oriented functional backgrounds such as R&D and marketing are most relevant for product and market innovations. Dallenbach, McCarthy, and Schoenecker (1999) argued that top managers having the primary experience in technically oriented functional areas such as production, engineering, and R&D will more likely focus on strategic investments in product innovation or process technology and better grasp the technical, operational, and financial implications of such investments. Accordingly, a CEO with the high degree of technical orientation in his or her functional background is more likely to effectively pursue and implement the firm's technological innovation.

Miller and Friesen (1982) contended that technocrats such as scientists and engineers acquire the knowledge and skills often making them most capable and motivated to develop new products and processes. Thus, emphasizing the importance of technocracy for the firm's innovativeness, they found that firms with a high proportion of managerial technocrats and great reliance on these technically specialized personnel for organizational decision making tend to lead to a high level of product innovation.

In sum, a CEO with technically oriented functional background is likely to better detect new technological or product opportunities and to be more capable of converting the detected opportunities into the final product which is commercially viable in the market (Nadkarni & Chen, 2014). Thus, the firm whose CEO has a greater orientation in his or her functional background may be better positioned to effectively implement the technological innovations. The upper echelons perspective (Hambrick & Mason, 1984) suggests that managers from "output functions" such as marketing, sales, and product R&D stress growth and search for new domains, whereas managers from "throughput functions" like production, process engineering, and accounting focus on operational efficiency. According to the perspective, CEOs with the main background in marketing and sales are attuned to new product or market opportunities and accordingly may implement the technological innovation effectively as much as those with technically oriented functional backgrounds. However, CEOs with the primary background in marketing and sales, who are less technically oriented in general, tend to focus on product extension or technological improvement rather than radical product innovation or technological innovation in pursuit of growth in the market (Dallenbach et al., 1999). Thus, the present study expects that CEOs with the main background in marketing and sales will be less effective in implementing technological innovations than those with technically oriented functional backgrounds. Based on the arguments above, the following hypothesis is suggested.

Hypothesis 1: The extent of technical orientation

in a CEO's functional background is directly and positively related to the firm's technological innovation performance.

B. Cross-functional coordination and technological innovation performance

Cross-functional coordination has been frequently recognized as a critical factor for successful technological innovation or new product development (Ayers, Dahlstrom, & Skinner, 1997; De Clercq et al., 2011; Song & Montoya-Weiss, 2001; Song & Parry, 1997; Song et al., 1997; Song & Song, 2010; Stock et al., 2013; Suder, Sherman, & Davis-Cooper, 1998; Troy et al., 2008; Xie et al., 2003). Cross-functional coordination refers to the extent of interaction, communication, information sharing, and joint involvement across diverse organizational functions such as R&D, production, and marketing (Song & Montoya-Weiss, 2001; Troy et al., 2008). Cross-functional coordination represents an important characteristic of organic organizational structure which enables the firm to effectively cope with dynamic environments arising from factors such as frequent changes in customer needs and tastes. Furthermore, cross-functional coordination reflects the intangible, affective and unstructured nature of cooperation or collaboration among functional units or teams in an organization (De Clercq et al., 2011; De Luca & Atuahene-Gima, 2007; Troy et al., 2008). Thus, cross-functional coordination can be conceived as a complex process or mechanism comprising the informal unstructured collaboration as well as the formal structured interaction among organizational functions (De Clercq et al., 2011). In order to develop successful new products or services, the firm needs to quickly detect customer needs, design new products, services, or processes using novel scientific and technological knowledge, and transform such R&D design into the final product or service that is commercially viable in the market. Thus, the firm cannot depend on a single function like R&D but requires the synergistic coordination and cooperation of diverse functions such R&D,

production/operations, and marketing in order to successfully develop new products or processes. A large body of literature has demonstrated that cross-functional coordination positively influences the new product success or technological innovation performance owing to the virtues it generates like increased sharing of market information, improved interaction and communication and high flexibility in organizational structure (Chen, Li, & Lin, 2013; De Clercq et al., 2011; Song et al., 1997; Song & Montoya-Weiss, 2001; Song & Parry, 1997; Stock et al., 2013; Troy et al., 2008). Thus, the following hypothesis is set forth.

Hypothesis 2: Cross-functional coordination is directly and positively related to the firm's technological innovation performance

C. The mediating role of technological innovation orientation

Although the present study has suggested the direct impact of a CEO's technically oriented functional background and cross-functional coordination on technological innovation performance in the preceding hypotheses, it is also expected that a firm's technological innovation orientation may have mediating effects through which those two factors affect the firm's technological innovation performance. Technological innovation orientation has been lately identified as a crucial factor influencing the technological innovation performance (Moon, 2013). Technological innovation orientation is defined as an organization-wide direction of thinking toward persistently creating or adopting new ideas, products, services, or processes. Going beyond the concept of technological orientation representing the firm's technology intensive and proactive inclination (Gatignon & Xuereb, 1997), technological innovation orientation refers to the degree to which the organizational members share the critical value of technological innovation and put consistent efforts and commitment to create and develop new product, services, or processes. From such a viewpoint, technological innovation

orientation can be conceptualized as comprising two aspects: *proclivity to technological leadership*, which represents the firm's tendency to pursue its proactive leadership role in technological development, and *openness to technological innovation*, which indicates the general inclination of members to share the value of the firm's technological leadership role and pursue technological innovation activities (Moon, 2013). As such, technological innovation orientation is not confined to the functional boundary of technology development or R&D, but bears the characteristics of organizational culture shared by organizational members across all functions and levels (Hurley & Hult, 1998; Siguaw et al., 2006; Talke et al., 2011).

In terms of resource-based view, technological innovation orientation, which is characterized as corporate culture denoting the belief and value shared by organizational members, confers a source of sustainable competitive advantage on the firm and can be regarded as the firm's chief strategic asset (Amit & Schoemaker, 1993; Barney, 1986). Furthermore, technological innovation orientation represents an adaptive mechanism (Hakala, 2011) which enables a firm to flexibly cope with the rapidly changing environment and can be also considered as the concept of a superordinate identity by which members identify with the organization and share a stake in the success of the organization (Sethi, 2000b) through holding in common the strategic value and importance of technological innovation. As technological innovation orientation is a history-dependent intangible asset accumulated over a considerable period of time, it is highly inimitable and non-substitutable and its strategic value is enhanced (Amit & Schoemaker, 1993; Barney, 1991). Accordingly, technological innovation orientation plays a critical role in generating the firm's sustainable competitive advantage and superior innovation performance, as can be seen in recent cases of global companies such as Apple and 3M symbolized as the icon of innovation which have been consistently achieving superior new product developments and innovation performance despite their previous experience in numerous product development failures. Prior research (Moon, 2013)

empirically showed that technological innovation orientation is positively related to the firm's technological innovation performance and indirectly affects the firm's financial performance through technological innovation performance. In spite of its theoretical and practical importance, the role of technological innovation orientation in the organizational performance has been rarely investigated in extant research.

Although the central premise of the upper echelons perspective, which underlies development of the preceding hypothesis suggesting the direct link between a CEO's technical background and the firm's technological innovation performance, has been widely accepted by researchers in strategic management and innovation, it does not receive consistently strong support from prior empirical research (Finkelstein & Hambrick, 1990). It is also in conflict with some other theoretical views suggesting little influence of top managers on organizational outcomes due to environmental and inertial forces (Finkelstein & Hambrick, 1990; Hannan & Freeman, 1977, 1984; Salancik & Pfeffer, 1977). In a related vein, some recent innovation studies (Chen et al., 2014; García-Granero et al., 2015; Talke, Salomo, & Rost, 2010) pointed out that managerial characteristics such as leadership styles and personal traits are not sufficient on their own to lead to effective innovative performance or outcome. Those studies do not deny the impact of top managers on organizational outcomes or performance but contend that the impact is indirect rather than direct. As such, those studies suggested and empirically found that organizational mechanisms such as organizational climate and corporate entrepreneurship play a fully or partially mediating role in the relationship between top managers' background characteristics and organizational innovation performance.

Due to their prominent position and decision-making authorities in the organizational hierarchy, CEOs play a pivotal role in directing and promoting the firm's energy and commitment for successful new product or technology development by mobilizing and allocating all the necessary resources needed to convert new product or technological ideas into

the final product that is commercially viable in the market (Nadkarni & Chen, 2011). On the other hand, the success of such organizational innovation cannot be obtained without the active involvement and participation of employees aligned to the CEO's innovative vision and strategic course of action. As such, the success of the firm's technological innovation should be a matter of not just the CEO or R&D department but the whole members in the organization. Innovation research has pointed out that real organizational change or innovation mainly emerges and diffuses at lower-levels in the organizational hierarchy (García-Granero et al., 2015).

As discussed in the preceding section, a CEO's technically oriented functional background must be a relevant characteristic of his or her cognitive framework and values in order to effectively promote and implement the organizational technological innovation. Yet, based on the arguments above, it may be maintained that such a CEO's technical background alone cannot ensure the firm's successful technological innovation performance. The whole employees in the organization should be collectively involved in technological innovation since they are all potential sources of new technological ideas that could mold the products, services, and process the firm generates (García-Granero et al., 2015). However, employees in general do not prefer organizational change and may be reluctant to pursue creative or innovative efforts in their work since those efforts may be seen as risky ones whose desired results cannot be easily obtained in the short term. Thus, to induce the technologically new or innovative activities from the employees, there must exist a shared paradigm in an organization whereby those employees believe in the critical long-term value of technological innovation and make every effort and commitment to create and develop new product or processes. In this regard, technological innovation orientation, which represents a cultural paradigm conceptualized as an organization-wide direction of thinking toward creating or adopting new technological ideas, may act as an intermediating mechanism through which a CEO's technically oriented functional expertise

and experience affect the firm's technological innovation performance by linking the CEO's technologically innovative vision and course of actions to the employees' full energy and commitment devoted to the development and implementation of organizational technological innovations. Accordingly, all the arguments above lead to the following hypothesis.

Hypothesis 3: Technological innovation orientation positively mediates the relationship between the extent of technical orientation in a CEO's functional background and technological innovation performance.

While as noted earlier, a numerous number of previous studies has pointed out the benefits cross-functional coordination brings about, a substantial amount of research also suggests that cross-functional coordination generates some potential adverse effects (De Clercq et al., 2011; Olson, Walker, & Ruekert, 1995; Sethi, 2000a, 2000b; Xie et al., 2003). Cross-functional coordination may cause conflicts among the new team members resulting from goal incongruity attributable to their original functional identities (Sethi, 2000b; Song et al., 1997), increase decision complexity due to involvement of diverse functional members (Sethi, 2000a; Troy et al., 2008), and reduce members' efficiency and commitment resulting from additional cross-functional workload along with their existing home function duties (Troy et al., 2008). As a result, prior innovation research has contended that due to its potential disadvantages, cross-functional alone may not be enough to lead to successful new product development or technological innovation (De Clercq et al., 2011; De Luca & Atuahene-Gima, 2007; Sethi, 2000a, 2000b; Tassarolo, 2007; Xie et al., 2003). Accordingly, in order for cross-functional coordination to lead to the successful technological innovation performance, the firm needs some intermediate mechanism to mitigate the detrimental effects that may occur in cross-functional process and to realize in full the benefits cross-functional coordination brings about.

Since various functions prioritize their goals

differently, the successful outcome cannot be achieved unless the divergent goals of those various functions are readjusted to the organization's common goal in the process of new product development or technological innovation. For instance, the primary goal of marketing lies in satisfying customer needs and developing and retaining markets, while R&D sets their first priority in creating new products or technologies and manufacturing gives the highest priority to production efficiency and attainment of product quality standards. Since those functional goals often conflict with each other, the optimal innovation outcome cannot be obtained unless the functional barriers are broken down to accomplish the organizational overarching goal (Song et al., 1997). Sethi (2000b) argued that since members of diverse functional areas in the organization tend to strongly indicate their respective functional identities, it is important to create the superordinate identity by which members identify with the organization and share a stake in the success of the organization in order to bring out the collective efforts and cooperation from organizational members. Research has shown that identification with the organization significantly and positively increases employee job performance and loyalty (Lee et al., 2016). Technological innovation orientation may serve as such a superordinate identity. Technological innovation orientation makes a contribution to the formation of a shared paradigm or vision which enables organizational members to break away from their functional parochialism and vested interests and to readjust to the organization's overall strategic direction and common goal for the successful new product development or technological innovation. Consequently, technological innovation orientation allows organizational members to exert their own efforts and commitment to maximize the firm's technological innovation performance by setting priority to the overall interests of the organization over their individual functional interests.

Prior studies suggested some variables such as slack resources (Chen et al., 2010) and knowledge integration mechanisms (De Luca & Atuahene-Gima, 2007) as positively mediating the relationship between

cross-functional coordination and product development or innovation performance. Those studies empirically demonstrated that cross-functional coordination lead to the effective product innovation performance partially or totally through such mediating mechanisms. However, since the potential adverse effects of cross-functional coordination such as interpersonal conflicts and low employee commitment, in essence, originate from the intangible and intricate human nature, use of the tangible resources such as organizational slack and knowledge integration systems may not sufficiently address the complicated human-related disadvantages cross-functional coordination engenders and may act as a limited role in positively mediating the linkage between cross-functional coordination and product innovation performance. Accordingly, technological innovation orientation as an organizational cultural mechanism is more likely to play a comprehensive role in positively mediating the relationship between cross-functional coordination and technological innovation performance by mitigating the detrimental effects of cross-functional coordination and realizing its potential benefits in full. Based on the aforementioned arguments and rationales, the following hypothesis is suggested.

Hypothesis 4: Technological innovation orientation positively mediates the relationship between cross-functional coordination and technological innovation performance

III. Research Method

A. Sample and data collection

Korean IT SMEs were selected as a research sample to test the proposed research model and hypotheses. With the aid of a professional survey research company, data for this study were collected from survey questionnaires whose respondents were CEOs or executives of a sample of 500 firms randomly selected from a list of IT SMEs registered in the Korea

Statistics. 110 completed surveys were received and resulted in a response rate of 22%. A final sample of 87 firms or surveys was used for empirical testing, after eliminating from the respondent sample 23 firms fewer than 10 employees. Firms with fewer than 10 employees were excluded from empirical analysis since these firms were not likely to have diverse functional teams or departments in the organization. A comparison between the respondent and non-respondent firms indicated that there were no significant differences ($p < .05$) with respect to sales and number of employees, so nonresponse bias was not a concern in this study. The final sample used in empirical analysis included 46 hardware and 41 software firms.

B. Measurement of variables

To operationalize the extent of technical orientation in a CEO's functional background, functional backgrounds were divided into the following five categories: (1) production/operations, (2) R&D/engineering, (3) marketing/sales, (4) accounting/finance, and (5) other functions not listed in the preceding categories. Then, adopting the way in which Rajagopalan and Datta (1996) operationalized the functional orientation in their research, the present study measured the extent of technical orientation in a CEO's functional background as the number of years a CEO had spent in functional categories (1) and (2) expressed as a percentage of the number of years the CEO had spent

in categories (1) through (5).

Cross-functional coordination was measured using relevant items from Song et al.'s (1997) and Yam et al.'s (2010) survey instruments. All survey items, unless specified otherwise, were measured with five-point scales (1=strongly disagree, 5=strongly agree). The measurement of cross-functional coordination included 4 items like (1) the degree of sharing information among the organizational functions; (2) the extent of formal or informal interaction among R&D, production, and marketing departments/teams; (3) the degree of cooperation among R&D, production, and marketing functions; and (4) the level of integration and control of the major functions. Cronbach's alpha of the measure of cross-functional coordination was 0.71, which demonstrates the acceptable level of reliability for the empirical research (Nunnally, 1978).

Technological innovation orientation was measured using Moon's (2013) survey instrument. As shown in Table 1, technological innovation orientation consists of two dimensions or subconstructs of proclivity to technological leadership and openness to technological innovation and each dimension or subconstruct comprises 5 survey items. The reliability and validity of this measure were assessed through second-order confirmatory factor analysis (CFA). The estimated measurement model fit the data well with adequate fit indices ($\chi^2=42.85$, $df=34$, $p=0.14$, $RMR=0.03$, $GFI=0.91$, $NFI=0.90$, $IFI=0.98$, $TLI=0.97$, $CFI=0.98$, $RMSEA=0.06$). Furthermore, Table 1 shows factor and item loadings, average variances extracted

Table 1. Results of Reliability and Validity Analysis on Technological Innovation Orientation

Constructs and Measurement Items	Loading	AVE	CR	α
Proclivity to technological leadership (5 Items)	.88			.89
1. Pursuing the state of the art of technology in the new product development	.70	.72	.84	
2. Readily accepting technological innovation based on research results	.76			
3. Prompt response to technological changes in competitors	.75			
4. Granting a high value for creation of new technological ideas	.65			
5. Systematically exploring new technological trends in the industry	.73			
Openness to technological innovation (5 Items)	.84			
6. Top management's aggressive pursuit of technological innovation ideas	.73	.76	.87	
7. Actively supporting labor, fund and equipment for technological development	.72			
8. Frequency of proposals (plans) for new products, services or processes	.81			
9. Valuing the experience of failing in creative technological development	.82			
10. Sharing the vision of technological innovation among all employees	.71			

(AVEs), composite reliabilities (CRs), and Cronbach's alpha of the measure. The factor and item loadings (ranging from 0.65 to 0.88) all exceed the recommended value of 0.5 with significance at $p < .001$ and represent convergent validity of the measure. The AVE values are greater than the cutoff point of 0.5 and also demonstrate convergent validity of the measure. In addition, discriminant validity in the two subconstructs of technological innovation orientation was examined by comparing the square root of AVE of each subconstruct with the correlation between the subconstructs. The square roots of AVEs of the subconstructs are 0.85 and 0.87, respectively, while the correlation between the subconstructs is 0.63. Thus, both AVEs of the subconstructs are larger than the correlation between the subconstructs and the discriminant validity of each subconstruct is established. The CR values also exceed the acceptable threshold of 0.70 and indicate high reliability of the measure. In addition, Cronbach's alpha (0.89) of the total 10 items of the measure indicates high internal consistency and provides additional justification for combining the values of all items into a single measurement index.

Technological innovation performance was measured using a modified version of Lee and Chung's (2010) survey instrument. The measurement for technological innovation performance included 4 items such as improvement in product/service quality and performance, price competitiveness, launching new products/services, and acquisition of copyrights. The reliability and validity of this measure was assessed through CFA. The estimated measurement model adequately fit the data with acceptable fit indices ($\chi^2=9.05$, $df=2$, $p=0.01$, $RMR=0.02$, $GFI=0.95$, $NFI=0.93$, $IFI=0.94$, $CFI=0.94$). The item loadings range from 0.67 to 0.81 with significance at $p < .001$, representing convergent validity of the measure. The AVE of the construct is 0.55, which also meets the requirement of convergent validity. The CR of the measure is 0.83 above the cut-off score of 0.70 and indicates high reliability of the measure.

This study included firm size, firm age, CEO tenure, and firm type as control variables in testing the suggested model and hypotheses. Firm size was

operationalized as the logarithm of the number of employees. Firm age was measured as the number of years since the firm's inception. CEO tenure was measured as the number of years a CEO had spent in the position of CEO. Firm type was included as a dummy variable to control for potential variations between hardware (coded as 1) and software (coded as 0) firms.

C. Assessing common method variance

Since data for all the constructs or variables used in this study were collected from the same resource or respondent, common method bias may have occurred. This potential problem was checked with the Harman one-factor test (Podsakoff & Organ, 1986). An unrotated factor analysis of the multiple-items (ordinal-scale) variables resulted in a solution of five distinct factors which accounted for 70.1% of the total variance, with the first factor explaining 37.4% of the variance. Since a dominant single factor did not emerge, common method bias is not likely to be a concern in the data for the current study.

D. Model and hypothesis testing

Table 2 displays the means, standard deviations and correlations of independent and dependent variables used for empirically testing the model and hypotheses. A preliminary analysis of the relationships between a CEO's technical background and cross-functional coordination, respectively and technological innovation performance through visual examination of Table 2 indicated that both independent variables are significantly and positively related to technological innovation performance, which appears to support hypotheses 1 and 2.

The three-step regression analysis taking the Baron and Kenny's (1986) approach was used to empirically test the proposed model and hypotheses. The largest VIF (variance inflation factor) in any of the hierarchical regressions was 1.03, suggesting no multicollinearity

Table 2. Descriptive Statistics and Correlations

	Mean	SD	FS	FA	CT	CTB	CFC	TIO
Firm size (FS)	3.32	0.72						
Firm age (FA)	11.07	5.00	.43***					
CEO tenure (CT)	7.54	3.18	-.11	.36***				
CEO Technical Background (CTB)	0.56	0.44	-.13	.40	.13			
Cross-functional Coordination (CFC)	3.54	0.47	-.10	-.09	-.04	.11		
Technological Innovation Orientation (TIO)	3.56	0.54	.07	.07	.06	.29**	.47***	
Technological innovation Performance (TIP)	3.37	0.60	.14	.13	.01	.24*	.29**	.42***

*p<.05, **p<.01, ***p<.001

Table 3. Results of Regression Analysis

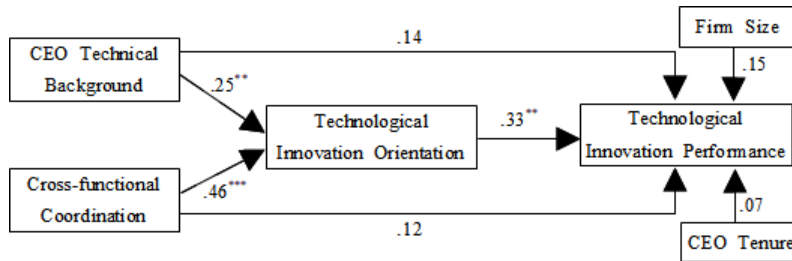
	TIO	Technological Innovation Performance	
	Model 1	Model 2	Model 3
Control Variables			
Firm size	.14	.16	.12
Firm age	.04	.05	.04
CEO tenure	.06	-.02	-.04
Firm type	-.07	.17	.19
Independent variables			
CEO technical background	.24*	.27*	.19
Cross-functional coordination	.46***	.30**	.16
Mediator			
Technological Innovation Orientation (TIO)			.32**
R ²	.31	.19	.26
Adjusted R ²	.26	.13	.20
F value	6.04***	3.22**	4.02***

Note: The regression coefficients are standardized. *p<.05, **p<.01, ***p<.001

concerns. As shown in Table 3, all the three regression models are significant with F values at $p<.01$. The first stage of regression (Model 1) indicated that both a CEO's technical background (the extent of technical orientation in a CEO's functional background, to be exact) and cross-functional coordination are significantly and positively related to technological innovation orientation at $p<.05$ and $p<.001$, respectively. The second stage of regression (Model 2) revealed that both a CEO's technical background and cross-functional coordination are significantly and positively related to technological innovation performance at $p<.05$ and $p<.01$, respectively. The third stage of regression (Model 3) adding technological innovation orientation as a mediating variable to Model 2 shows that the effect of technological innovation orientation on technological innovation performance is significant

($p<.01$) and positive but that the effects of a CEO's technical background and cross-functional coordination on technological innovation performance were not significant any more, suggesting full mediation.

Based on the Baron and Kenny's (1986) approach, the mediation effect will be supported if the following three conditions are met by regression analyses: (1) the independent variables (here, a CEO's technical background and cross-functional coordination) are significantly related to the mediator (technological innovation orientation); (2) the independent variables are significantly related to the dependent variable (technological innovation performance); and (3) when the mediator is present, the relationship between the independent variables and dependent variable is still significant but decreases (partial mediation) or becomes non-significant (full mediation). Taken together, the



Note: The path coefficients are standardized. * $p < .05$, ** $p < .01$, *** $p < .001$

Figure 1. Results of Structural Equation Modeling

results of the three-step regression analysis supported hypotheses 3 and 4, whereas they reject hypotheses 1 and 2. Any of these control variables in the regression models did not significantly affect technological innovation performance.

The present study also used the structural equation modeling to check the robustness of the preceding regression results. Firm size and CEO tenure were included in the model as control variables. Figure 2 shows the results of structural equation model. The estimated measurement model fit the data well with adequate fit indices ($\chi^2=8.10$, $df=8$, $p=0.42$, $RMR=0.07$, $GFI=0.96$, $AGFI=0.91$, $IFI=0.99$, $TLI=0.99$, $CFI=0.99$, $RMSEA=0.01$). As shown in Figure 2, the results indicate the path coefficients from a CEO's technical background to technological innovation performance and from cross-functional coordination to technological innovation performance are not significant at $p < .05$. These results do not support the direct effects of a CEO's technical background and cross-functional coordination on technological innovation performance. So hypotheses 1 and 2 are not supported. The path coefficients from a CEO's technical background to technological innovation orientation and from cross-functional coordination to technological innovation orientation are significant and positive at $p < .01$ and $p < .001$, respectively. Furthermore, the path coefficient from technological innovation orientation to technological innovation performance is also significant and positive at $p < .01$. Taken together, these results demonstrate the fully mediating effects of technological innovation orientation between a CEO's technical background and cross-functional

coordination, respectively and technological innovation performance. So hypotheses 3 and 4 are supported. Any coefficient from control variables to technological innovation performance is not significant at $p < .05$. Overall, the results of structural equation model are consistent with those of the regression analysis, demonstrating the robustness of the results of the present study's statistical analysis.

IV. Conclusion

In order to fill up the gaps or deficiencies in previous studies, the present research proposed and empirically tested a conceptual research model and hypotheses in which a CEO's technically oriented functional background and cross-functional coordination affect the firm's technological innovation performance, directly and indirectly, via technological innovation orientation. Analysis of a sample of 87 small and medium-sized enterprises (SMEs) in the Korean IT industry showed that technological innovation orientation fully mediated the positive relationship between the firm's technological innovation performance and a CEO's technically oriented functional background and cross-functional coordination, respectively. Both a CEO's technically oriented functional background and cross-functional coordination did not have significant direct effects on the firm's technological innovation performance when technological innovation orientation was controlled in the model.

This research makes the following three distinctive theoretical contributions to strategic management and innovation research. The first contribution lies in showing that technological innovation orientation fully mediates between a CEO's technical background and cross-functional coordination, respectively and technological innovation performance. Accordingly, this research demonstrates that technological innovation orientation, which represents an organizational culture conceptualized as an organization-wide direction of thinking toward creating and adopting new or creative technological ideas, plays a pivotal in accounting for the effects of a CEO's technical background and cross-functional coordination on the firm's technological innovation performance. Such mediating effects of technological innovation orientation will provide a fine-grained understanding of the relationship between a CEO's technical background and cross-functional coordination, respectively and technological innovation performance, given lack of extant research on the relationship between managerial functional background and technological innovation performance and the unresolved controversy of prior research over the direct and positive effect of cross-functional coordination on technological or product innovation performance. Moreover, in spite of its theoretical and practical importance, the role of technological innovation orientation in the firm's organizational performance has been rarely investigated in prior research. Thus, the results of this study are expected to provide an important basis enabling future research to explore the diverse routes of technological innovation orientation to firm performance in the context of technological innovation.

Second, this study empirically investigated the relationship between a CEO's functional background and the firm's technological innovation performance. Given the absence of extant empirical research examining the relationship between managerial functional background and innovation performance, the present study will make a valuable contribution to strategic management and innovation research by providing an empirical analysis of both direct and indirect effects of a CEO's technical background on the firm's technological

innovation performance. Especially, the results of this study are expected to considerably reconcile the conflict between two contrasting theoretical views regarding whether the role of top managers matters with respect to strategic innovation and performance. One view suggests that top managers have little influence on strategic innovation and organizational outcomes due to environmental constraints and organizational inertial forces, while the other view sees the role of top managers as having a major effect on strategic innovation and performance (Eggers & Kaplan, 2009; Finkelstein & Hambrick, 1990). The results of the present study set a middle tone between those two opposing views by suggesting a contingency perspective that the effect of a CEO's technical background is indirectly made on the firm's technological innovation performance fully through an intermediate mechanism of technological innovation orientation. In this regard, the results of this study are basically in line with prior studies contending that top managers influence innovation outcomes indirectly rather than directly (Chen et al., 2014; García-Granero et al., 2015; Talke et al., 2010).

The third contribution relates to empirical examination of the relationship between cross-functional coordination and technological innovation performance. In previous studies, there has been a substantial amount of debate regarding the direct and positive impact of cross-functional coordination on technological or product innovation performance due to some potential disadvantages as well as advantages it brings about. The best way to resolve the controversy may be to identify some relevant intermediate mechanisms whereby cross-functional coordination affects the firm's technological innovation performance. Although a few studies suggested variables such as slack resources (Chen et al., 2010) and knowledge integration mechanisms (De Luca & Atuahene-Gima, 2007) as partially or fully mediating the relationship between cross-functional coordination and product development or innovation performance, those tangible mechanisms may have limitation in sufficiently addressing the intricate human-related issues such interpersonal conflicts and low employee commitment. Thus, given lack of extant empirical research exploring relevant

mediating mechanisms that may link cross-functional coordination to firm innovation performance, the results of this study will be able to provide some clue to resolving the controversy regarding the direct and positive impact of cross-functional coordination on the firm's technological or product innovation performance by suggesting and empirically investigating technological innovation orientation, which represents an organization culture, as a mediating mechanism whereby cross-functional coordination influences the firm's technological innovation performance.

The findings of this study also provide some valuable implications for practicing managers. Above all, they provide managers with an important message that technological innovation orientation plays a pivotal role in achieving the firm's successful technological innovation performance. Thus, the CEOs or top managers should cultivate technological innovation orientation, that is, organization culture representing the organization-wide direction of thinking toward persistently creating and adopting technologically new or innovative ideas, products, services, or processes in order to enhance the firm's technological innovation performance and secure its sustainable competitive advantage. Accordingly, the CEOs or top managers need to exhibit the transformational leadership to create strong trust in their organizations (Koo, Kim, & Kim, 2017) and should not spare all the available resources and administrative support so that the whole members can share the critical and long-term value of the firm's technological leadership and make collective effort and commitment to persistent technological innovation. Especially, the CEOs or top managers should be advised that their long-term and consistent efforts are required to build up such a technologically oriented innovation culture since it may take substantial amount of time for the organizational culture to be developed and installed in an organization (Kang, Solomon, & Choi, 2015). The findings of this study convey to managers another critical message that a CEO's technically oriented functional background and cross-functional coordination help enhance the firm's technological innovation performance but that they alone may not be sufficient to lead to the

successful technological innovation performance. Thus, the practicing managers must keep it mind that a CEO's technically oriented expertise and cross-functional coordination must be supplemented by the technologically oriented innovation culture, that is, technological innovation orientation, if they are to lead to successful technological innovation performance.

Before accepting the results of the present research as conclusive, some limitations of this study should be noted for future research. First, the generalizability of this study is limited to IT SMEs. Therefore, future research needs to ensure the external validity of the results of this study by reexamining the research model suggested by the present study based on different samples of large firms and SMEs in other industries. Second, data from this study were obtained from single respondents or informants. Although the survey data used for this study were obtained from CEOs or executives who are familiar with their firm's overall strategic directions, the survey data from single respondents alone may have some limitation in completely capturing the concept of technological innovation orientation representing the firm-wide direction of thinking shared by the organizational members. Finally, this study used cross-sectional data, which, as with most management and social science research, may have some limitation in corroborating the causal relationships among those variables suggested in the present research model. For example, it may be argued that technological innovation orientation affects cross-functional coordination in order reverse to what was indicated in the research model of this study. In a similar vein, technical innovation orientation may affect a CEO's technical background in a way that the firm with high technological innovation orientation selects a CEO with the primary background in technical functions as the right track. The present study would not deny the possibility of such reverse causal relationships. However, the issue of such causal or chronological relationships should not distract attention from the focus of the present research. The central focus of this study is not on the direct causal relationships

between cross-functional coordination and a CEO's technical background, respectively and technological innovation orientation, but on whether those two independent variables affect the firm's technological innovation performance, directly or indirectly, through technological innovation orientation as a contingency variable. Future studies, using some longitudinal data, could examine the aforementioned causal or chronological relationships, although it is dubious that this causality issue or problem can be dealt with in full. Furthermore, since technological innovation orientation will be built up in an organization in an evolutionary way, there may be a time lag between technological innovation orientation and technological innovation performance which may not be able to relevantly capture with the cross-sectional data. Only longitudinal studies will be able to address this problem.

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