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Innovation in Incubated Software Firms

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ABSTRACT

The study explored the determinants of product innovation in software start-ups supported by the incubation centers. Innovative output and performance were used as indicators of the product innovation. To this end, an empirical research including 380 incubated start-ups in Thailand was conducted. An Ordinary Least Squares regression was used to analyze the collected data. The study revealed that entrepreneurial personality and technological opportunity are significantly important for product innovation. Moreover, the findings positively support the importance of business incubator to innovative enterprises.

Key words: Product innovation, entrepreneurial personality, technological opportunity, software start-ups, incubation center

INTRODUCTION

The software industry has grown unimpeded for many decades and can be regarded as the most thriving industry in the world. It is also acknowledged as a core competency for global competitiveness of most industries. In addition, the software industry is characterized as the prototype of the high technology industry in terms of relative low-investment, environmentally friendly and innovation-driven growth. Although the research on innovation tends to focus primarily on large firms, innovation is at least as important for small firms (Vermeulen *et al*., 2003), especially in software development Small and Medium Enterprises (SMEs) as they are expected to contribute substantially to technical innovation and product renewal (Olsson and McQueen, 2000).

Despite the supposed ease of innovation, only smaller firms have greater difficulties in relation to innovation activities and face several challenges in commercializing their innovations (Fiates *et al*., 2010). It is also widely accepted that new technology-based firms face greater obstacles than other firms, e.g., lack of financial resources, inadequacy of management and marketing (Fazlzadeh and Moshiri, 2010), thereby warranting support from governmental institutions, such as science parks and incubation centers (Colombo and Delmastro, 2002). Most existing literature on incubator research has focused on the development, configuration and economic impact (Scillitoe and Chakrabarti, 2010), providing limited insights regarding successful incubated ventures (Saemundsson and Holmen, 2011); as such, they have failed to illustrate a related picture of entrepreneurship and innovation. Product innovation can be one of the sources of competitive advantage, helping firms adapt to changing environments (Vermeulen *et al*., 2003).

It is important to note here that most of the empirical studies on the influences of innovation have been carried out in industrialized developed countries; using such findings to describe the innovative behavior in countries with a less-developed technological base is likely to be inappropriate (Charoenporn, 2005). Specifically, the research investigated the influence of entrepreneurial determinants and external business incubator resources to the product innovation of software start-ups in Thailand. Overall, the results of this study will contribute to the understanding of entrepreneurial innovation that the governments in developing countries seek to boost, especially in the local technology industry. Policymakers can make a more informed decision when supporting the incubated entrepreneurs.

LITERATURE REVIEW

Product innovation: Even if it is possible for a firm to be more competitive in cost and differentiation (service or quality), firms need to innovate at least on occasion to gain a competitive advantage (Vermeulen *et al*., 2003). To achieve this advantage as a small firm, the key prerequisite lies in new technologies or product innovations for both new and existing markets. 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 measured as innovative output (InnoOut) and innovative performance (InnoPer).

Innovative output: The main objective of entrepreneurs participating in innovation is to have results in innovation output (InnoOut). Various indicators measuring innovative output have been described in the literature, such as (1) The number of patents, (2) New product announcements and (3) Degree of newness of new products, typically referred to as the degree of innovation (Garcia and Calantone, 2002; Romijn and Albaladejo, 2002; Vermeulen *et al*., 2003; Weterings and Koster, 2007). Degree of innovation is a good indicator for innovative output as both "number of patents" and "new product announcements" are unsatisfactory for measuring firms' innovation in business services, including the software industry. These firms do not have a R and D department (Weterings and Koster, 2007) and most software firms tend to modify their product to meet their customers' needs which makes products difficult to patent (Vermeulen *et al*., 2003).

Innovative performance: Innovative performance (InnoPer), represented as how much value or achievement can be created after the innovation, is used to reflect the broadest definition of innovation that most measures of innovation are incomplete (Linder, 2006). Indicators for innovative performance can consist of multiple dimensions, such as profitability, survival, productivity and satisfaction (Berthelot, 2008). Nevertheless, in this empirical research, profitable growth will be employed as it has been cited as the most important indication of new venture success (Hmieleski and Ensley, 2007) and is often used to capture venture performance in the entrepreneurship literature to date (Berthelot, 2008).

Entrepreneurial personality: Studying entrepreneurial personality is likely to identify differences between entrepreneurs and non-entrepreneurs. Moreover, entrepreneurial studies have demonstrated that entrepreneurs are significantly more innovative than non-entrepreneurs (Ho and Koh, 1992; Robinson and Sexton, 1994). Three main entrepreneurial personalities have

been identified as the key recurring traits in the entrepreneurship literature (Ahmad, 2010; Berthelot, 2008): (1) Need for achievement, (2) Locus of control and (3) Risk-taking propensity. These traits were represented as the entrepreneurial personalities in this study.

Need for achievement: The concept of need for achievement (nAch) has been extensively studied in entrepreneurship (Johnson, 1990; Shane *et al*., 2003) because it is a key characteristic of individuals who strive to excel in all activities, regardless of the obstacles that need to be faced (Berthelot, 2008). As entrepreneurs often face great obstacles (Markman and Baron, 2003), nAch is an important entrepreneurial personality for a successful entrepreneur. Shane *et al*. (2003) concluded that McClelland (1961) work found that individuals high in nAch enjoy challenging activities or tasks that have a high degree of individual responsibility for outcomes and include clear feedback on performance. McClelland (1961) further argued that people high in nAch will be more likely to pursue entrepreneurial jobs than other types of roles (Shane *et al*., 2003). Overall, the findings suggest that nAch is significantly related to firm founding (Collins *et al*., 2004) and entrepreneurial activity (Johnson, 1990; Sagie and Elizur, 1999). In addition, nAch plays a critical role in explaining entrepreneurial activities, especially venture performance (Lee and Tsang, 2001). Thus, based on prior research, the following hypotheses are proposed:

- **Hypothesis 1a:** Need for achievement (nAch) positively influences the innovative output of incubated software start-ups
- **Hypothesis 1b:** Need for achievement (nAch) positively influences the innovative performance of incubated software start-ups

Locus of control: Locus of control (Loc) is the belief that individuals' actions or personal characteristics affect outcomes (Shane *et al*., 2003). People with a high internal locus of control believe they have an influence over the outcomes of their actions, whereas individuals with an external locus of control believe that the outcome of an extent is within the hands of fate and destiny (Berthelot, 2008; Shane *et al*., 2003). Entrepreneurs are usually oriented toward an internal locus of control (Korunka *et al*., 2003; Shane *et al*., 2003; Vecchio, 2003) because they desire positions from which their actions have a direct impact on results (Shane *et al*., 2003). This fact even crosses cultural boundaries (Bonnett and Furnham, 1991). Nevertheless, there is only limited evidence relating locus of control to being an entrepreneur or leading to venture performance (Berthelot, 2008). Very few studies have noted the internal locus of control in a frame of innovation. Lee and Tsang (2001) found internal locus of control to be significantly related to venture growth for medium firms among Singaporean entrepreneurs. To briefly summarize the arguments, the following hypotheses are proposed:

- **Hypothesis 2a:** Locus of control (Loc) positively influences the innovative output of incubated software start-ups
- **Hypothesis 2b:** Locus of control (Loc) positively influences the innovative performance of incubated software start-ups

Risk-taking propensity: When engaging in business ventures, individuals might face the high uncertainty or potential losses in decision-making situations. Risk-taking propensity (Rtp), a relatively stable characteristic that can be modified through experience, describes an individual's disposition and tendency to take or avoid risks (Akinbobola and Ehigie, 2010). Shane *et al*. (2003)

claimed from several recent evaluative studies that firm founders objectively have a high propensity for risk compared to the general population but that firm founders do not perceive their actions as risky. Begley (1995) found that risk-taking propensity was the only trait on which founders and non-founders differed. Nevertheless, previous empirical studies demonstrated that this risk-taking characteristic showed inconclusive influence to the venture performance (Vecchio, 2003). Entrepreneurs might have a different perception of risk and do not report high levels of risk-taking propensity because they do not perceive themselves as risk-takers-that is, entrepreneurs might exploit opportunities that they see as safe while others would perceive these same opportunities as risky (Berthelot, 2008). According to the reviewed literature, the third set of hypotheses can be as follows:

- **Hypothesis 3a:** Risk-taking propensity (Rtp) positively influences the innovative output of incubated software start-ups
- **Hypothesis 3b:** Risk-taking propensity (Rtp) positively influences the innovative performance of incubated software start-ups

Technological opportunity: Innovation, in many aspects, is often underestimated and is limited to the notion of technological innovation and R and D. Innovation is the combination of technology with the market's need to create a profitable opportunity (Trott, 2002). The concept of technological opportunity is associated with underlying sciences and technologies that firms use as the sources of technical progress during innovation. Thus, firms that study such kinds of opportunities are not only able to adapt and survive but create flexibility to deal with uncertainty. Technological opportunities are categorized into industrial technological opportunity (Ito) and non-industrial technological opportunity (Nito).

Industrial technological opportunity: Industrial technological opportunity (Ito) linking to the interaction of external sources has increasingly become an essential factor for the ability to innovate. Opportunity sources within the industry, such as suppliers, competitors, or users of goods and services might provide updated technologies and market information. This opportunity can be formed as collaboration in order to rapidly access vital external resources (Katila and Mang, 2003). As such it can be hypothesized from the literature that:

- **Hypothesis 4a:** Industrial technological opportunity (Ito) positively influences the innovative output of incubated software start-ups
- **Hypothesis 4b:** Industrial technological opportunity (Ito) positively influences the innovative performance of incubated software start-ups

Non-industrial technological opportunity: Non-industrial technological opportunity (Nito) can be acquired from sources such as universities, research centers, government agencies and trade associations. These institutions can provide missing external inputs into the learning process, such as external staff training, parts and components, consulting services and R and D grants, that the firm itself cannot (easily) provide (Romijn and Albaladejo, 2002). Thus, the role of non-industrial technological opportunity (Nito) can be hypothesized as follows:

- **Hypothesis 5a:** Non-Industrial technological opportunity (Nito) positively influences the innovative output of incubated software start-ups

- **Hypothesis 5b:** Non-Industrial technological opportunity (Nito) positively influences the innovative performance of incubated software start-ups

Business incubator resources: It is particularly important to those industrialized economies in which successful new small high-technology firms served as a critical role in the development of local, regional and national economies through the creation of jobs and the generation of profits. Innovations are encouraged in their start-up stage (Scillitoe and Chakrabarti, 2010). Therefore, business incubators are created to provide an infrastructure of technical, logistic and administrative supports that a young firm needs in the process of struggling to gain a foothold in a competitive market (Guy, 1996). It is also widely believed that a business incubator can provide a nurturing environment for new business start-ups (Mian, 1996), thereby accelerating the development and success of affiliated ventures to achieve economic development goals (Hansen *et al*., 2000; Mian, 1996; Abetti, 2004). This research studied two specific and important types of services that tenant firms can gain for their innovation and business-namely, (1) Incubator technological resources and (2) Incubator business development resources.

Incubator technological resources: Most incubators do not focus conspicuously on physical space (Ratinho and Henriques, 2010) but rather emphasize the effective combination of value-added services. Incubator technological resources (Itr) feature the following services: Access to university research activity and technologies; laboratory and workshop space and facilities; industry contacts; technology transfer processes; research and technology supply pipelines; intellectual property protection and technological knowhow skills (Scillitoe and Chakrabarti, 2010). These supports have been identified as important intermediary outcomes for the incubator technological resources. Thus, based on prior research, this study proposes the following:

- **Hypothesis 6a:** Incubator technological resources (Itr) positively influence the innovative output of incubated software start-ups
- **Hypothesis 6b:** Incubator technological resources (Itr) positively influence the innovative performance of incubated software start-ups

Incubator business development resources: Nascent technology-intensive firms typically lack business experience and marketing skills and, therefore, might have limited chances for survival (Bruneel *et al*., 2012). Incubator business development resources (Ibdr) are intended to offer successful development and sustainable growth for those start-ups. Incubator business development resources include business planning, tax assistance, personnel recruiting, marketing, management, accounting, general legal expertise, accessing financial capital and business networking (Chan and Lau, 2005; Scillitoe and Chakrabarti, 2010). Based on these studies, the following hypotheses are proposed:

- **Hypothesis 7a:** Incubator business development resources (Ibdr) positively influence the innovative output of incubated software start-ups
- **Hypothesis 7b:** Incubator business development resources (Ibdr) positively influence the innovative performance of incubated software start-ups

MATERIALS AND METHODS

Sample and data: The business incubation centers of the software parks located in central, northern, northeast and southern Thailand supported the study by distributing electronic surveys to measure the product innovation of software start-ups that participated in the incubation program from 2010 to 2012. The incubation centers provided a contact list of 420 start-ups; 380 electronic replies (90.48%) were received.

The dataset was a good match for the study because the fundamental prerequisites for start-ups joining the incubated program of the software industry in Thailand are that (1) Independent entrepreneur(s) came up with a business idea and sought to develop, improve and sell software and (2) The entrepreneur(s) had no experience; however, in cases where the entrepreneur(s) had already set up the firm, the firm had to be independent start-ups rather than incumbent-backed firms with no more than three years of experience in this business. These prerequisites imply that a firm's size and age are systematically controlled in the study. To join the incubation program, software developers willing to be entrepreneurs have to pass the selection process. The selection process identifies a potential idea and indicates how the firm could benefit from the incubator's services. The aim of the process is to select entrepreneurs willing to take advice and share information as well as contribute to a positive atmosphere of entrepreneurial support within the incubator (Cammarata, 2003).

Vermeulen *et al.* (2003) mentioned that venture performance in terms of returns (sales/profit) is not commonly employed in research on small and medium-sized firms because the financial performance of these firms is not publicly available. However, through the acknowledgement of the non-disclosure agreement between incubation centers and entrepreneurs it was found that these data were a good match to the research purpose. During the selection process, the incubator centers gain each company's commitment to provide revenues, investment, employment and other necessary data throughout the incubation period (Cammarata, 2003) and for at least two years thereafter in the case of the incubation centers in software parks in Thailand. The software business incubator provides workspaces and supportive environments to software developers during their start-up and the early stages of their business. Program participants can select either "in-wall incubation", where the incubatee sets up the firm in the center, or "out-wall incubation", where the incubatee sets up or has already set up the firm outside the center. Although software developers can work anywhere with their computers and internet access, all of the incubatees are required to attend the prerequisite courses and training arranged by the incubation center. Courses and training include entrepreneurship courses, business training, product and services training and software development standards.

Variables and model of the study

Variables: The innovation output was measured by degree of newness of new products or degree of innovation. This indicator was categorized as three possible values: 0 if the firm did not introduce any new or improved products into the market; 1 if the product introduced to the market in that period was new to the firm and 2 if the product introduced was new to the market (Vega-Jurado *et al.*, 2008; Romijn and Albaladejo, 2002; De Jong and Vermeulen, 2006). In addition, the innovative performance in the study was indicated by the growth profit (%) of the new product (Hmieleski and Ensley, 2007).

As proposed by Berthelot (2008), need for achievement (nArch), locus of control (Loc) and risk-taking propensity (Rtp) were classified according to a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). These include 5 items for need of achievement, 8 for locus

of control and 4 for risk-taking propensity. Industrial and non-industrial technological opportunities were identified using 5-point scales proposed by Vega-Jurado *et al.* (2008). In addition, the indicators of incubator technological resources (Itr) and business development resources (Ibdr) were adapted from Meru and Struwig (2011) and developed by the authors for the 5-point Likert scale.

Model of the study: The study used Ordinary Least Squares (OLS) regression model to estimate the determinants of the product innovation for incubated software entrepreneurs. Product innovation can be measured using innovative output (InnoOut) and innovation performance (InnoPer). All independent variables were tested separately using Eq. 1 for InnoOut and Eq. 2 for InnoPer. These two models depict a broader range of understanding in the product innovation. The entrepreneurs started their businesses with new ideas that subsequently became new products/services. This might represent a high degree of innovation due to fact that the products are new to the market or even the world. However, the entrepreneurs might generate limited profits because of high investments (operation cost, employees, etc.) or the loss of profits in the market (high price, technology changes, etc.). Inevitably, product innovation is represented by innovation output and innovative performance in this study using the following models:

$$\text{InnoOut} = \alpha_1+\beta_1(\text{nAch})+\beta_2(\text{Loc})+\beta_3(\text{Rtp})+\beta_4(\text{Ito})+\beta_5(\text{Nito})+\beta_6(\text{Itr})+\beta_7(\text{Ibdr}) \quad (1)$$

$$\text{InnoPer} = \alpha_2+\beta_8(\text{nAch})+\beta_9(\text{Loc})+\beta_{10}(\text{Rtp})+\beta_{11}(\text{Ito})+\beta_{12}(\text{Nito})+\beta_{13}(\text{Itr})+\beta_{14}(\text{Ibdr}) \quad (2)$$

Where:

InnoOut	=	Innovative output of the software-incubated start-ups
InnoPer	=	Innovative performance of the software-incubated start-up
nAch	=	need of achievement
Loc	=	Locus of control
Rtp	=	Risk-taking propensity
Ito	=	Industrial technological opportunity
Nito	=	Non-industrial technological opportunity
Itr	=	Incubator technological resources
Ibdr	=	Incubator business development resources

RESULTS

The regression results shown in Table 1 are the standardized β coefficient derived from each predicting variable, along with its significance, as well as the overall model information, such as the R-squared (R^2) and adjusted R^2.

Table 1: Regression on innovative output (InnoOut) and innovative performance (InnoPer) of software start-ups participating in the incubation program

Variable	Constant	nAch	Loc	Rtp	Ito	Nito	Itr	Ibdr	R^2	Adjusted R^2
InnoOut (β±S.E.)	-36.34±7.41**	0.08±1.19	5.55±1.35**	-1.20±0.99	5.28±1.24**	0.95±1.36	4.97±1.53**	10.56±1.15**	0.764	0.576
InnoPer (β±S.E.)	-84.11±10.92**	15.71±1.75**	7.45±1.99**	5.17±1.46**	-3.76±1.83*	8.85±2.00**	0-7.06±2.26**	-1.20±1.69	0.66	0.42

No. of observations = 380 **and *Indicate significance levels at 1 and 5%, respectively

For innovative output (Eq. 1), the results suggested that locus of control (Loc), industrial technological opportunity (Ito), incubator technological resources (Itr) and incubator business development resources (Ibdr) had a statistically positive influence on the innovative output of incubated software start-ups, thereby supporting H2a, H4a, H6a and H7a. Nevertheless, need of achievement (nAch), risk-taking propensity (Rtp) and non-industrial technological opportunity (Nito) had no statistically significance, rejecting H1a, H3a and H5a.

In addition, for innovative performance as stated in Eq. 2, need of achievement (nAch), locus of control (Loc), risk-taking propensity (Rtp) and non-industrial technological opportunity (Nito) had a statistically positive influence on the innovative performance of incubated software start-ups. Thus, the empirical results supported H1b, H2b, H3b and H5b. On the contrary, regarding H4b and H6b, industrial technological opportunity (Ito) and incubator technological resources (Itr) had a negative influence on innovative performance. Finally, incubator business development resources (Ibdr) had no statistical influence, thereby rejecting H7b.

DISCUSSION

The study provided evidence that certain behaviors of need for achievement (nAch) are directly associated with innovative performance, not innovative output. The finding related to nAch in terms of the positive impact on venture growth showed the same results as studied by Lee and Tsang (2001) among Chinese entrepreneurs in SME businesses in Singapore. In start-ups, entrepreneurs might focus on how to develop business and survive based on their existing products/services rather than innovating products or services.

The finding also provided strong empirical support for locus of control (Loc) to the innovative output and performance. Entrepreneurs with a high internal locus of control are inclined to undertake bold and imaginative strategic actions, such as innovation (Deligianni *et al*., 2010). The results suggested that entrepreneurs with a high internal locus of control will be influenced by their own efforts striving to find innovation for growth. In the context of business, innovation no longer results from chance activities but is determined by the individual's ability to dominate the business environment.

In addition, the results also suggested that risk-taking propensity (Rtp) had no effect on the innovative output of software firms; nevertheless it was strong when associated with innovative performance. This implied that entrepreneurs with particularly high-risk attitudes might survive or succeed in their business. On the contrary, Caliendo and Kritikos (2012) proposed that moderate risk-decision entrepreneurs, over the long term, have a tendency to survive and succeed in their business. These inconsistent conclusions arise from business and marketing objectives that vary from business to business.

Industrial technological opportunity (Ito) had a strong positive relationship with the innovation output. On the contrary, Vega-Jurado *et al*. (2008) argued that, for science-based firms, industrial technological opportunity lost all explanatory power and only non-industrial opportunities exercised a significant influence on the firm's innovation. This inconsistency might be related to different industries and business strategies needed for software market. The empirical results also showed that Ito had a negative influence on the innovative performance. This finding concurs with Chan and Lau (2005) findings that cooperation within the industry is not preferred by founders of technology start-ups because, first, they are usually technology experts who already have sufficient background and knowledge used for their internal development and, second, they might afraid that the product technology would be stolen by outsiders (Chan and Lau, 2005).

When facing non-industrial technological opportunity (Nito), the incubated-software entrepreneurs only had a strong tendency for the innovative performance. On the contrary, Temel *et al.* (2013) proposed that cooperating with consultants and private labs seems to negatively affect innovation performance. These contradictory results might be from the geographical perspective and because the government policy in Thailand encourages local institutes and universities to purchase products/services from the incubated start-ups.

The findings revealed that the incubator technological resources (Itr) have two significant influences on innovative start-ups. First Itr had a strong positive effect on innovative output. This result is consistent with Khalil and Olafsen (2010) argument for the World Bank's study. Second itr had a negative influence on innovative performance. This finding implies that incubatees' belief in the incubator technological resources, such as software or technical training, might be outdated and inconsistent with the market requirements. If they employ such incubator resources, the profits from their new products/services would decrease accordingly.

For incubator business development resources (Ibdr), the empirical results also showed a relationship with innovative output only. Incubated firms need business development assistance-in particular, marketing assistance from the incubator (Scillitoe and Chakrabarti, 2010). They have a tendency to focus on perfecting their product or service and run out of time and money before getting to the market successfully. Thus, infusing an understanding of buyers' needs during the early stages of product or service development via marketing assistance can increase the potential success of the venture (Scillitoe and Chakrabarti, 2010).

Overall, the results of this study contributed to the key role played by the incubation center in fostering entrepreneurs capable of running their business and developing their innovative products/services. Thus, based on the research findings, practical managerial implications with respect to incubation centers are as follows. First, as incubatees' personalities have a strong influence on product innovation, the incubation center should arrange "entrepreneurial mindsets coaching", such as conducting inspiration sessions where successful alumni of incubatees can share their own success stories to inspire new incubatees to build self-image and ignite passions in order to access incubatee personalities' hidden value. Second, based on the negative effect of the industrial technological opportunity to the innovative performance, the entrepreneurs might be afraid of confidential information or know-how leakage during the product development phase. Thus, the incubation center should pay more attention to the current approach of supporting industrial cooperation to start-ups. Apart from creating a flourishing environment, the incubator should seek to increase trust and openness by promoting "norms-based" intellectual property in the software IT industry in Thailand. Third, the negative influence of incubator technological resources implied that incubatees' beliefs in the outdated and market-inconsistent software or technical training would limit their profits. Thus, the incubator should update the technology available by providing the latest technological resources to the incubatees. If the available resources are already up to date and comparable with changing market, the incubator center should publicize this information and ensure that incubatees are well aware of this information.

CONCLUSION

The aim of this study was to examine the determinants of product innovation in the incubated software start-ups in Thailand. The study focused on the main contributions-namely, entrepreneurial personality (need of achievement; locus of control; risk-taking propensity), technological opportunity (industrial technological opportunity and non-industrial technical

opportunity) and incubation center resources provided to those nascent firms (incubator technological resources and business development resources). In searching for the determinants of entrepreneurial innovation among many studies, this empirical research would support a broader range of understanding to the start-ups' innovation in the high technology industry, especially within the context of an Asian country such as Thailand.

The regression analysis showed that innovative output is significantly related to the locus of control, industrial technological opportunity, incubator technological and business development resources. In addition, all determinants were found to be significantly related to the innovative performance, except for the incubator business development resource.

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