

Entrepreneurial Product Innovation: A Second-Order Factor Analysis

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ABSTRACT

Product innovation is as a vital tool for nascent entrepreneurs seeking to achieve a competitive advantage. This study investigates the integrated and complex relationships that exist between innovation and entrepreneurship by using partial least squares structural equation modelling (PLS-SEM). Entrepreneurial product innovation is tested with second-order factors comprised of entrepreneurial personality, technological opportunity and incubator resources. For this purpose, the empirical research used data from 389 incubated start-ups in Thailand. The study found that these three antecedents are significant for product innovation with effects of varying size. The study magnifies the prominent role of business incubators in fostering entrepreneurial capabilities to boost new products/services. Moreover, the findings suggest that the incubation centre resources mediate the influence of entrepreneurial characteristics by expediting and facilitating product innovation.

Keywords: Entrepreneur; Incubation; PLS; Product Innovation

1. INTRODUCTION

In the fast-pace of global change in uncertain and competitive business environments, informed customers become empowered and markets are shifted towards rapid product development. Innovation, especially for new ventures, has become a critical factor of success encompassing the creation of economic productivity and methods of working and operating (Baron & Tang, 2011; Cheng et al., 2012; Edison et al., 2013). To achieve and sustain a competitive advantage, ventures must continuously innovate in order to deliver novel products (for both goods and services) relative to customers' current perception of value (Khalil & Olafsen, 2010; Edison et al., 2013). Linking to performance and growth, product innovation offers opportunities to capture new markets in order to gain high profits and build dominant positions in the marketplace by exploiting the firm's competencies or exploring emerging technology (Cheng et al., 2012). In recent years, the role of entrepreneurs, and particularly in the context of small and medium-sized enterprises (SMEs), in stimulating innovation and leading new business creation has become apparent within a research trend (Marcati et al., 2008; Belso-Martinez et al., 2013). Even though it is general belief that it is easier for smaller companies to innovate, in fact, these companies encounter more discouraging obstacles in bringing inventions to market (Khalil & Olafsen, 2010) and greater difficulties in commercializing their innovations (Fiates et al., 2010). Thus, policymakers are induced by the decisive challenge not only of spurring invention adapted to the local environment, but also of exerting relevant influences that allow the inventions to be coupled in the early stages of new venture creation and innovation projects (Khalil & Olafsen, 2010; Belso-Martinez et al., 2013). Such governmental programs can be implemented through science parks and incubation centres (Colombo & Delmastro, 2002). From a policy perspective, a better understanding of efficient incentives to support innovation is of utmost importance in the deployment of scarce resources (Radas & Bozic, 2009; Mayer-Haug et al., 2013). However, despite those strong commitments from the government, little direct evidence is available on how new ventures exploit sources of competitiveness and encourage innovative activity in their companies (Radas & Bozic, 2009; Baron & Tang, 2011; Belso-Martinez et al., 2013). Besides, most of the existing literature that deals with determining factors significant for SME innovation come from developed economies, and those findings may not be generalized to the fullest extent in the context of developing countries (Intarakamnerd et al., 2002; Radas & Bozic, 2009). This study seeks to define the relationship

among the technological opportunities, the incubator resources, and the entrepreneurial personality. Such integrated and complex relationships have never before been the subject of research, especially in Asian countries. In order to examine the hierarchical models, this study employs qualitative analysis using partial least squares structural equation modelling (PLS-SEM) in a second-order factor structure. This second-order factor modelling can enhance the conceptualization and estimation of the overall model through the underlying commonality among its first-order dimensions (Andres, 2010). Thus, it offers both greater flexibility and parsimony in specifying model constructs (Andres, 2010). The structure can be constructed as the entrepreneurial personality determined by three first-order factors (i.e., need of achievement, locus of control, and risk-taking propensity). The technical opportunity can be modelled from non-industrial opportunity and industrial opportunity. In addition, the joint effects of business development resources and technological resources form the second-order construct of incubator resources. Survey data were collected from the Software Park registered company and were used to estimate a mathematical model.

2. THEORETICAL MODEL AND RESEARCH HYPOTHESES

2.1 Technological Opportunity

Identifying and selecting the best opportunities for new businesses are among the most important abilities of a successful entrepreneur (Ardichvili et al., 2003). Bygrave and Hofer (1991) suggested that entrepreneurs and entrepreneurial organizations differ from the established firm in the way they develop and exploit opportunities. Based on many studies, Ardichvili et al. (2003) offered the summary that, in broad terms, an opportunity may be the chance to meet a market need (or interest or want) through a creative combination of resources to deliver superior value that are initially unformed and then become increasingly developed over time. In environments with a high level of technological opportunities (external knowledge), firms will have greater incentives to invest in research and development (R&D) (Vega-Jurado et al., 2008). They will make use of these opportunities to stimulate their R&D activities rather than substitute their competencies (Arora & Gambardella, 1990; Veugelers, 1997). The challenge, for the entrepreneurs, is to balance their decisive spending while enhancing firm-level innovativeness. Some missing inputs that the firms themselves cannot easily endure, such as external staff training, parts and components, and consulting services, are ready for the entrepreneurs to acquire if they see a channel of opportunity. Thus, not only do the strong firms survive but they also thrive by gaining advantages from technological opportunities. Opportunity found within the industry sources such as suppliers, competitors or users of goods and services, are categorized as industrial technological opportunities, while those technologies from advanced and research technology sources such as universities, research centres, and government agencies are categorized as non-industrial technological opportunities.

2.1.1 Industrial Technology

Firms expand their technological opportunities by applying external knowledge from suppliers, customers and/or competitors in the form of original or adapted knowledge. Katila and Mang (2003) argued that industrial players employ technological opportunities through collaboration in order to rapidly access vital external resources. This collaboration creates a strategy leading to technological opportunities for competitive advantage. Thus, the entrepreneurs foster their innovative activities through strategic external partners.

2.1.2 Non-Industrial Technology

The non-industrial technological opportunities generated by scientific institutions are of major interest for advanced technology-intensive firms. Arising from scientific breakthroughs and the diffusion of new technology, these opportunities require collaboration with universities and research organizations to translate new scientific and engineering principles into radical or modular innovations (Palmborg, 2001). In particular, a greater amount of universities are creating more start-ups to exploit their intellectual property (Di Gregorio & Shane, 2003).

On the role of technological opportunity in product innovation, the following hypothesis is proposed:

Hypothesis 1: Technological opportunity will have a positive influence on product innovation.

2.2 Incubator Resources

It is believed that start-ups and high-growth firms, especially in high-technology sectors, play driving roles in generating economic returns at the local and national levels. They are a major source of potentially innovative and technology-based products. Thus, governments around the globe emphasize policies that foster innovation growth in the start-up stage of firms. One such governmental program is a business incubator, where subsidized and support services are provided to nascent firms to reduce barriers to entering market. These include an infrastructure of technical, logistic and administrative supports that can provide a nurturing environment for accelerating the development and success of affiliated ventures (Mian, 1996; Hansen et al., 2000; Abetti, 2004). One of the most important roles of an incubator is to act as an intermediary or mediator by providing a “bridge” between incubated firms and relevant innovation-supporting systems, i.e., knowledge and technology, financial capital, market-related resources and human capital (Bergek & Norrman, 2008). However, there is also contrary evidence suggesting that incubators have little or no effect on the success of ventures in terms of survival, innovation (Tamasy, 2007), and job growth (Reitan, 1997). As a result, there is no clear understanding on the value of establishing business incubators as an appropriate vehicle to help promote and facilitate the development of technology firms (Chan & Lau, 2005; Ratinho & Henriques, 2010). Nevertheless, Barbero et al. (2012) suggest that studies on incubation have been conducted in diversified sectors offering poor incubator performance results; thus, they suggest, studies on sector specialized incubators can demonstrate better performance results. This study will focus on two specific and important types of services – technological and business development.

2.2.1 Technological Resources

Technological resources feature services such as access to research activity, facilities and experts, technology transfer training, and industry contacts. For new ventures, these resources are often beyond their abilities and thus require external sources of competence for innovation (Scillitoe & Chakrabarti, 2010). As a result, an incubator can serve as a valuable source during the early development stage of start-ups.

2.2.2 Business Development Resources

Business development resources include the following services: operation support, business planning, tax assistance, personnel recruiting, marketing, management, accounting, general legal expertise, accessing financial capital, and business networking (Chan & Lau, 2005; Scillitoe & Chakrabarti, 2010). Bruneel et al., (2012) argued that nascent technology firms typically lack business experience and marketing skills and thus may have limited chances for survival. Incubated firms need business assistance, particularly marketing assistance, from an incubator (Scillitoe & Chakrabarti, 2010). They have a tendency to focus on perfecting their product or service and running out of time and money before successfully getting to market. Moreover, in addition to training, founders may benefit from active coaching of company routines, including the forms, rules, procedures and strategies around which organizations are constructed and through which they operate (Bruneel et al., 2012).

Conjecturing from the research above, the second hypothesis is as follows:

Hypothesis 2: Incubator resources will have a positive influence on product innovation.

2.3 Entrepreneurial Personality

Entrepreneurs are individuals who discover an opportunity and exploit it to create a new venture (Shane & Venkataraman, 2000). In this regard, for many years, researchers have studied characteristics or specific personality traits that entrepreneurs possess as one of the most empirically researched topics in the field of entrepreneurship (Vecchio, 2003). Moreover, entrepreneurs are significantly more innovative than non-entrepreneurs (Ho & Koh, 1992; Robinson & Sexton, 1994), and their personality traits have a direct effect on firm performance (Wong et al., 2006; Cantner et al., 2007). They often have greater difficulty in relation to innovation activities and face several challenges in commercializing their innovations (Fiates et al., 2010). These obstacles may include lack of financial resources and inadequacy of management and marketing (Fazlzadeh & Moshiri, 2010). Thus, small firms deserve governmental institution support programs, such as incubation centres (Colombo & Delmastro, 2002). The incubator

centre can provide a nourishing environment for business and technological assistance; however, there is much evidence of a high failure rate among incubated ventures. One reason for this failure is that the incubatees overestimate their personal strengths while underestimating their weaknesses (Wong et al., 2006). In this study, need for achievement, locus of control, and risk-taking propensity are represented as key entrepreneurial personalities.

2.3.1 Need for Achievement

Need for achievement is a key characteristic of individuals who strive to excel in all activities, regardless of the obstacles to be faced (Berthelot, 2008); it is thought to be a key entrepreneurial personality and has been studied extensively in the entrepreneurship literature (Johnson, 1990; Shan, 2003). McClelland (1961) in Shane et al., (2003) argued that individuals who have a high need for achievement enjoy challenging activities or tasks that have a high degree of individual responsibility for outcomes (Shane et al., 2003). Thus, the characteristics of need for achievement are significantly related to founding entrepreneurs (Collins et al., 2004), entrepreneurial activity (Johnson, 1990; Sagie & Elizur, 1999) and especially venture performance (Lee & Tsang, 2001).

2.3.2 Locus of Control

Locus of control is the belief that individuals' actions or personal characteristics affect outcomes (Shane et al., 2003). Individuals with a high internal locus of control believe they can influence outcomes with their ability, effort and skill, whereas people with an external locus of control believe that their success depends on fate and destiny (Shane et al., 2003; Berthelot, 2008). Entrepreneurs are usually oriented towards the internal locus of control (Korunka et al., 2003; Shane et al., 2003; Vecchio, 2003) because of their desire to have a direct impact on results (Shane et al., 2003). Thus, internal locus of control is significantly related to venture growth (Lee & Tsang, 2001). Moreover, entrepreneurs with an internal locus-of-control personality tend to undertake innovative strategies (Wijbenga & van Witteloostuijn, 2007). It is also belief that internal locus of control is within the entrepreneur without cultural boundaries (Bonnett & Furnham, 1991).

2.3.3 Risk-Taking Propensity

Risk-taking propensity can be defined as an individual's tendency to take or avoid risk (Sitkin & Weingart, 1995). In situations with uncertain consequences, risk is a vital component of most entrepreneurial decision-making. Some may be high risk takers while some may be risk-averse (Salleh & Ibrahim, 2011). Those entrepreneurs with a high propensity for risk do not perceive their actions as risky (Shane et al., 2003). In addition, risk-taking propensity may be the only trait in which founders and non-founders differ (Begley, 1995).

Consistent with the prior research, and given that those traits have been commonly used to describe entrepreneurs, this study proposes the following:

Hypothesis 3: Entrepreneurial personality will have a positive influence on product innovation;

Hypothesis 4: Entrepreneurial personality will have a positive influence on technological opportunity; and

Hypothesis 5: Entrepreneurial personality will have a positive influence on how the entrepreneurs utilize business incubator resources.

3. RESEARCH MODEL

The key prerequisite to achieving advantages as a small firm, therefore, is new technology or innovation for both new and existing markets. Innovation is not limited only at the initial stages of a new venture; rather, it is developed and embedded in entrepreneurial and innovative behaviour through the product and service that the venture delivers at all stages. Product innovation is the introduction of a good or service that is new or significantly improved regarding its characteristics or intended uses, including significant improvements in technical specifications, components and materials, incorporated software, user-friendliness or other function characteristics (OECD, 2005). Product innovation can be one source of competitive advantage, helping firms to adapt to changing environments (Vermeulen et al., 2003). Nevertheless, most empirical studies of innovation have been conducted in developed countries, and using such findings to describe the innovative behaviour in developing countries is likely to be inappropriate (Charoenporn, 2005). This study shall depict the analytical concept for product innovation of

Thai start-ups. The relationships among entrepreneurial personality, technological opportunity and incubator resources are laid out schematically in Figure 1.

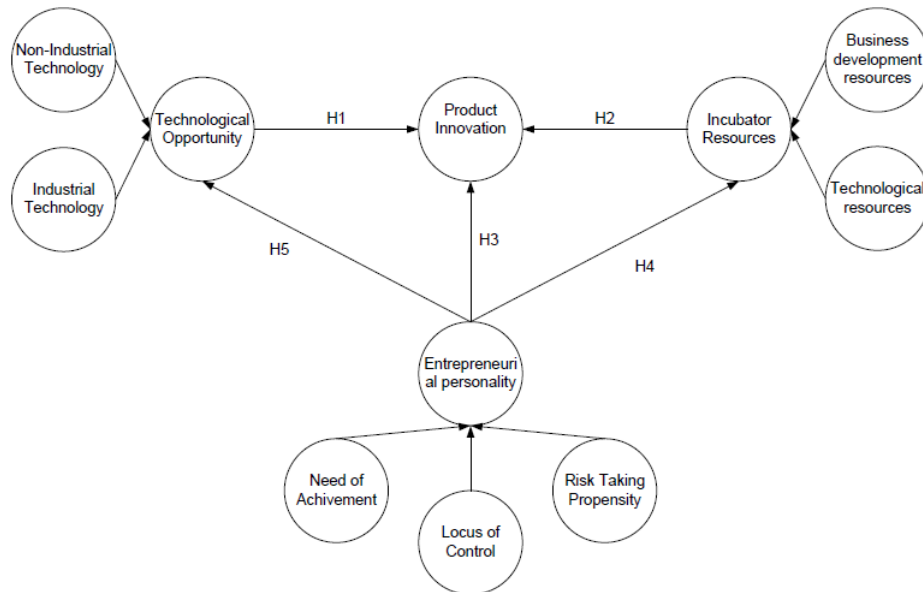


Figure 1: Research Model of the Study

In the research model, structural equation modelling (SEM) was used to measure each variable based on multiple indicators. This technique is also referred to as “latent variable measurement” (Ketkar et al., 2012). It allows for the inclusion of higher-order variables (hierarchical component model). Thus, the first-order latent variables (measurement model) can be represented as the loading of the second-order latent variable (structural model) (Wetzels et al., 2009). Consequently, entrepreneurial personality as the second-order latent variable consists of three first-order factors: need of achievement, locus of control, and risk-taking propensity. The variables of technological opportunity and incubator resources can be also constructed as second-order latent variables.

4. RESEARCH METHODOLOGY

4.1 Data

Data collection for this study was done in a standardized form with a scaled response to a specific focus group, i.e., companies registered as incubatees with the Software Parks in Thailand within the past three years. An online web survey service was utilized to collect the data. Strict procedures were undertaken to ensure that there was no survey bias by communicating with each surveyor prior to the survey to ensure that they had adequate access to the Internet and no difficulty in filling out the online survey. The study was geared towards newer firms and entrepreneurs. The incubation centre itself imposed a strict selection process for the companies that it included in its incubation program. All incubatees were required to attend the prerequisite courses and training arranged by the incubation centre. Courses and training includes entrepreneurship courses, business training, product and services training, etc. The study was undertaken with a list of 420 companies provided by the software park of Thailand. Out of the 420 surveys sent out, a total of 389 fully completed responses were received and assessed. The empirical results are based on these 389 completed surveys.

4.2 Variables

The literature describes various indicators that measure product innovation; however, number of patents, new product announcements, and degree of innovation have received the most attention (Garcia & Calantone, 2002; Romijn & Albaladejo, 2002; Vermeulen et al., 2003; Wetering & Koster, 2007). Nevertheless, in business services such as the software industry, number of patents and new product announcements are unsatisfactory indicators for

measuring firms’ innovation (Wetering & Koster, 2007). Thus, in this study, product innovation can be measured by degree of innovation. This variable can be measured as 0 if the firm has not introduced any new or improved products to the market; 1, if the firm has introduced any products that are new to the firm; and 2, if the firm has introduced any products that are new to the market (Romijn & Albaladejo, 2002; De Jong & Vermeulen, 2006; Vega-Jurado et al., 2008). Following this measurement, it is possible to obtain insights into the innovative behaviour of firms that hardly patent their products or have no R&D departments (Wetering & Koster, 2007).

The first-order factors for technological opportunity can be indicated by the proposed measurement of Vega-Jurado et al. (2008). Industrial and non-industrial technological opportunities are classified according to a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). In the case of industry technological opportunity, the manifest variables were firms in the same group, suppliers, competitors and customers, while the variables used for non-industry technological opportunity were expert or consultants, commercial laboratories / R&D firms, and universities and public research organizations / technology centres.

In view of incubator resources being proposed as a second-order factor in the research model, the manifest variables of the first-order variables in both technological resources and business development resources were adapted from Meru (2011) and developed by the authors in the 5-point Likert scale.

For the second-order latent variables of entrepreneurial personality, the study measured manifest variables according to 7-point scales as proposed by Berthelot (2008). These include 5 items for need of achievement, 8 for locus of control, and 4 for risk-taking propensity.

4.3 Validity and Reliability of Constructs

Latent variable measurement requires that validity and reliability tests be conducted to ensure that indicators designed to measure one latent variable are not confused by respondents with indicators designed to measure other latent variables (Ketkar et al., 2012). To access those tests, a null model for the first-order latent variables was initially established in non-structural relationships in Partial Least Squares (PLS) (Wetzels et al., 2009). Convergent validity, measuring the correlation between manifest variables and the respective latent variable, is usually based on a comparison of loadings. Such loadings for all respective latent variables must be 0.5 or above for the convergent validity of a measurement model to be considered acceptable (Chin, 1998; Ketkar et al., 2012). In this research, the sets of factor loadings were all above 0.7; thus, they were considered to be acceptable.

Table 1 shows the coefficients used to assess the model’s reliability. The reliability, measuring the correlation among manifest variables themselves in each latent variable, is generally considered to be acceptable if the composite reliability (CR) and average variance extracted (AVE) associated with the variables exceed the cut-off values of 0.7 and 0.5, respectively (Wetzels et al., 2009; Ketkar et al., 2012). As shown, the CR of all first- and second-order factors are well above the 0.7 threshold, and all AVEs exceed the cut-off value of 0.5. Moreover, the discriminant validity, which measures whether manifest variables in the respective latent variable are correlated or not with other latent variables, is acceptable if the square root of the AVE for each latent variable is higher than any of the correlations between the latent variable in question and any other latent variables in the model (Chin, 1998; Ketkar et al., 2012). As can be seen from Tables 2 and 3, all square roots of AVEs (in bold along the diagonal) are higher than the intercorrelations of the constructs shown below them. Thus, the discriminant validity of the research model is acceptable.

Table 1: Composite Reliability (CR) and Average Variance Extracted (AVE) of the Measurement Model

First-Order	CR	AVE	Second-Order	CR	AVE
Industrial technological opportunity	0.796	0.566	Technological Opportunity	0.735	0.581
Non-industrial technological opportunity	0.734	0.580			
Technological resources	0.824	0.539	Incubator Resources	0.876	0.779
Business resources	0.926	0.640			
Need for achievement	0.817	0.599	Entrepreneurial Personality	0.790	0.569
Locus of control	0.833	0.556			
Risk-taking propensity	0.835	0.558			
Product innovation	1.000	1.000			

Table 2: Discriminant Validity of the Latent Variables for the First-Order Construct

Construct	1	2	3	4	5	6	7	8
Industrial technological opportunity	0.752							
Non-industrial technological opportunity	0.163	0.762						
Technological resources	0.355	-0.009	0.734					
Business resources	0.130	0.149	0.559	0.800				
Need for achievement	0.177	0.379	0.044	0.032	0.774			
Locus of control	0.248	0.373	0.055	0.353	0.149	0.746		
Risk-taking propensity	0.474	0.318	0.313	0.250	0.268	0.582	0.747	
Product innovation	0.359	0.199	0.508	0.695	0.173	0.331	0.351	1.000

Note: Square roots of AVE are shown in bold along the diagonal.

Table 3: Discriminant Validity for the Second-Order Construct

Construct	Technological Opportunity	Incubator Resources	Entrepreneurial Personality	Innovation
Technological opportunity	0.762			
Incubator resources	0.232	0.883		
Entrepreneurial personality	0.572	0.288	0.754	
Innovation	0.366	0.681	0.392	1.000

Note: Square roots of AVE are shown in bold along the diagonal.

5. EMPIRICAL RESULTS AND DISCUSSIONS

5.1 Empirical Results

The PLS-SEM was used to test the proposed research model. This method evaluates the predictive power of the independent variables by looking at the standardized partial regression coefficients (β), and evaluates the explanatory power of the entire model by looking at the coefficient of multiple determinations (R^2) (Leimeister et al., 2009). The results of β coefficients together with the corresponding level of significance were shown near the arrows, and the R^2 of the dependent variables are depicted in Figure 2. Moreover, indirect and total effects of each second-order antecedent variable can be explored together with their size effect (f^2) in Table 4.

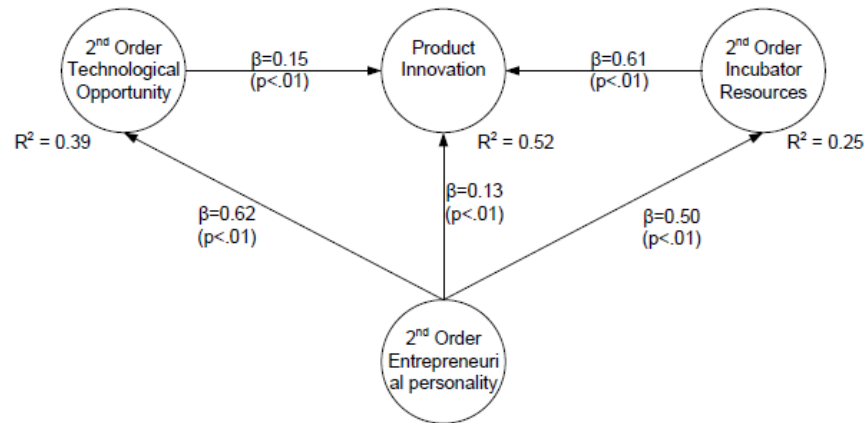


Figure 2: Findings of the Structural Model

Notes: β is the standardized partial regression coefficients; R^2 is the coefficient of multiple determinations.

Table 4: Effects of Antecedent on Dependent Variables

Dependent Variables	R ²	Path (β) and Size (f ²)†	Antecedent Variables		
			Second-Order Entrepreneurial Personality	Second-Order Technological Opportunity	Second-Order Incubator Resources
Product Innovation	0.52	Direct	0.131** (0.051)	0.150** (0.055)	0.609** (0.415)
		Indirect	0.401** (0.157)		
		Total	0.532** (0.209)		
Second-Order Technological Opportunity	0.39	Direct	0.623** (0.389)		
		Indirect			
		Total			
Second-Order Incubator Resources	0.25	Direct	0.504** (0.254)		
		Indirect			
		Total			

Notes: * p < .05, ** p < .01, † Effect sizes (f²) are in parentheses

Table 5: Model Fit Indices

Indices	Values
APC	0.404, p < 0.001
ARS	0.388, p < 0.001
AVIF	1.380

As indicated by the explanatory R² of the dependent variables, 52% of the variance in product innovation can be explained by the three second-order independent variables. Figure 2 also shows that R² of the technological opportunity and incubator resources (endogenous variables) surpass the threshold of 0.1 (Falk and Miller, 1992), and thus are well illustrated by the entrepreneurial personality.

Figure 2 and Table 4 suggest that technological opportunity has a significant positive relationship with the product innovation (β = 0.15, p < .01), thus supporting Hypothesis 1, even though it has a weak effect on product innovation due to the small effect size f² (0.055). Moreover, Hypothesis 2 is supported. The incubator resources have a significantly positive and strong influence on product innovation since the β coefficient (0.609, p < .01) and effect size f² (0.415) are significant. All remaining hypotheses are also supported. The entrepreneurial personality is significantly positively related with product innovation (Hypothesis 3, β = 0.131, p < .01), with a small effect size (0.051). Entrepreneurial personality has a significantly positive and strong effect on technological opportunity (Hypothesis 4, β = 0.623, p < .01; f² = 0.389) and incubator resources (Hypothesis 5, β = 0.504, p < .01; f² = 0.254). Despite having a small direct effect on the product innovation (Hypothesis 3), entrepreneurial personality lays the emphasis on indirect effect (β = 0.401, p < .01; f² = 0.157) and interestingly does have significant total effect (β = 0.532, p < .01; f² = 0.209).

As shown in Table 5, the WrapPLS software also provided meaningful indices for the context of variance-based SEM, including Average Path Coefficient (APC), Average R² (ARS), and Average Variance Inflation Factor (AVIF) (Ketkar et al., 2012). Their values are as follows: APC = 0.404, p < 0.001; ARS = 0.388, p < 0.001; and AVIF = 1.380 are fit with the data (statistically significant APC and ARS), and low overall collinearity (AVIF < 5).

5.2 Discussions

The finding provides strong support for the role of technological opportunity, incubator resources and entrepreneurial personality in entrepreneurial product innovation, even though the size of their effects tends to vary. The relationship of technological opportunity to entrepreneurs has been discussed among researchers. While some claim that most sources of technological advancement come from within the industry (Klevatorick et al., 1995), other say that only non-industrial opportunities exercise a significant influence on a firm’s innovation output (Vega-

Jurado et al., 2008). These unclear results are required to use pre-defined industrial classifications to trace and analyze the nature and dynamics of innovation (Palmborg, 2001). In the software industry, the result provides prominent evidence that technological opportunity is acquired, shared, and integrated with external knowledge during the product development. The study also supports the tendency of smaller firms to be associated with radical innovation, to have a focused competence base, and to achieve rapid growth in the industry while facing greater technological opportunity (Palmborg, 2001; Mukhopadhyay & AmirKhalkhali, 2004). Though technological opportunity can be considered an important factor in product innovation, its effect is small. This finding concurs with the findings of Chan and Lau (2005) that consulting on product development is not the main concern of technology start-ups since founders are usually technology experts. Moreover, for developing countries where technological activity is in stagnant technologies (Montobbio & Rampa, 2005), the seeking of customer requirement and market gap is more distinctive for innovation incentives. Thus, the software entrepreneurs focus more on their competences rather than gaining technology from external partners.

Despite contested merits of incubators (Chan & Lau, 2005), the analysis (Wong et al., 2006) reveals that the resources of a business incubator have a strong positive effect for innovative small ventures. This is consistent with the World Bank's study that business incubators have positive effects both for creating viable, innovative, high-growth enterprises and for the broader innovation and entrepreneurship ecosystem (Khalil & Olafsen, 2010). This supports Lin and Tzeng's (2009) findings of the benefits of technology incubator programs in different stages; in the set-up-office period, the programs could provide the rental subsidy and share general resources costs; in the initial marketing period, the programs could provide training resources, market network relations, proposed customer databases, and legal or business advice; in the start-to-sell period, the programs could provide public image, media relations, market networks, and venture capital. The size of the influential effect can be inferred from the sector specialization (software industry) of the incubator which features (1) high-quality advisory services, premises and equipment, which benefit both the incubator (cost reduction) and the incubation centre (quality of advice, tailored premises); and (2) the image effects of the location (e.g., media presence, positive word of mouth) (Barbero et al., 2012).

The structural analysis suggests that entrepreneurial personality is a crucial factor for both the direct and indirect effect on the formation of product innovation. This finding is consistent with that of the study on Indonesian entrepreneurs' personality traits in relation to innovative behaviour (Prihatin Dwi Riyanti, 2004). Unlike many studies of entrepreneurship that have found little evidence), this research focused on specific personality traits (i.e., needs of achievement, locus of control, and risk-taking propensity) in relation to entrepreneurship and found positive empirical support. As seen in Figure 2, the size of the direct effect is very small, which could partially explain the contradictory results seen by different researchers when studying entrepreneurship and personalities. The size of its total effect also indicates that the entrepreneur's personal characteristics play a more important role when the mediating variables – i.e., technological opportunity and incubator resources – are presented. As illustrated by the structural diagram (Figure 2), the mediating effect associated with the incubated firms' founders can significantly enhance the innovation output. As expected, incubation centres support entrepreneurs in developing and commercializing their products and services, and can be considered as amplifiers for venture performance. The study demonstrates that, when incubatees possess strong characteristics and develop their innovative behaviour throughout the incubated program, the output in terms of product innovation leading to venture performance tends to improve. Thus, this may explain why some incubates fail in practice. Moreover, the research underscores those traits as special ways for entrepreneurs to innovate systematically or habitually (Drucker, 1985) and as prerequisites to becoming a successful entrepreneur (Holt, 1992).

6. CONCLUSION

The goal of this study is to comprehend the interaction of the factors involved in entrepreneurial product innovation, especially within the context of an Asian country such as Thailand. These main contributors – including entrepreneurial personality, technological opportunity and incubation centre resources – have been identified as factors that impact product innovation and have been analyzed in isolation in many studies due to their complexity. In this paper, however, the results demonstrate that second-order factor analysis in PLS-SEM can effectively capture the underlying mechanisms and offer an extension to the findings of prior research on start-ups' innovation in the high-technology industry. In testing the hierarchical model of technological opportunities, this study suggests that

higher opportunities are directly associated with new product development; however, for the Thai software industry, the start-ups seem to pay less attention to acquiring new knowledge or collaborating with external organizations in their pursuit of product realization. To meet customer requirements and create a niche market, they may focus on customization based on existing technologies in which they have expertise. The results of the study also magnify the prominent role played by business incubators in fostering entrepreneurial capabilities of running a business, boosting new products/services, and assisting them to maintain competitiveness. In other words, innovation-driven start-ups would not have succeeded without initial support, especially in terms of achieving technological and business development, at crucial stages from the incubator. Moreover, this study achieved successful results in assessing and explaining the overall personality effect as a second-order composite latent construct comprised of three first-order factors (i.e., need of achievement, locus of control, and risk-taking propensity). Having strong entrepreneurial traits may establish a higher tendency to push ideas and new products. Nevertheless, the effect is quite small due to the many environmental factors that often prevent entrepreneurs from maintaining enthusiasm about generating benefits from their creativity. This study suggests that incubation centre resources mediate the influence of entrepreneurial characteristics by expediting and facilitating product innovation. Thus, apart from creating a nurturing environment, the incubator should also focus on recognizing and developing entrepreneurial mindsets and behaviour in order to access these personalities' hidden value.

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