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Increasing Software Firm Performance: Entrepreneurial and Software Characteristics and the Moderating Effect of the Regulatory Environment

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Abstract: Software firm managers require a solid understanding of software firm behavior, particularly the effect of their firm's entrepreneurial and software characteristics on performance. Thus, this study investigates the effects of two entrepreneurial characteristics (innovativeness and risk taking) on two software characteristics (innovativeness and standardization) which lead to software flexibility and performance. This study also examines the moderating role of the regulatory environment in the relationships between entrepreneur and SW characteristics. Data from 257 domestic Korean software firms were collected from a random sample. The structural equation model was formed using AMOS 19.0 to test the proposed hypotheses. The results indicate that the two entrepreneur variables had positive effects on SW characteristics which in turn had a positive effect on software flexibility and performance. Moreover, the regulatory environment had positive effects as a moderator between entrepreneurial and software characteristics.

Key words: Entrepreneur characteristics, SW innovativeness, SW standardization, SW flexibility, performance, regulatory environment

INTRODUCTION

The information and communication industry has seen growth both in the hardware and in products including smartphones, displays and semiconductors. Software firms have emerged as pivotal forces in the information and communications industry. Thus, weaker domestic software industry players are vulnerable in the hardware-oriented domestic information and communications market which significantly limits the software industry's growth and development. However, the software industry's role in increasing the competitiveness of other industries emphasizes the critical need for research on individual software companies and their competitiveness and capabilities (Nidumolu, 1996). Governmental and public institutions are endeavoring to establish long-term plans to increase support from other industries in the development of the software industry. However, the true importance of software companies has not been acknowledged: there is inadequate awareness of the software industry and its constituent companies.

Given the technology-centered nature of the industry, the need for research to strengthen technological competitiveness through technology innovation is great. Moreover, rapid technological change is reducing product's useful life and making technological innovation central to a consistent competitive advantage. Yam *et al.* (2004) highlight the importance of R&D, specifically, investment in technological innovation competence. A previous study (Adams *et al*., 2006) claimed the need for technological innovation to secure competitive dominance amidst a rapidly changing competitive landscape and the need to successfully enter new markets. For a software firm to secure a competitive advantage, the standardization of the software development process and the introduction of innovative technologies are essential factors, given the intangible nature of the products.

In this context, competitiveness through technological innovation is vital. Because many domestic software firms are small to medium in size, the software entrepreneur's characteristics represent the driving force for firm growth (Sciascia *et al*., 2006). Software businesses require technological innovation; the industry environment shapes the vision, strategy and goals of the entrepreneur. The role of the entrepreneur or the CEO is

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central to firm success in technological innovation. McKenney (1995) emphasized the role of the entrepreneur who promotes the introduction of new information technology by the firm. Keen (1991) asserted that the entrepreneur is the most important factor in a firm's ability to manage IT-related change.

However, prior studies have focused on research into technological capabilities or the value of a single technology by focusing on a specific software aspect or encompassing the entire information communications industry but studies have not focused on software firms specifically in their analyses. Although, software-related research has analyzed the effect of a software project (or a process used in a software project) as one of the factors influencing a firm's competitiveness (Wang *et al*., 2008), it is difficult for such studies to explain the diverse aspects of a software firm.

Therefore, research emphasizing the role of entrepreneurial characteristics with respect to software characteristics would inform managers of their effect on innovation and provide guidance to domestic software firms for increasing competitiveness. The research questions addressed in this study are as follows: What are the distinct effects of entrepreneurial characteristics on the two software characteristics? What is the influence of software characteristics on software flexibility and performance? What is the role of the regulatory environment in the relationships between the entrepreneur and the software characteristics? The research questions are answered by analyzing data collected from 257 domestic software firms that focus on software technology development or product development as their core business.

Empirical results indicate that the two entrepreneurial variables influence the two software characteristics which indicates a significant positive impact on software flexibility. Additionally, the results confirm a positive relationship between software flexibility and firm performance. Finally, the regulatory environment enhances the relationships between the entrepreneurial and the software characteristics. The implications of this study help software development entrepreneurs and business practitioners such as senior management and technology development managers, to achieve technological goals by providing pertinent information prior to software technology development or product development. Moreover, the study shows the effect of control factors in the external environment on the link between the firm's entrepreneurs and the software characteristics and informs policymakers and business support agency staff of the external factors required for competitive superiority, thereby contributing to the development of successful software industry policies.

Literature review

Entrepreneur characteristics in the software industry: The software industry is technology-intensive; it is commercialized through new technology and creativeness (Yoo *et al*., 2009). The software industry relies on a workforce with specialized skills which is characteristic of knowledge-intensive sectors. Software firms demonstrate competitiveness through the entrepreneur's creative and technology-oriented characteristics, rather than specific production facilities. Therefore, direction-setting for technology development by the firm's CEO or R&D managers is vital. Analysis of entrepreneurs who can execute innovative technological development forms is a core aspect of software firm research.

The entrepreneur is an individual defined as someone who founded and operates the firm and carries out innovation as a pioneer with an adventurous spirit (Lee, 2013). The characteristics of the entrepreneur have been examined in many studies and these characteristics have become synonymous with an entrepreneurial orientation. Other studies use various concepts such as entrepreneurial orientation and entrepreneurial proclivity. Examining characteristics such as innovativeness and risk sensitivity, Miller (1983) claimed that the firm that strives for product and market innovation takes a certain level of risk, reacts adventurously and gets a head start before the competition.

Rogers (1995) defined innovativeness as "the processed product of a new idea". The technologically-oriented entrepreneur who focuses on innovation puts the development of groundbreaking products at the forefront of the firm's culture. As a result, the development of new technologies forms the norms of management strategy and firm activity (Hurley and Hult, 2008). The more technology-oriented a firm is, the more likely it is to develop innovative products; the technology orientation of an entrepreneur in a venture firm has a significant influence on the performance of new product development (Lee *et al*., 2011). In this aspect, Boso *et al.* (2012) asserted that entrepreneurial characteristics influence the firm's success through product innovation.

In addition, software firms also have a high degree of associated risk because the industry focuses on R&D. Risk taking is the tendency to explore new and unfamiliar markets or engage in rash activities such as investing substantial resources or borrowing heavily with uncertain results; risk-taking requires identification of opportunity. Slevin and Covin (1990) defined risk taking as the tendency to prefer a higher risk project with unpredictable rates of return and the will to seize opportunities while Frishammar and Horte (2007) defined risk taking as the level of willingness to utilize substantial and risky resources despite the possibility of financial failure.

Zahra and Covin (1993) claimed that entrepreneur characteristics can be measured by both risk taking and the adventurousness of the entrepreneur.

Software characteristics: From a business perspective, software represents various solutions for businesses or the integration of existing systems within a firm. Thus, software requires unique characteristics to be successful in a competitive knowledge-based industry. Jang *et al.* (2011) claimed that software should be innovative, standardized and flexible to ensure the strategic IT success of its client users. Innovativeness as a technological characteristic of software has been widely studied. Innovativeness typically indicates that the developed product is new and state-of-the-art. Garcia and Calantone (2002) defined innovativeness as the measurement of innovation newness.

Jordan and Segelod (2006) asserted that the innovativeness of software products must result in product advantages, product newness and firm structural change. Prior studies deal with various aspects of software characteristics. For example, Lamastra (2009) analyzed 324 Italian software firms to develop an innovation performance indicator for Free/Open Source Software (FOSS). The results indicated that FOSS had a higher average performance indicator than proprietary software. Furthermore, Nirjar (2008) suggested important indicators of technological innovation performance such as global, national and firm-developed products and activities.

Another software characteristic is standardization that can be viewed as the official or documented process containing the technological details of software development. Liu *et al.* (2008) defined standardization as creating a document detailing streamlined methods of project usage, processes, tools and technology. When the relationship between standardization and R&D activity is seen from the perspective of technological innovation, firms with extensive R&D activities participate more aggressively in the standardization process to develop a marketable product or process that is compatible with other firm's products and processes (Farrell and Saloner, 1985).

Nidumolu (1996) asserted that standardization could be divided into output control and behavior control standardization. Suh and Jung (2003) claimed that standardization is the formalization of technological development and that standardization improves process performance. Additionally, Na (2004) has studied the influence of standardization and requirement uncertainty on software project performance. The result found that software development standardization reduces residual performance risk. Kim *et al.* (2002) analyzed the influence of requirement uncertainty and control standardization on users, project team interrelations and software quality using risk-management methods. Although, control standardization had a significant influence on interrelations, it did not significantly affect software quality.

Although, there are no studies that directly examine the relationships among entrepreneurial characteristics such as individual innovativeness, risk taking and software process standardization, entrepreneurial characteristics may influence process standardization, one of the success factors of technological innovation. By writing method manuals (such as standard quality controls), entrepreneurial characteristics can influence the firm's qualitative technological capabilities (Lee *et al.*, 2001).

One outcome of software characteristics is software flexibility that measures the quality of a software product. Eden and Mens (2006) defined software flexibility as the degree to which it is easy to amend the system and its components based on the applications and the environment. Alternatively, flexibility is defined as the ease of modification or responsiveness of the software, based on the requirements of the user or system environments. Flexibility is an important indicator in software quality (Liu *et al.*, 2008).

Regarding software development, developers may design software products without considering the required maintenance and repair because of problems such as limited development periods, low budgets and human resource constraints. Therefore, managers of software firms, who consider the reusability of software products, find product flexibility to be an important control factor. In some instances, the consistent requirements of the software increase in complexity, even after the product delivery deadline because of changes in the business environment. Therefore, product development without flexibility considerations could lead to cost overruns, deadline extensions and lower firm competitiveness. Flexible software makes it easier to change system requirements that are subject to frequent updates. Therefore, software flexibility is critical for software development (Gasili and Caldiera, 1995). Liu *et al.* (2008) asserted that software flexibility has a significant influence on performance.

Flexibility is directly linked to firm competitiveness; a firm strengthens education and knowledge sharing to enable flexibility. When software flexibility is utilized, the firm can rapidly respond to client requirements, reduce re-working, deadline constraints, costs and the fatigue level of development personnel. In a study by Wang *et al.* (2008), software flexibility had a positive impact on project performance. Jang *et al.* (2011) studied the impact of change control and management reviews on flexibility and software firm performance while considering innovativeness. They concluded that software flexibility improves software firm performance: the more flexible the firm is in amending or changing software requirements (in terms of costs and time), the greater the improvements in the software firm performance.

Regulatory environment: Institutional theory defines a firm as an organization that complies with production and trading requirements in the technological and regulatory environment and seeks legitimacy in the process; institutions include normative, regulative and cognitive aspects as components of that legitimacy. DiMaggio and Powell (1983) classify institutional pressure into three categories: normative, coercive and mimetic. If institutional pressure is successfully accepted by a specific agent, individual or group, institutionalization has taken effect (Covin and Slevin, 1991).

Among institutional factors, coercive pressures arise from regulatory agency or industry associations. For example, differences in size and competitiveness between large, small and medium enterprises are substantial in the software industry. The government in some countries ruled that firms with a certain level in revenue are limited in the participation of government IT projects. In addition, to improve the product quality of domestic software firms, the government continuously requests for quality certification from institutions that are participating in software industry promotion policies.

Mimetic pressures occur when a firm copies another firm to combat environmental uncertainties. Given the characteristics of software products, consumers tend to use products and technology that have heavily penetrated the market. Thus, software firms often adopt (as new) technologies previously used by competing firms. Additionally, some firms consistently copy competitors through quality certifications issued by competitor firms. Finally, normative pressures are institutional factors that are developed by specialized groups (Liang *et al*., 2007). These pressures occur in a situation in which members of an organization develop similar objectives and traits and consider existing traditions and controls that match their values to be paramount.

Institutionalism states that innovation occurs for economic, technological, social and institutional reasons (Meyer and Rowan, 1977). DiMaggio and Powell (1983) asserted that the higher the uncertainty in the achievement of the firm's objectives, the more the firm will comply with institutional requirements and the more innovation will be adopted by the organization. These situations lead the firm to utilize businesses, processes and programs that are already utilized by competing firms (or firms in similar industries) because of market confidence, this method will free the firm from scrutiny and post-adoption surveillance.

Software firm performance: From a business perspective, software applies to business support solutions and firm system integration and may be based on the level and state of the application. A software firm is defined as an organization that provides service business in the form of development, production, manufacturing and distribution as indicated in the Software Industry Promotion Act. Yoo *et al.* (2009) claimed that software firms primarily conduct product development of software, middleware, utilities, solutions and system integration.

Studies on software firm performance began after the 1990's. Information on software development projects, given the nature of software development, links high-quality human resources, innovative management methods and technology to firm performance. Nidumolu (1996) measured software project performance by categorizing performance according to the software development process; the software performance of products improved as a result of the project. As there are inherent correlations between the effectiveness of the process and product quality, it is important to measure the performance of both the process and the product. Additionally, Nam and Na (2001) investigated the influence of the level of software process capability and investment in information technology on firm performance and proposed a performance measurement model for software processes and IT investment.

Ahn and Kim (2002) verified the factors influencing software venture firm performance. Firm performance was divided into business strategy, business resources, technological strategy and technological resources; firm performance was measured using a balanced scorecard. Six factors affect the performance of a software venture firm including competitive strategy characteristics, entrepreneur capabilities, corporate culture, technological and product development strategy, technological operations strategy and human resources. Among these factors, corporate culture was found to have a negative impact on performance.

Nambisan (2002) investigated whether the actions of senior management and software developers as internal firm stakeholders, influence firm evolution and innovation. The researcher proposed a model that asserted that a software developer's innovativeness and pride and senior management's attitude towards technological leadership, external networks and process compliance, drive the evolution and innovation of software firms. Suh and Jung (2003) categorized the factors that affect software development project performance into risk management factors (user involvement, development team and standardization) and project risk factors (technology, requirements and organizational environment).

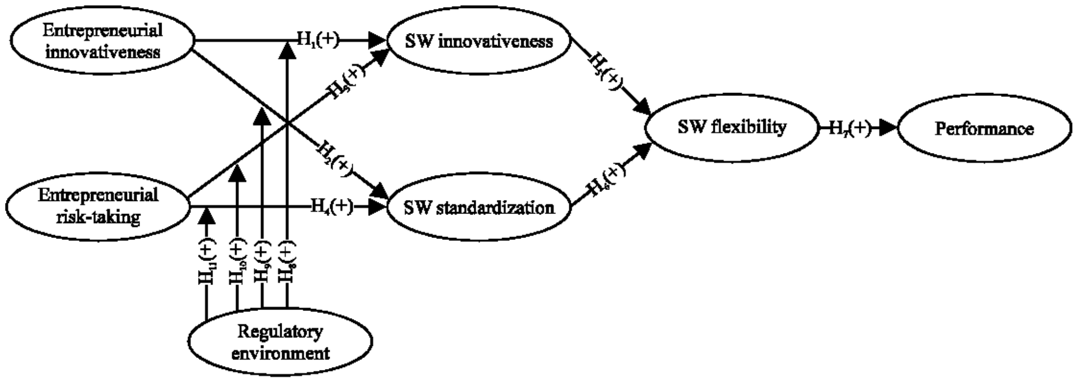

Fig. 1: Research model with hypotheses

Research model and hypotheses

Research model: To improve the competitiveness of the software industry, we propose the research model in Fig. 1 which shows the direct effects model and the anticipated moderation of the relationship between the two variables of entrepreneurial (innovativeness and risk taking) and software characteristics (innovativeness and standardization). At the firm level, the two entrepreneurial variables are the direct antecedents of the software characteristics which are an antecedent of another software characteristic (i.e., flexibility) and firm performance. However, the strength and significance of the relationships between entrepreneurial and software characteristics are influenced by another variable (i.e., the regulatory environment). The current study empirically investigates these causal and moderating relationships using data collected from software firms and suggests meaningful theoretical and practical implications. Figure 1 presents the research model and the proposed study hypotheses.

Hypotheses development

Entrepreneur innovativeness and risk-taking: Miller (1983) defined an innovative and risk-taking firm as “the firm that strives for product and market innovation, takes a certain level of risk, reacts adventurously and gets a head start before the competition”. Prior studies (Covin and Slevin, 1989; Zahra, 1996) suggest that entrepreneurial characteristics are derived from innovativeness and risk taking. Although, there is no research on how entrepreneurs in a software firm impact software and their own firm’s products, entrepreneurial characteristics significantly affect the product development, innovation, strategies, standardization and performance of the firm (Frishammar and Horte, 2007).

Entrepreneurial characteristics are strategic tendencies in the decision-making and execution processes of a firm that seeks to create innovative value to achieve differentiation from competing firms. Innovativeness is a management behavior that seeks to actively adopt process innovation and management techniques. Innovativeness is also a series of anticipative reactions by the firm, responding to changes in the environment which are used to drive organizational change. For a firm to continuously grow, it must possess technological innovative capabilities that can lead the market and its technologies. Technological innovation invigorates investment in productive capacity and the economy, improves productivity, produces new and high-quality products and brings productivity changes to new and existing industries (Myers and Marquis, 1996).

Many researchers have confirmed that entrepreneurial characteristics including innovation and risk-taking, can influence technological innovation. For example, Zahra and Cobin (1993) proposed a significant positive relationship between entrepreneurial characteristics and SW product innovation. Furthermore, Garcia and Calantone (2002) claimed that the innovative managers often generate innovative product ideas. A review of the research on how entrepreneurial innovativeness impacts software standardization implies that software standardization is a process that formalizes or documents the technological aspects of the software development process (Jang *et al*., 2011). In this aspect, Liu *et al.* (2008) defined software standardization as detailed documentation of consistent usage methods, processes, tools and technology in a project. Nidumolu (1996) has offered software standardization as an important development method that solves problems arising during software development.

Although, software standardization takes time and effort, innovative management can improve the overall development process and reduces requirements uncertainty which leads to the improvement of software product performance and the successful completion of the development project. Software standardization is a firm asset for carrying out related projects in the future and consistently improving the firm's competitiveness. The importance of standardization has recently increased because the development of products not tied to specific platforms is now possible and because standardized products often have lower development costs given their compatibility with other software and increasing connections through networks.

Empirical studies on the directly influential relationship between entrepreneurial characteristics and software standardization are lacking. However, entrepreneurial characteristics were found to have a positive influence on the documentation of processes such as in the standard quality control methods used by manufacturing firms (Lee and Tsang, 2001). Sung (2009), through studies of domestic firm standardization activities, indicated that management interest, regardless of the type of standardization is a core determinant of firm standardization activities. Based on these studies, we expect that two entrepreneur variables create the environment for innovative and standardized software development.

- H_1: entrepreneurial innovativeness has a positive influence on software innovativeness
- H_2: entrepreneurial innovativeness has a positive influence on software standardization

Software firms have a high rate of return and are characterized by their R&D focus. Similar to venture firms, software ventures involve a high degree of risk-taking. Risk-taking as an entrepreneurial characteristic of a software firm is the tendency to explore an unfamiliar market or engage in rash activities such as investing substantial resources or borrowing heavily with uncertain results. Despite these risks, software firms identify and seize opportunities. Miller and Friesen (1982) have defined risk-taking as management behavior that attempts to exploit an opportunity, despite an expectation that the loss of resources could be significant. Additionally, Slevin and Covin (1990) have defined risk taking as the tendency to prefer high-risk projects compared to low-risk projects with predictable rates of return and the willingness to courageously and actively seek opportunities.

Kwun (2010) asserted from the resource-based view that entrepreneurial characteristics such as risk taking affect firm technological capabilities including standardized products and quality control methods. In addition, Jun and Yoon (2011) claimed that managerial risk taking impacts all technological variables associated with product standardization and innovativeness including technological superiority, competitiveness and the share of revenue from innovative products. Based on these claims, the following two hypotheses are proposed:

- H_3: entrepreneurial risk-taking has a positive influence on software innovativeness
- H_4: entrepreneurial risk-taking has a positive influence on software standardization

Software Characteristics: Software should possess characteristics such as innovativeness, standardization and flexibility to make it a useful tool for firms. Garcia and Calantone (2002) define software innovativeness as providing newness to the consumer while considering the newness of the market and technology. During software development, it is important to ensure software flexibility so as to increase the quality results of the technological innovation. The pursuit of flexibility drives firms to continuously introduce and develop innovative techniques because of the short life cycle of software. Flexibility enables the expansion of research development efforts or other technological innovations so as to create new techniques. The resulting technological innovation and process improvements lead to an increase in software flexibility and improvements in the quality of developed software (Wang *et al.*, 2008). Jordan and Segelod (2006) suggested that software innovation includes product advantages, freshness, changes in company structure and that the higher the level of software innovation, the greater the flexibility of the software.

The introduction of new techniques greatly increases in cases of highly innovative software because software and techniques are continuously evolving and creating new products and methods from the old. Therefore, software innovativeness and flexibility are closely related. Wang *et al.* (2008) claim that software flexibility increases the maintenance needs of software development outcomes and responsiveness to new techniques, potentially resulting in productivity increases. The authors also suggest that software innovation promotes software flexibility and advances companies technological performance. Thus, we expect that increasing software flexibility is a result of the influence of software innovation. This observation informs the following hypothesis:

- H_5: software innovativeness has a positive influence on software flexibility

Standardization is another characteristic of software, defined as the detailed documentation of consistent usage methods, processes, tools and technology in a project (Liu *et al.*, 2008). If process standardization is implemented during software development, the project boundaries are clear and cost and time management is easier. This facilitation of management enhances software flexibility and the performance results of software development projects (Nidumolu, 1996). Additionally, the project team for software development becomes consistent and project implementation is easier when processes are standardized. This strengthens the overall quality of software and influences project performance. Nidumolu (1996) indicated that an increase in standardized tools for software development processes or techniques such as output and action control standardization lowers the uncertainty and enhances project performance, thereby increasing software quality. Liu *et al.* (2008) claimed that the standardization of software processes advances software project performance and software quality metrics.

Business demands for software are continuously changing. Therefore, software products must be flexible for effective and quick adjustment. Methods to increase software flexibility include the consideration of changes in software demands and advancements in software development such as structural design or object-oriented design and a shift in focus to influential factors that have flexibility during the development process. Wang *et al.* (2008) observed that software product flexibility significantly influences the success of project development because control activities such as control of change or maintenance regulation during the development process are important accelerators. High levels of maintenance control activities can help achieve software flexibility and advance complicated application maintenance and software development project performance.

Dekleva (1992) suggested that flexibility in a software product, often resulting from process standardization can reduce the time required for rework. Rework mainly involves technical conceptual design and any misunderstanding can cause delays in a software project's development. Thus, software standardization greatly influences software flexibility. The following hypothesis has been formulated based on this observation.

- H_6: software standardization has a positive influence on software flexibility

Software flexibility and firm performance: Research on the performance of software companies typically addresses software development projects or aspects of software characteristics including flexibility. Previous studies (Campbell and Gingrich, 1986) observed that an increase in software flexibility improves software companies performance. Liu *et al.* (2008) defined software flexibility as the ability to respond to new requirements and to make rapid and inexpensive modifications to software. Because software flexibility decreases the cost and time required for software development an increase in flexibility is related to improved competitiveness.

The relationship between flexibility and firm performance has been addressed in various studies. For example, using business process outsourcing companies as subjects, Nadkarni and Herrmann (2010) observed that strategic flexibility influences a company's performance. Process compliance and readiness improve the flexibility and innovation of a company which in turn, enhance performance (Nambisan, 2002). Mathew *et al.* (2012) studied Indian software companies as subjects. The authors found that factors such as organization culture, satisfaction with software projects, the flexibility of the software development process and project quality positively influence software companies profitability and organization innovativeness.

Software development is characterized by various complicated technological development characteristics such as complexity, specialization, suitability and reliability. Therefore, flexibility in both the software and development processes is crucial for improving firm performance (Gunsel and Acikgoz, 2013; Yang and Chen, 2003). Thus, the following hypothesis is proposed:

- H_7: software flexibility has a positive influence on performance

The moderating effect of the regulatory environment: Prior research (Ahn, 2009) found that environmental factors have a positive impact on the decision to develop information systems or software. Environmental changes in the market and industry require that firms are continuously innovative. A firm's uncertain environment can spur innovation and adaptation to changes in the external environment. Among institutional environmental factors, the software industry is influenced by the regulations and policies of firms and related industries (Liang *et al.*, 2007). Many governments provide funding support through technological development policies to consistently initiate and hasten R&D investment. This government support manifests as institutional support. Technology development funding that promotes a certain industry (including the software industry through government policies) is an institutional factor designed to invigorate national industry growth by supporting individual firms.

Software firms are active in an industry with significant government support and a great deal of regulation in comparison with other industries. Governments in many countries require the adoption of a standards process for technology or software development based on domestic or international technological standards which may enhance the effects of entrepreneurial characteristics on software characteristics and the successful completion of software projects (Zhu *et al.*, 2006). Moreover, there are active support programs in place for the adoption of innovative technologies in the development of competitive software. Once the technology is developed, to commercialize the technology and apply it to related industries, the product must meet international standards which relates to the competitiveness of the software firm. Recently, many regulatory environments including various support programs by government and firms have been established for firms to obtain the desired levels of technological competitiveness from their software partner firms. These programs support technology consulting participation in related standardization and the funding of these initiatives.

However, limited empirical research examines whether regulatory factors such as institutional support from the government or large enterprises is beneficial to firm software development. This current study asserts that the regulatory environment as the component of institutional support, acts as a moderator in the relationship between entrepreneurial characteristics (such as innovativeness and risk-taking) and software characteristics (such as innovativeness and standardization). The following hypotheses are proposed:

- H_8: the regulatory environment enhances the relationship between entrepreneurial innovativeness and software innovativeness
- H_9: the regulatory environment promotes relations between entrepreneurial innovativeness and software standardization
- H_{10}: the regulatory environment promotes relations between entrepreneurial risk-taking and software innovativeness
- H_{11}: the regulatory environment promotes relations between entrepreneurial risk-taking and software standardization

MATERIALS AND METHODS

Sample: With the growing emphasis on the importance of the software industry, this study attempts to fill an existing gap in the research and measures the performance of software companies by observing the effects of entrepreneurial and software characteristics on performance. The study subjects include domestic software companies that have been developing new software; the research uses a survey-based method.

A total of 2,000 final questionnaires were distributed using multi-dimensional means such as email, mail, direct visits and web surveys over a 5 month period. A total of 276 surveys were collected. Only 257 surveys were used in the analysis: 19 responses were discarded because they were considered insincere. Table 1 describes the gender, title, type of work and classification of the software business of the 257 respondents. A majority of respondents were male (77.8%). The sample was composed of high-level executives (24.5%), CEOs (21.4%), department heads (16.3%), deputy heads of departments (14.4%) and section chiefs (12.5%). The employees possessed in-depth knowledge of their business and had the proper authorization to make associated decisions.

Table 1: Respondent demographics

Demographic categories	Frequency	Percentage
Gender		
Male	200	77.8
Female	57	22.2
Current position		
Associate level	14	5.4
Deputy section chief level	18	7.0
Section chief level	32	12.5
Deputy head of department level	37	14.4
Department head level	42	16.3
Executive level	63	24.5
CEO	55	21.4
Type of work		
Research services	93	36.2
Technological services	63	24.5
Administrative services	86	33.5
Other	15	5.8
Classification of business (Multiple responses)		
Systems software	87	33.9
Development software	49	19.1
Applications software	81	31.5
Services related to computers	58	22.6
Digital content development service	64	24.9
Embedded software development service	85	33.1
Total	257	100.0

The classification of software development and the proportion allocated to each category was system software (33.9%), followed by application software (31.5%) and embedded software development (24.9%). The main duties of respondents consisted of research (36.2%), administrative (33.5%) and technological (24.5%) services. Table 1 shows the characteristics of the respondent companies and individuals.

Measures: The survey instrument used to measure each latent variable was developed using items adopted from previous studies. For example, items used to measure the two entrepreneurial characteristic variables were adopted from Frishammar and Horte (2007), Gonzalez-Benito *et al.* (2009). The three software characteristic variables were measured using items adapted from Jang *et al.* (2011). The dependent variable, i.e., firm performance was measured using items adopted from Nagpal and Lyytinen (2010), Ravichandran and Lertwongsatien (2005). Finally, the moderator items, i.e., the regulatory environment, were developed using measures adapted from Liang *et al.* (2007). The survey participants responded with their level of agreement or disagreement on a seven-point Likert-type scale, ranging from "1" (strongly disagree) to "7" (strongly agree).

Measurement items developed for inspection of the suggested research model were initially tested for validity, confirmed using theoretical concepts and then, revised to suit the research. Additionally, the survey questions were revised based on the responses obtained from the interviews of affiliates who implement software development in companies. Then, the final measurement items to be used in this research were developed. For the refinement and screening of these measurement items, a pilot test was conducted focusing on companies that are currently developing software or are planning to develop software. The pre-investigation results showed that there were no factors that hindered the measurement item's reliability and validity.

The analysis of measurement model: The proposed research model was analyzed using AMOS 19.0 to test the validity of the measurement model and hypotheses. First, the suitability of the measurement model with 27 items was assessed to determine the overall fit of the collected data on the measurement models. Several indices from Confirmatory Factor Analysis (CFA) including the relative chi-square (χ^2/df), GFI, AGFI, RMSEA, NFI, CFI and IFI were observed for the overall fit test. The results of the initial measurement model's suitability showed that the GFI (0.847) and RMSEA (0.077) indices were below the promotion value suggested in the existing research. Modification Indices (MI) showed that one item (SI3) measuring software innovativeness had an effect on variables that were not of interest. Thus, the fitness test was re-evaluated after removing these two items. The results showed that the recommended level of the overall index of the measurement model was satisfactory (IFI = 0.948, GFI = 0.885, AGFI = 0.820, CFI = 0.948, χ^2/df = 1.871 and RMSEA = 0.044).

After the suitability test, the final data (n = 257) gathered before the structural model test were used to test the measurement tool's reliability and validity. For the reliability, the commonly used Cronbach's alpha coefficient (threshold 0.7 and above) was employed (Nunnally, 1967). Validity can be confirmed using the convergent validity test and the discriminant validity test. For testing using convergent validity, factor loading, composite reliability and Average Variance Extracted (AVE), the results of CFA from AMOS 19.0 were used. If the factor load was >±0.4, the factor was considered significant (Barclay *et al*., 1995). The composition reliability index must be >0.7 and each latent variable's average value must be >0.5 for convergent validity to exist (Fornell and Lacker, 1981). Finally, the discriminant validity test used the AVE as suggested by Fornell and Larcker (1981) and the Pearson correlation analysis method. To test whether discriminant validity exists, each latent variable's AVE square root value must exceed the correlation coefficient between the latent variable and other latent variables.

Table 2: Reliability and convergent validity test

Constructs/Items	t-values	Loading	Cronbach's alpha	CR	AVE
Entrepreneur innovativeness					
EI1	-	0.825	0.827	0.882	0.714
EI2	17.013	0.914			
EI3	14.193	0.792			
Entrepreneur risk-taking					
ER1	-	0.781	0.765	0.868	0.687
ER2	14.781	0.899			
ER3	13.177	0.802			
SW innovativeness					
SI1	-	0.899	0.812	0.872	0.697
SI2	15.621	0.791			
SI4	16.304	0.810			
SW standardization					
SS1	-	0.871	0.910	0.900	0.694
SS2	16.369	0.823			
SS3	15.799	0.806			
SS4	16.687	0.830			
SW flexibility					
SF1	-	0.796	0.853	0.865	0.680
SF2	14.118	0.839			
SF3	14.124	0.839			
Regulatory environment					
RE1	-	0.862	0.907	0.892	0.734
RE2	10.364	0.912			
RE3	12.386	0.792			
Performance					
P1	-	0.749	0.869	0.876	0.640
P2	13.574	0.874			
P3	11.707	0.764			
P4	12.481	0.807			

Reliability test results showed that the Cronbach's alpha value was between 0.812 and 0.910 which is greater than the level required to confirm reliability (i.e., >0.7). A convergent validity test that used the loadings, composite reliability and AVE value showed that all items were greater than the threshold, demonstrating convergent validity among the measurement items. All of the latent variable's square roots of AVE were higher than the correlation; therefore, there was no discriminant validity. The test of the measurement model provides evidence for internal consistency and statistical validity. Table 2 and 3 show the results of the reliability and validity tests of the measurement model.

The analysis of structural model: After validating the measurement model, a Structural Equation Modeling (SEM) approach was used to find the causal relationships among the variables presented in this research model.

Table 3: Discriminant validity test

Constructs	1	2	3	4	5	6	7
Entrepreneur innovativeness	**0.845**						
Entrepreneur risk-taking	0.340	**0.829**					
SW innovativeness	0.471	0.478	**0.835**				
SW standardization	0.360	0.336	0.242	**0.833**			
SW flexibility	0.380	0.501	0.626	0.481	**0.825**		
Regulatory environment	0.013	0.270	0.233	0.314	0.374	**0.857**	
Performance	0.441	0.452	0.509	0.454	0.469	0.247	**0.800**

Items in bold type along the diagonal represent the square root of the AVE. For discriminant validity, diagonal values should exceed off-diagonal correlations

Table 4: Direct effect results

Paths	Coefficient	SE	t-values	Results
H_1: entrepreneur innovativeness→SW innovativeness	0.364**	0.076	4.801	Supported
H_2: entrepreneur innovativeness→SW standardization	0.359**	0.113	3.187	Supported
H_3: entrepreneur risk-taking→SW innovativeness	0.338**	0.059	5.736	Supported
H_4: entrepreneur risk-taking→SW standardization	0.174*	0.084	2.016	Supported
H_5: SW innovativeness→SW flexibility	0.491**	0.017	6.939	Supported
H_6: SW standardization→SW flexibility	0.388**	0.055	7.016	Supported
H_7: SW flexibility→performance	0.436**	0.179	2.853	Supported

*: p<0.05, **: p<0.01

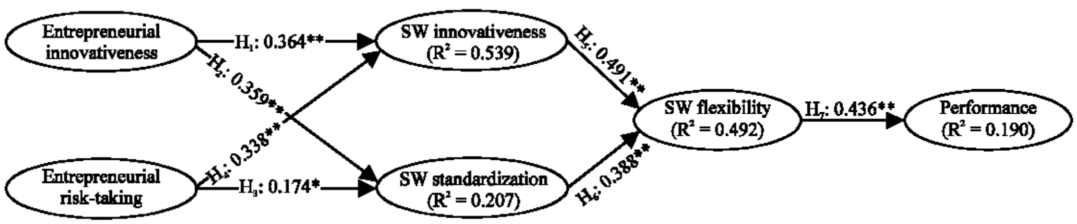

Fig. 2: Structural model (only direct effects); *p<0.05, **p<0.01

The analysis of structural models helps to gauge the suitability of structural models and the relationships between the research model variables (standardized coefficient) and the coefficient determination of the R-squared (R^2) of the endogenous variables. First, the results of the structural model suitability test used the same index as that of the measurement model suitability test. The results show that the structural model had a good fit to the collected data (IFI = 0.939, GFI = 0.856, AGFI = 0.815, CFI = 0.939, χ^2/df = 2.151 and RMSEA = 0.036). Thus, we had no difficulty in testing the research hypotheses.

Table 4 shows the results of the direct effect model that tested H_1 to H_7. First, entrepreneurial innovativeness and risk-taking are significantly associated with software innovativeness (H_1: β = 0.364, p<0.01; H_2: β = 0.359, p<0.01, respectively). Entrepreneurial innovativeness also shows a significant positive effect on software standardization (H_3: β = 0.338, p<0.01), supporting H_3. However, entrepreneurial risk-taking was not significantly related to software standardization; thus, we reject H_4. The relationships between the two software characteristic variables (software innovativeness and software standardization) and software flexibility were supported at p<0.01 (H_5: β = 0.491, p<0.01; H_6: β = 0.388, p<0.01, respectively). Software innovativeness had a greater impact on software flexibility than software standardization. Finally, the path coefficient between software flexibility and performance was 0.436, p<0.01, thus supporting H_7.

The second important finding from the analysis is the coefficient of determination R^2 of the endogenous variable. The value of R^2 refers to the ratio explained by the regression line and the exogenous variable of the changes in the research model. Entrepreneur innovativeness and risk-taking explained 53.9 and 20.7% of the variance in software innovativeness and software standardization, respectively. These results imply that changes in software innovativeness and software standardization can be explained by the change in entrepreneur innovativeness and risk-taking. Additionally, software innovativeness and software standardization explained 49.2% of the variance in software flexibility. Finally, software flexibility explained the 19% dispersion that expresses performance. Figure 2 shows the results of the direct effects with the standardized path coefficients and their respective significance levels.

Moderation effects: A Moderated Multiple Regression (MMR) approach was performed to analyze the moderating effect of the regulatory environment

Table 5: Moderating effect results

Hypothesis (results)/Constructs	Analysis of main effect model Std. coefficient	Analysis of main effect model t-values	Analysis of interaction effect model Std. coefficient	Analysis of interaction effect model t-values
H_8 (Supported)				
Entrepreneur innovativeness	0.366	7.682**	0.382	8.921**
Regulatory environment	0.214	3.258**	0.263	3.380**
Entrepreneur innovativeness×Regulatory environment			0.219	2.471*
R^2 (SW innovativeness)	0.215	0.262		
F-value	16.112** ($\Delta R^2 = 0.047$)			
H_9 (Supported)				
Entrepreneur innovativeness	0.336	5.012**	0.319	4.627**
Regulatory environment	0.268	4.437**	0.249	4.238**
Entrepreneur innovativeness×Regulatory environment			0.127	1.878*
R^2 (SW standardization)	0.196	0.219		
F-value	7.451** ($\Delta R^2 = 0.023$)			
H_{10} (Supported)				
Entrepreneur risk-taking	0.316	5.248**	0.349	5.760**
Regulatory environment	0.197	1.934*	0.128	2.601**
Entrepreneur risk-taking×Regulatory environment			0.059	1.906
R^2 (SW innovativeness)	0.158	0.197		
F-value	12.288** ($\Delta R^2 = 0.039$)			
H_{11} (Supported)				
Entrepreneur risk-taking	0.221	3.549**	0.174	2.123*
Regulatory environment	0.210	3.573**	0.206	3.751**
Entrepreneur risk-taking×Regulatory environment			0.115	2.217*
R^2 (SW standardization)	0.149	0.162		
F-value	3.925* ($\Delta R^2 = 0.013$)			

*p<0.05, **p<0.01

(Carte and Russell, 2003). The MMR approach uses the difference of the R^2 value (ΔR^2) from the analysis of the two models to compute the F-value. First, a model including independent and moderating variables as preceding variables is analyzed to yield the R^2 value (R^2_a). Then, the second model is analyzed after adding the interaction term to the first model to yield the R^2 value (R^2_m). Using the equation proposed by Carter and Russell (2003):

$$F_{(df_m - df_a, N - df_m - 1)} = \frac{\Delta R^2 (N - df_m - 1)}{(1 - R^2_m)(df_m - df_a)}$$

the F-value is computed to test the moderating effect. For example, H_8 tests the moderating effect of the regulatory environment on the relationship between entrepreneur innovativeness and software innovativeness. First, R^2_a (0.215) is obtained when entrepreneur innovativeness and the regulatory environment are preceding variables for software innovativeness. Then, the second model including the interaction term (entrepreneur innovativeness×regulatory environment) is analyzed to yield R^2_m(0.262). Considering ΔR^2 (0.047), the number of preceding variables (df_a = 2, df_m = 3) and the sample size (n = 257), the F-value (16.112) is calculated based on the formula. Thus, H_8 is significantly supported at p<0.01. H_9, H_{10} and H_{11} were tested using the same approach as H_7. All proposed moderating effects were accepted with the exception of H_{11} which tested the effect of the regulatory environment on the relationship between entrepreneur risk taking and software standardization. Table 5 summarized the results for the testing of H_8 to H_{11}.

RESULTS AND DISCUSSION

Entrepreneur characteristics: The relationship between entrepreneurial innovativeness and software innovativeness displayed a path coefficient of 0.364 (t = 4.801) which was statistically significant and H_1 was confirmed. This result reflects the tendency of technology-oriented entrepreneurs to be interested in new, innovative, value-added technology development leading to innovativeness of their software. This result also matches the assertions of DiMaggio and Powell (1983), who argued that the higher the uncertainty that a firm will achieve its objectives, the more likely the firm will yield to institutional pressures to adopt innovation. Moreover, entrepreneurial characteristics have a close relationship with the factors influencing new product development. Firms with a high degree of innovation orientation from the entrepreneur, actively pursue innovative activities such as new product development whereas conservative entrepreneurs choose activities involving departments when carrying out new product projects that are highly innovative (Frishammar and Horte, 2007; Liang *et al.*, 2007). The relationship between entrepreneurial innovativeness and software standardization has a path coefficient of 0.359 (t = 3.187) which is statistically significant and thus, H_2 was adopted. Development of products with a high degree of standardization is beneficial to the performance of the overall development process and reduces uncertainty in requirements which leads to improved software performance and successful development project completion. Network project development is currently increasing. Network-based software maintains its newness through updates that address problems, functionality and security. If the standardization process is not present in software development, it is difficult to implement updates when users demand them. Thus, the importance of standardization is increasing.

Moreover, if standardization is effective, the process remains a firm asset for the implementation of related future projects and advancing firm competitiveness. Therefore, highly innovative entrepreneurs recognize the importance of software standardization. This result was similar to the results of previous research that proved that entrepreneurial innovativeness has a positive impact on the documentation of methods such as standard quality control procedures in manufacturing firms (Li *et al*., 2010).

The relationship between entrepreneurial risk-taking and software innovativeness was significant with a path coefficient of 0.338 (t = 5.736) and thus, H_3 was accepted. This result reflects the phenomenon that entrepreneurs who are willing to take risks tend to pursue highly profitable opportunities, despite the possibility of large losses, thereby leading to software innovativeness. Avlonitis and Salayou (2007) state that the risk sensitivity of an entrepreneur of a small or medium enterprise is an important influencing factor on firm innovation orientation such as new product development performance. On the other hand, Kreiser *et al.* (2013) asserted that entrepreneurial risk-taking tendencies do not impact firm performance. The authors asserted that entrepreneurs strive to advance the firm's innovativeness if the future is predictable; environments with a high level of uncertainty complicate future environment predictions by entrepreneurs. Therefore, this study asserts that sensitivity to risk does not impact firm decision making.

The relationship between entrepreneurial risk-taking and software standardization had a path coefficient of 0.174 (t = 2.058) and had a statistically significant influence; therefore, H_4 was accepted. The study by Sung (2009) targeting domestic firm standardization activities asserted that, regardless of the type of standardization activity, management's consistent interest and efforts have a meaningful effect on standardization. Another study (Jang *et al*., 2011) found that managers with a high level of risk-taking behavior exert greater effort in developing standardized software than managers with a low level of risk-taking behavior. The relationship between the entrepreneur's risk taking and software standardization is thought to be meaningful because software standardization reduces the requirement uncertainty of software development and assists in improving firm competitiveness in a consistent manner over the long term. Entrepreneurs can predict the future to a certain extent when the uncertainty of the future firm environment is low. Although, standardization may be risky, costly and require significant human resources, the entrepreneur believes strongly that the firm will be more competitive as a result.

Software characteristics: Because the relationship between software innovativeness and software flexibility had a path coefficient of 0.491 (t = 6.939) and was statistically significant, H_5 was supported. Innovative software may face constantly changing requirements including functionality improvements and additions. Software should be designed in a flexible manner to actively respond to users' business needs. Therefore, there is a significant relationship between software innovativeness and software flexibility. This result is consistent with those of prior studies (Ahn, 2009) that have asserted that software firms facing a short technological life cycle tend to constantly reinforce the adoption and development of innovative technology. Ultimately, through product or process improvements resulting from technological innovation, software flexibility is increased and the quality of the developed software is also improved. Jordan and Segelod (2006) demonstrated that software with higher innovativeness had greater performance in project execution than software with lower innovation and flexibility which is one software quality indicator. Highly innovative software may face a need for consistent functionality upgrades and additions after project completion because of new technology adoption. Therefore, software innovativeness and flexibility are closely related.

The relationship between software standardization and software flexibility with a path coefficient of 0.388 (t = 7.016), was shown to be statistically significant and H_6 was adopted. Nidumolu (1996) claimed that standardized software reduces residual risk after the development project and leads to a positive influence on the performance of the overall process or product. Additionally, Jiang *et al.* (2004) argued that software firms that are ready to standardize processes and policies of product development identify problems during the development process by comparing the process with standardized counterparts. This standardization leads to higher-scale development process improvements and increases the flexibility and quality of the developed product.

Liu *et al.* (2008) found that in the relationship among software standardization, flexibility and performance, software flexibility acts as an agent between standardization and performance and standardization acts as a quality indicator of software flexibility. Specifically, the management of software standardization in developing software is important for its success (Liu *et al.*, 2008). This result indicates superior clarification of scope, cost and time management with effective standardization of software which leads to flexible software.

Performance: The relationship between software flexibility and performance had a path coefficient of 0.436 ($t = 2.853$) and thus, H_7 was accepted. This result implies that the greater the software flexibility, the more flexible the reference model when designing new software which results in less time spent re-working unprepared development processes and/or lower costs for new development projects. Additionally, the accumulation of flexible IT projects results in opportunities for case studies of flexibility and the intangible assets of the firm.

Recent online-based software requires consistent updates to improve security and allow compatibility with the latest applications. Software without flexibility would result in a slower response to consumer demands, technological gaps with competing firms and reduced firm competitiveness. Therefore, software flexibility leads to the reinforcement of firm competitiveness. This result is similar to the results of the study by Na (2004) and Nidomolu (1996) which confirm that software with high flexibility increases development performance by reducing post-development residual risk.

Regulatory environment: Entrepreneurs in many small and medium software firms have engineering backgrounds and tend to be heavily reliant on government regulatory support and funding. These firms are often unable to achieve commercial product production because they lack an understanding of the market and the ability to raise capital, despite successful technological development. This face provides the rationale for substantial governmental R&D support for software firms in comparison to other industries (Jiang *et al.*, 2004). Moreover, Zhu *et al.* (2006) analyzed the influence of regulatory factors in the adoption of e-Business in developed and developing countries and found that regulatory factors tend to speed up the adoption of e-business in developing countries, unlike in developed countries. This government regulatory support of entrepreneurs reinforces their innovativeness because they are given an environment in which entrepreneurs need to catch up with the latest technology to achieve competitiveness. Similarly, regulatory factors tend to enhance the impact of the entrepreneur on software development, innovativeness and standardization (Zhu *et al.*, 2006).

Additionally, entrepreneurial risk-taking is affected by regulatory factors that standardize control mechanisms of software development via process standardization. The funding from government policies and government technological support mechanisms reinforce software innovativeness and standardization given the firm's internal need to develop innovative software and apply standardization. Considering that the entrepreneur tends to prefer high yielding projects and the pursuit of new opportunities (Slevin and Covin, 1990), risk-taking entrepreneurs find new opportunities more attractive given government policy that supports these opportunities in an institutional and regulatory manner. Thus, regulatory factors influence entrepreneurs with innovativeness and risk-taking tendencies by offering support from governmental and related agencies when firms spearhead software innovativeness and standardization, ultimately reinforcing these risk-taking tendencies.

CONCLUSION

This research studies software companies to observe and analyze the relationships between entrepreneurial characteristics (innovativeness and risk-taking) and software characteristics (innovativeness, standardization and flexibility) and the effects that they have on company performance. The research results can be summarized as follows. First, entrepreneurial innovativeness and risk-taking are positively related to the two software characteristics (innovativeness and standardization). Additionally, software innovativeness and standardization are positively related to software flexibility which significantly influences firm performance. The findings are consistent with previous research, suggesting that software innovativeness and standardization lead to software flexibility (Liu *et al.*, 2008; Nidumolu, 1996; Wang *et al.*, 2008).

Highly innovative software may result in continuous demand for function improvement and additional demand for new functions during the initial phases of use. Thus, a standardized process must be followed to create flexible software such that the same standardized process can be used in the development of new software. This method would clarify the issues that may arise in the initial process; continuous application of standardization would result in a more sophisticated development process. Innovative and standardized software will eventually influence flexibility. Software flexibility is a criterion for quality and software with flexibility is better able to address and respond to consumer demands. Thus, it is necessary to preferentially consider standardization and innovation to develop flexible software.

Second, software flexibility has a positive influence on a software company's technological performance. This finding is consistent with those of previous research which show that software characteristics dictate software companies performance (Jiang *et al*., 2004; Wang *et al*., 2008). To improve performance, a systemized and standardized process must be established within the company and manual activities must become the company's intangible assets. Software innovation must bring about differentiation between the company and other (competing) firms. An increase in flexibility results in a decrease in production costs and time which eventually improves company performance. Finally, firms should utilize the existing regulatory environment. The strategic value of the software development process may depend on distinct combinations of entrepreneurial factors and software characteristics in combination with regulatory factors for creating optimal firm performance.

LIMITATIONS

As with any social science commentary, this study has some limitations that direct future research. The main limitations of this study concern the sample and the research method. First, the study observed one point in time, rather than adopting a longitudinal perspective; therefore, the validity of the findings is limited. Additionally, the current study used a single key informant from whom to collect data. However, the key informant might not represent the entire organization. To address this limitation, we collected data only from senior managers. Second, the current study contains a generalizability issue because the data was collected in one country. Thus, the generalizability would be increased by the inclusion of software companies from other countries. Finally, the study modified the adopted measurement items from prior studies which potentially causes misspecification of variables in the research model. Future studies should develop and validate more items to measure each construct in the research model. Additionally, future studies involving a global sample would be useful. Our study highlights the effect of entrepreneurial characteristics on software characteristics and investigates how the regulatory environment can leverage the relationships among the factors in the two characteristics. Future studies should consider investigating additional organizational variables and other firm-specific characteristics and their influence on performance with respect to software characteristics. A study of entrepreneurial characteristics and their relationships with software characteristics would provide a complete approach to understanding the difficulties that underlie problems in firm performance.

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