รายงานวิจัยฉบับสมบูรณ์

โครงการ การศึกษาผลกระทบของการพัฒนาเทคโนโลยีที่มีต่อความสัมพันธ์ระหว่างการพัฒนากลยุทธ์และการวางแผนของธุรกิจและการพัฒนาผลิตภัณฑ์ใหม่ของกลุ่มธุรกิจขนาดย่อม ในประเทศไทย

โดย

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เอกสารแนบหมายเลข 1

สัญญาเลขที่ TRG4580079

รายงานวิจัยฉบับสมบูรณ์

โครงการ การศึกษาผลกระทบของการพัฒนาเทคโนโลยีที่มีต่อความสัมพันธ์ระหว่างการพัฒนากลยุทธ์และการวางแผนของธุรกิจและการพัฒนาผลิตภัณฑ์ใหม่ของกลุ่มธุรกิจขนาดย่อม ในประเทศ

ดร. จิตติภางามเกริกโชติ มหาวิทยาลัยอัสสัมชัญ

สนับสนุนโดยสำนักงานกองทุนสนับสนุนการวิจัย

(ความเห็นในรายงานนี้เป็นของผู้วิจัย สกว. ไม่จำเป็นต้องเป็นเสมอไป)

กิตติกรรมประกาศ

นักวิจัยพี่เลี้ยง

ผู้วิจัยในโครงการ TRF4580079 ต้องการขอขอบคุณนักวิจัยพี่เลี้ยง Dr. Mark W. Speece จากสถาบันเทคโนโลยีแห่งเอเชีย ประเทศไทย ที่ได้ให้คำแนะนำและสนับสนุนงานวิจัยนี้อย่างสม่ำเสมอ ตั้งแต่เริ่มต้นโครงการจนกระทั่งจบ รวมเวลาประมาณ 2 ปี

ภาครัฐ

ผู้วิจัยในโครงการ TRF4580079 ต้องการขอขอบคุณหน่วยงานและตัวแทนหรือเจ้าหน้าที่ที่ปฏิบัติงานในภาครัฐที่ได้ให้ความร่วมมือเป็นอย่างดีมาก เช่น สถาบันอาหารแห่งประเทศไทย ภาควิชาวิทยาศาสตร์และเทคโนโลยีการอาหาร คณะอุตสาหกรรมเกษตรมหาวิทยาลัยเกษตรศาสตร์ ศูนย์เทคโนโลยีอิเลคทรอนิกส์และคอมพิวเตอร์แห่งชาติ สมาคมวิทยาศาสตร์อาหารและเทคโนโลยีทางอาหารแห่งประเทศไทย

ภาคเอกชน

ผู้วิจัยในโครงการ TRF4580079 ต้องการขอขอบคุณหน่วยภาคเอกชนและตัวแทนหรือเจ้าหน้าที่ที่ปฏิบัติงานในภาคเอกชนที่ได้ให้ความร่วมมือเป็นอย่างดีมาก เช่น ห้างสรรพสินค้าเซ็นทรัล สาขาสีลม ห้างสรรพสินค้าเดอะมอลล์ สาขาท่าพระ ที่อนุญาติให้ความร่วมมือในการแจกแบบสอบถาม รวมทั้งบริษัทผู้ไม่ประสงค์ออกนาม ที่อนุญาติให้ความร่วมมือในการให้ข้อมูลจากการสัมภาษณ์ทั้งหมด

มหาวิทยาลัยอัสสัมชัญ

ผู้วิจัยในโครงการ TRF4580079 ต้องการขอขอบคุณ คณบดี รองคณบดี ผู้อำนวยการบัณฑิตวิทยาลัย และ เจ้าหน้าที่ที่เกี่ยวข้องในบัณฑิตวิทยาลัยทุกคน ที่ให้ความร่วมมือเป็นอย่างดีมากในการทำวิจัยครั้งนี้

ครอบครัว

ผู้วิจัยในโครงการ TRF4580079 ต้องการขอขอบคุณ คุณแม่ นางศิริกุล งามเกริกโชติ ที่เป็นกำลังใจให้ผู้วิจัยมาโดยตลอด

รหัสโครงการ: TRG4580079

ชื่อโครงการ: การศึกษาผลกระทบของการพัฒนาเทคโนโลยีที่มีต่อความสัมพันธ์ระหว่างการพัฒนากลยุทธ์และการวางแผนของธุรกิจและการพัฒนาผลิตภัณฑ์ใหม่ของธุรกิจ SMEs ในประเทศไทย

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งานวิจัยชิ้นนี้เป็นการตรวจสอบความสัมพันธ์ของ การพัฒนากลยุทธ์การเปลี่ยนแปลงสิ่งแวดล้อมทางธุรกิจ กลยุทธ์เทคโนโลยี การเปลี่ยนแปลงทางเทคโนโลยี และการพัฒนาผลิตภัณฑ์ใหม่ ของอุตสาหกรรมอาหารขนาดย่อมในประเทศไทย ส่วนหนึ่งของผลงานวิจัยเป็นการพัฒนาและตรวจสอบแบบจำลอง อย่างไรก็ตาม ก่อนจะกำหนดการเลือกบริษัทตัวอย่าง ได้มีการสัมภาษณ์ผู้เชี่ยวชาญ 11 คนจาก 4 สถาบัน ได้แก่ สถาบันอาหารแห่งประเทศไทย ภาควิชาวิทยาศาสตร์และเทคโนโลยีการอาหาร คณะอุตสาหกรรมเกษตรมหาวิทยาลัยเกษตรศาสตร์ ศูนย์เทคโนโลยีอิเลคทรอนิกส์และคอมพิวเตอร์แห่งชาติ สมาคมวิทยาศาสตร์อาหารและเทคโนโลยีทางอาหารแห่งประเทศไทย เพื่อค้นหาข้อกำหนดในการพัฒนาผลิตภัณฑ์ใหม่ให้ประสบความสำเร็จ ขั้นตอนที่ 1 เป็นการสัมภาษณ์ 3 บริษัทที่ประสบความสำเร็จในการพัฒนาผลิตภัณฑ์ใหม่โดยคัดเลือกจากคำแนะนำของผู้เชี่ยวชาญดังกล่าวข้างต้น เพื่อวิเคราะห์บทบาทของการเปลี่ยนแปลงสิ่งแวดล้อมทางธุรกิจ กลยุทธ์เทคโนโลยี การเปลี่ยนแปลงทางเทคโนโลยี ที่มีต่อการพัฒนาผลิตภัณฑ์ใหม่เพื่อการส่งออกให้ประสบความสำเร็จ ขั้นตอนที่ 2 การวิเคราะห์ข้อมูลเชิงคุณภาพ โดยสัมภาษณ์บริษัทที่ไม่ประสบความความสำเร็จในการพัฒนาผลิตภัณฑ์ใหม่เพิ่มอีก 3 บริษัท เพื่อกำหนดรายละเอียดของตัวแปร ซึ่งจะนำไปใช้ในการสร้างแบบจำลอง ผู้ให้สัมภาษณ์ทั้ง 11 ท่าน โดยที่แต่ละท่านมีตำแหน่งเป็นเจ้าของ กรรมการผู้จัดการ และผู้จัดการอาวุโสตามแผนกต่างๆ ได้แก่ การตลาด การผลิต และการวิจัยจาก 6 บริษัทขนาดย่อม ขั้นตอนที่ 3 การวิเคราะห์ข้อมูลเชิงปริมาณ โดยได้รับแบบสอบถามเป็นจำนวน 154 ชุดจากบริษัทขนาดย่อม ซึ่งนับเป็น 23 เปอร์เซ็นต์ของจำนวนแบบสอบถามทั้งหมด ผลการศึกษาพบว่าบริษัทขนาดย่อมควรมีการพัฒนาการตรวจสอบการเปลี่ยนแปลงสิ่งแวดล้อมทางธุรกิจ เพื่อนำมาพัฒนาผลิตภัณฑ์ใหม่ที่เหมะสม บริษัทขนาดย่อมควรจะมีการตอบสนองการพัฒนาเทคโนโลยีเพื่อแข่งขันกับตลาดโลกได้ในอนาคต การขาดความระวังการเปลี่ยนแปลงเทคโนโลยีสามารถทำให้การพัฒนากลยุทธ์จากการเปลี่ยนแปลงสิ่งแวดล้อมทางธุรกิจล้มเหลว

คำหลัก: การพัฒนากลยุทธ์จากการเปลี่ยนแปลงสิ่งแวดล้อมทางธุรกิจ, กลยุทธ์เทคโนโลยี การเปลี่ยนแปลงทางเทคโนโลยี, การพัฒนาผลิตภัณฑ์ใหม่, อุตสาหกรรมอาหารขนาดย่อม, ประเทศไทย

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This research examines the relationship among environmental scanning, technology strategy, technology turbulence, and new product development in food processing SMEs in Thailand. A model has been developed and tested as an output of this study. Prior to determining which companies to use in the samples, in-depth interviews were conducted with five experts from the National Food Institute in Thailand, the Food Science and Technology faculty of Kasetsart University, Food Science and Technology Association of Thailand (FoSTAT), and National Electronics and Computer Technology Center (NECTEC) to determine criteria for identifying successful new product development in the food processing industry. Step 1: Multiple in-depth interviews within three companies chosen as case studies, supplemented with company documentation. Three successful NPD companies were analyzed to examine the role of environmental scanning and technology strategy in their NPD practices and how it contributed to export success. Step 2: Qualitative analysis using in-depth interviews with three companies successful in NPD, and another three SMEs which have been rather unsuccessful. The three factors of technology strategy, environmental scanning aspects, and new product development practice were defined in detail for the Thai context, and the feasibility of the working theoretical model was assessed. A total of eleven respondents across the six SMEs, who were owners, managing directors, senior managers from the marketing, production, and R&D departments were interviewed. Step 3: Quantitative analysis using mail survey to test the model. After several rounds of questionnaire development and testing, the questionnaire was sent and the survey obtained 154 responses from SMEs whose product is semi-processed and processed food, representing a 23 percent response rate. Study results indicate that SMEs need to continually practice environmental scanning to develop appropriate new food products. They should act strategically and react to technology developments as a fast follower in both new product development (NPD) and advances in production process to boost competitiveness of food products from Thai SMEs worldwide in the near future. Lack of awareness of turbulent changes of technology can cause failure in practices environmental scanning components on NPD.

Keywords: environmental scanning, technology strategy, technology turbulence, new product development, small- and medium-enterprise (SMEs), Thailand

INTRODUCTION

Hill and Jones (2004) stated that new product development (NPD), driven by customer needs is a major competitive advantage across tight functional integration. Small- and medium-enterprises (SMEs) in the Thai food industry has highly aware of such changes. For example, food producers are aware they need to increase their investment along with upgrading food safety standards demanded by European Union (EU) and the United States (The Nation newspaper, 2003). To sustain these competitive advantages in the global business, we need to know how much Thai SMEs practices their environmental scanning process.

Wheelen and Hunger (2004) stated that companies should consider societal environment as high strategic factors to specifically define opportunities and threats of their future growth. Changes of technology especially towards natural resource availability, part of societal environment, create a great impact on the food sector. In the South East Asian region, where a lot of environmental changes occurred, Thailand has to catch up with those changes by developing high skills especially of technology in order to successfully and globally developing new product.

However, little research has examined the influence of the level of technological changes on environmental scanning practices. This research defines level of technological changes clearly by technology strategy and technological turbulence. Therefore, a major part of this research investigates the impact of technology strategy and technological turbulence on environmental scanning practices of SMEs in the Thai food industry. In addition, the influence of environmental scanning practices is shown on new product development.

METHODOLOGY

There are total three major steps to collect primary information. Prior to step one, the *expert opinion method* was in practiced in order to define the meaning of successful of NPD and which companies in their point of view are succeeded in terms of NPD. In so doing, seven organizations, all of which are food-related organizations, were contacted for a face-to-face interview with their top executive and senior manager. Out of all the seven organizations, some belong to government whereas some are private. Prior to determining which companies to use in the samples, the pilot in-depth interviews were conducted with twelve experts to determine criteria for identifying successful new product development in the food processing industry.

Four out of seven organizations, the interviews were conducted with their president or director. Three interviews were conducted with a manager. All interviews were face-to-face conducted and based on

structured questionnaire, using *open-ended questions*. Interview lasted approximately from one to one and a half hour and was followed by specific questioning concerning different, but related topics. These questions helped better understanding of market overview both domestic and export as well as the current situation of food industry and NPD in Thailand. Since all interviews were conducted at exclusive locations (interviewees' office), interruptions could be minimized. After completion of all interviews, lists of companies in stage 1 was developed.

Primary data was collected in three steps shown as the following: -

Step 1: Multiple in-depth interviews with *semi-structured questions* with three case studies chosen as case studies, supplemented with company documentation. These three successful NPD companies were analyzed to examine the role of environmental scanning, technology strategy, and technology turbulence in their NPD practices.

Step 2: Another three unsuccessful NPD companies have been exposed through qualitative analysis using *in-depth interviews*. As a insightful result based on interview, the contrast and greater number of technological issues will be critically revealed. As such, the three factors of technology strategy, environmental scanning aspects, and new product development practice were defined in detail for the Thai context, and the feasibility of the working theoretical model was assessed. A total of eleven respondents across the six SMEs, who were owners, managing directors, senior managers, and assistant manager from marketing, production, and R&D departments were interviewed. Also, along with several follow-ups to obtain more information has been done to complete question during research process (Ngamkroeckjoti *et al.,* upcoming).

Step 3: Quantitative analysis using mail survey will be distributed to SMEs in Thailand to test, justify and compare the intensity of these factors application. The sample frame derived by the total population of SMEs lists from the National Food Industries (NFI) and Institute for Small and Medium enterprises Development (SMEs) in Thailand. In 2000, the total number of small and medium food companies are listed approximately 5,904 companies (Department of Industrial Works, Ministry of Industry). The sample will select from lists of food companies whose product is semi-processed or processed excluding ricemill. The random sample is based an analysis on 20 percent of response rate from the total 2,195 companies (Suwannaporn, P. and Speece, M., 2003). The mail survey listed covers the parent company and subsidiaries whose product focus only on semi-processed and processed food. Data collection period is listed in Table 1 shown in the next page. The pre-testing stage has been done in the first three days at the SMEs fair. Questionnaire is adjusted by cutting out the environmental scanning technique for analysis. Also, the word is rewritten to be more localized used language in order to make the audience more understandable. All questionnaires are decisively

distributed in Thai language. The actual response from the mail survey is only 9% because of changes of address, no receiver, and many businesses have been dissolved. Based on different organizer of exhibition, there is little problem of similar SMEs respondent in answering questionnaire. The reliability had been tested after the first 32 questionnaires at the SMEs fair conducted by Department of industrial promotion.

RESULTS, DISCUSSION, AND CONCLUSION

The case studies indicated that more extensive environmental scanning, coupled with a fast follower technology strategy, results in stronger market position both internationally and domestically. The in-depth interviews in Step 2 suggest that environmental scanning practices have an influence on NPD outcomes. Step 2 aims at understanding the relationships between the environmental scanning process and new product development by looking at the impact of technology strategy and technology turbulence. It focuses on only qualitative research, which is often viewed as appropriate for exploratory purposes. However, several constraints may limit the results of his study. Only eleven persons were interviewed in this study. While small sample qualitative interviews are often the best way to explore concepts, additional research with a greater number of respondents is needed to confirm results and statistically test the proposed model more thoroughly. The qualitative work shows that it is feasible, but larger scale quantitative research is necessary to demonstrate the statistical relationships.

While this research shows that SMEs can be quite proactive in technology strategy, use environmental scanning well, and have very good NPD, they rarely have sufficient resources to do it exactly they way large companies with more resources do. In the food sector in Thailand, this includes linking market and sensory information generated by the consumers, and identifying desired product attributes required by specific target markets. How to best keep track of technological developments is somewhat problematic, however. Supplier linkages are somewhat weak in the Thai food processing industry (Suwannaporn and Speece, 2003).

NPD remains a key competitive advantage issue for some SMEs in the food industry as they enter an increasingly competitive and turbulent environment locally and internationally with technology changing rapidly. This research has shown that the interviewees recognize the importance of environmental scanning practice to the NPD for their growth and survival. Moreover, SMEs who are capable of being fast follower in technology strategy view long term prospective for planning. This means that they scan not only to achieve sales target but also to assess long-term demand. Their successful new product development for market expansion in the form of joint ventures and franchising requires them to scan the appropriate environmental factors in order to identify the issues of industrial market on

time. They need to scan rapid information flow from the appropriate sources of information. Thus, companies need to define clearly their environmental scanning objectives, factors, and sources of information in order to successfully design and launch new products into the market (Ngamkroeckjoti, 2000).

Finally, the qualitative results suggest that SMEs who continually practice of environmental scanning have potential to be successful in developing new products. Moreover, more proactive technology strategy leads SMEs to implement better environmental scanning process – environmental scanning seems to be a necessary element of very proactive technology strategy. Likewise, a higher degree of technology turbulence probably forces company that use environmental scanning to use it more to remain competitive.

Through quantitative methodology, this research examines the three relationships: 1) technology strategy and environmental scanning; 2) technology turbulence and environmental scanning; and 3) environmental scanning and new product development. Only two relationships show the significance. The first is the relationship between technology turbulence and environmental scanning. The more rapidly turbulent changes of technology lead companies to use environmental scanning more extensively. Also, these changes caused scanning different components of environmental scanning aspects. The second relationship between environmental scanning and new product development is significant. Companies should scan environment, thus key issues is exactly what components of environment they should focus on.

There is an insignificant relationship between technology strategy and environmental scanning practices. However, after adjust scale measurement more properly, there is needed to further test this relationship again.

Environmental Scanning, Technology Strategy, and New Product Development among SME Exporters in Thailand

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Environmental Scanning, Technology Strategy, and New Product Development among SME Exporters in Thailand

Abstract

Evolving consumption patterns in Asian markets has activated stiffer competition among Thai small and medium enterprises (SMEs), who export. One area in which they are working to upgrade competitiveness is in developing new products for Asian markets. Most SMEs need some kind of environmental scanning process to develop new foods and textures, in order to keep up with changes of consumption behavior. The need to be competitive runs through the whole production process in terms of various forms and texture of food. For example, companies try to produce whiter rice, more hygienic foods, fresher but longer shelf life, softer forms of many food products, or more flexibly shapes and forms to suit local needs in export markets. Since Thailand has one of the world's major agribusiness industries, cooperation for technology transfer with other Asian countries, particularly Japan is important in developing new products. This research looks at the use of environmental scanning in new product development to examine the impact of technology strategy of SMEs in Thailand.

Key words: environmental scanning, technology strategy, new product development, SME exporters, Thailand

Introduction: SMEs and innovation

Small and medium enterprises (SMEs) play an important role in the Thai economy, as is the case in many countries of the developing world. In many countries, SMEs are leaders of growth and technology innovation (Boonritmontri, 2001). However, SMEs in less developed countries are often more traditional and do not contribute much to technology innovation and new product development (NPD). Instead, they often play a role of follower, frequently contributing little to technology development, so that their "new" products are not really anything new to the market or to customers.

SMEs need to develop better understanding of how and when NPD works well under conditions of changing external environmental factors so that they can improve NPD performance. They will need to be competitive in every aspect including innovation of NPD in order to prosper in a globalized economy.

Environmental scanning is one way to keep up with environmental changes relevant to the company's competitiveness.

Environmental scanning activities within an organization evolve continuously as a result of volatility in the business environment and the diverse nature of businesses. In the case of SMEs, both successful and unsuccessful business strategies have emerged in the past decade. One of many successful strategies is to design and launch new products or services into the market. Successful companies that have designed and launched new products or services should have efficiently scanned and successfully caught the trend of environmental changes (Ahituv *et al,* 1998).

However, all these new products or services may extensively use advanced technology as a factor in achieving target performance in the designing and launching process. Therefore, technology and the approach toward strategic implementation of technology is an important strategic factor that helps firms to capture niche markets when successful scanning has been done under turbulent changes of environment. In particular, technology strategy probably influences the strength of the relationship between environmental scanning and new product performance (Figure 1).

This study builds on work arguing that environmental scanning is important for successful implementation of NPD (Ahituv *et al.*, 1998). In addition, several works have defined the relationship between technology strategies and new product performance (Zahra *et al.,* 1994; Ryan, 1996; Sharif, 1994; Zahra and Bogner, 1997). Presumably, technology strategies may have an influence on the relationship between environmental scanning and NPD. Even though changes of technological factors are one aspect monitored in the environmental scanning process, a major issue remains of how technology strategy may play a role in the use of environmental scanning in NPD (Moorman and Miner, 1997).

Thailand is a representative context – it is a middle-income developing country with a strong SME sector, but still partially shielded from competitive pressure in the global economy. Currently, some of the biggest challenges Thai SMEs faces regard access to management expertise, capital, information, and technology (Bangkok Post, 2002). Thus, the importance of better conceptual understanding about environmental scanning, technology strategy, and NPD is matched by the critical managerial need for SME to be well-prepared for the very dynamic and very competitive conditions in world markets. Further, other developing Asian countries may be able to follow a Thai model if Thai SMEs learn how to thrive. Nguyen *et al.* (2001), for example, found that Vietnamese entrepreneurs will be more proactive with a lead example of successful innovativeness. Thus, we investigate these issues in Thai SMEs in the processed food industry, a sector, which is strong in Thailand.

Food Industry SMEs

The Thai government established SME policies more than 25 years ago, viewing SMEs as a critical element in long-term economic growth. Wiboonchutikula (2001) shows that during the period 1987-1996, SMEs participated in the sustained growth, creating jobs and becoming important suppliers to larger firms. Since 1997, many look to SMEs as the primary source of economic recovery. The food industry is one of thirteen industrial focuses for economic growth, according to the Thai Federal Trade Industry (2001). According to one estimate, eighty-eight percent of all registered SMEs are in the food sector (Thai German Business Development Services and Networks, 2000), and food and beverage SME producers account for forty-two percent of factories (HKTDC, 2002). Average size, however, is small, with the food and beverage industry accounting for only twelve percent of total investment and fourteen percent of total employment.

Over the past two decades, Thai SMEs have emerged as important exporters, similarly to trends in many other countries. In more advanced countries, the SMEs have had to keep up with product and process technology, R&D, and knowledge of market demand patterns and export regulatory systems. Some prior research shows that SMEs have committed resources, skills, experience, and attitudes towards exports in Australia and UK (Phlip, 1998; Baldacchino, 2002). They are paying attention to a number of external environmental factors in UK such as changes in technical standards and regulations, increased competition in domestic markets, and increased export opportunities (Smallbone *et al.,* 1996).

Keeping up with environmental conditions is critical for food SMEs. Cumbers (1995) showed that a new regulatory regime in the UK food industry relating to production process and transport resulted in increased fixed costs, which disproportionately fell on smaller firms. Holt and Henson (2000) found that food products achieved more reliability with implementation the Hygiene and Hazard Analysis Critical Control Point (HACCP) process. Similarly, Haugh (2000) examined attitudes and responses towards new European Union hygiene requirements, and recommended that SMEs should be more proactive toward legislative and regulatory changes. Hewitt-Dundas and Roper (1999) indicate that some SMEs in Northern Ireland's food industry use NPD as a competitive tool. We look at these issues of NPD, environmental scanning, and technology strategy in slightly more detail in the following sections.

New Product Performance

Results from several countries indicate that changes of environmental factors have an impact upon new product performance. In Thailand, Suwannaporn and Speece (2000) found that companies should be aware of changing environmental factors, particularly technology, because it helps companies to continue developing new products to increase their performance. In Japan, Song and Parry (1997a) focused more

on the relationship between the company's internal environment and external factors than on market-oriented activities, which drive new product success. The results indicate the effect of competitive environment, marketing synergy, and technical synergy in selecting the project. Companies that successfully introduced new products had good cross-functional integration, which facilitated incorporating information about competitive and market intelligence, marketing proficiency, and product competitive advantage.

In a cross-national comparative study of Japan and the USA about environmental factors that influence new product success, it was found that the key environmental factors were internal commitment, market potential and competitive intensity (Song and Parry, 1997b). Other research has also confirmed that decision-making incorporates perceived uncertainty about the environment. Under environmental turbulence, the greater memory dispersion detracted from creativity while reducing company performance. Various other types of perceived uncertainty about the environment have also been identified, including technological uncertainty, and uncertainties about marketing environments, such as consumer uncertainty, competitive uncertainty, and resource uncertainty (Moorman and Miner, 1997).

Environmental scanning

Prior research has found that strategic managers need to extensively scan changes in environmental factors to create corporate policies for both short- and long-term missions (Wheelen and Hunger, 2002). Moreover, Ahituv *et al.* (1998) suggested that whenever companies introduce new products into their market, environmental scanning is an important strategic planning process in helping managers to achieve their targeted performance. Successful companies will be more flexible in adapting their scanning to environmental changes; they scan the environment at a higher frequency to track competitors, customers, and technology sectors; and they look more for objective views provided by external information. Ultimately, they possess significantly more computerized marketing information than companies that do not scan or do not scan well.

From three case studies of international companies in Thailand, Ngamkroeckjoti and Johri (2000) found that local companies had restructured and periodically scanned environmental factors to match enterprise and industry characteristics, even before the 1997 economic crisis in Thailand. They concluded that international companies had successfully decentralized to regional and country offices to examine specific market factors. This allowed them to generate concrete perspectives about the future trends; and they could use capital and knowledge intensive advanced technologies to reduce environmental uncertainty. Furthermore, scanning sources of information of all firms are incorporated into the relationship with customers, suppliers, and many government agencies.

Beal (2000) examined the effects of the frequency in scope of environmental scanning on the alignment of environment and competitive strategy, using a sample of US small manufacturing firms in a wide variety of industries. The results suggest that managers of small businesses do collect information on external environmental sectors, particularly customers and competitors, in order to align corporate strategy. Moreover, firms in both growth and mature industries should scan various types of information in order to compete most effectively. Such information focuses on competitors and customers, independent of the strategy employed.

Technology strategies

Technology strategies can be defined in various dimensions. Most technology strategy research has looked at business strategies, corporate planning, and competitive or comparative advantages of enterprises (Zahra *et al.,* 1994; Ryan, 1996; Sharif, 1994 and 1997; Zahra and Bogner, 1997). Based purely on a literature review, Zahra *et al.* (1994) investigated the linkage among technology strategy, competitive strategy, and company performance. The study identified the competitive strategy of both content and process of technology to ensure successful company performance can be achieved.

In the US software industry, Zahra and Bogner (1999) examined the relationship between technology strategies and new venture performance (NVP). Superior NVP could be achieved with a formal technology strategy, which matched carefully between technological choices and external environments. In other words, the results suggest that the company can better forecast the impact of environmental forces on the venture's technology strategy choices when they use environmental scanning.

In Asian countries, particularly South Korea and Indonesia, Sharif (1994, 1997) defined technology strategy involvement as; technology leader, follower, exploiter and extender. Sharif also linked technology strategy classifications with business strategy in each stage of the business life cycle of enterprises. Under these circumstances, business strategies are determined as price leadership, quality leadership, feature leadership, and image leadership. He concludes that, to be a market leader, genuine progress of a strategic view of technology are: setting priorities, identifying what's most critical to the success of the enterprise, and focusing improvement efforts on technology capability for producing better-quality products at lower costs to the marketplace faster. He also suggests that all industrial enterprises of Indonesia need to actively adapt and manage technological changes better, if they are to be able to avoid being bypassed by other enterprises in the Southeast Asian region.

Later work by Shariff (1997), based on four case studies in South Korea and Indonesia, found that technological self-reliance is the most important strategic mission of a company in ensuring successful performance in the global market. He also recommends that enterprises in developing countries should

create competitive technology-based relative advantage relating to factor cost advantage. In doing so, a company may institutionalize strategic planning on how to reduce costs, improve quality, protect environment, add features, and shorten project cycle-times to enhance technological capabilities.

Ryan (1996) examined the importance of the relationship between technology strategy and corporate strategies within firms in Australian companies. He concludes that Australian firms must link technology to corporate policy and develop an understanding of technology strategy in terms of conceptual and analytical work. He indicates that technology strategy is an implicit context through all aspects of corporate policy. This means that innovation and leading-edge technology are a top priority in meeting customer requirements.

Research Objectives

Our research here aims at understanding how environmental scanning, NPD, and technology strategy fit together in the context of the Thai food processing industry, among SMEs who export to Asian markets. We might summarize the set of issues we will examine in Figure 1; specifically, we wish to

1) To examine the relationship between environmental scanning aspects and new product development in successful SMEs in Thailand;
2) To assess how technology strategy factors affect the relationship between environmental scanning and new product development in SMEs in Thailand;
3) To present recommendations for implementation of environmental scanning and technology strategy in SMEs, aiming to increase new product deveopment competencies.

*** Figure 1 about here ***

Research Methodology

The research methodology is based on multiple in-depth interviews within three companies chosen as case studies, supplemented with company documentation. Other work has shown that qualitative case study approaches work quite well for exploring details of how NPD works (e.g., de Weerd-Nederhof, 2001). Prior to determining which companies to use as case studies, in-depth interviews were conducted with five experts from food-related organizations in Thailand. One expert was from the National Food Institute in Thailand. Two were from the Food Science and Technology faculty of Kasetsart University, who also consults with industry. The last two experts were from the National Science and Technology Development Association of Thailand (NSTDA).

One key issue in these interviews was to set up selection criteria for what constitutes successful new product development in the food processing industry. Based on the experts' strong research

experience, specifically in NPD, one of the most common approaches that can indicate successful NPD is continuous on-the-shelf placement for at least six months to two years. This exact duration depends on product classification, raw materials, packaging, and the production process. Having determined criteria to identify which companies were successful at NPD, then the experts helped to identify three SMEs which were successful, which were representative of broader parts of the food processing industry, and where we would be able to gain good access.

The interview topic guidelines were developed from the information obtained from the pilot work with the experts, the literature review, and prior experience of the authors in conducting research among Thai companies on issues of environmental scanning and NPD. At least two persons were contacted for interviews in each company, and three in two of the companies where various roles in the new product development processes are well defined and separate. Finally, the main respondents consisted of eight people across the three SMEs, who were senior managers from the marketing, production, and research & development departments. The interview process actually consisted of an initial in-depth interview, about two hours in length, and shorter follow-up interviews to clarify issues.

In addition, there were a number of short, information gathering discussions with other staff in the companies when one of the senior managers referred us to them. Generally, however, these were for basic information, as most of these staff was not extensively involved in the strategic issues, which were the topic of the research. Most of the interviews / discussions were held in Thai, though some of the managers used English sometimes. All quotes that follow are translated from Thai by the first author of this paper.

Environmental scanning objectives

All three companies that were interviewed have successfully developed and launched new products to serve export markets by scanning for turbulent changes in the environment. The first interviewed company scanned to pioneer Konyac powder[1] development, as there is a great potential for growth in world markets, especially in Japan, based on Thai production.

Top executives have found a huge demand for imported Konyac in the Japanese market over the past ten years. Konyac, in the form of noodles is normally considered an important type of health food among Japanese consumers, much like rice and rice noodles. Top executives at the head office finalized the decision-making process in developing Konyac powder exported to Japanese market with the

[1] Konyac is an ingredient made from the root of the konnyaku plant. It can be used as a binding agent in many food products. It takes the place of gelatin in certain processed food products.

production based in Thailand. One of them summarized the attractions of the product by stating "Konyac contains glucomannan which is a natural dietary, calorie free, high fiber powder. Glucomannan suppresses appetite and contains no harmful drugs or stimulants. Moreover, glucomanan is effective for reducing total cholesterol." Glucomannan appears to reduce LDL ("bad") cholesterol and increase HDL ("good") cholestoerol. Studies have also found evidence that glucomannan can improve blood sugar control and lower blood pressure (Venter *et al.*, 1987; Doi, 1995; Vuksan *et al.*, 1999; Arvill and Bodin, 1995; Reffo *et al.*, 1990; Walsh *et al.,* 1990)

According to the executive, "we foresee a bright future for popular consumption of Konyac not only in Japan but also in worldwide markets including Thailand." They base their assessment on finding that popular market trends in Thailand seem to follow those of Japan, giving good opportunity for Konyac. World Health Organization research which they, for example, indicates that "Thai people reduced malnutrition significantly over the years and improved per capita food availability, mainly through broad ranging, integrated health and nutrition approaches with the involvement of local organizations." (Human Development Report, 1997). Moreover, the managing director of the company indicates that "Thai people, especially women, would most likely prefer Konyac as a component of a good natural, healthy consumption program."

In addition to huge market demand, top executives are willing to take greater risks because of the strong foundation of the company. Such strong foundation can be explained in terms of cost of capital and variety of in-house expertise to successfully develop Konyac in order to serve demand worldwide in the future. The company can finance product and market development costs from continuous long-term profit by exporting ginger to the Japanese and US markets. At the same time, experts, such as highly experienced mechanical engineers and food scientists can be obtained from local academic institutions and cooperating Japanese expatriates.

This can better explain the primary environmental scanning objective, which is to predict future driving forces affecting Konyac development in the company. Nevertheless, to start a long-term period in the local market, the company's environmental scanning objective has expanded to serve more of the local demand in Thailand by launching a variety of shapes of Konyac noodles, such as square and rounded. In other words, the company adjusts their strategies in developing new shapes of Konyac to serve local markets at the appropriate time.

Environmental scanning objectives of the other two interviewed companies are rather different from the first company's objectives. The next two companies produce rice flour and rice vermicellias their major products, respectively. With more than forty years of working experience in the Thai rice industry, the two companies continuously follow-up changes of local consumption styles. Both companies agree

that the potential growth of value-added rice products in Thailand and Asian countries leans towards higher quality and needs for new textures.

The second company has successfully developed rice noodles, coming up with versions which are more white (instead of brownish) color, more hygienic (through the process of drying with fluorescent simulated sunlight), which also helps eliminate dirt that gets in during preprocessing), more fresh (longer shelf life), more soft, more flexible in shape for local needs, and dried versions for export. Top executives of the company state that; "we know that market needs for changes of texture has to drive development of new products, which requires consistently good cooperation between the marketing and research & development departments. The company is hiring very few consultant companies in order to evaluate our new products."

In the same manner, the third company has successfully developed quick cooking brown rice because corporate analysis found that consumers' lifestyles are changing at a rapid pace. One top executive explained: "changes of consumption style leads the research & development department of our company to develop new products whose taste and texture (including cooking time) fit the specifications of the most current consumer behavior. The value-added brown rice can be cooked in only 10 minutes and its texture is softer than the original brown rice, which generally needs 25 – 30 minutes for the cooking process. This product has targeted medium-to-high income level consumers whose time is of great value. Its price is 20 percent higher than normally cooked brown rice. The company also plans to horizontally diversify quick cooking brown rice into snacks with a variety flavors, such as chicken and seafood, to serve the export market, particularly Japan in the very near future."

The success of these companies can be indicated by market shares in many Asian countries including Thailand. In summary, both companies scan to analyze the rice industry trends of Asian consumers, including Thai people. They have been able to use scanning information to successfully develop rice noodles and quick cooking brown rice to serve local and export markets as new consumer trends arise.

Environmental scanning factors

For Konyac, consumption demand in the Japanese market is a primary external issue, and environmental scanning focuses on this factor. Sufficient financial support from the head office of the Thai supplier is a key internal environmental scanning factor. Basically, the huge supply of Konyac from production based in Thailand has emerged as a key supplier for the export market, especially Japan. As a result, understanding the market and knowing the specifications and market preferences of Konyac allows for more likelihood of success of products as soon as they are launched onto Japanese market.

Frequently the Japanese customer provides some market research findings and product samples to the Thai supplier.

Regarding internal financial support, the company's owner states; "to pioneer Konyac, it has been a long awaited and laborious task. We had to develop Konyac powder from the konnyaku planted in Thailand in order to fit the most appropriate specifications for the Japanese market. Before succeeding, the company took a total of five years only for the experimentation procedure. A huge project like this has taken long time and large amounts of money for investment so that we could continuously develop the product until finalizing the most appropriate specifications. From time to time, we needed financial support from the head office for further progress on this experiment and to repeatedly fund new procedures. The company also scans other new competitive textures of Konyac so as to serve our own local market expansion."

In response to local market competition, which is considered another important environmental scanning factor, the company horizontally diversified Konyac into a variety of food forms and marketed these foods themselves at a recently opened restaurant, which serves as a source of information about consumer response. It generally takes six months to one year before new products can be successfully launched onto the Thai market. Some of the forms of Konyac now on the market include Thai noodles, jelly, Konyac as a filler in sausage, and mixed in hamburger meat patties. Konyac versions of these products, with its main core benefits of low fat and low cholesterol as a food ingredient, is able to compete with competing products by being positioned as a nutritional and healthy food. Thus, this company considers local competition as the second most important of environmental scanning factors, due to its expansion of Konyac locally, after first building export markets.

The other two interviewees, who focus on the local market, consider local competition scanning as the prime factor. Companies who produce and develop rice and rice noodle (both fresh and dried) are considered as major competitors of these interviewed companies. These products include rice flour, glutinous rice flour, native rice starch, native waxy rice starch, modified rice starch, rice vermicelli, rice stick, rice noodle, and ready-made confectionery flour. They compete in capturing all income target groups. Since there is high potential growth of demand the company has decided to develop a machine in order to consistently supply large sales volume on time (see technology strategy). As a top executive states "we are more than ready in every way to develop new products on our own. This includes more than forty years of working experience in this industry, our refurbished factory is built with capability to use recycled waste water, we have a variety of expertise, and training courses."

The companies are aware of stiffer price competition with not only local companies but also other neighboring countries like Vietnam and Cambodia, where the export price of rice is cheaper, although

quality is not at the level of Thai rice. This regional competition has been seriously scanned as a major competitive environmental factor. Response has partly been to make sure that the companies build strong market positions in parts of the market, which are not so vulnerable to price competition. One company decided to develop value-added rice textures, focusing on quality, rather than continuously trying to match cost structures of competitors such as Vietnam and Cambodia. As one of the top executives stated: “In comparison with rice from other countries, we realize that our core competency is Jasmine rice. We develop our new products from the best raw material we have in Thailand. We are the leader in terms of production technology of rice in Thailand.”

In order to compete in the high-to-medium income segment, the companies are broadening the rivalry to Western-style fast food products mostly made of flour, including spaghetti, macaroni, pizza, buns, french fries, and bread. Consumers in this segment normally have higher educational levels. This particular consumption style of the younger generation looks for higher quality rice noodles and quick cooking brown rice. Thus, value-added rice noodles can be more successfully developed by being more of a white color, odorless, and fresh, with a similar texture to spaghetti or macaroni made from wheat flour. As one top executive put it: “currently, there is great competition among rice producers. Thus, the company decided to add value like quick cooking and vitamin enriched rice.” The quick cooking brown rice and vitamin enriched rice was developed because of consumer time constraints and cost savings in the cooking process, and growing sophistication about nutritional needs.

In conclusion, scanning starts by focusing on local changes in consumption style, and is extended to highly stress the intense competition, both domestic and regional, in basic standard rice products. These two interviewed companies developed new products which focus on value-added features in order to compete with other well-established companies and low-priced products imported from neighboring countries. By following consumer trends and moving some of their market base out of the traditional standard products into parts of the market more concerned with quality, they maintain ability to compete in the future markets.

Technology strategy

One Thai company interviewed acts as a technological fast follower in producing Konyac, which was originally produced and popularly consumed by the Japanese. The company developed Konyac powder, initially relying mostly on product know-how from a Japanese corporation. The Japanese needed a source of Konnyaku plants, which the Thai company successfully planted, and moved into semi-processed and processed forms in Thailand. The company spent five years in joint research and development with food scientists at the Food Science Faculty, Kasetsart University and Japanese

laboratories in order to serve the growth in demand from Japan. The advanced research of this product technology has taken long time because the approach in planting Thai Konnyaku in northern Thailand is different from Japan. The Thai owner seems to thing this may be because of growing conditions, and claimed: "the longest molecule of glucomanan from the Thai Konnyaku, which is considered to be the best for people's digestion, can only be produced in Thailand."

Therefore, the customization of the Thai Konnyaku into the most appropriate powder based on the specifications needed in Japan is considered as the first successful application of the development process. This long-term process has consumed large amounts of money and time, and required considerable human resources, particularly food scientists and engineers, before succeeding. This huge investment led the company to aim for becoming a major exporter of the best Konyac worldwide to gain the return on investment. The managing director indicates, "Before making the decision to develop Konyac powder, we needed local food scientists and engineers to copy both product and production technology from the Japanese company. [We wanted to do it] so that we are able to maintain those technologies in the future without them." In other words, the technology strategy of this company is to stay in front of market trends by developing Konyac powder as its new product. Put in conceptual terms, they aim to be able to jump in quickly with their own R&D as soon as they spot trends, which is very much the definition of fast follower in technology strategy (Sharif, 1994, 1997).

In contrast, the other two interviewed companies are considered as product technology exploiters or technology extenders. Their technology strategy is to follow market trends with only incremental development of their current product, rice. One of the companies developed value added rice noodles while the other developed quick cooking brown rice. The core competency of the value-added rice noodles and quick cooking brown rice is the Thai Jasmine rice, with a world famous reputation in appearance, cooking texture and aroma (JRN, 1998). Both companies depend on their own in-house research and development departments in Thailand to broaden the product range within this core competency, but they are simply taking standardized technology which already exists and developing their own versions of products which already exist widely. Consequently, they produce to basically serve local market volume and compete with other companies in the markets of neighboring countries.

Moreover, the newness of what the companies do differs not only in technology use, but also in market development. The first interviewed company has spent another two years for launching Konyac to make it well known and accepted in the Thai market, where it had not been common before. Konyac is now very popular among the young generation of consumers, whose major concern focuses on health and dietary supplement foods. The target groups of customers have expanded to diabetic and high

cholesterol customers. Finally, Konyac has been positioned in Thai drug stores as a healthy food supplement.

To become a market leader of Konyac, the company has actively developed new products from Konyac powder into variety of shapes and textures, which is considered as the second application process. There are, for example, noodles shaped like rice, mini-fruit gel sweets containing Konjac, yogurt with Konyac, and cooked boiled rice with Konyac. As the owner states, "we continuously invest in Konyac." They continuously define new products for the Japanese market, and for the Thai market, and invent in market development so these products which did not exist before become successful.

This new product development creates business opportunities among customers concerned with healthy foods. Moreover, the market growth of Konyac showed the way to establish the first fast food restaurants selling a variety of Thai foods mixed with forms of Konyac. In 2002, the company successfully opened two restaurants in the Bangkok metropolitan area, and continues to grow this part of the business by franchising the fast food restaurants selling a variety of Konyac foods. As a result, the company will eventually become a supplier of Konyac to companies in Thailand nationwide.

This situation illustrates a successful business leader gaining first mover advantage and dominating a new market, which will allow it to control large market share for a long time. New entrants may have difficulty to capture much of the Konyac market. They will need a huge investment and a long time to discover develop other products, or even copycat products using Konyac in a variety of food supplements, as this company has developed proprietary Konyac technology which is not widely available. Currently, the company is moving to patent the technologies worldwide. From being a product technology fast follower, the company has successfully become a technology leader in one small market niche, based on identifying new market opportunities.

In terms of production technology, the company is also a fast follower. It originally transformed Konyac into a powder following the Japanese technical know-how. From the original model of the machine made by Japan, the company substituted a number of the imported machines with ones made by local engineers with local raw materials, at about one-tenth the cost. Then, they customized the machine to be able to semi-process and process a variety of forms of Thai Konyac. The machines are capable of producing consistent Konyac powder and processed food products. Current R&D on the production technology aims at improving machine life, but this is not yet a critical competitive issue as there is not yet much competition, so the company has plenty of time to work on further reduction in production costs. The machine customization has allowed the company to extend the Konyac technology in build capability and capacity to produce the appropriate texture (mentioned above) from Konyac powder, allowing it to build and dominate this new market in Thailand quickly.

The other two companies only develop products which already exist in the market, and export their new products, especially to Japan, as Japanese companies discover them and place orders with specifications, but they do not specifically develop new products for the Japanese market on their own. Both of these rice companies can be considered technology exploiters or technology extenders. The rice noodle company has joint research and development between its subsidiary company and Japanese customers. Initially, this company produced value added rice noodles corresponding to the specification requirements of competitive products produced by a Japanese customer. Therefore, the appropriate product technology has been customized in order to fit the characteristics of Jasmine rice. The successfully developed product competes against existing ones in the Japanese market. This producer also imported the original machinery and made more copies to serve large volume production, with some adaptation for Thai Jasmine rice characteristics. Thus, in addition to Japan, this great opportunity has allowed the company to become a major exporter of value-added Jasmine rice noodles worldwide.

Environmental scanning implementation

More than forty years of working experience serves the top executives of the interviewed companies in identifying sources for information input into successful development of new products. However, there are some differences in how broadly and how formally the scanning process is implemented, and how systematically it is integrated into a continuous NPD process.

The product concept for Konyac powder was originally mutually agreed upon by the top executives of the head office of the Thai agribusiness group and a Japanese company who wanted the product for Japan. The Japanese side provided some technical assistance when needed. Top executives at the Thai head office built a successful development process for Konyac, and this contributed to a strong foundation for continued cooperation between the Thai and the Japanese companies, as they continue to search for market opportunities in Japan.

This company allocates profits from one of its other highly successful export products (ginger) to NPD. “Return on investment from exporting ginger creates our own investment budget amount to support new products, with continuous experimentation until success. This means that we have the cash flow to continuously run the experimentation.” The head office of this Thai agribusiness group fully support the very active NPD of this affiliate, with financing and experts in a variety of fields in case of emergency. In fact, they constantly push the NPD process to come up with the appropriate specifications to fit Japanese customer demand.

In comparison, at the other two companies, top executives focus on their own in-house research. They continuously develop the appropriate new product so as to fit changes of Thai consumption style.

These two companies incrementally developed current products, semi-processed and processed rice, based on ideas derived from the working experience of family members, and feedback from customers and suppliers. The scanning process is somewhat more ad hoc in these companies, and NPD does not really have a dedicated source of funds, but proceeds on a project by project basis.

Discussion and conclusions

The first company interviewed primarily scans changes in the environment in order to export new products, especially Konyac, to the Japanese market before translating them to the domestic Thai market. As a result, it explicitly differentiates product specifications between export markets and local market forms of Konyac characteristics, and its NPD aims at keeping ahead of demand with new products in each of its major markets. In contrast, the two interviewed rice companies primarily scan to create internal market strength in Thailand by meeting local demand. Local production is viewed as a base before developing their current products to fit export, adapting to specifications of foreign customers to meet demand in those markets.

The first company spent five years for research and development of the best Konyac planted in Thailand, and on developing new processed products from it. Technologically adept companies like this one are leaders who stay in front of market trends. They invest in the long-term in product and process technology to become a major supplier worldwide early in the product life cycle, before there is much competition. To be able to do this, the company's environmental scanning process is necessarily way ahead of the others in the same industry. The other two interviewed companies spent only six months to one year to fit the appropriate specifications of their current products to changing needs in domestic consumption styles. Technological exploiters and extenders like them adept current products to follow market trends. They develop value-added products, which are new products to their companies, but not necessarily to the market, to gain price competitive advantage in the foreign markets.

The Konyac company started by scanning environmental factors from outside in, while the other two companies scan inside out (see Figure 2). The Konyac company focused originally on demand in the foreign market, especially Japan, before turning their viewpoint to local competition to develop variations of product characteristics for domestic markets later on. Now, both external and domestic environmental scanning is important, as they have developed the Thai market into an important part of their business. The other companies primarily focus on local product competition, before they started paying more attention to scanning in neighboring countries, at first because of worries about price competition from countries such as Laos, Vietnam, and Cambodia. Scanning for foreign market demand is still not

extensive, as they mainly rely on foreign customers to do this and to provide them with specifications to input into their NPD process.

*** Figure 2 about here ***

The first company in the study primarily scans both external and internal sources of information to develop a new exported product like Konyac. External sources of information comprise technological know-how and skills from expatriates, especially from Japan. Domestic sources of information include local Thai food scientists for product technology, engineers for production and process technology, and internal assessment of financial support from the head office of the group. The company later scans information based on in-house research and development to fit product specifications with local demand. The other two companies scan for sources of information inside first, focusing on in-house research including customer response to new products previously launched into the market. They look for foreign companies to cooperate afterwards to further develop value-added products to serve export markets.

The Konyac company environmental scanning technique is more oriented toward demand in the foreign markets first, and seeks to build in product responsiveness to meet those specifications. They built a broader picture to launch a successful product into the foreign market. The domestic market is not ignored, but it is simply one among several markets, each of which gets its own attention. The other two companies instead focussed on local customer responsiveness before turning their attention to foreign market competition afterwards.

These case studies suggest that companies in the Thai food industry who use scanning successfully in developing new products initially emphasize focused differentiation, one of Porter's generic competitive strategies (Porter, 1990). They concentrate on particular consumer segments, product lines, or geographic markets, attempting to serve them well and build a strong position. The Konyac company shows a more advanced form of this, focusing on a niche market in Japan. However, the two other companies discussed here also focus on value-added rice products, but first in the domestic market. Thereafter, the companies aim at a differentiation strategy (Porter, 1990), which covers broader mass consumer markets, and aim to be considered as global suppliers with their NPD (Wheelen and Hunger, 2002). The Konyac company is most advanced at moving toward this strategy. The usage of both appropriate strategies by successful scanning companies indicates a long-term vision of NPD.

To be a technology leader or fast follower in pursuing these strategies, companies need a certain amount of resources. Among SMEs, this would mostly be upper medium in size (approximately 200 employees). NPD needs strong financial, bio-technology and food science, and engineering support to

stay in front of consumer demand. As argued in Jones and Tang (2000), scanning strengthens the core competitiveness in the food industry. The emphasis is on product and process innovation to stay ahead of consumer trends so that the company can build strong, profitable positions early and erect entry barriers.

Companies who exploit and extend the usage of technology develop new products from their basic technology resources in reaction to capture rapid changes of environmental competitive factors, rather than in anticipation of changes. Some of the key recent shifts include more educated and sophisticated consumers, higher quality imported products and more demand for quality in the middle to upper parts of the market, the 1997 economic crisis, and price competition from neighboring countries in the lower end of the market. As discussed in Sharif (1997), technological competitiveness gives companies facing these environmental changes opportunities in global markets if they are adequately prepared to evolve from comparative advantage based on factor costs to competitive advantage based on technology value-added through better technology.

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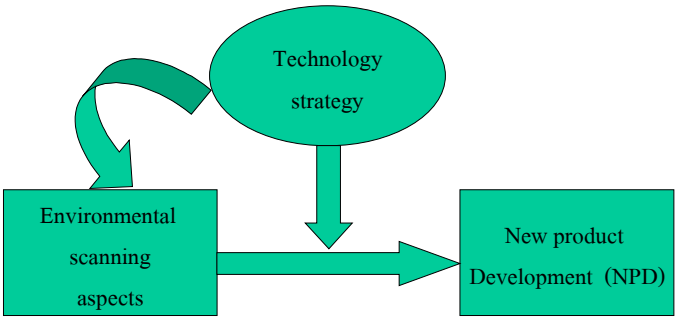

Figure 1: Environmental Scanning, Technology Issues, and NPD Performance

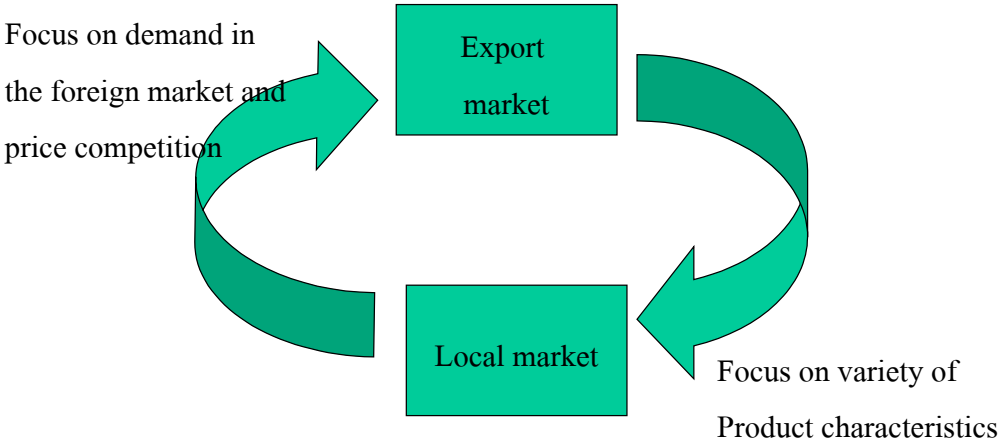

Figure 2: Environmental Scanning Factors

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Environmental Scanning in Thai Food SMEs:

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ABSTRACT

Small- and medium enterprises (SMEs) in the Thai food industry put a lot of effort into keeping up with changes of consumption patterns locally and in the South East Asia region. To see how successfully they are able to create competitive advantage, we examine the relationship among environmental scanning (ES) practice of SMEs, technology strategy, and technology turbulence, to see the impact on new product development (NPD) outcomes in the Thai food industry. The qualitative research was conducted using semi-structured in-depth interviews with food experts and SME owners. Results indicate that SMEs need to continually practice environmental scanning process to develop appropriate new food products. Technology strategy plays a role in how much ES they use, with the fast follower technology strategy requiring the most extensive ES. Lack of awareness of turbulent changes of technology can cause failure in NPD. A simple conceptual model is proposed to show how technology strategy, technological turbulence, and ES affect NPD performance.

Key words: environmental scanning, technology strategy, technology turbulence, new product development, small- and medium-enterprise (SMEs), Thailand

INTRODUCTION

Innovation and the introduction of new food product development (NPD) is one effective way for SMEs to gain advantage in the marketplace (Rudder, *et al* 2001). However, there are several important challenges in developing new food products. Management information is frequently scarce, either because information sources are lacking, or, often, because management does not really utilize information well. Advances in technology also make strategic thinking about technological applications critical (Bogue, 2001). To fully utilize new product development (NPD) as a competitive tool in food industries, SMEs need to make effective use of environmental scanning, and understand technology strategy and technology turbulence. Only recently, research has begun to investigate the impact of these things on success in NPD.

Some research identifies core competencies of new product or process development of SMEs in the food industry. For example, Avermaete *et al.,* (2003) discusses the need to continuously introduce new product, develop new processes, make changes in the organizational structure, and

explore new markets. Schopf (2002) discusses the importance of integrating external service providers into NPD. Successful product innovation depends on company characteristics (age and size) and on regional economic factors (Avermaete *et al.*, 2003), which is an important environmental scanning issue.

One frequent cause of failure in NPD is too little attention to external factors. Thai SMEs, for example, frequently fail to tap information through some form of environmental scanning, believing that they do not have sufficient resources and cannot afford to waste funding needed for research and development or purchase of more advanced technology. This is likely to be a short-sighted view, managers need to have a better understanding of new product development and how external information is useful in making their NPD more effective and efficient. They should have more extensive knowledge of how to practically implement environmental scanning, the influence of technology strategy, and the influence of technology turbulence in using environmental scanning in their NPD.

Thus, this study examines the influence of environmental scanning aspects, technology strategy, and technology turbulence at various stages of new product development in Thai SMEs in the food processing industry. We use this data to show how Thai SMEs practice environmental scanning. Those that use it well seem to have more successful new product development. From the examination of environmental scanning in Thai SMEs, we put forward propositions for how future research can develop a more comprehensive understanding of these issues.

ENVIRONMENTAL SCANNING

Prior research has found that strategic managers need to extensively scan changes in environmental factors to create corporate policies for both short- and long-term missions (Wheelen and Hunger, 2002). Moreover, Ahituv *et al.* (1998) suggested that whenever companies introduce new products into their market, environmental scanning is an important strategic planning process in helping managers to achieve their targeted performance. Successful companies will be more flexible in adapting their scanning to environmental changes. They scan the environment at a higher frequency to track competitors, customers, and technology sectors; and they look more for objective views provided by external information. Ultimately, they possess significantly more computerized marketing information than companies that do not scan or do not scan well.

Examining case studies of international companies in Thailand, Ngamkroeckjoti and Johri (2000) found that local companies had restructured and periodically scanned environmental factors to match enterprise and industry characteristics, even before the 1997 economic crisis in Thailand. They concluded that international companies had successfully decentralized to regional and country offices to examine specific market factors. This allowed them to generate concrete perspectives about the future trends; and they could use capital and knowledge intensive advanced technologies to reduce

environmental uncertainty. Furthermore, information generated by scanning could be incorporated into the relationship with customers, suppliers, and many government agencies.

Beal (2000) examined the effects of the frequency in scope of environmental scanning on the alignment of competitive strategy to the environment, using a sample of US small manufacturing firms in a wide variety of industries. The results suggest that managers of small businesses do collect information on external environmental sectors, particularly customers and competitors, in order to align corporate strategy. Moreover, firms in both growth and mature industries should scan various types of information in order to compete most effectively. Such information focuses on competitors and customers, independent of the strategy employed. In Thailand, at least on form of such external information, market research on customers, has a large impact on the success rates of NPD in the food industry (Suwannaporn and Speece, 2003).

NEW PRODUCT PERFORMANCE

Results from several countries indicate that changes of environmental factors have an impact upon new product performance. In Thailand, Suwannaporn and Speece (2000) found that companies should be aware of changing environmental factors, particularly technology, because it helps companies to continue developing new products to increase their performance. Cross-functional information flow about such issues is also a key factor in successful NPD (Suwannaporn and Speece, 2003). In Japan, Song and Parry (1997a) focused more on the relationship between the company's internal environment and external factors than on market-oriented activities, which drive new product success. The results indicate the effect of competitive environment, marketing synergy, and technical synergy in selecting the project. Companies that successfully introduced new products had good cross-functional integration, which facilitated incorporating information about competitive and market intelligence, marketing proficiency, and product competitive advantage.

In a cross-national comparative study of Japan and the USA about environmental factors that influence new product success, the key factors were internal commitment, market potential, and competitive intensity (Song and Parry, 1997b). Other research has also confirmed that better decision-making incorporates perceived uncertainty about the environment. Under environmental turbulence, greater memory dispersion detracted from creativity while reducing company performance. Various other types of perceived uncertainty about the environment have also been identified, including technological uncertainty, and uncertainties about marketing environments, such as consumer uncertainty, competitive uncertainty, and resource uncertainty (Moorman and Miner, 1997).

In the Irish food industry, Bogue's (2001) research considered NPD as a key competitive advantage factor of large companies during rapid changes of technology and consumer behavior. His research focuses on the relationships between the voice of customers and importance of NPD

process, and shows the importance of information about external conditions for NPD to work most effectively.

ENVIRONMENTAL SCANNING PRACTICES IMPACT NPD

This study aims to highlight how Thai SMEs practices environmental scanning in order to examine the successful new product development. Figure 1 summarizes the development of issues in prior researches. Companies which scan are accordingly aware of the changes of environment, of consumer behavior, of management perception, and of new product development trends (Wilding, 1985; Hise and Groth, 1995; Lewis, 1990; Moorman, and Miner, 1997; Ribordy *et al.*, 1992; Rothberg *et al.*, 1999; Song and Parry, 1997a; Song and Parry, 1997b).

FIGURE 1 NEW PRODUCT DEVELOPMENT OF PAST RESEARCH FROM 1980S TILL PRESENT

Prior research indicates that managers should integrate practices for scanning external and internal environment information sources into the management strategic decision-making processes in order to understand the competitive situation from the early stages of new product development (Rothberg *et al.*, 1999; Moorman and Miner, 1997). Generally, the external environmental changes are identified in terms of strategic alliances between Japanese and European companies, international business entry strategies, and advanced technology expertise (Lewis, 1990). Companies should also have good cross-functional integration, which facilitated incorporating information about competitive and market intelligence, marketing proficiency, and product competitive advantage in order to introduce new product successfully. The internal capability and commitment to fully utilize environmental indicators are as important as getting the external information on such things as market potential and competitive intensity (Song and Parry, 1997a; Song and Parry, 1997b).

Another key managerial issue is changes of consumer behavior and manager attitudes towards changes new product requirements in response to such environment changes (Wilding, 1985; and Ribordy *et al.*, 1992). Prior research has examined the influence of managerial awareness on external environmental profiles on improved opportunities for succeeding in developing new product (Hise and Groth, 1995). However, the reality of how managers practice environmental scanning processes to develop successful new products still remain unanswered. To address this, the specific external environmental scanning practices of managers on new product development are explicitly investigated in this study. The various practices of scanning processes are diverse in different environments, but they all require top management awareness of and ability to use scanning. Therefore, the following proposition is put forward:

P1: The greater the use by top management in scanning changes of environment on time, the better the development of new products in SMEs. Conversely, the less use SME operators make of environmental scanning, the worse is the performance of NPD.

One of the objectives in this study was to confirm that environmental scanning practices actually help companies to improve success rates in new product development, and to see exactly what owners or managing directors of SMEs think such problem-solving entails.

TECHNOLOGY STRATEGY

The concept of technology strategy has been developed from the technological planning. Technology can be considered as a strategic weapon, which in our context can contyribute to successful design and launch of new product (Zahra *et al.*, 1994; Sharif, 1997). Most technology strategy research has looked at business strategies, corporate planning, and competitive or comparative advantages of enterprises (Zahra *et al.,* 1994; Ryan 1996; Sharif 1994 and 1997; Zahra and Bogner 2000). Zahra *et al.* (1994) investigated the linkage among technology strategy, competitive strategy, and company performance. Examining both content and process of technology contributions to successful company performance they defined six dimensions of technology strategy. They academically define six dimensions of technology strategy. They are technological innovation posture, dominant technological thrust and goals, globalization of technology strategy, technology sourcing, technology investments, and organizational mechanisms.

A group of industrial engineering and business specialists (Glyde, 1999) defined four technology strategy issues slightly differently, including: what technologies to develop, the cost and suitability of existing technologies for organization and unit goals, whether to seek technological leadership in those technologies, and whether to guard or share new technology developments. In the US software industry, Zahra and Bogner (2000) examined the relationships between technology strategies and new venture performance (NVP). Superior NVP could be achieved with a formal technology strategy, which was matched carefully between technological choices and external environments. In other words, the results suggest that the company would be better able to forecast the impact of environmental forces on the venture's technology strategy choices when they use environmental scanning.

Working with data from South Korea and Indonesia, Sharif (1994) has classified four technology strategy, which range from very proactive in the development and use of technology to little technology capability at all:

- technology leader – leadership through state-of the-art technologies. We note that this is quite rare among Thai producer. Instead, we do consider them as fast follower;

- technology follower – following with rapid application and adaptation of new advanced technologies as others develop them;
- technology exploiter – exploiting the use of standardized technologies and some adaptation; and
- technology extender – extension of the salvage value of obsolete technologies by simply using old, off-the-shelf technologies.

Sharif (1994) also linked technology strategy classifications with business strategy in each stage of the business life cycle of enterprises. In his terminology, the four business strategies include price leadership, quality leadership, feature leadership, and image leadership. He concludes that to be a market leader, the company must have a strategic view of technology. This requires setting priorities, identifying what is most critical to the success of the enterprise, and focusing improvement efforts on technology capability for moving better-quality at lower costs to the marketplace faster. He also suggests that industrial enterprises of Indonesia need to actively adapt technology and manage technological changes better if they are to avoid being bypassed by other enterprises in other Southeast Asian region. He recommends that technology in developing countries based on producing value-added products will create a more competitive advantage in the worldwide market – i.e. the pure extender strategy does not seem to provide long-term competitive advantage.

Later work by Shariff (1997), based on four case studies in South Korea and Indonesia, found that technological self-reliance is the most important strategic mission of a company in ensuring successful performance in the global market. He also recommends that enterprises in developing countries should create competitive technology-based relative advantage relating to factor cost advantage. In doing so, a company may institutionalize strategic planning on how to reduce costs, improve quality, protect environment, add features, and shorten project cycle-times to enhance technological capabilities.

Ryan (1996) examined the importance of the relationships between technology strategy and corporate strategies within firms in Australian companies. He concludes that Australian firms must link technology to corporate policy and develop an understanding of technology strategy in terms of conceptual and analytical work. He indicates that technology strategy is an implicit context through all aspects of corporate policy, and that innovation and leading-edge technology are the top priority in meeting customer requirements.

TECHNOLOGY STRATEGY, NPD, AND ENVIRONMENTAL SCANNING

This section will briefly review research investigating the influence of NPD strategies. Prior research suggested that companies, which employ more proactive competitive and technologies strategies, have more potential to be successful in environments characterized by dynamic product technologies (Spital and Bickford, 1992). Cooper (2000) argued that “fast follower” technology

strategy is the best attack plan for the industry innovator to rapidly enter market with a successful new product. Other work similarly confirms that technology strategy plays a role in product or process innovation (Oswald and Nelson, 2000). However, more research is required to specifically examine how much these two factors are actually related.

In some US corporation, technology strategy and environmental scanning techniques are considered important tools for developing long-term scenarios for NPD in order to create future competitive advantage (Greenwald and Rudolph, 1996). Some research from Italy proposed a framework to consider technology strategy as a subset of environmental scanning in order to sustain competitive advantage (Chiesa and Manzini, 1998)

Companies should adopt the proactive approaches to initiate technology to enhance NPD flexibility so that new products are able to stay current with appropriate consumer demand (Nambisan, 2002). The trade press in New Zealand has also discussed the importance of technology strategy in industrial companies for keeping products current with rapidly changing demand patterns (Glyde, 1999).

However, while such issues have begun to get some attention in academic research, not much has been done to develop in-depth understanding about interrelationships between technology strategy and environmental scanning for NPD. Strategy and planning issues do have an impact on NPD success, for example, in the Thai food processing industry (Suwannaporn and Speece, 2003), suggesting that companies should clarify corporate level strategy from the beginning in order to be successful in developing new products. This research looks at the impact of technology strategy on corporate environmental scanning practices, examining the following two propositions.

P2: The more proactive the technology strategies applied by SMEs operators, the greater the practices of environmental scanning process. Conversely, the less proactive the technology strategies applied by SMEs operators, the fewer the practices of environmental scanning process.

P3: The more proactive the technology strategies applied by SMEs operators, the stronger the relationship between environmental scanning practices and successful new product development. Conversely, the less proactive the technology strategies applied by SMEs operators, the weaker the relationship between environmental scanning practices and successful new product development.

TECHNOLOGICAL TURBULENCE AND ENVIRONMENTAL SCANNING

During the 1990s, a few studies began to pay attention to the issue of technological turbulence (Jaworski and Kohli, 1993; Moorman, and Miner, 1997). Moorman and Miner (1997) defined technological turbulence as the degree of technological change associated with new product technologies, and examined the linkage between technological turbulence and NPD. They found that

a high degree of technological turbulence might enhance NPD in companies that attempt to keep up, because of diverse knowledge and skills among employees that increase the probability of exploiting emerging opportunities.

Jaworski and Kohli (1993) defined technological turbulence as the rate of technological change, and examined the impact of technological turbulence upon the relationship between market orientation and business performance. Market orientation focuses on customers and market conditions, and in this context, customer information and market segmentation would be some of the main drivers of NPD efforts, with a strong role for the marketing department. However, they found that the market orientation of a business is an important determinant of its performance regardless of the technological turbulence.

However, this is one of the few attempts to see how technological turbulence actually relates to the need for external information in the NPD process. Little research has identified how strong the relationship is between technological turbulence and new product development through environmental scanning practices. Therefore, this issue is addressed here by examining the following proposition:

P4: The higher the degree of technological turbulence, the greater the use of environmental scanning practices of SMEs. Conversely, the lower the degree of technological turbulence, the less the use of environmental scanning.

P5: The higher the degree of technological turbulence, the stronger the relationship between environmental scanning practices and more successful new product development. Conversely, the lower the degree of technological turbulence, the weaker the relationship between environmental scanning practices and more successful new product development.

RESEARCH METHODOLOGY

This study is based on in-depth interviews with six SMEs chosen as case studies, supplemented with company documentation. As noted above, the issues of this research are not very extensively researched. Qualitative methods provide rich detail for exploring viewpoints, allowing the researcher to gain a better initial understanding of the problem and to identify phenomena, attitudes, and influences (Healy and Perry, 2000; Maxell, 1996). Other work has shown that a qualitative case study approach works quite well for exploring details of how NPD works (e.g. de Weerd-Nederhof, 2001).

Prior to determining which companies to use as case studies, in-depth interviews were conducted with seven experts from organizations, which work with the processed food industry in

Thailand on R&D and NPD. One expert was from the National Food Institute (NFI) in Thailand[1]. Two were from the Food Science and Technology faculty of Kasetsart University. The other two experts were from the Food Science and Technology Association of Thailand (FoSTAT). The last two experts were from National Electronics and Computer Technology Center (NECTEC).

The cases were chosen in consultation with the experts knowledgeable about NPD in the Thai food processing industry, who specialize in food processing technology. The expert interviews identified criteria which could be used to distinguish more successful vs. Less successful new product development. According to their strong research experience working with industry in NPD, the experts decided that the most common industry that indicates successful NPD is continuous on-shelf placement for at least six months to two years. The exact duration depends on the classification as consumer product, Original Equipment Manufacturer (OEM) product (manufactured to specification for another company, or ingredient, as well as the packaging and the production process). After discussing and determining criteria to identify which companies were successful at NPD, the experts helped to identify three food SMEs which were successful and three other SMEs, which were less successful at NPD. All were representative of expertise of the food processing industry, and where we would be able to gain good access.

The interview topic guidelines were developed from the information obtained from the pilot work with the experts, the literature review, and prior experience of the authors in conducting research among Thai companies on issues of environmental scanning and NPD. From the six selected SMEs, at least two persons from three companies were contacted for the main interviews. Finally, the total eleven respondents across the six SMEs, who were owners, managing director, senior managers from the marketing, production, and research & development departments are interviewed. The interview process actually consisted of an initial in-depth interview, about two hours in length, and shorter follow-up interviews with respondents and additional personnel to clarify specific issues.

There were a number of these short, information gathering discussions with other staff in the companies when one of the senior managers referred us to them. Generally, however, these were for information about operational issues, as most of these staff was not extensively involved in the strategic issues, which were the topic of this research.

ENVIRONMENTAL SCANNING IN THE NPD PROCESS

The interviews started on a general level, with questions about the role of environmental scanning in new product within the past one to three years. The discussion covered two aspects of environmental scanning practices: - objectives and factors. All interviewees indicate that in order to develop new products successfully, environmental scanning objectives plays a significant role. For

example, one executive from a company which developed Konyac powder[2] emphasized the importance of environmental scanning as reflected in his strategic objective to develop Konyac plantations in the northeastern part of Thailand and to continuously invest in research and development of Konyac products.

"We developed Konyac because we foresaw a bright future for popular consumption of the product not only in Japan but also in worldwide markets including Thailand."
(Note: All interview quotes in the discussion were translated from the original Thai language transcripts by the first author of this article).

At the time the decision was made to go into Konyac, the product did not exist in Thailand, and this statement implies a strong role environmental scanning in terms of predicting future driving forces affecting Konyac development in the company.

Another statement was from managing director of rice noodle company which successfully developed new textures of rice noodles. He stated:

> "Based on our working experience in this industry for more than forty years, we know that market needs for changes of rice texture has to drive development of new products. This requires consistently good cooperation between the marketing and research & development departments. The company is hiring very few consultants in order to evaluate our new products."

This statement implies the successful analyses of rapid changes in consumers' lifestyle on time, which is considered the primary environmental scanning objective of the company.

For environmental scanning factors, internal financial support and long-term working experience are considered major significant factors. The executive of the company that successful Konyac development company stated:

> "A huge project like this has taken a long time and large amounts of money for investment so that we could continuously develop the product until finalizing the most appropriate specifications. From time to time, we needed financial support from the head office for further progress on this experiment and to repeatedly fund new procedures. The company also scans other new competitive textures of Konyac so as to serve our own local market expansion."

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[2] Konyac is an ingredient made from the root of the konnaku plant. It can be used as a binding agent in many food products. It takes the place of gelatin in certain processed food products.

Similarly, another executive of a new rice texture talked about the extensive environmental scanning to keep up with market demand and technology for rice texture. This company has good NPD capability:

> "We are more than ready in every way to develop new products on our own. This includes more than forty years of working experience in this industry, our refurbished factory is built with capability to use recycled waste water, and we have a variety of expertise, and training courses."

On the contrary, the respondents, who used minimal scanning practices were more likely to fail in their development of new products. They frequently skipped the scanning stage before designing and launching new products onto the market. One general manager who did not use scanning on a project noted how the product had failed in the launch:

> "Following the changes of the Thai consumers towards more local tastes like tom yum kung, num tok, and larb, I failed in designing and launching a product too rapidly. It was a chilled sausage with green curry paste, with basil, a Thai herb and made it spicy. I thought that this was the trend of the Thai taste but was wrong."

By the same token, a general manager of a food company, which was less successful in launching their products, which are Air Dry ham (Szechwan ham), Air dry meat, Parma ham (Italian style) in capturing the mass domestic market. Lack of market input resulted in products which have unsuitable texture (too hard) and unsuitable taste (too salty), so they cannot fit to local demand. Instead, these products have been served only for tourists at the five star hotels and supermarkets where they are able to capture the nich market of foreigner. As the general manager stated:

> "I did not know earlier that these products would be unpopular in the mass market. In the past, even without any market research, these new products have been able to serve the local market demand."

In addition, another company that failed in designing and launching a new rice cracker with chicken or vegetable tastes is another example of a company with little practice of the environmental scanning process towards successful NPD. The managing director stated that:

> "This product has been proposed by the research and development department. During 1997 crisis, we decided to market this product right away along with downsizing the package from Baht 5 to Baht 2 (exchange rate was Baht 45.00 per dollar at the time). I thought that we would be successful in launching new flavor of rice cracker - chicken and vegetable along with popular old ones, tomato and jalapeno together in similar brand. Therefore, these two new tastes should have had greater potential of market acceptance. However, the market yield was far below our target planning result."

One relative young beverage company was less than successful in launching soybean milk. The Thai owner had automatically launched a Taiwanese designated taste of soybean milk without noting that consumption tastes in the Thailand market differed. The owner stated:

> "We have to change the taste and package of soybean milk before launch again to fit the specification of Thai customers."

All of these comments shown in the three cases, which do not use much external information analysis imply that the failure to set environmental scanning objectives and bring information into the NPD process had an impact upon the development process. The companies did not mentioned much about the environmental scanning factors because they do not use environmental scanning much, but they were clear that lack of external information can jeopardize success in designing and launching new products.

TECHNOLOGY STRATEGY AND ENVIRONMENTAL SCANNING

To explore how proactive use of technology strategy has influenced environmental scanning practices and NPD, the interviewees were asked whether the degree of technology strategy they pursue affects NPD through environmental scanning practices. All companies, who successfully develop NPD indicated that the proactive use of technology strategy strengthens the practices of the environmental scanning process. For example, a top executive of the company that successfully developed Konyac in the form of powder describes a proactive technology strategy:

> "Before making the decision to develop Konyac powder, we needed local food scientists and engineers to adapt the product and copy the production technology from the Japanese company. [We wanted to do it] so that we are able to maintain those technologies in the future without them."

In terms of product technology, the Konyac company has became a fast follower, able to initiates the since he initiates the transformational raw material (Konyac) into new consumption forms (powder) through their technological innovation. Moreover, managing director of the rice noodle company described how technology has been proactively used in his company:

"We joined our research and development subsidiary with our Japanese partner in order to develop new products according to the specification that fit our customers. These made-to-order products are supplied only to customers of our joint Japanese partner."

The above description from the top executive of a rice noodle company essentially positions the company as a technology exploiter, able to adapt technology successfully development new products.

On the contrary, an interviewee from a sausage company in Thailand claims the reason for one of his less successful NPDs was that:

> "We extended existing company technology in our research & development department to design a chilled sausage with a mixture of green curry paste. However, because of lack of research & development skills, the sausage could not stay on the shelf for a long period of time. After a certain period of time, and unlike the others, this particular product was considered a failure from the market feedback. We use existing technology to design and develop the fresh chilled chicken sausage. The fresh product is delicious. But its shelf-life was very short. Its smell and taste changed within a week. This was because of a shortage of technical skills in our research & development department."

Similarly, another interviewee from a successful snack company, with many successful products, notes that some failed in designing and launching onto the market. He is essentially talking about simply using the same technology over and over to come up with different flavors of the same products:

> "I try to maximize our production capacity by mixing our product with a variety of seasonings. I will launch new flavors whenever we think that, based on my work experience in this industry for at least 20 years, it is the right timing. Some flavors are a success, like tomato and paprika, unlike others, shrimp and chicken are not."

The last company very clearly followed a technology extender strategy, and used production technology originally developed by a Taiwanese company in order to produce soybean milk in its

original formula. However, in the beginning stages of product introduction, the sales volume had not reached the target. As the marketing manager of the company stated:

> "Four years ago, the company directly launched this product with its original formula marketing by local agencies. We launched the product as soon as we had completely copied the production technological process. We failed to reach the sales plan from the beginning, and as a major result from a short shelf-life."

The above three poor performance situations occurred mainly because companies were not using environmental scanning practices in their NPD, but there seems to be a fairly strong association with quite passive technology strategy. They are all essentially technology extenders. The more successful companies, which use environmental scanning, are more proactive in use of technology.

TECHNOLOGY TURBULENCE AND ENVIRONMENTAL SCANNING

The interviews also explored how technology turbulence has influenced environmental scanning practices and NPD. One executive of the successful rice noodle development stated that because market tastes, the products in the market, and product technology continuously change,

"We continuously invest in research and development on our own to maintain the market leader position in such stiff competition. The analyses of both new product and research and development technologies have always complimented each another. For example, since we daily use a large amount of water, we cooperate with Japanese companies to set up a water recycling system in the rice production process."

This statement indicates a major concern of top executive towards a degree of technological changes. Companies with more environmental scanning and proactive technology strategies are able to keep up with changing technology, recognizing that they cannot simply use old technology. Some managers who have not had as much success seem also to be learning from poor performance experiences. For example, the marketing manager of the beverage company which faced a failed new product recognized that lack of attention to change had partly caused the problem. His company has started doing more of their own R&D.

> "Four years ago, as soon as we completely had copied the milk production technology, the soy-bean milk with the formula originally from Taiwan was launched. We learned from failure at the beginning stage that changes in consumer groups mean changes of taste. We have to develop the flavors through research and development technology."

A general manager of a meat product company, who had a less successful NPD stated that: -

"Normally, we are successful in producing and launching products onto the market. We are keen in its given made-to-order formula. Therefore, we do not invest in technology, which is used to develop new product. After we produced sausage mixed with curry taste, we failed in launching into the market."

The above situations occurred because companies are inactive in environmental scanning practices even in the face of some degree of technology turbulence.

INTEGRATIVE MODEL

Environmental scanning activities within an organization evolve continuously as a result of volatility of environment and the diverse nature of businesses. In the case of these food processing SMEs in Thailand, both successful and unsuccessful business strategies have emerged in the past decade. One successful strategy is to design and launch new products or services onto the market by incorporating extensive information about the external environment in NPD.

To achieve success in designing and launching new products, companies should have efficiently scanned and successfully caught the trend of environmental changes (Ahituv *et al.,* 1998). However, all these new products rely extensively on up-to-date technology, at the minimum, adapted to local conditions, as a factor in achieving their target performance.

Therefore, technology is an important strategic factor that helps the firms to address market needs when scanning had been successfully done under turbulent changes of environment. In particular, technology strategy and technological turbulence seem to moderate the strength of the relationship between environmental scanning and new product performance (see Figure 2).

Drawing on Ahituv's (1998) work, this study concluded that there is a relationship between environmental scanning and new product development success. More specifically, the more extensive use of environmentyal scanning seems to contribute to the more successfully new product development by making sure that the NPD process addresses real market needs, adapts to specific customer tastes, and incorporates the most appropriate technology into products. In addition, a few researchers have defined the relationship between technology strategies and business strategy (Zahra *et al.,* 1994; Zahra and Bogner, 2000; Sharif, 1994; 1997; Ryan, 1996). Although they sometimes mention NPD as part of business strategy, the discussion is not very detailed about this. Here, the case studies seem to indicate that technology strategies have an influence on the relationship between environmental scanning and new product development. More proactive technology strategies

seem to enhance the strength of the relationship. Certainly, companies that make strategic us of technology use environmental scanning more.

Finally, a major issue is how rapidly changing technology affects the environmental scanning process in new product development (Moorman and Miner, 1997). Technology turbulence may also have an impact upon the relationship between environmental scanning and new product development. More turbulence makes scanning more critical, so the impact of environmental scanning on NPD success would be greater in more turbulence markets. Certainly more rapidly changing environments would cause at least some companies to use more environmental scanning.

The simple model is probably appropriate for examining these issues throughout developing Southeast Asia. Thailand is a representative context – it is middle-income, has a strong SMEs sector, but is still partially shielded from full competitive pressure in the global economy. In as sense, Thailand leads other countries in Southeast Asia in the food processing sector, without being completely separate from them in practice. Nguyen *et al.* (2001), for example, argues that, because of turbulent business environment, Vietnam' SMEs will need to be proactive and innovative to remain successful.

FIGURE 2 ENVIRONMENTAL SCANNING, TECHNOLOGY STRATEGY, TECHNOLOGY TURBULENCE, AND NEW PRODUCT DEVELOPMENT

MANAGERIAL IMPLICATIONS

The results of the in-depth interviews suggest that environmental scanning practices have an influence on NPD of SMEs. Moreover, the company's technology strategy (leader, fast-follower, follower, exploiter, and extender) influences their use of scanning and probably how much scanning can have an impact on NPD. Further, the degree of technology turbulence similarly is likely to influence how much environmental scanning can contribute to success in NPD of SMEs.

SMEs, which have already been successful in developing new product, need to continue their practices of environmental scanning for upcoming new product development (particularly about texture/stickiness, taste, color, seasoning, and hygiene). With the changing environmental factors, consumers continually come up with new ideas about what they want, and technology continually comes up with new ways to provide it better. The need for environmental scanning is likely to intensify as technological change accelerates and more companies learn the advantages of scanning. The level of scanning that gives competitive edge today may become routine in the future. Therefore, in order to design and launch new product successfully, SMEs have to continuously develop their environmental scanning processes in order to successfully fit NPD with the changes of consumption

characteristic and technology on time. They also need to be aware that highly turbulent technology environments may be harder to predict, and thus require even closer attention. They need to adjust their environmental scanning practices towards NPD in order to serve changes of consumer demand on time with the best technologies.

Only a few Thai companies are successful as fast followers in technology strategy. To become one of these, companies need a considerable amount of R&D investment as well as investment in scanning processes, and long-term experience in the particular industry in order to develop their expertise in any technological development field. Large companies diversified across many food products can support such continuous huge investment amount, but our research shows that some SMEs can do it too by staying narrowly focused. The Konyac company, for example, is quite advanced in Konyac technology, but it does not spread its R&D efforts much more broadly. Companies including SMEs who are capable of being technology fast followers need environmental scanning as a critical element in the success of the strategy. If they do it well, they have the potential to be more successful than most others in designing and launching new products; i.e. NPD can become strategic, rather than tactical.

CONCLUSIONS

This research aims at understanding the relationships between the environmental scanning process and new product development by looking at the impact of technology strategy and technology turbulence. It focuses on only qualitative research, which is often viewed as appropriate only for exploratory purposes. However, several constraints may limit the results of his study. Only eleven persons were interviewed in this study. While small sample qualitative interviews are often the best way to explore concepts, additional research with a greater number of respondents is needed to confirm results and statistically test the proposed model more thoroughly. The qualitative work shows that it is feasible, but larger scale quantitative research is necessary to demonstrate the statistical relationships.

Further quantitative research would be beneficial to examine the frequency of usage of specific environmental scanning objectives, factors, and sources of information to examine which specific elements have the most impact on successful designing and launching of new products., under different technology strategies and technological turbulence. It would also be useful to examine the differences in NPD activities and processes between small, medium, and large organizations. While our research shows that SMEs can be quite proactive in technology strategy, use environmental scanning well, and have very good NOPD, they rarely have sufficient resources to do it exactly they way large companies with more resources do. In the food sector in Thailand, this includes linking market and sensory information generated by the consumers, and identifying desired product attributes required by specific target markets. How to best keep track of technological developments is

somewhat problematic, however. Supplier linkages are somewhat weak in the Thai food processing industry (Suwannaporn and Speece, 2003).

Within these limitations, however, this paper does demonstrate the influence of environmental scanning practices on successful and less successful NPD of the Thai SMEs food industry. SMEs use environmental scanning to keep track of both local and foreign markets. NPD remains a key competitive advantage issue for some SMEs in the food industry as they enter an increasingly competitive and turbulent environment locally and internationally with technology changing rapidly. This research has shown that the interviewees recognize the importance of environmental scanning practice to the NPD for their growth and survival. Moreover, SMEs who are capable of being fast follower in technology strategy view long term prospective for planning. This means that they scan not only to achieve sales target but also to assess long-term demand. Their successful new product development for market expansion in the form of joint ventures and franchising requires them to scan the appropriate environmental factors in order to identify the issues of industrial market on time. They need to scan rapid information flow from the appropriate sources of information. Thus, companies need to define clearly their environmental scanning objectives, factors, and sources of information in order to successfully design and launch new products into the market (Ngamkroeckjoti, 2000).

Finally, the qualitative results suggest that SMEs who continually practice of environmental scanning have potential to be successful in developing new products. Moreover, more proactive technology strategy leads SMEs to implement better environmental scanning process – environmental scanning seems to be a necessary element of very proactive technology strategy. Likewise, a higher degree of technology turbulence probably forces company that use environmental scanning to use it more to remain competitive.

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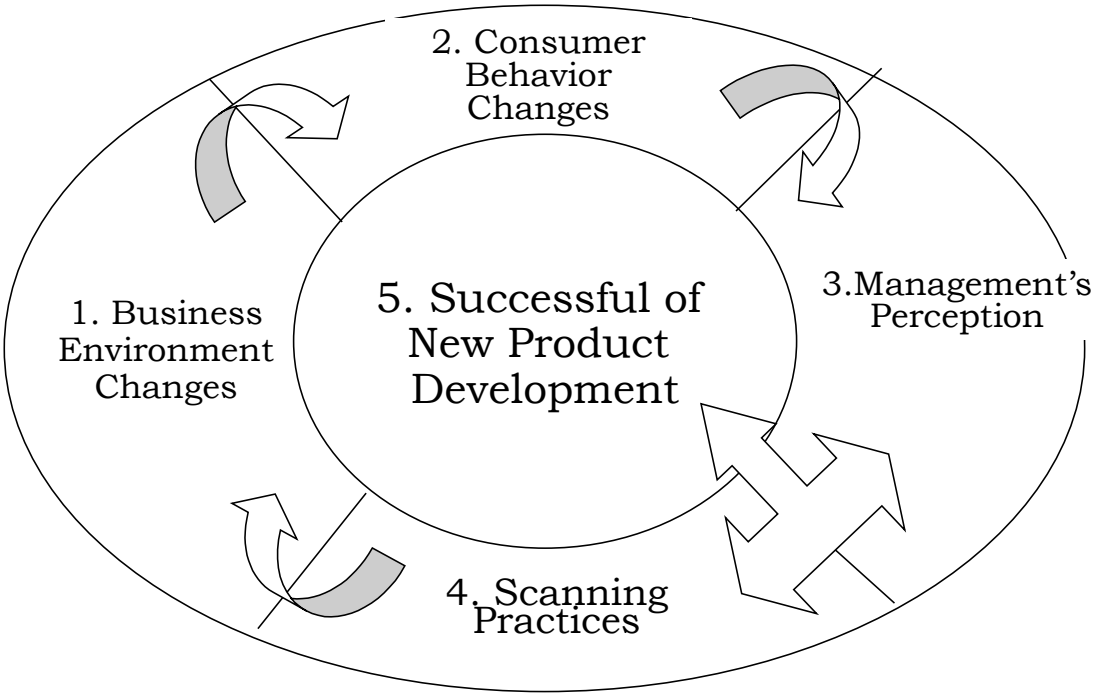

FIGURE 1 NEW PRODUCT DEVELOPMENT OF PAST RESEARCH FROM 1980S TILL PRESENT

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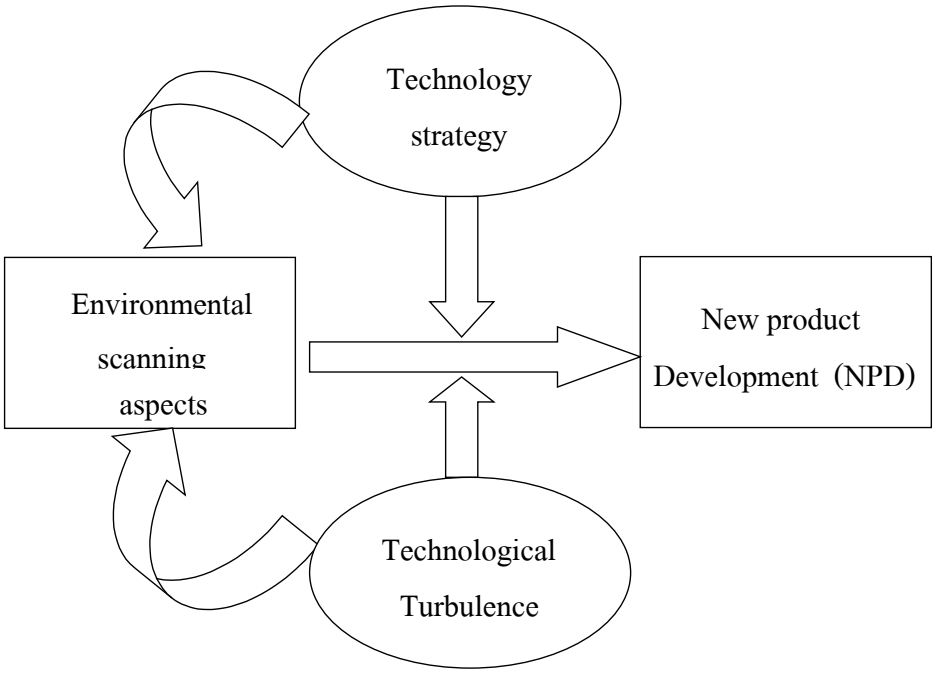

FIGURE 2 ENVIRONMENTAL SCANNING, TECHNOLOGY STRATEGY, TECHNOLOGY TURBULENCE, AND NEW PRODUCT DEVELOPMENT

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Environmental Scanning and New Product Performance: The impact of technology turbulence

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ABSTRACT

To play a role of a food technology leader, the Thai SMEs has to scan turbulent changes of technology and design concrete technology strategy in order to sustain competitive advantage by developing new product in the South East Asia region. A conceptual model is developed to test the three hypotheses. This quantitative study was conducted to examine the relationship among technology turbulence, technology strategy, and environmental scanning. Also, the relationship between environmental scanning practices and new product development is developed. Technology turbulence plays a significant role towards environmental scanning practices. Also, without environmental scanning practices, new product may have difficulties to develop.

1. INTRODUCTION

Hill and Jones (2004) stated that new product development (NPD), driven by customer needs is a major competitive advantage across tight functional integration. Small- and medium-enterprises (SMEs) in the Thai food industry has highly aware of such changes. For example, food producers are aware to increase their investment along with upgrading food safety standards demanded by European Union (EU) and the United States (The Nation newspaper, 2003). To sustain these competitive advantages in the global business, we need to know how much Thai SMEs practices their environmental scanning process.

Wheelen and Hunger (2004) stated that companies should consider societal environment as high strategic factors to specifically defines opportunities and threats of their future growth. Changes of technology especially towards natural resource availability, part of societal environment, create a great impact on the food sector. In the South East Asian region, where a lot of environmental changes occurred, Thailand has to catch up with those changes by developing high skills especially of technology in order to successfully and globally developing new product.

However, little research has been exposed to a certain extent of the influence of the level of technological changes on environmental scanning practices. This research defines level of technological changes clearly by technology strategy and technological turbulence. Therefore, a major part of this research investigates the impact of technology strategy and technological turbulence on environmental scanning practices of SMEs in the Thai food industry. In addition, the influence of environmental scanning practices is shown on new product development.

2. SUCCESS FACTORS OF ENVIRONMENTAL SCANNING PRACTICES AND NEW PRODUCT DEVELOPMENT

2.1 Technology Strategy and Environmental Scanning Practices

Most recent research investigates the influence of technology strategy on either the corporate or the business strategic levels. During 1990s, several research examined the relationship between technology strategy and business strategies. Zahra *et al.* (1994) studied the relationship between globalization of technology strategy and different types of competitive strategy. In addition, they defined technology strategy, based on of literature in various dimensions. They are for example technological innovation posture, dominant technological thrust and goals, globlaization of technology strategy, technology sourcing, technological investments, and organizational mechanisms. At the same time, the definitions of types of business strategies are defenders, cost leadership, analysers, cost differentiation, and prospectors. Later in 1997, Zahra and Bogner (1997) examined the influence of environmental moderators on different dimensions of technology strategy of the U.S.-based software firms. Their research highlighted key dimensions of technology strategy which are radicality, intensive product upgrades, research & development spending levels, external sources, and copyrights and other means of intellectual capital protection. Environmental moderators in this research are dynamism, hostility, and heterogeneity. The results indicate that companies should scan their external environments in order to analyze more accurate information regarding to their conditions of market, competition, and the appropriate technology strategy. Moreover, managers need to tap external sources of information in order to constantly innovate and examine new technologies for their products.

Cooper (2000) defined technology strategy specifically in his model as strategic master plan that guides your business's new product war efforts. His concept is that product innovation and technology strategy (PITS) drives successfully new product and process development. Relating to generic strategies, prior research confirms that it directly imply for technology strategy and for the focus on product or process innovation (Oswald and Nelson, 2000). However, more research is required to specifically examine how much these two factors are actually related.

Sharif (1994; 1997) integrated the plausible four technology strategy to four business strategies dimensions as a business grew through product life-cycle characteristics. His 1994 study concentrated on the context of developing countries like South Korea and Indonesia. He found that the start-up enterprises have two alternative business strategic options: - technology leader and technology extender strategies. At the growing stage, companies have three strategies: - technology leader, follower, and exploiter strategies. At the mature enterprise, the strategic options are technology exploiter and technology extender. He concluded that through the technological integration into the business strategic planning, companies have greater potential to become successful in strategic development process. Companies should set priorities, identify the critical success factor, and focus improvement efforts on technology capability for producing better-quality products at lower costs to the marketplace. In his further 1997 study, he stated that only with the technological self-reliance, companies in the developing countries has greater potential to compete in

both domestic and international markets than the others that do not. Still, it is little study to define exactly how technology strategy impact upon environmental scanning practices.

At the corporate level, Ryan (1996) examined how successful manufacturing firms in Australia in formalizing the incorporation of technology strategies into corporate plans will be. He concludes that the priority work of corporation is to link technology to corporate policy and develop an understanding of technology strategy in terms of conceptual and analytical work. Also, he determines that technology strategy is an implicit context through all aspects of corporate policy. This means that innovation and leading-edge technology are the top priority in meeting customer requirements.

Within the corporate strategic architecture of the three Italian firms, Chiesa and Mazini (1998) propose the model related the technology strategy process to the development of a unique and distinctive set of technological resources that allow the firm to attain a sustainable competitive advantage through redefine the dynamic context.

In Italy, Airaghi (1998) found that company mostly considered technology as competence. For example, Finmeccanica is a good example in relating technology strategies to industrial strategies. The company is the second largest manufacturing group in Italy and the first high-tech sector in various fields (aerospace, energy, defence, transport, and automation). Finmeccanica built up and decentralized research laboratories all over the world. This decision allows key competence through technological areas: - information technology, systems engineering, materials, mechanics and electronics.

At the US long-term corporate strategy, Greenwald and Rudolph (1996) suggest a scenario technique for analysing the successful long-term technology investment in developing new product. Firms should identify driving forces through science/technology, political/economic, consumer/social, industry/market, regulatory, and uncertainties then analyse. Scenario of product and market scope should include complementary and/or substitute products, as well as those of suppliers and customers.

Even in the 1999 trading press, the team of Gylde industrial engineering and business specialists commented that technology strategy is a subset of corporate strategy. Technology strategy should help firms to address technologies to develop, cost to achieve organizational goals, technological leadership, and new technology developments.

Under environmental uncertainties, a simple classification of generic technology strategies including fast-follower, follower, exploiter, and extender leads to create competitive strategies. As a consequence, companies should practiced environmental scanning aspects like objectives, factors, and sources of information prior to create competitive advantage. Thus, we therefore hypothesize,

H1: Proactive technology strategy of firms will lead to greater practices of environmental scanning objectives, factors, and sources of information.

Author/Year	*Concept*	*Target sample*	*Conclusions*
Industrial or Corporate strategy			
Ryan, N. (1996)	Compare technology strategy of local, successful, export manufacturing firms in Australian context with international literature in USA and Europe.	Australian firms	Conceptualization of technology policy in the regional economies to allow modification according to the business conditions, which apply within regional economies.
Airaghi, A. (1998)	The relationship between Technology strategy and industrial strategies	Finmeccanica – the second largest manufacturing group in Italy and the first in the high-tech sector	Decentralzed to allows distribution of key competence.
Chiesa, V. and Manzini, R. (1998)	Create framework to formulate a dynamic technology strategy in the corporate level strategies	Three large companies : -Kodak, Canon, and Philips	Relate technology strategy process to develop of a unique and distinctive set of technological resources in order to allow sustainable competitive advantage.

Table **1** **-** *Literature reviews indicate technology strategy in the industrial or corporate strategy*

Industrial or corporate strategy in press	
Author/Year	*Comment*
Greenwald and Rudolph (1996)	Team develops scenarios to identify product or market segmentation, changes industry profile, and new policy issued by governmental regulations.
Glyde team of industrial engineernig and business speacilists (1999)	Technology strategy must be continually upgraded in order to maintain market shard against primary technology movers.

Table 2 – Presses indicate technology strategy in the industrial or corporate strategy (continued)

Author/Year	*Concept*	*Target sample*	*Conclusions*
		Business strategy	
Zahra, S.A. *et al.* (1994)	The development of technology strategies and firm's competitiveness to reap the benefits of adopting or investing in technology.	The paper refers to many large companies, such as NEC, Microsoft, Motorola, Sony, General Motors, General Electric, etc.	The possible linkage between competitive and technology strategies, using a hybrid typology that combines previous classifications.
Cooper, R.G. (2000)	Create framework to identify the linkage product innovation & technology strategy (PITS) to portfolio management and new product process.	160 businesses	PITS specifies strategic arenas and thrust of a new product strategy. Strategic arenas comprise types of markets, applications, technologies and products – on which the business's new product effort will focus.
Sharif, M.N. (1994)	Describe the framework for integrating business and technology strategies in the context of developing countries.	Five Indonesian firms (UNDP/UNESCO: PT.IPTN (aircraft); PT.KRAKATAU (steel); PT.BARATA (construction); PT.INTI (telecommunication); and PT.INKA (railways).	Leading enterprises integrate technology strategies into business strategies to produce better-quality products at lower costs onto the marketplace.

Table 3 - literature reviews related to technology strategy to business strategy

Author/Year	*Concept*	*Target sample*	*Conclusions*
Business strategy (continued)			
Sharif, M.N. (1997)	Create framework for establishing an integrated technology-based competition strategy in developing countries to increase competitive advantage.	Four case studies from South Korea (Hyundai – Automobile, POSCO – iron and steel aircraft) and Indonesia (PT. IPTN – aircraft, PT.Krakatau - iron and steel).	Self-reliance enterprises who can integrate technology into their strategy have greater potential to be successful in the competition.
Zahra, S.A. and Bogner, W.C. (1999)	They examine the impact of environmental factors on the relationships between technology strategies and new venture performance.	581 microcomputer software producers	The active scanning of environmental factors especially competition has an impact upon the relationship between technology strategy and new venture performance.

Table 4 - literature reviews related to technology strategy to business strategy (continued)

2.2 Technological turbulence and environmental scanning practices

Following to definition of Kohli and Jaworski (1990) and Jaworski and Kohli (1993), technology turbulence is 'the rate of change of the entire process of transforming inputs to output, and the delivery of those outputs to the end consumer.'

During 1990s, the research signification of technological turbulence is highly distinguishable role from other macro-environmental factors towards the successful business performance. Most research found that technological turbulence moderates the relationship between market- or export market-orientation and business performance (Jaworski and Kohli, 1993; Appiah-Adu, 1997; Cardogan *et al.,* 2003). Others found that technological turbulence moderates the relationship between interdepartmental organization and new product performance (Menon *et al.*, 1997; Moorman and Miner, 1997). Only Morgan (1999) examined the direct impact of technological turbulence upon export strategy.

Comparable results shown in domestic business performance, technological turbulence did not moderate UK small business market orientation-performance relationship. As small firms have limited resources, thus they may not be affected from such turbulent changes (Appiah-Adu, 1997). Neither US large business, regardless of technological turbulence US managers should put their effort to improve market orientation to achieve business performance (Jaworski and Kohli, 1993). In export business performance, Cardogan *et al.* (2003) found that under conditions of either high or low technological turbulence, export market orientation behavior may have positive impacted upon export growth and sales.

Menon *et al.* (1997) found the strongly moderated by technological turbulence towards the relationship between interdepartmental conflict and product quality in US firms. Moorman and Miner (1997) also found the dispersed effect of technological turbulence towards the association of organizational memory and product creativity. Different from Morgan (1999), he proposed the conceptual arguments of the relationship between perceived technological turbulence in the domestic market and export strategy development at the pre-export level. Due to stiffer competition of food production amongst SMEs whose sales yield for both domestic and export businesses, technology turbulence is considered as an important factor towards newly and globally developed food product performance. Besides, when companies perceived more turbulence, they may see more need for scanning information. Thus, technology turbulence may have a direct impact upon environmental scanning practices of Thai SMEs. Hence:

H2: Greater perception of high technological turbulence will lead to greater practice of environmental scanning objectives, factors, and sources of information.

Author/Year	*Concept*	*Target sample*	*Conclusions*
Jaworski and Kohli (1993)	This research examines why are some organizations more market-oriented than others and what effect does a market orientation have on employees and business performance.	222 US member companies of Marketing Science Institute (MSI)	market orientation of a business is an important determinant of business performance regardless of the technological turbulence of the environment of which it operates.
Appiah-Adu (1997)	This study examined whether market-orientation links to small business context and explores the potential influence of market growth, competitive intensity, market and technological turbulence on any relationship identified.	132 UK small firms	There is positive impact of market orientation upon small business performance. Moreover, there is mixed effect of the competitive environment on the market orientation-performance relationship.
Cardogan (2003)	This study examines the issue of how export market-oriented behaviors influence export success.	Hong Kong based manufacturing exporters	export market-oriented behaviors are important predictors of several dimensions of export performance.

Table 5 Literature reviews indicate the relationship between technological turbulence and several variable factors

Author/Year	*Concept*	*Target sample*	*Conclusions*
Morgan (1999)	Proposed the conceptual arguments of the relationship between perceived technological turbulence in the domestic market and export strategy development at the pre-export level.	None	This paper has cited the conceptual arguments underlying three propositional statements regarding the nature of association between competitive intensity, technological turbulence, and product-market turbulence.
Menon *et al.* (1997)	This study examines the role of organizational factors affecting interdepartmental interactions and their subsequent effects on product quality.	222 US member companies of Marketing Science Institute (MSI)	Product quality is affected by inter-deparmental conflict and connectedness.
Moorman and Miner (1997)	This paper argued that whether organizational memory affect key new product development process by influencing the interpretation of incoming information and the performance product action routines.	92 new product development projects	If organization fails to understand the subtle ways in which different features of organizational memory influence product development, they fail to harvest the full value of organizational learning.

Table 6 Literature reviews indicate the relationship between technological turbulence and several variable factors (continued)

2.3 Environmental scanning and new product development

Hise and Groth (1995) examined the effectiveness of external environmental assessment to develop new products successfully. Consequently, they create framework to develop external environmental profiles in order to develop new product. Moreover, they provide guidelines for environmental scanning programs in order to help managers to develop new product more successfully. Moreover, Ahituv *et al.* (1998) explored how Chief Executive Officer (CEOs) use information systems in their decision making as a tool to scan the successful new products. A very little research had been examined the direct effect of environmental scanning and new product development of SMEs. Thus,

H3: Greater practices of environmental scanning will lead to higher success rates of NPD.

This study aims to highlight how Thai SMEs practices environmental scanning in order to satisfy the successful new product development. Moreover, how technology strategy and technology turbulence affect environmental scanning practices. *Figure 1* below shows the development of prior researches (Ngamkroeckjoti *et al.,* upcoming). They are accordingly aware of the changes of environment, of consumer behavior, of management perception, and of new product development trend.

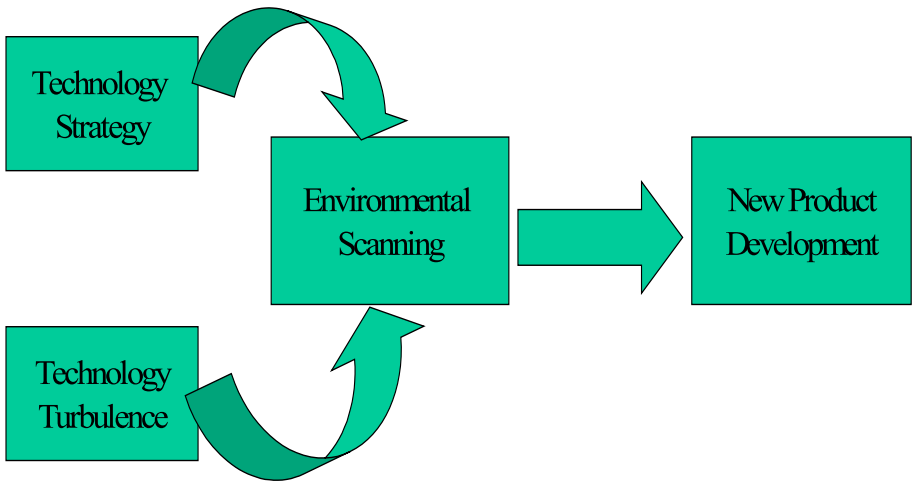

Figure 1 - Technology strategy, technology turbulence, environmental scanning practices, and new product performance

3. METHODOLOGY

There are total three major steps to collect primary information. Prior to step one, the *expert opinion method* was in practiced in order to define the meaning of successful of NPD and which companies in their point of view are succeeded in terms of NPD. In so doing, seven organizations, all of which are

food-related organizations, were contacted for a face-to-face interview with their top executive and senior manager. Out of all the seven organizations, some belong to government whereas some are private. Prior to determining which companies to use in the samples, the pilot in-depth interviews were conducted with twelve experts to determine criteria for identifying successful new product development in the food processing industry listed in Table 7 shown next page.

Organization	*Public/private organization*	*Position*
1. Institute of Food Research and Product Development (Kasetsart University)	Public university	Director and another NPD expert
2. National Food Institute (NFI)	Government agencies	Director and an assistant
3. Thai Food Processors' Association	Private organization	President
4. Food Science and Technology Association of Thailand (FoSTAT)	Public organization	President and an assistant
5. Thai Frozen Foods Association	Private organization	Manager
6. The Federation of Thai Industries (FTI)	Government agencies	Two Managers
7. National Science and Technology Development Agency (NSTDA)	Public organization	Two Managers

Table 7 Seven organizations participated in personal interviews for a preliminary study

Four out of seven organizations, the interviews were conducted with their president or director. Three interviews were conducted with a manager. All interviews were face-to-face conducted and based on *structured questionnaire*, using *open-ended questions*. Interview lasted approximately from one to one and a half hour and was followed by specific questioning concerning different, but related topics. These questions helped better understanding of market overview both domestic and export as well as the current situation of food industry and NPD in Thailand. Since all interviews were conducted at exclusive locations (interviewees' office), interruptions could be minimized. After completion of all interviews, lists of companies in stage 1 was developed.

Primary data was collected in three steps shown as the following: -

Step 1: Multiple in-depth interviews with *semi-structured questions* with three case studies chosen as case studies, supplemented with company documentation. These three successful NPD companies were analyzed to examine the role of environmental scanning, technology strategy, and technology turbulence in their NPD practices.

Step 2: Another three unsuccessful NPD companies have been exposed through qualitative analysis using *in-depth interviews*. As a insightful result based on interview, the contrast and greater number of technological issues will be critically revealed. As such, the three factors of technology strategy, environmental scanning aspects, and new product development practice were defined in detail for the Thai context, and the feasibility of the working theoretical model was assessed. A total of eleven respondents across the six SMEs, who were owners, managing directors, senior managers, and assistant manager from marketing, production, and R&D departments were interviewed. Also, along with several follow-ups to obtain more information has been done to complete question during research process (Ngamkroeckjoti *et al.,* upcoming).

Step 3: Quantitative analysis using mail survey will be distributed to SMEs in Thailand to test, justify and compare the intensity of these factors application. The sample frame derived by the total population of SMEs lists from the National Food Industries (NFI) and Institute for Small and Medium enterprises Development (SMEs) in Thailand. In 2000, the total number of small and medium food companies are listed approximately 5,904 companies (Department of Industrial Works, Ministry of Industry). The sample will select from lists of food companies whose product is semi-processed or processed excluding ricemill. The random sample is based an analysis on 20 percent of response rate from the total 2,195 companies (Suwannaporn, P. and Speece, M., 2003). The mail survey listed covers the parent company and subsidiaries whose product focus only on semi-processed and processed food. Data collection period is listed in Table 1 shown in the next page. The pre-testing stage has been done in the first three days at the SMEs fair. Questionnaire is adjusted by cutting out the environmental scanning technique for analysis. Also, the word is rewritten to be more localized used language in order to make the audience more understandable. All questionnaires are decisively distributed in Thai language. The actual response from the mail survey is only 9% because of changes of address, no receiver, and many businesses have been dissolved. Based on different organizer of exhibition, there is little problem of similar SMEs respondent in answering questionnaire. The reliability had been tested after the first 32 questionnaires at the SMEs fair conducted by Department of industrial promotion. Table 8 below shows valid reliability coefficients of each variable during the period of both 30 pre-testing and after completing the 124 surveys.

Variables	*Reliability of 30 pre-testing surveys (cronbach's alpha [a])*	*Reliability of 124 surveys (cronbach's alpha [a])*
New product development		
New product performance (question # 2)	0.82	0.88
Successful factors of New Product Development (question # 3)	0.88	0.77
Environmental scanning practices		
Environmental Scanning Objectives (question # 4)	0.78	0.81
Environmental scanning factors (question # 5)	0.82	0.83
Environmental scanning sources of information (question # 6)	0.83	0.77
Technology turbulence		
Technology turbulence (question # 8)	0.74	0.82
Overall Reliability of question # 2-6 and 8	*0.90*	*0.89*

Table 8 Reliability test of variables

[a] Cronbach's alpha or Cronbach's coefficient alpha access the internal consistency reliability of their instrument that had different scoring and response scales (Kerlinger and Lee, 2000, pp. 650)

Composite variable

Most variables have composite variables. Environmental scanning practices have three composite variables: - objectives, factors, and sources of information (see Appendix 3). New product development has two composite variables: - new product performance and time to success (see Appendix 2) while technology turbulence has only one composite variable (see Appendix 3). Technology strategy has four categories: - fast-follower, follower, exploiter, and extender (see Appendix 3). We compute mean of each sub-dimension of an individual variable. Table 9 shows composite variable of technology turbulence, environmental scanning objectives, factors, sources of information, new product performance, and time to success.

Variable factors	*Composite variables*
Environmental scanning	Mean [environmental scanning objectives (Question # 4), factors (Question # 5), and sources of information (Question # 6)]
New product performance	Mean [performance (Question # 2), and time to success (Question # 3)]
Technology turbulence	Mean [technology turbulence (Question # 8)]
Technology strategy	Categorical variables (fast-follower, follower, exploiter, and extender

Table 9 Composite variables used as of Figure 1

We compute the mean of environmental scanning, new product performance, and technology turbulence (see Table 10-13) prior to analyse through linear regression approach.

Variables of new product performance	*Mean*	*Std. deviation*
1. Sales volume	2.97	1.10
2. Growth rate	3.15	1.14
3. Turnover rate	3.08	1.11
4. Customer acceptance	3.48	1.10
5. Market share	3.00	1.02
6. Payback of investment	2.80	1.00
Subtotal Mean of new product performance	*3.08*	*0.85*
Variables of time to success of new product performance	*Mean*	*Std. deviation*
1. Sales over break even immediately	2.90	0.94
2. Sales achieve within 6 months - 1 year	3.22	0.85
3. Sales achieve within 1.01 - 3 years	3.39	0.84
4. Sales achieve more than 3 years	3.35	1.02
Subtotal of time to success of new product performance	3.22	0.71
Total Mean	**3.15**	**0.63**

Table 10 *Mean and standard deviation of time to success of new product performance*

Variables of environmental scanning objectives	*Mean*	*Std. deviation*
Predict future driving forces	3.45	0.85
Raise manager's awareness	3.77	0.87
Formulate strategy	3.77	0.86
Adjust the strategies of the co	3.92	0.86
Assess the impact on fin goals	3.69	0.89
Analyse trends of industry	3.74	0.88
Act as an early warning system	3.35	0.94
Generate a set of scenarios about the behavior of environment	3.12	1.02
Subtotal of environmental scanning objectives	*3.60*	*0.60*
Variables of environmental scanning factors	*Mean*	*Std. deviation*
Global economic factors	2.97	1.17
Asia-Pacific economic factors	3.00	1.02
Thailand economic factors	3.31	1.08
District economic factors	3.31	1.09
Global technology factors	3.08	1.08
Local technology factors	3.26	0.96
Legal factors	3.29	1.07
Political factors	2.94	1.07
Socio-cultural factors	3.31	1.16
Competition factors	4.06	0.99
Subtotal of environmental scanning factors	*3.25*	*0.67*
Variables of environmental scanning sources of information	*Mean*	*Std. Deviation*
Publication	3.31	0.99
Public organization	3.44	1.04
Local and foreign customers	3.78	0.94
Local and foreign suppliers	3.27	1.04
Local and foreign competitors	3.58	1.11
Information from consult company	2.71	1.19
Seminars/ Exhibitions/ Conferences	3.15	1.07
Trade associations	2.69	1.97
Co-partner company cooperation	2.70	1.09
Relationships between friends/relatives locally or abroad	3.15	1.10
Subtotal of environmental scanning sources of information	*3.18*	*0.61*
Total of environmental scanning practices	**3.34**	**0.51**

Table 11 *Mean and standard deviation of environmental scanning sources of information*

Variables of technology turbulence	*Mean*	*Std. deviation*
Changes in Technology in product group	3.14	1.12
Changes in Technology in product process in NPD	3.30	1.10
Changes in Technology in R&D in NPD	3.36	1.03
Changes in Technology in R&D in product process	3.35	1.07
Opportunities	3.66	1.01
Forecast technology in 5 years ahead	3.16	1.04
New product ideas succeed through technology breakthrough	3.55	1.05
Total of technology turbulence	**3.36**	**0.82**

Table 12 Mean and standard deviation of technology turbulence

Variables of technology strategy	*Frequencies*	*Cumulative percentage*
Fast Follower	23	18.5
Follower	51	59.7
Exploiter	9	66.9
Extender	41	100
Technology strategy (fast-follower, follower, exploiter, extender)	124	

Table 13 Frequencies and cumulative percentage of technology strategy

4. SURVEY FINDINGS

4.1 Multiple Regression analysis

4.1.1 Technology strategy and technology turbulence & environmental scanning practices

There is a high degree of association and positive coefficient relationship between the technology turbulence and environmental scanning practices, namely objectives, factors, and sources of information. Significant f is 0.000, and beta coefficient is 0.26 (+). Companies who have expressed concern about the technology turbulence emphasize environmental scanning practices more than others do. Table 14 below shows the significant figure of the relationship between technology turbulence and environmental scanning practices.

Data measurement of technology strategy is in the form of category variable. Thus, we transform those categorical data into dummy variables. In our output, the follower category represents the

baseline. Exploiter or extender was combined into a single category because there were not many extenders and the qualitative work indicated that they operate very similarly. Also, the dummy variables representing technology strategy is insignificant, including no relationship between technology strategy and environmental scanning practices.

	Unstandardized Coefficients (B)	*Std. Error*	*Standardized Coefficients (Beta)*	*t*	*Sig.*
(Constant)	2.86	0.20		14.536	0.000
V8mean	0.16	0.06	0.26	3.003	0.003
dummy for fast follower	-0.12	0.13	-0.09	-0.969	0.33
dummy for exploiter and extender	-0.11	0.10	-0.11	-1.142	0.26

a Dependent Variable: ESMEAN

Table 14 *Multiple regression analysis between technology strategy andenvironmental scanning practice*

To examine the companies' focus on components, we find mean of all sub-components of technology turbulence in order to divide into three scales: - low turbulence, medium turbulence, and high turbulence based on the percentage ratio of 40:40:20 (see Table 15 and 16). We use ANOVA to test at which practices of environmental scanning should be associated when turbulent changes of technology occurred.

	scale	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.57	1	.8	.8	.8
	1.71	1	.8	.8	1.6
	1.86	1	.8	.8	2.4
	2.14	5	4.0	4.1	6.5
	2.29	4	3.2	3.3	9.8
	2.43	4	3.2	3.3	13.0
	2.57	9	7.3	7.3	20.3
	2.71	4	3.2	3.3	23.6
	2.86	8	6.5	6.5	30.1
	3.00	11	8.9	8.9	39.0
	3.14	4	3.2	3.3	42.3
	3.29	7	5.6	5.7	48.0
	3.43	7	5.6	5.7	53.7
	3.57	6	4.8	4.9	58.5
	3.71	8	6.5	6.5	65.0
	3.86	12	9.7	9.8	74.8
	4.00	9	7.3	7.3	82.1
	4.14	10	8.1	8.1	90.2
	4.29	4	3.2	3.3	93.5
	4.43	3	2.4	2.4	95.9
	4.57	2	1.6	1.6	97.6
	4.71	1	.8	.8	98.4
	5.00	2	1.6	1.6	100.0
	Total	123	99.2	100.0	
Missing	**System**	**1**	**.8**		
Total		**124**	**100.0**		

Low turbulence

Medium turbulence

High turbulence

Table 15 *Mean of sub-components of technology strategy*

Variable factors	Environmental scanning aspects		
	Objectives Parameters (sig.)	**Factors Parameters (sig.)**	**sources of information Parameters (sig.)**
Technology turbulence (sig.)	0.157	0.021	0.038
Base high turbulent	-	-	-
Medium parameter	-0.205 (01.166)	-0.289 (0.006)	-0.188 (0.214)
Low parameter	-0.288 (0.055)	-0.467 (0.079)	-0.384 (0.013)

Table 16 *ANOVA of technology strategy & technology turbulent and environmental scanning*

Result in Table 16 shows that there is significant relationship between technology turbulence and environmental scanning factors and sources of information. In other words, the higher the turbulence of technology, the higher impacts on changes of environmental scanning factors and also on sources of information. On the contrary, the lower the turbulence of technology, the lower impacts on changes of environmental scanning factors and also on sources of information.

4.1.2 Environmental scanning practices and new product development

Table 17 next page shows that there is a high degree of association and positive coefficient relationship between environmental scanning practices, namely objectives, factors, and sources of information and new product development. Significant f shows 0.000 and beta coefficient is 0.317 (+). Companies, who have expressed concern about the practices of environmental scanning, emphasize the development of new product successfully more than others do.

	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t	Sig.	95% Confidence Interval for B	
						Lower Bound	Upper Bound
(Constant)	1.824	.362		5.035	.000	1.107	2.541
ESMEAN	.396	.107	.317	3.692	.000	.183	.608

a Dependent Variable: NPD

Table 17 Regression analysis between environmental scanning practice and new product development

5. RESULTS AND DISCUSSION

Only hypotheses two and three provide significant relationship while the first shows insignificance as a result. Firstly, there is significant relationship between technology turbulence and environmental scanning practice. This result indicates that technology turbulence has influenced on environmental scanning practice of SMEs in the Thai food processing industry. This result indicates that SMEs who are aware of the great turbulent changes of technology should emphasize on environmental scanning practice in developing competitively new product onto both local and foreign markets. In other words, the awareness of technology turbulence helps SMEs to develop better practices of environmental scanning.

Secondly, similar result as Hise and Groth (1995) research shown, companies who emphasize on environmental scanning practice have greater opportunities to successfully develop new product onto the market. However, scope of this research specifically focuses on environmental scanning of SMEs affect successful new product development while Hise and Groth (1995) evaluators from various sizes of companies.

Finally, an insignificant relationship result between technology strategy and environmental scanning practice has been illustrated in Table 14. This indicates that no matter how proactive technology strategy of firms is, little had affected to environmental scanning practice.

6. CONCLUSIONS

Through quantitative methodology, this research examines the three relationships: 1) technology strategy and environmental scanning; 2) technology turbulence and environmental scanning; and 3) environmental scanning and new product development. Only two relationships show the significance. The first is the relationship between technology turbulence and environmental scanning. The more rapidly turbulent changes of technology lead companies to use environmental scanning more extensively. Also, these changes caused scanning different components of environmental scanning aspects. The second relationship between environmental scanning and new product development is significant. Companies should scan environment, thus key issues is exactly what components of environment they should focus on.

There is an insignificant relationship between technology strategy and environmental scanning practices. However, after adjust scale measurement more properly, there is needed to further test this relationship again.

7. Limitation of research

This research focuses on quantitative methodology, which confirms the results of the qualitative methodology in the previous research (Ngamkroeckjoti *et al.*, upcoming and Ngamkroeckjoti, *et al.,* upcoming). The relationship between technology strategy and environmental scanning is insignificant. This can be as a result of bias towards the understanding of proactive technology strategy. More specifically, respondents may confuse the meaning of proactive technology strategy especially follower, extender, and exploiter. Respondents whose technology strategy degree is technology exploiter may choose follower. Likewise respondents whose technology strategy degree is technology exploiter may choose extender. However, some respondents whose technology strategy is follower may choose the right one. Similar result may happen to the understanding between extender and exploiter. Therefore, data is scattered and untrue results are shown. Other limitations are the specific time and scope of research. The time spent in data collection is during 2003 period only. Scope of this research focus on only food processing industry in Thailand.

8. Future research

Further study may focus on the selected industries, which have highly involved in technology, particularly telecommunications, beverage, and finance industries. Technology strategy in literature is subjectively concept and no quantitative measurement shown. The simple scale we use has some problem, which we learned during follow-up interview after survey data was shown. Thus, future research should quantify studies by develop better scales. The concept of technology strategy in literature should be developed.

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Appendix 1 Definition of Variables

Variables	Concept Definition
New Product Information	
New Product Name	A title or brand name given to a new product.
Times Spent on Designing and Launching Process	Duration of designing and launching process of a new product (in years).
Period of Launching New Product to Market	A time in which a new product is launched into the market.
New Product Performance (NPP)	
Sales Volume	The amount of products sold (Phongthammarug, 2000).
Sales Growth	The percentage of change in sales volume of a product during a period of time, usually one year (Song and Parry, 1997b).
Market Share	The percentage of sales of a product relative to total sales in the same product category (Cooper and Kleinschmidt, 2000).
Return on Investment (ROI)	A profitability ratio that measures the overall effectiveness of management in generating profits within its total assets. (Cheasakul, 2000)
Scanning Sectors in the Societal Environment	
Economic Sector	The nature and the direction of the economy in which a firm competes or may compete (Hitt *et al*., 2002).
Technological Sector	Includes the institutions and activities involving with creating new knowledge and translating that knowledge into new outputs, products, processes and materials (Hitt *et al*., 2002).
Political-legal Sector	The arena in which organizations and interest groups compete for attention, resources and a voice of overseeing the body of laws and regulations guiding the interactions among nations (Hitt *et al*., 2002).
Socio-cultural Sector	Concerned with a society's attitudes and cultural values (Hitt *et al*., 2002).
Demographic Profile	
Number of Employees	Employment, which is measured in persons.
Investment on Fixed Assets	The amount of money SMEs spend on fixed assets such as buildings, machines, equipment, etc, exclusive of land.

Appendix 2 Operational Definition of Influencing Variables

Variables	Sub-Variables	Operational Components	Level of Measurement	Question Number
New Product Information	New Product Name	Rice grain and cereal products Seafood, meat and poultry products, Vegetables and fruits, Seasoning, Beverages	Nominal	1.1
	Times Spent on Designing and Launching Process	0 - 1 year, 1.01 - 2 years, 2.01 - 3 years, More than 3 years	Interval	1.2
	Period of Launching New Product to the Market	During the period of 1998-2003	Nominal	1.3
New Product Performance (NPP)	Sales Volume	Small, Large	Interval	2.1
	Sales Growth	Constant, Increasing, Decreasing	Interval	2.2
	Market Share	Leader, Follower	Interval	2.3
	Return on Investment	Positive, Negative	Interval	2.4
Successful factors of new product development		Successful, failure	Interval	3.1-3.5

Appendix 3 Operational Definition of Influencing Variables (continued 1)

Variables	Sub-Variables	Operational Components	Level of Measurement	Question Number
Environmental scanning objectives	Variety of different scanning objectives	Predict future, Raise manager's awareness, Formulate strategy, Adjust the strategies, To assess the potential impact, To analyse trends, To act as an early warning systems, To generate a set of scenarios, Others	Interval	4.1-4.9
Environmental scanning factors	Economic Sector	Global Economic, Regional Economic, Local Economic	Interval	5.1-5.3
	Technological Sector	Global Technology, Local Technology	Interval	5.4-5.4
	Political-Legal Sector	Laws and Regulations, Government Policies	Interval	5.6-5.7
	Socio-Cultural Sector	Social, Cultural, and Demographic Trends	Interval	5.8-5.9
Environmental scanning source of information	External	Publications, customers, etc.	Interval	6.1-6.16
	Internal	Board member, supervisors, subordinates	Interval	6.17-6.24
Technology strategy		fast-follower, follower, exploiter, externder	nominal	7.1-7.4
Technology turbulence			Interval	8.1-8.8

Appendix 4 Operational Definition of Influencing Variables (continued 2)

Variables	Sub-Variables	Operational Components	Level of Measurement	Question Number
Demographic Profile	Number of Employees	1 -50 persons 51 - 100 persons 101 - 200 persons	nominal	10
	Investment on Fixed Assets	Less than 25 Million Baht 25.01 - 50 Million Baht 50.01 - 100 Million Baht 100.01 - 150 Million Baht 150.01 - 200 Million Baht	nominal	11
	Business life cycle stages	Start up business, growth, Entry into diversified products, and Expansion into new markets	nominal	12

Output จากโครงการวิจัยที่ได้รับทุนจาก สกว.

1 ผลงานที่กำลังจะตีพิมพ์ในวารสารวิขาการนานาชาติ

1.1 Ngamkroeckjoti, C., Speece, M.W., and Dimmit, N.J., Environmental Scanning, Technology Strategy, and New Product Development among SME Exporters in Thailand, *Journal of Asia-Pacific Business* (on revision of the journal by 24th June 2004 see attached file). Please note that we have submitted this article on 19th May 2004 to Journal of Small Business Strategy, however there is no any further response at all from the editor after several attempts. Instead, we have decided to submit to Journal of Asia-Pacific Business.

1.2 Ngamkroeckjoti, C., Speece, M.W., and Dimmit, N.J., Environmental Scanning in Thai Food SMEs: The Impact of Technology Strategy and Technology Turbulence, *British Food Journal* (submitted May 2004).

1.3 Ngamkroeckjoti, C., Speece, M.W., and Dimmit, N.J., Environmental Scanning and New Product Performance: The impact of technology turbulence, Management Decision (on final revision by mentor).

2 การนำผลงานวิจัยไปใช้ประโยชน์

2.1 เชิงพาณิชย์

2.2 เชิงนโยบาย

2.3 เชิงสาธารณะ – สามารถสร้างเครือข่ายและความร่วมมือทั้งภาครัฐและภาคเอกชน ในกรณีภาคเอกชน ผู้วิจัยและทีมงานได้รับความร่วมมือจากผู้มีส่วนร่วมในการจัดงานนิทรรศการ และงานแสดงสินค้าต่างๆ โดยเฉพาะความร่วมมือในการกรอกแบบสอบถาม (ดูตารางที่ 1) รวมทั้ง สมาคมวิทยาศาสตร์อาหารและเทคโนโลยีทางอาหารแห่งประเทศไทย ในกรณีภาครัฐ ผู้วิจัยและทีมงานได้รับความร่วมมือจากกระทรวงพาณิชย์ กรมส่งเสริมการส่งออก กรมส่งเสริมอุตสาหกรรม ทั้งนี้รวมถึงหน่วยงานรัฐบาล เช่น สถาบันอาหารแห่งประเทศไทย ศูนย์เทคโนโลยีอิเลคทรอนิกส์และคอมพิวเตอร์แห่งชาติ ภาควิชาวิทยาศาสตร์และเทคโนโลยีการอาหาร คณะอุตสาหกรรมเกษตรมหาวิทยาลัยเกษตรศาสตร์ เป็นต้น

2.4 เชิงวิชาการ – มีการนำผลที่ได้จากการศึกษาวิจัยชิ้นนี้ไปประกอบการสอนในวิชา การจัดการระหว่างประเทศ ซึ่งอยู่ในความรับผิดชอบของผู้วิจัย

3 การเสนอผลงานในที่ประชุมวิชาการ

1.1 The 8th International Conference on Marketing and Development: Globalization, Transformation, and Quality of Life, as of 5th - 6th January 2003 จัดในประเทศไทย

3.2 ประชุมวิชาการจัดโดยสำนักงานกองทุนสนับสนุนการวิจัย วันที่ 9 ถึง 11 มกราคม 2547

สถานที่	ชื่อนิทรรศการ และงานแสดงสินค้า	ผู้จัด	วันที่	วันที่เก็บข้อมูล	จำนวนแบบสอบถาม	เปอร์เซนต์ (%)	เปอร์เซนต์สะสม (%)
1. ศูนย์การค้าสีลมคอมเพล็กซ์	งานแสดงสินค้า SMEs	กรมส่งเสริมการส่งออก	9 ถึง16 มีนาคม 2546	9, 12 และ 16 มีนาคม 2003	32	26	26
2. เมืองทอง อิมแพค อารีนา	งานแสดงสินค้า Asian International Merchandise	CMP Media (Thailand) Co., Ltd.	21 ถึง 30 มีนาคม 2546	23 และ 28 มีนาคม 2003	7	5.6	31.6
3. ศุนย์จัดงานไบเทค	ThaiFex and ThaiMex 2003	กรมส่งเสริมการส่งออก	28 พฤษภาคม ถึง 1 มิถุนายน 2546	31 พฤษภาคม และ 1 มิถุนายน 2003	56	45.2	76.8
4. เดอะมอลล์ สาขา บางแค	งานแสดงสินค้า SMEs	กรมส่งเสริมอุต-สาหกรรม	10 -16 กรกฎาคม 2546	10 และ 14 กรกฎาคม 2003	18	14	91
5. การส่งแบบสอบถามทางจดหมาย		ทีมนักวิจัย			11	9	100

ตารางที่ 1 การเก็บรวบรวมข้อมูล

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