Doctoral Dissertation

Empirical Analysis of the Innovation Process of SMEs by Structural Equation Modeling (SEM)

by

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Abstract

This dissertation attempts to empirically clarify the innovation process of small- and medium-sized enterprises (SMEs) in Japan and ASEAN countries and identify factors for promoting innovation by employing SEM (Structural Equation Modeling). The whole innovation process starting the origin of ideas and ends to achieving innovation is divided into two sub-processes such as the absorptive process through which outside information is employed to enhance innovation capability and the transforming process through which innovation capability promotes innovation. Factors extracted for promoting innovation include (i) internal innovation capability; (ii) external linkages; (iii) organizational structures; and (iv) human resources. (i) Internal innovation capability includes the technological level such as the number of patents, production facility, and so on. (iii)Organizational structures contain decision making process, ways implementing R&D, density of communications and discussions, QC, cross-functioning team. (iv) Human resources include the ability and skills of engineers and employees as well as top management, HRD (human resource development). This study focuses on identifying the contents of these factors and particularly the causal relationship among factors, that is, which factor is a cause or a result.

This study is based on questionnaire surveys and in-depth interviews in Japanese and ASEAN SMEs. In constructing hypotheses to be verified, observations obtained from these field surveys are fully used in addition to literature survey on past papers. In particular, since there are lots of various SMEs which own different characteristics, this study classifies SMEs into categories and analyzes intensively so as to obtain meaningful results by comparing SMEs in different categories.

Chapter 2 presents the basic framework of this dissertation, and in so doing, the nature of R&D and HRD among Japanese SMEs are analyzed from various SMEs we visited. In the chapter, three categories of innovation are selected depending upon size in terms of the number of employees, types of products, orientation toward innovation, and so on. The typical three firms were Dynic, Kyokko Electrics (Kyokko), and Maeda Precision Manufacturing (Maeda). The analysis identified factors that determine the structure of R&D and HRD that will improve internal information capability affecting innovation which include (i) company size, (ii) product, (iii) form of manufacturing, (iv) source of

innovation, (v) attitude towards risk. In addition, it was also revealed that three companies adopted ISO 9001 as a standard for organizing R&D.

Chapter 3 and 4 examine Japanese SMEs, and the former emphasizes internal innovation capability and the causal relationships among the factors consisting internal innovation capability. Based on the questionnaire survey, for seven latent variables related to R&D were extracted, namely (i) autonomy and (ii) monitoring and forces discipline, which are related to characteristics of top management; (iii) learning and (iv) active discussions and communication, which related to enhancing ability of engineers and employees; (v) R&D organizational structure, (vi) R&D implementation, which related to R&D; and finally (vii) level of technology. Results of SEM show that autonomy is the most important in the causal relationships among these factors. This is consistent with the observations obtained from field surveys.

In Chapter 4, based on the accumulated results of onsite surveys, innovation in SMEs are classified into three types: (i) top management-based innovation, (ii) improvement-based innovation, and (iii) development-based innovation. How innovation and the R&D process differ for each type of innovation is one of the research questions addressed by this chapter. To test the hypotheses, two models, an R&D model and a full model, are developed. The R&D model elucidates how internally produced information in the company and information obtained from external linkages are joined with R&D and produce innovation. The full model explicitly introduces variables related to technology possessed by a firm as its internal innovation capability. Furthermore it examines relationships between this capability and R&D, especially their cause-and-effect relationship to ascertain whether internal innovation capability or R&D is the cause of innovation. Using SEM, this chapter identifies different paths to innovation corresponding to three types of innovation.

Chapter 5 and 6 are related to ASEAN firms, and Chapter 5 focuses on the role of human factors in the innovation process of firms in Indonesia, Thailand, the Philippines, and Vietnam. Firms are first required to obtain new information related to innovation and then integrate it with indigenous resources owned by firm. This study identifies essential factors which promote these capabilities. In the absorptive process, two types of personnel are examined, namely those who have working experience with multinational companies (MNCs) and those indigenous to the firm. As for the transforming capability, organizational learning processes including quality control (QC) and cross-functional teams are examined. Based on SEM, this analysis demonstrates two different channels or mediators. The most important mediators for locals to connect with MNCs are top management and factory managers who have working experience with MNCs, whereas indigenous employees such as local engineers, managers, and line leaders are identified

for connectivity with locals. The direct and indirect effects of external linkages on innovation are also estimated. In the transforming process, cross-functional teams have a larger impact on innovation than QC.

Chapter 6 aims to identify factors promoting innovation in the framework of R&D based on surveys on firms in five ASEAN countries. The method of analysis is to divide sample firms into two categories, namely "the formal R&D group" and "informal R&D group." The main aims of the analysis are to examine whether two groups' R&D are similar or different and identify which of the internal capabilities, consisting of technology, human factors and organization factors, promote innovation. Hypothesis I tests whether the two groups have different R&D process. For the procedure of verifying this hypothesis, an estimation model with the same variables for the two groups is constructed. Hypothesis II is related to the extraction of different factors that are specific to each group for the promotion of innovation. To verify this, a separate estimation model whose variables are specific to each group is constructed and examined. The results of the first estimation procedure indicate that the two groups pursue product innovation differently. The formal R&D group promotes innovation by (i) a cross-functional team, (ii) QC, (iii) learning processes such as HRD and worker training. These variables are not significant in the informal group firms. This verifies Hypothesis I. An estimation model applicable only to the informal group is examined. As a result, the attributes of top management leadership, such as their experiences and overseas study, are identified as being significant only to the informal group. Accordingly, Hypothesis II is demonstrated.

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Chapter 1 Introduction

1.1 Objectives of this study

SMEs (Small- and medium-sized enterprises) not only in Japan but also the East Asian Economies are required to transform themselves from being manufacturing into knowledge based economies. For this goal, firms there have to achieve innovation by enhancing their innovation capability. The innovation process has been analyzing intensively and the factors promoting innovation have been obtained such as R&D, technology, managerial organization, human factors, and ICT use, to create innovation. Since most new information is obtained from outside the firms (Chesbrough, 2003, 2006), the collaboration with outside organizations such as universities, public research organizations, other local firms, and so on is indispensable for local firms.

The innovation process of SMEs has been extensively analyzed thus far and previous studies have been focusing on the following research questions: (i) Content of the innovation process and innovation capability of SMEs; (ii) How does internal capability promote innovation; (iii) What are the external linkages through which SMEs obtain new information; and (iv) How do external linkages enhance internal capability and innovation? This study also follows these RQs. Besides these, the following new insights are added which are less concerned by the previous studies: (i) Connectivity; and (ii) Informal R&D. “Connectivity” indicates how SMEs connect to external linkages to absorb new information. In more detail, what kind of forms they absorb information, which issue is termed as “transmission mechanism.” and who absorb information, which issue is referred to as “gatekeeper.” This this study aims to identify the concrete transformation and persons who achieve the roles. “Informal R&D” implies that R&D without formal unit or organization. SMEs are too small to organize specific personnel who concentrate in only R&D. But they somehow successfully achieve innovation. This study attempts to analyze how these two formal and informal R&D are different in terms of organization, implementation, and performance.

1.2 Conceptual framework

The innovation process and R&D are complex subjects to analyze, since there are many factors behind these subjects. In theory, innovation in an economy promoted by capital, labor and technology, as the endogenous economic growth theory emphasizes. In reality, on the other hand, it is difficult to raise these factors and promote economic development across the entire economy, but it is more difficult to improve the power of innovation within individual firms. In this section, important concepts and frameworks of this study

are summarized.

1.2.1 Innovation process: four aspects

The innovation process inside the firm is a learning process consisting of four dimensions; acquisition, assimilation, transformation, and exploitation. Acquisition is the process to identify the relevant information from the total amount of information. Assimilation is the ability to process and analyze the information obtained. Transformation is the ability to modify and adopt new knowledge and combine this with knowledge already existing inside the firm. Exploitation is the ability to transform this knowledge into innovation or competitive advantage.

1.2.2 Internal innovation capability

Since new information related to technology, consumer's needs, and so on, necessary to innovation mainly comes from outside the firm (Chesbrough, 2003, 2006), it is required to obtain such information firstly, and then integrate it with indigenous resources the firm owns for successful innovation. Thus, information contained is useless if the recipients do not possess the capability or potentiality to convert it to applications or innovations. This study terms this "Internal innovation capability" or "Innovation capability" for short, indicating the ability to absorb new information, including that related to technology, management, marketing, or the market, and integrate them to achieve innovation. Innovation capability is thus related to both the current or potential level of technology and that of engineers or employees, which can be measured by their current situation. If firms have already applied for patents, then it is reasonable to consider they have higher technological ability. If their engineers have earned higher engineering degrees such as MS or higher, they have high potentiality of new technologies. This study constructs several concepts or measures to indicate the innovation capability of firms, on the basis that innovation is actually the joint result of information linkages and capability. Without both, innovation is hard to be achieved. Thus the absorptive capability determines the competitive advantage of a firm (Barney, 1991).

The innovation capability is defined as the ability to continuously transform knowledge and ideas into new products, processes, and systems for the benefit of the firm and its stakeholders (Lawson and Samson, 2001). Innovation capability consists of various factors, which are listed as audit tools, for measuring innovation capability, and related factors are categorized into groups; Mariano and Pilar (2005), for example, categorize them as follows: (1) Communication with the external environment; (2) Level of know-how and experience within the organization; (3) Diversity and overlap in the knowledge structure; and (4) Strategic positioning. The causality among these categories

is one of the major research questions in this area, to identify the causes and results (Lawson and Samson, 2001; Perdomo-Ortiza, Benitob, Galendeb, 2009).

Based on the above literature, this study attempts to identify internal capability which includes the technological level, human resources, and organizational culture nature such as communication between workers and top management, speed of decision-making, and leadership of top management.

1.2.3 Linkages

As already mentioned, since new information necessary to innovation mainly comes from outside the firm (Chesbrough, 2003), this study emphasizes agents outside the firm which own and provide information promoting internal capability, that is, transaction and knowledge channels (Tsuji and Miyahara, 2010, 2011), for example. The former is to transfer information from agents via transactions or supply chain (Pietrobelli and Rabellotti, 2011). The latter includes universities, regional research institutions, and business organizations, which can transfer technology and other information to local firms. The domestic effort of individual firms and external factors, when assimilated, enhance internal capability so that the companies can create their own new products, services, technologies and ideas. This study thus examines how external factors contribute to improving internal capability.

Linkages were described as consisting of the following: (i) production linkages; (ii) research linkages; and (iii) human linkages (Tsuji and Miyahara, 2010, 2011). Production linkages indicate that information related to innovation is convoyed through market transactions. This consists of the "Forward" and "Backward Linkages": the former represents technology which is transferred from customers to firms and the latter from suppliers to firms. A typical example of the former is the hierarchical production structure of the Japanese automotive industry. The automotive assemblers provide cutting-edge technology to their suppliers through blueprints, or by sending their engineers to teach and train the engineers of the suppliers. They often have joint projects to apply new technologies. Suppliers also spontaneously develop new technology by themselves in the process of parts production (Tsuji et al., 2013). An example of backward linkage is found in the case of a firm which purchases new machines and equipment, and then develops new products by making full use of them. Firms can obtain new technologies through universities or other public R&D institutions, which are examples of research linkage. Human linkages are the transfer of new technologies via top management and senior engineers.

The above literature focuses on how innovation capability is formed and contributed to final outcomes of innovation. The arguments are not limited to the

innovation process in the developed economies, but applicable to the developing economies. The firms in the developing economies have their own problems; weak basis for internal capability particularly due to lack of technology, human resources and knowledge infrastructure. The strategy the firms or governments in the less developed economies are different from that in the developed economies. Among literature on the innovation process or internal capability related to the less developed economies, Ernest (2002) emphasizes blending diverse international and domestic sources of knowledge and making use of international linkages. Kesidoua and Szirmai (2008) also specify two types of knowledge spillover in the Uruguay software industry; local and international, and they obtained the conclusion that the latter is more important than the former. Pietrobelli and Rabellotti (2011) shows international knowledge spillover via the global value chain which enhance innovation in the less developed economies. Srholec (2011) and Mkandawire (2007) take social factors such as human capital or skill formation in the innovation process into consideration. Chen and Puttitanun (2005) examines the relationship between innovation and intellectual property rights.

1.2.4 Transmission mechanism

The mechanism of how external sources influence internal capability is referred to as the "transmission mechanism," and to identify these channels is another task of this study. The transmission mechanism is defined as a particular route from external sources that promote the internal capability of local firms. Let us take a university as an example. There are many ways in which it can transfer new technology to local firms. It might provide its patents via an agreement, accept the firm's engineers into the laboratory, or dispatch its researchers to firms to lead R&D activity. This study aims to identify the particular routes that promote internal capability.

The collaboration with entities outside the firm such as other firms, universities, and local research institutions in the innovation process came to be the center of research and analyzed in the framework of "open innovation" (Chesbrough, 2003, 2006). In developing countries, MNCs have superiority in technology, know-how, management, and local firms have to absorb those from them. Prior to absorbing new information, local firms have to initiate the connectivity to MNCs, through which locals obtain necessary information. Some of previous papers attempted to identify such routes which are referred to as "transmission channels." More concrete examples are accepting "guest engineers" from MNCs or "dispatching engineers" to MNCs to participate in training or R&D activities. Even prior to these agreements, locals have to establish the connectivity. In earlier studies on the innovation process back to the 1960s or 1970s, the parsons who fulfilled those functions were termed by "gatekeepers." In this sense, the first mission of

the study is to identify these agents from the survey data.

1.2.5 R&D process

Previous research on innovation did not differentiate between formal and informal R&D activities, and many papers focused implicitly on the former. It is natural to think that smaller local SMEs cannot afford to own R&D institutions, laboratories, or affiliated firms which specialize in R&D, or even smaller R&D units in their factories. The reasons are clear; they are short of investment funds, R&D personnel, and the basic level of technology. Under these circumstances, however, there are many SMEs which have successfully achieved innovation in various industries. Although these SMEs do not own specific R&D facilities, they somehow conducted similar activities. Thus we define R&D activities which are not conducted by specified in-house organizations, departments, or sections of firms as informal R&D activities. These two categories of R&D activities are thought to be the same in terms of objectives and contents, the only differences being found in the way they are conducted.

Informal R&D activities are categorized by the types (a) top-down and (b) bottom-up. The former implies that the R&D activity is directed by the owner of the SME, whereas the latter implies that they are conducted through the initiative of personnel or workers engaged in the production processes or in job-shops. In what follows, more detailed explanations are provided.

1.2.5.1 Top-down informal R&D

This type of R&D is characterized by the leadership of the SME owner, who plays an essential role in the whole innovation process. The owner is generally an engineer with knowledge, skills, ideas, and experience, and at the same time he is capable of managing all aspects of a firm, including marketing, HRD (Human resource development), and so on. He can directly and independently invent new products and discover new production processes. In addition to engineering ability, he also has a passion and high motivation toward innovation. He is more interested in creating something new rather than making improvements, and thus this type of informal R&D can be applicable to product innovation. Typical examples of these owners are those of start-ups or venture businesses. There are two sub-categories in this type; one upgrades the same technology or the same kind of product, whereas the other shifts the domain of the product in the process of upgrading.

It is also noted that the owners belonging to this category were intensely committed to nurturing their employees by telling employees about their experiences, how to obtain skills and know-how, and how to maintain their attitudes toward invention and innovation.

These owners also made efforts to converse with their employees. Since the firms are not large enough to employ college graduates, various types of on-the-job training are inevitable. In this sense, this type of leader is referred to as a "servant leader," as initiated by Greenleaf (1977).

Regarding the factors of breakthrough, in addition to owners finding new ideas or new technology, advice from university professors and customers, such as large firms, are noticeable. This does not occur through long-term or formal collaboration with the advice-givers, but rather through ad hoc consultation.

According to these observations, the top-down type of informal R&D tends to focus on product innovation.

1.2.5.2 Bottom-up informal R&D

Innovation due to this type of informal R&D comes from the manufacturing sites or job-shops. Reducing production costs is mandatory for firms to increase profits. Cost reductions can be achieved at the manufacturing site by reducing the production failure rate, speedup, or savings in materials, labor, energy, and so on. Another way to reduce costs is speedup at the manufacturing site. Reductions in failure rate, for example, can be achieved through simple efforts made by workers as well as top management by means of 5S, QC, and by training that entails very little cost. That is, these can be tried by all kind of SMEs. In this sense, what innovation in this type of informal R&D seeks is process innovation such as the improvement of production processes (*Kaizen*).

Regarding the factors that promote informal R&D in addition to the reduction of the failure rate or speedup of production, these come from customers who use the products including (i) model changes in the final product, (ii) claims from customers, and (iii) improvement of product quality. At the time of a model change in the customer's final product, SMEs which supply materials or parts have to change their products, which, in a sense, is their innovation. That is, innovation indicated in one firm is transmitted to other firms via the supply chain. Due to customer claims regarding quality, SMEs as parts suppliers are required to improve their manufacturing process, which also implies process innovation. Thus this type of informal R&D tends to create mainly process innovation, and accordingly innovation of this kind can be termed "*non-autonomous*," whereas that achieved by top-down R&D is termed "*autonomous*."

Actual implementation of this kind of informal R&D can be found in Dynic, for example. Dynic's R&D team consists of three kinds of members or specialists, namely those who have come from the (i) manufacturing, (ii) technology, and (iii) marketing sections. The members from (i) are in charge of a particular section of the manufacturing process, those from (ii) are specialists in wider or general production technology, and

those from (iii) are sales personnel who take responsibility for selling the particular materials or parts. This team works together to handle claims or proposals from customers. The team is precisely cross-functional, which was the target of our previous studies and which we have continuously analyzed. The role of Dynic's cross-functional team coincided with the results we have obtained thus far.

Another important feature of bottom-up informal R&D is record keeping. All trials and discussions in the team, whether they lead to success of failure, were recorded in digitalized form. The aims of this record are to share information on trial and error among members and for future reference. When the team comes across some problem, members can check the record to find similar cases and solutions from past experience. Table 1 summarizes the above discussion.

1.3 Methodology

This study employs SEM (Structural equation model) or CSA (Covariance structural analysis), which enables a study of the relationship among various variables that are related to each other. SEM is said to be a mixture of factor analysis and regression analysis; the former constructs latent variables from observed variables by using factor analysis, while the latter examines the causal relationship between latent variables by regression analysis. Thus, SEM analysis can be used even for cases in which the variables are endogenous and the usual Least Squares cannot be applied. The idea of SEM was proposed as CSA by Bock (1960) initially and developed by Bock and Bargmann (1966) in order to solve issues related to multivariate analysis. Later Bagozzi (1980) and Bollenn (1989) termed this as SEM.

The merits of SEM are summarized as follows: regression analysis, which enables the causal relationship between variables, can handle only the observed variables, that is, endogenous variables, which are referred to as "latent variables" in SEM. Factor analysis can construct latent variables, which are common nature behind observed variables, but it cannot analyze their causal relationship. SEM can solve the issues related to factor and regression analysis and integrate these two methods. In other words, SEM introduces latent variables which are not observable, and by fixing the causal relationship between latent and observed variables, statistically examines the social as well as natural phenomena.

An important problem is to solve the endogeneity problem of variables. Economic variables used in empirical studies are more or less endogenous variables whose values are determined inside the model. Without a proper estimation method, estimated coefficients tend to have biases. In addition, we also examine a second important methodological problem related to reverse correlation between innovation and the

internal innovation capability index or other variables. We have to prove that the relationship between those variables is causation rather than simple correlation. Coping with these theoretical problems, the treatment model and other methods are utilized to solve the above-mentioned two problems. These models are quite difficult in practice; for example, to find instrumental variables is a difficult task, but SEM seems to be rather tractable. In this sense, this study mainly employs SEM.

1.4 Outline of this dissertation

This dissertation consists of six chapters. Following Introduction, Chapter 2 analyzes the nature of R&D and HRD among Japanese firms by selecting the following three firms from the manufacturing industry, depending upon size in terms of the number of employees, types of products, orientation toward innovation, and so on.

Chapter 3 and 4 examine Japanese SMEs, and the former emphasizes internal innovation capability and the causal relationships among the factors consisting internal innovation capability. Based on the questionnaire survey, for seven latent variables related to R&D were extracted, namely (i) autonomy and (ii) monitoring and forces discipline, which are related to characteristics of top management; (iii) learning and (iv) active discussions and communication, which related to enhancing ability of engineers and employees; (v) R&D organizational structure, (vi) R&D implementation, which related to R&D; and finally (vii) level of technology. Results of SEM show that autonomy is the most important in the causal relationships among these factors. This is consistent with the observations obtained from field surveys.

In Chapter 4, based on the accumulated results of onsite surveys, innovation in SMEs are classified into three types: (1) top management-based innovation, (2) improvement-based innovation, and (3) development-based innovation. How innovation and the R&D process differ for each type of innovation is one of the research questions addressed by this chapter. To test the hypotheses, two models, an R&D model and a full model, are developed. The R&D model elucidates how internally produced information in the company and information obtained from external linkages are joined with R&D and produce innovation. The full model explicitly introduces variables related to technology possessed by a firm as its internal innovation capability. Furthermore it examines relationships between this capability and R&D, especially their cause-and-effect relationship to ascertain whether internal innovation capability or R&D is the cause of innovation. Using SEM, this chapter identifies different paths to innovation corresponding to three types of innovation.

Chapter 5 focuses on the connectivity of SMEs to other organizations to obtain information related to innovation employing SEM in the innovation process of firms in

four member states of ASEAN, namely Indonesia, Thailand, the Philippines, and Vietnam. The key factors for R&D extracted are (i) the size of firm, (ii) types of product and production, (iii) seeds of innovation, (iv) attitude toward risk, and (v) learning process. The common factor acting as the basis for the firms' R&D structure was identified as ISO9001. This chapter also focuses on the role of human factors and identifies essential factors which promote internal innovation capability. In the absorptive process, two types of personnel are examined, namely those who have working experience with multinational companies (MNCs) and those indigenous to the firm. As for the transforming capability, organizational learning processes including QC and cross-functional teams are examined. The analysis demonstrates that MNCs have the largest impact as external linkages. The most important mediators for locals to connect with MNCs are top management and factory managers who have working experience with MNCs, whereas indigenous employees such as local engineers, managers, and line leaders are identified for connectivity with locals.

Chapter 6 aims to identify factors promoting innovation in the framework of R&D based on surveys on firms in five ASEAN countries. The method of analysis is to divide sample firms into two categories, namely "the formal R&D group" and "informal R&D group." The main aims of the analysis are to examine whether two groups' R&D are similar or different and identify which of the internal capabilities, consisting of technology, human factors and organization factors, promote innovation. Hypothesis I tests whether the two groups have different R&D process. For the procedure of verifying this hypothesis, an estimation model with the same variables for the two groups is constructed. Hypothesis II is related to the extraction of different factors that are specific to each group for the promotion of innovation. To verify this, a separate estimation model whose variables are specific to each group is constructed and examined. The results of the first estimation procedure indicate that the two groups pursue product innovation differently. The formal R&D group promotes innovation by (i) a cross-functional team, (ii) QC, (iii) learning processes such as HRD and worker training. These variables are not significant in the informal group firms. This verifies Hypothesis I. An estimation model applicable only to the informal group is examined. As a result, the attributes of top management leadership, such as their experiences and overseas study, are identified as being significant only to the informal group. Accordingly, Hypothesis II is demonstrated.

The final chapter summarizes the dissertation and indicates the direction of further research.

Chapter 2 Innovation without Formal R&D Units: Analysis based on Field Research

2.1 Introduction

Due to economic development in ASEAN economies during the most recent decade, the transformation of economies from simple production bases to knowledge-based economies has been occurring, and among remarkable events have been the so-called south-south FDI (foreign direct investment). Thai firms, for example, have been constructing networks of gas stations in neighboring countries such as Cambodia and the Philippines. Vietnamese firms have been investing in farms in Laos. These are also symptoms of regional integration. For further transformation, macroeconomic reforms including sector-specific or firm-specific policy is required for industries or firms to upgrade their business, technology, production, management, and human resources. Although larger firms, such as conglomerates, are now becoming global companies, these are exceptional. The majority of firms are still SMEs (small- and medium-sized enterprises). The up-grading of various SMEs in these regions is an urgent issue. It is difficult to explain how to up-grade SMEs, since there is no coherent theory or policy particularly applicable to these regions. To formulate practical and tractable strategic policy, to study the cases of successful transformation and to extract lessons to learn from these cases is realistic and reasonable. This study thus aims to find key strategic factors for SMEs to transform themselves into new types of firms which can survive or create a knowledge-based economy. The key issue is innovation. Our research theme here is how to enhance innovation among regional SMEs.

2.2 Background

2.2.1 Innovation and R&D

The innovation process was defined and studied by Cohen and Levinthal (1990), Zahra and George (2002), for example. They consider innovation to be a learning process consisting of four dimensions; acquisition, assimilation, transformation, and exploitation. This innovation process can be viewed and analyzed from R&D activities. Similar to the above four processes, the R&D process can be decomposed into the following processes: (i) idea generation; (ii) screening business analysis; (iii) development; (iv) testing; and (v) commercialization (Booz, Allen and Hamilton, 1982). In this R&D process, the internal innovation capability plays an essential role in achieving innovation. R&D is one of the riskiest business activities, the failure rate being somewhere in the order of 25 to 45 percent (Crawford, 1987; Cooper, 2001). For every seven new product ideas, about

four enter development, one and a half are launched, and only one succeeds (Nadia, 2011). Because of this nature of R&D, numerous textbooks and handbooks have been published for firms, including Crawford (1987, 1997), Smith and Reinertsen (1998), Cooper (2001), and Kahn (2013). All these books and other academic papers examine *formal* R&D. Bhuiyan (2011) recognized this by claiming as follows:

> Booz, Allen and Hamilton (1982) found that companies that have successfully launched new products are more likely to have some kind of formal NPD (new product development) process and that they generally pass through all of the above stages.

This paper, however, focuses not only on formal R&D activities, which are defined as those related to the enhancement and empowerment of all elements of internal innovation capability, but also on informal R&D. The latter indicates firms that do not have systematic organizations or arrangements for conducting R&D to elevate innovation capability. This paper examines the innovation process of Japanese SMEs which are too small to own specific sections or units for R&D. Our field research over more than ten years found that there are two kinds of R&D, namely formal and informal. Accordingly the field research of the Japan Team aims to clarify the key factors for firms to establish R&D units, how they conduct R&D, and whether there are differences in performance and conducting innovation between the two types of R&D activities.

2.2.2 Informal R&D

It is natural to think that smaller, local SMEs cannot afford to own R&D divisions, laboratories, or affiliated firms which specialize in R&D, or even smaller R&D units in their factories. The reasons are clear; they are short of investment funds, R&D personnel, and the basic level of technology. Under these circumstances, however, as we have examined in previous papers, there are many SMEs which have successfully achieved innovation in various industries. Although these SMEs do not own specific R&D facilities, they somehow conducted similar activities. Thus we define R&D activities which are not conducted by specified in-house organizations, departments, or sections of firms as informal R&D activities. These two categories of R&D activities are thought to be the same in terms of objectives and contents, the only differences being found in the way they are conducted. To grasp the nature of informal R&D activities, field surveys were conducted in the Tokyo and Osaka areas and interviews conducted with the following firms: Dynic, Kyokko, and Maeda Precision Manufacturing. The following discussion is based on the field surveys.

2.3 Conceptual framework

2.3.1 Factors promoting innovation under informal R&D

2.3.1.1 Top management

The leadership of the SME owner plays an essential role in the whole innovation process, this being particularly seen in ventures. The owners are generally engineers with knowledge, skills, ideas, and experience, and at the same time they are capable of managing all aspects of a firm, including marketing, HRD, and so on. They can directly and independently invent new products and discover new production processes. In addition to engineering ability, they also have passion and high motivation toward innovation, and are more interested in creating something new, which is product innovation, rather than making improvements. Typical examples of these owners are those of start-ups or venture businesses. Even currently large firms were SMEs when they were established, and owners invented new products, promoted sales, and expanded the managerial organization. Moreover, the owners belonging to this type were intensely committed to nurturing their employees by telling employees about their experiences, how to obtain skills and know-how, and how to maintain their attitudes toward invention and innovation. These owners also made efforts to converse with their employees. Since the firms are not large enough to employ college graduates, various types of on-the-job training are inevitable. The owners also take the initiative to implement HRD. It was in this context that the generation of current top management was surveyed.

2.3.1.2 Size of firms

As already mentioned, the size of firms in terms of the number of employees and capital is an important factor. Although this concept is primitive, it is crucial for these firms when establishing an R&D unit. R&D is not a simple process but is related to other learning practices such as QC or cross-functional teams. These practices require a certain number of employees.

2.3.1.3 Types of products and production methods

Types of products and production methods, namely, whether the products are final products or parts determine the direction of innovation and R&D. Parts are also categorized as complete or simple parts, and physical parts or materials, and these are also important.

In the case of final products or complete parts, it is essential for firms to carry out R&D to create new products, and more resources and funds are required for R&D. However, as most SMEs are engaged in the manufacture of simple parts or material manufacturing, there are fewer chances to create something new, but more opportunities for improvement; process innovation rather than product innovation.

2.3.1.4 Seeds of innovation

The type of product thus determines the type of innovation, and this can be discussed from the viewpoint of the sources of innovation or R&D methods. In the case of firms producing final products, searching and finding seeds of innovation is carried out under their own responsibility, and the R&D process can be termed "autonomous." In contrast, when the products are simple parts or materials, seeds of innovation come basically from the buyers of their products. Typical examples are as follows: (a) model changes in the final product, (b) claims from customers, and (c) improvement of product quality. At the time of a model change in the customer's final product, SMEs which supply materials or parts are required to change their products, which, in a sense, is their innovation. That is, innovation initiated in one firm is transmitted to other firms via the supply chain. Due to customer claims regarding quality, SMEs as parts suppliers are required to improve their manufacturing process, which also implies process innovation. Thus this type of informal R&D tends to create mainly process innovation, and accordingly innovation of this kind can be termed "non-autonomous."

2.3.1.5 Risks

Autonomous or non-autonomous innovation can be analyzed from the viewpoint of attitude toward risk. The former is very risky, while the latter is less so. If firms can afford to bear various kinds of risks, they will be capable of conducting R&D for a new product. On the other hand, R&D for process innovation is less risky, since it can be achieved by reducing the failure rate in production, or savings in materials, labor, energy, and so on. Another way to reduce costs is speedup at the manufacturing site. Reductions in the failure rate, for example, can be achieved through simple efforts made by workers as well as top management by means of 5S, QC, and by training that entails very little cost.

2.3.1.6 Learning process

The learning process consists of practices related to information sharing, improving the quality of a product, or promoting the efficiency of production among related personnel and sections. QC and cross-functional teams are typical examples that have been the targets of ERIA research for many years. Other learning practices include the digitalization and saving of documents and reports, and BCPs (business continuity plans). The former indicates that all kind of documents are digitalized and saved, aiding in later searches for needed documents, while the latter includes skill transfer to future generations. Senior craftsmen with specific skills have been retiring and it is feared that accumulated skills, such as intuition and know-how will be lost.

2.3.1.7 Open innovation

Open innovation is an important factor in formal and informal R&D. Firms that own formal R&D units can collaborate with universities and develop their innovation capability, and firms without formal R&D units can connect with universities to obtain new technology through joint research. In any case, firms need to have their own technology which attracts research institutions.

2.3.2 HRD and innovation

HRD is another key factor for innovation and R&D. Larger firms can hire employees with higher degrees such as an MSc or Ph.D., while SMEs tend to hire graduates from engineering colleges or high schools, who are required to enhance their skills in the firms, since the lifetime employment system is common in Japan, even among SMEs.

2.3.2.1. Skill formation: OJT and OFFJT

The typical practice is in-house OJT (on-the-job training). HRD also takes different forms according to the technology, product, size of firm, and so on. Newly employed workers are assigned to specific sections and receive OJT for acquiring skills from senior colleagues. Larger firms have separate employees and sections that specialize in HRD, but SMEs cannot generally afford to this, since they are too small to practice HRD on a large scale. Besides OJT, OFFJT is also commonly adopted by SMEs for a certain number of days and times a year. Employees generally participate in skill-raising lectures organized by industrial associations related to their work. In the skill-raising process, employees are required to acquire specific skills; failure to do so will mean that they are not promoted to higher positions.

2.3.2.2 Mid-career recruitment

As already mentioned, lifetime employment is common and hiring mid-career specialists is very difficult.

The factors discussed in this section are summarized in Table 2.1.

Table 2.1 Firm profile

	Dynic	Kyokko	Maeda Precision
Year of establishment	1919	1947	1901
Capital	5.7 billion yen	85 million yen	36 million yen
Sales	27.8 billion yen	4 billion yen	600 million yen
Generation of president	Not family business	Third	Forth
Number of employees	600	180	57
Main products	Chemical, fabric, paper, etc.	Sensor, controller	precision compact machine parts
Type of product	Material and simple parts	Final products and complete parts	Simple parts
Type of production	Make-to-stock, or mass production	Build-to-order, OEM	Build-to-order
Type of innovation	Process	Product	Product
Seed of innovation	Claim and model change of buyers	Technology	Technology
Type of R&D	Formal and informal	Formal	Informal
R&D/sales	2%	5%	5%
R&D personnel	30-45 (R&D section) 150 (factory)	19 (R&D section) 14 (factory)	None
Collaboration partner	Buyer	University and other firms	University and other firms
Cross functional team	Engineers and marketing	Less active	None
HRD of engineers	OJT	Own effort	OJT (intensive)
New employees	University graduate and some with MS degree	technical college, technical high school, and mid-career recruitment	Regular high school graduate
Evaluation system of ability	Five scales of achieved skills	None	Skill map for particular machine and operations
Award system	Yes	None	Yes

2.4 Case studies

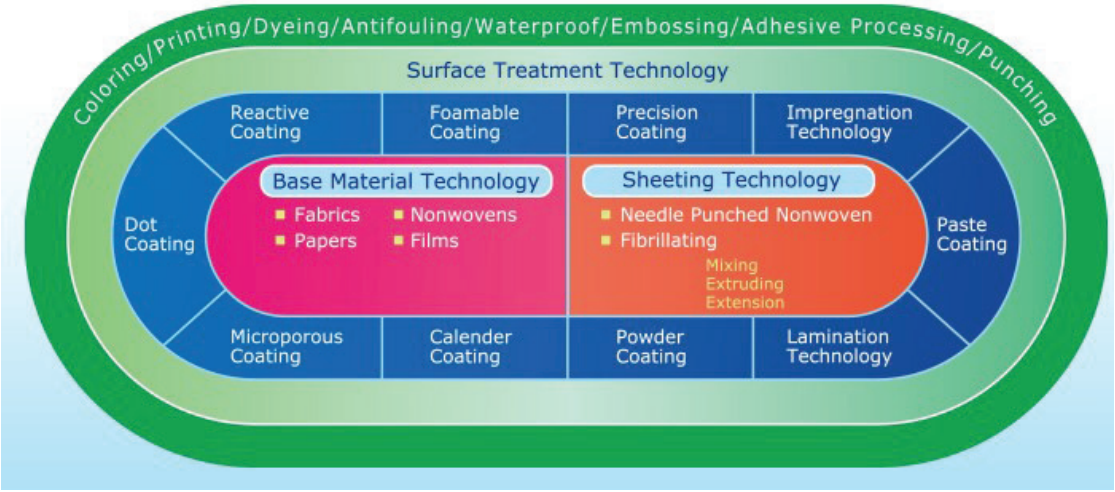
2.4.1 Dynic

2.4.1.1 Profile

Dynic was established in 1919 and has been manufacturing products such as bookbinding cloth and dyes. It was the first domestic firm to sell typewriter ribbon in 1932 and domestic nonwoven fabric in 1957. Dynic was a prominent firm during this period. However, the economic shift from fabric to the machinery industry, such as electric appliances, automobiles, precision machinery, and so on began in the 60s. Since then

Dynic has had to transform itself to adapt to new industries. The strategy it took for coping with the transformation was to take advantage of its accumulated technologies, including coating, coloring, laminating and embossing, to develop a wide range of related technologies to sell to the market. By honing its technologies, it created new frontiers where almost anything is possible. As a result, Dynic is manufacturing all related materials and parts which are used for a wide range of final products by consumers, including offset printing film, printing materials for full color inkjet printers, auto parts (nonwoven fabric), desiccant for smartphones, caps for dairy products, and so on. Its array of technology is shown in Figure 2.1.

Figure 2.1 Dynic's technology map



Source: Dynic

The head office is located in Tokyo and there are five factories in Japan. Overseas factories are located in the US, UK, Singapore, Thailand, Indonesia, Hong Kong, and three in China. Annual sales total about USD 300 million, and the number of employees is around 600. The current president is not a member of the founder's family, and is an engineer. Since Dynic has various kinds of products, it has a divisional system, with seven divisions based on type of products, namely, the first takes care of publishing, stationery, and fancy products; the second division produces print media supplies, such as offset printing film, printing materials for full color printing, and cloth for magnetic bank passbooks; the third division handles nonwoven fabric products, and so on. Since Dynic's products are materials or parts, the type of production is either make-to-stock or mass

production. These characteristic products and production methods determine the form of its R&D and HRD.

2.4.1.2 R&D structure

Dynic has two types of R&D activities: One is an independent R&D Center and the other consists of groups attached to the each of the seven divisions. There two R&D Centers, attached to the Shiga and Saitama factories, which are engaged in long-term research on new technology and products. The two R&D Centers have their own budget and researchers; there are about 35 engineers engaged in R&D and about 16 are attached to each R&D Center. In addition to the two R&D Groups, Dynic also has a Test and Analysis Group and an IPR (intellectual property rights) Management Group. Accordingly, these are within the category of formal R&D. The seven divisions own their own R&D-related groups in the factories; namely, the Technology, Manufacturing, and Marketing Groups. Some divisions have additional groups, such as Quality Assurance and Material Groups. These groups are attached to factories and are engaged in taking care of general manufacturing, improving the quality of products and reducing losses or the failure rate. They cope with all kind of problems on the production lines and in job-shops, and in this sense, they take care of daily problems. Their work is related to R&D in the short-run, which can termed informal R&D. Dynic's R&D structure is shown in Figure 2.2.

A. Execution of product development

When a seed of new product is discovered, further development to realize innovation takes the following procedure.

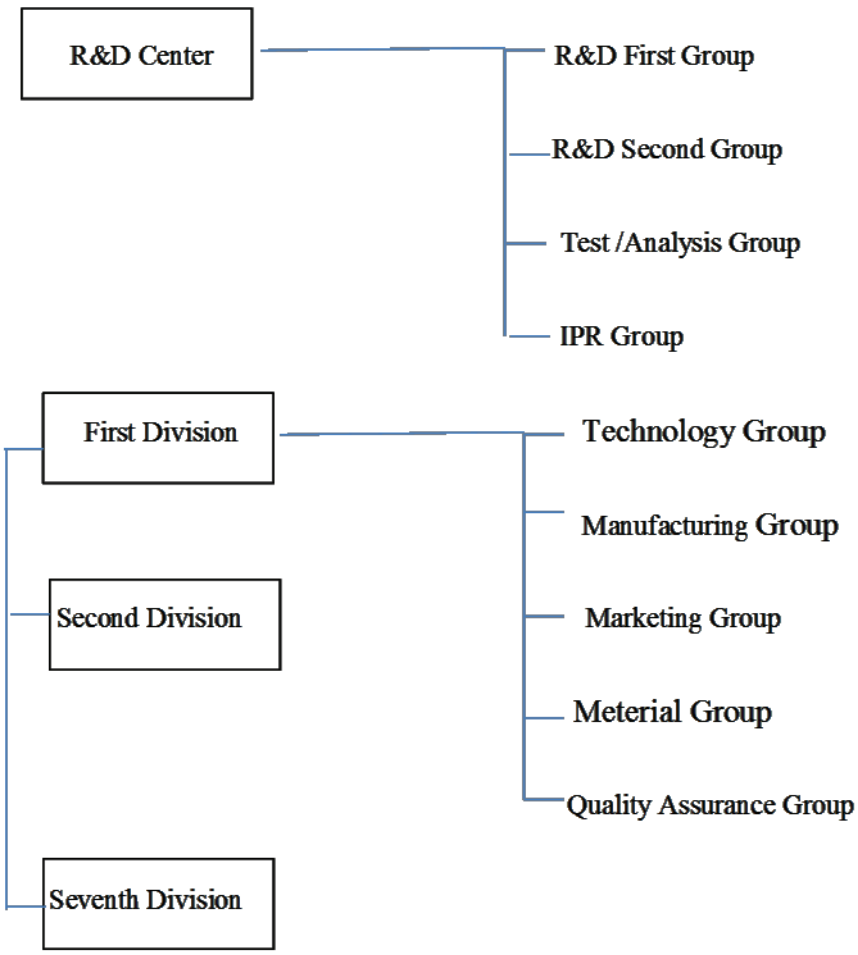
(1) **Development Meeting**

This is a meeting set up in the division, in which the current information related to technology, marketability, production possibility are discussed by the Marketing and Manufacturing Groups. Then it proceeds to the next step.

(2) **Production/marketing Meeting**

This meeting is also in the division and discusses on the market, sales, and future production situation. In this meeting, in addition to the Marketing and Manufacturing Groups, the Material Group also joins. The project then passes to the following step.

Figure 2.2 R&D structure of Dynic



(3) **Quality and Profitability Meeting**

This meeting is related to factory issues and discusses quality, productivity, and costs. Then the next step is as follows:

(4) **Design Review**

Before entering production, the final design and related issues such as validity, material, production method, and the possibility of design change are discussed. The factory manager and all related groups participate. In some cases, a buyer who is an R&D collaborator can participate in the design review.

B. Characteristics of innovation and R&D

Dynic's innovation includes (i) radical innovation, such as desiccant for LED displays in smartphones, which is due to collaboration with a university laboratory and an outside expert; (ii) incremental innovation, which is realized from buyers in the form of claims, requests, and model changes; and (iii) process innovation, including reducing failure rates by better usage or maintenance of equipment. Most of the innovation is ether (ii) or (iii), since radical innovation does not usually occur frequently.

The most of Dynic's product innovation is the result of (i) discussion with buers, (ii) model changes in the final product, (iii) claims from buyers and final customers, and (iv) improvement of product quality by its own R&D. When the buyers want to change the model of a final product, parts or material suppliers are asked to change their products as well by indicating their desires or specs. If Dynic succeeds in doing this, it achieves innovation. Customer claims regarding quality is similar. Parts suppliers are asked to improve the quality of parts or materials, and if Dynic succeeds in doing this, it will result in innovation. Thus this type of informal R&D tends to achieve mainly process innovation, and accordingly, innovation of this kind can be termed "non-autonomous," whereas that achieved by product innovation such as desiccant for OLED displays through R&D is termed "autonomous."

Another type of innovation carried out by Dynic is related to the reduction of production costs, and is mandatory for firms to increase profits. Cost reductions can be achieved at the manufacturing site by reducing the production failure rate, production speedup, or savings in materials, labor, energy, and so on. Reductions in failure rate, for example, can be achieved through simple efforts made by workers as well as top-management by means of 5S, QC, and by training that entails very little cost. That is, these methods can be tried by all kind of SMEs. In this sense, what innovation in this type of informal R&D seeks is process innovation such as the improvement of production processes (*Kaizen*).

Regarding the factors that promote informal R&D, in addition to the reduction of failure rate or production speedup, these come from customers who use the products and include (a) model changes in the final product, (2) claims from customers, and (3) improvement of product quality. At the time of a model change in a customer's final product, SMEs which supply materials or parts have to change their products, which, in a sense, is their innovation. That is, innovation indicated in one firm is transmitted to other firms via the supply chain. Due to customer claims regarding quality, SMEs as parts suppliers are required to improve their manufacturing process, which also implies process innovation.

Actual implementation of this kind of informal R&D can be found in Dynic, for example. Dynic's R&D team consists of three kinds of members or specialists, namely, those who have come from Groups such as (a) manufacturing, (b) technology, and (c) marketing sections. The members from (a) are in charge of a particular section of the manufacturing process, those from (b) are specialists in wider or general production technology, and those from (c) are sales personnel who take responsibility for selling the particular materials or parts. This team works together to handle claims or proposals from customers. The team is precisely cross-functional, and Dynic's cross-functional teams coincided with our research results as a factor promoting innovation obtained several years ago.

2.4.1.3. Dynic's HRD

A. OJT and OFFJT

Dynic recruits around 15 new employees every year. They are newly graduated university students, among them being several recruits who hold an MSc degree. Dynic does not accept mid-career employment recruitment. Dynic's HRD thus aims to train university graduates. They receive basic training such as an introduction to Dynic, and then they are assigned to a factory to work. Again, after taking basic training to understand the functions of the factory, they receive training in the division and group, which manly consists of OJT. Senior workers teach and train on a face-to-face basis at the production line or in the job-shop. Job rotation is a popular practice, but all recruits take jobs in only one division. The seven divisions are too many to rotate jobs. Dynic also provides opportunities for OFFJT (Off-the-job Training) by participating seminars or training courses organized outside agents.

B. Technical forum

This is a special feature of Dynic HRD. The technical forum aims to upgrade employees' skills. The technical forum is held every two months. In addition to younger employees, all engineers in the factory are required to participate. The contents of the forum are to present their R&D activities, giving examples of both successes and failures. The objectives of this are not only training in giving presentations to others, including preparation and making materials, but also that of listening to other people's presentations taking notes, and so on. This forum also provides lectures on (i) IPR by its IPR Group every six months; (ii) management of chemical materials by its Group; and by (iii) outside experts.

C. Skills evaluation system

Skills necessary for work in each group of the division are listed, and engineers are evaluated on a five-point scale in accordance with this list. This system clarifies engineers' current skill level and necessary skills to be acquired by further training or education. This evaluation is conduced once a year. Engineers cannot be promoted unless the requirements are satisfied. This is a rather strict requirement.

D. Registration as a design engineer

The title of Design Engineer is approved by the head of engineering when younger engineers raise their skills at the required level. It serves as skills qualifications and is used as an objective for younger engineers to aim for.

E. Research report system

This consists of reports of R&D practice, including objectives, process, results, and further problems. The collections of these reports are preserved for a long time and used as 'textbooks' for younger engineers. The reports are digitalized for easy search and used for the 'succession of technology.'

F. Award system

Dynic holds R&D Presentation Meetings every three months with top management and division managers participating. The meetings take one whole day of weekend. The best of new products, improvements, R&D activities, marketing, and so on are selected and presented with awards. This provides incentives as well as raising morale among employees.

2.4.1.4 Summary of Dynic

Thus Dynic owns formal and informal R&D units, and the latter is much more active than the former, since the resources input to the two endeavors are different. This is due not only to the riskiness of R&D for new product development but also to the environment such as markets, products, technology, equipment, and so on. The markets in which Dynic is located are quite competitive and the firm must compete with competitors in terms of firstly price and secondly quality and others, such as procurements. Severe competition in the markets causes Dynic to take the strategy of stressing process innovation over product innovation.

As an impression from the interview, the R&D structure and execution are well-organized and sophisticated in detail. The reason found is that Dynic follows the ISO9001

manual for R&D and HRD. In addition, Dynic has been up-grading the structures through its own creativity and effort.

2.4.2 Kyokko Electrics

2.4.2.1 Profile

Kyokko Electrics was established in 1947 to engage in radio, detector and sensor manufacturing. In the 1962 Akashi Factory, and then in 2008 the Ohkubo Factory, were established. In 2001, Kyokkyo obtained ISO9001 and 2000. The founder of Kyokko was an engineer and graduated from the engineering department of a national university. The breakthrough was to start manufacturing sensors for automatic doors, to which the founder introduced by his former classmate in university who was engaged in sensor manufacturing and asked the founder to join him in this area. Since then, Kykko has been specializing in automatic doors for various fields and its basic technologies are sensing and electric substrates. The current major products are in the following four areas; (i) automatic doors; (ii) Bullet train (various types of controllers and automatic doors); (iii) ships (engine and navigation controllers); and (iv) new areas, such as food (automatic beer server). The share of the products in sales in the top three products accounts for 25% of sales each and remainder accounts for final 25%. Kyokko has also been targeting new areas such as robotics, aerospace and aeronautics, as well as the medical and bio engineering fields.

The firm's capita amounts 85 million yen and annual sales total four billion yen. The number of employees is 180. The current president is the third-generation CEO and is not an engineer. The annual R&D investment by the firm is about 200 million yen, around 5% of the total sales. Kyokko has a flexible manufacturing system to cope with small lot production of a large number of products and thus the type of production is build-to-order or OEM. Sensors and related products require high confidence and precision craftsmanship, Kyokko solves these problems with automatic implementation or mounting production machines, which also contributes to efficient production. Kyokko considers that manufacturing itself is not sufficient, and that developing new products is much more important. That is, it is less concerned with process innovation. Manufacturing in Kyokko implies implementing and mounting, since all parts are purchased from parts suppliers. The firm does not manufacture any parts itself, and specializes in the production of final products and complete parts.

2.4.2.2 R&D structure

Kyokko owns R&D units and thus its R&D is formal. The R&D structure is shown in Figure 4. There are two R&D units; one is located on the fourth floor of the head office which is known as the "Technology Department," while another is in the Ohkubo Factory, which names the "Design Section." The Technology Department consists of three groups, the Sensor Group, the Food Group, and the Research Group, and the total number of employees engaged in R&D is 20. These groups work on new orders. The Design Section consists of a Railway Group and a Building Group, and the number of employees engaged in R&D is 14. In addition to new orders, the roles of the two R&D units are divided depending on whether a design drawing capability exists or not. Orders that have a design drawing are forwarded to the unit in the factory, while those without a design drawing are forward to the head office. The latter owns design plans drawn up, and are related to more basic technologies and processes. The orders that have a design drawing can be handled by the R&D unit located in the factory. The work carried out by these two sections mainly concerns R&D. Other sections such as Production Management, Production Technology, Implementing and Assembling are more or less related to manufacturing. Production Management takes care of materials, Production Management deals with the maintenance of equipment, and remaining two are directly related to manufacturing. As mentioned above, since the production lines are fully automated, there is no need for improvement of production processes which is termed by process innovation. Thus the employees in the Implementing and Assembling Section are part-time workers who are managed by regular staff implying that no advanced technology or skills are required. In this sense, Kyokko is less concerned about 3S, 5S, and QC. The up-grading of skills is considered as a voluntary matter of employees. The reason why the workers and engineers work in this way will be discussed in the next section. The structure of Kyokko's R&D is shown in Figure2 3.

The seeds of R&D or new product come from marketing or some outside partners, they are discussed and examines at the director and manager meeting which is held every morning. The most of cases are determined whether they are or not at this moment. This fast decision-making is a merit of Kyokko. After the detailed examination and reviewing process, finally projects were determined.

2.4.2.3 Characteristics of Kyokko's R&D

As discussed in the previous section, Kyokko owns advanced-level technology, which is its competitive advantage. It proudly declares anything related to electrics and electronics can be produced by Kyokko. What, then, are the sources of its technology? In addition to nurturing the technological knowledge and skills of engineers, which will be discussed in

the section of HRD, Kyokko learns advanced technologies from collaborators at various prominent universities such as Tokyo, Kyoto, Kobe, Tohoku, Ritsumeikan and other universities. Due to its level of technology, the firm has established wide-ranging and close connectivity with these universities. This network has also enabled Kokkyo to be invited to join consortiums organized by universities or large firms, allowing it to enter new fields such as robotics, satellites, aeronautics and aerospace, as well as medical and bioengineering. Success in such projects and the reputation of its technology and confidence has attracted new partners. 60-70% of public project applications have been won by the consortium which Kyokko has joined. Kyokko has already established a virtuous cycle in its business. In addition to public projects, Kyokko began a beer server business through its own sales and marketing efforts. The firm's marketing section approached Asahi Beer and began a joint research with that company. The resulting product contributes greatly to Kyokko's total sales.

Since the size of the firm is small, Kyokko endeavors to make the decision making process as short as possible. It does not have a daily report, or a weekly report, but in the R&D project, accurate records are required in case trouble or claim occurs after its products are sold.

2.4.2.3 Kyokko's HRD

(1) **Career path**

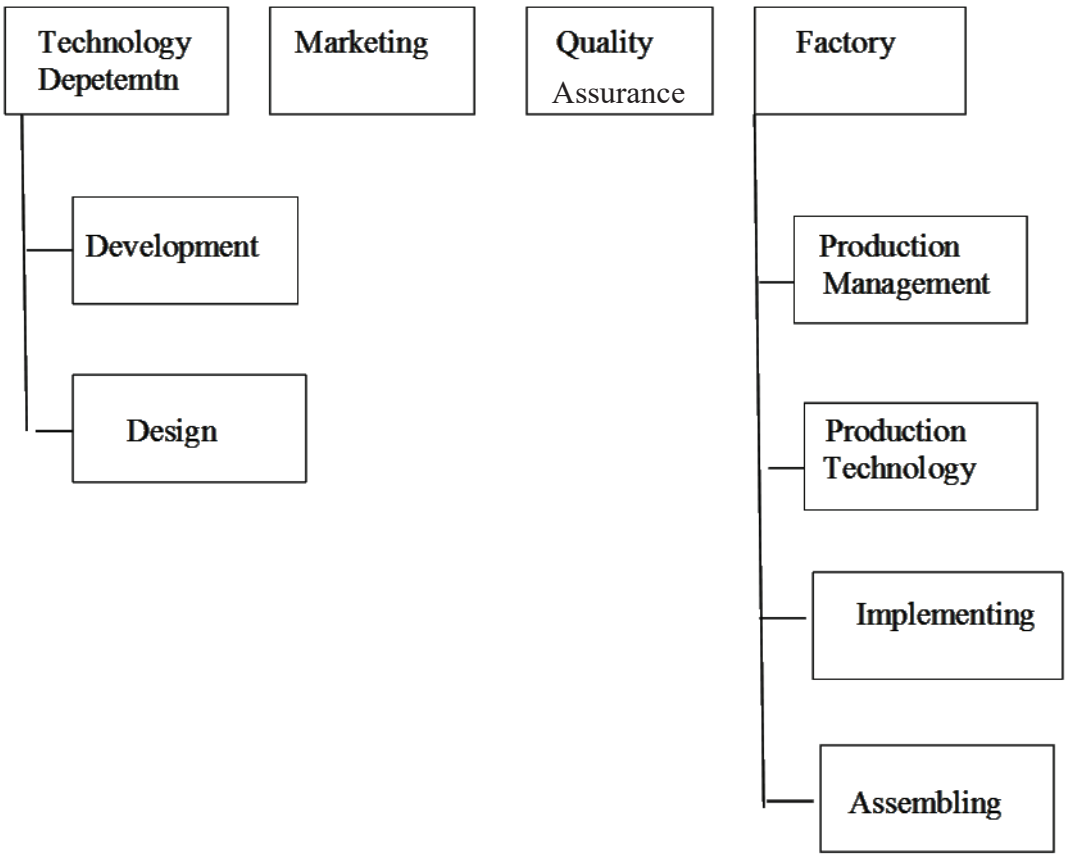
Because of its small size, the number of newly graduated employees is not large. Generally, around 30 university or engineering college graduates apply to the firm each year, five are interviewed, and one or two are finally accepted. Some of these applicants have an MSc degree. The share of new graduates assigned to the R&D units is 50%. The career path they follow is that (i) they are trained for CAM/CAD operation, which is a fundamental for engineering in this firm. (ii) After this, they are assigned to a group, and work together with the four to eight engineers in the group. (iii) The next step is to become a project leader. At about 35-40 years of age, they will generally reach the position of manager.

(2) **Acquisition of skills**

Compared with other firms, Kyokko does not place importance on OJT, which is quite different from other firms. Again, Kyokko's core competence lies in technology, but not skills or craftsmanship, and its advanced and automated equipment can serve as much as traditional craftsmen, except for soldering, which cannot be replaced by machine. Related engineers are required to take official examinations annually. The situation with OFFJT is similar to other firms; employees can participate in outside training courses of one to three days twice or three times a year. Kyokko dispatches its engineers to university

laboratories for two years. It is said that the research environment in Kyokko is better than in university laboratories, since the firm has better equipment, testing devices, and even the latest information on technology can be obtained via the Internet. Kyokko is less concerned about QC or cross-functional teams, because it believes that skills or technologies must be obtained by the efforts of the engineers themselves. Kyokko also thinks that the supreme delight of engineers lies in the realization of their desires or the customer's satisfaction. This is the motivation for engineers. If the firm needs specific technology to develop a new product, then it will simply hire those specialists, instead of nurturing or training employees over a long period of time. This is also quite a contrast to traditional thinking.

Figure 2.3 Kyokko's R&D structure



(3) **Mid-career recruitment**

Kyokko stresses mid-career recruitment, and the head-hunting of engineers with higher degrees; some have a Ph.D. degree from Tokyo University, or an MSc from Kyoto University. The share of new graduates assigned to the R&D units is around 50%, as mentioned earlier. The reasons why the applicants have a high technological level is due to the salary level. In fact, the average annual bonus is equal to 6.5 months' salary, which is far higher than other manufacturing SMEs.

2.4.2.4 Summary of Kyokko

As seen in the previous sections, Kyokko has a different philosophy regarding business management as well as orientation toward R&D and HRD from other SMEs. As a result, Kyokko has registered about 10 patents each year. The R&D structure is similar to Dynic, because both follow ISO9001. Kyokko's way is a bit different; it has accepted ISO's principles in areas such as the management manual or format of documents, but has different arrangement in other aspects. Since Kyokko obtained ISO, R&D efforts have been accelerated. Once ideas for an innovation are obtained, then systematic or managed R&D following ISO is feasible, but the essential issue is how to obtain such seeds or ideas for innovation. It is very impressive that a person such as Edison could not have been created even by systematic education or training. The development of creative thinking entirely depends on the way of thinking or imagination of engineers, and accordingly the raising of skills is left entirely to the voluntary effort of engineers.

2.4.3 Maeda Precision Manufacturing

2.4.3.1 Profile

Maeda Precision Manufacturing was established in 1901 to offer watch repairing services, and was re-organized as a corporation on May 1, 1954. Maeda's main business consists of the manufacturing of precision compact machine parts, precision compact gears, and design and planning/development of gear mechanisms. The annual sales total about 600 million yen. Most of the products are simple parts and the production method is built-to-order. The size of orders is from 10 to 30 parts, prices varying from 1,000 yen to 10,000 yen per part. Total capital held by the firm is about 36 million yen. 95% of sales come from parts manufacturing and processing. ISO9001 was obtained in 2005 and JISO in 2015. The total number of employees is 57. The current president is the fourth-generation CEO and is not an engineer. He joined the firm after working in a bank for two years. Maeda has two factories, the Shioya and Himeji Factories, and the firm's head office is located in Kobe. There are four employees in the head office, 35 in the Shioya Factory, and 15 in the Himeji Factory. As for work categories, two-thirds of the employees are

engaged in processing, five to six are engineers and programmers, five in quality assurance, and the remainder in marketing, accounting, and general affairs.

The firm's products consist of (i) micro-precision gears such as super gears, helical gears, internal gears, bevel gears, etc. These small gears are 0.08～5.0mm in size, and (ii) micro-precision parts such as information communication parts, medical parts, aircraft parts, satellite communication parts, compact speed reducer assemblies, hydraulic precision parts, and so on. These are traditional Maeda's products, and the firm expects to have few competitors in these areas.

Maeda aims to expand into new areas, such as gear and drive units, robots and manipulators, medical equipment, vacuum equipment, and semiconductor manufacturing equipment. To enter these new areas, Maeda has been collaborating with university laboratories. The share of entirely new products is around 5% and major products are more or less related the existing products.

2.4.3.2 Maeda's R&D and HRD

Since the size of the firm is too small to own R&D units, the category of R&D is classified as informal R&D. Therefore, its R&D targets improvements in the quality of products and production process, which is related to skill-raising in its engineers, that is, HRD.

(1) Maeda's R&D Principles

Maeda Precision Manufacturing does not want to be a "subcontractor" of a "subcontractor." There are two means to realize this dream; technology and craftsmanship, by which Maeda produces products only Maeda can produces. Maeda has introduced advanced equipment, such as machining centers, or testing equipment to measure the accuracy of their works. Maeda manufactures precision compact gears and similar products, and in the processing of the materials, machining centers and other machine tools are used for cutting, grinding, and polishing. At the final stage of manufacturing, more precise adjustments are conducted manually with the help of testing devices with attached microscopes, for example.

The main products are parts but Maeda wishes to enter new final product areas. Examples include so-called a hair-washing assistance machine, that is, an automatic hair washing machine; machines to assist with agricultural works, and satellites antenna. In collaborating with other business partners and university laboratories, Maeda has produced these experimentally with financial support from local governments. The sources of information on new technology are open innovation with those partners. Thus, while Maeda is too small to own its R&D unit, the form positively participates in consortiums, which plays the same role as R&D, to develop new areas, instead.

(2) Skill formation

New employment consists of two university graduates, the remainder being graduates of engineering or regular high schools. At first, they are trained in the use of CAD/CAM, which is a requirement for employees who work in this firm. The main form of training is OJT. Basically, senior workers teach and train the new employees on a man-to-man and face-to-face basis. They follow the training manual, repeating it again and again. The firm began to digitalize reports of the procedure, materials, reasons for success or failure, and trainees also learn how to write these documents. The digitalized documents are saved and stored for future reference, which is similar to the procedure at Dynic.

Whether new employees can develop their skills or not depends on their willingness to carry through with the training and self-improvement. Therefore, during training, it is important to have an atmosphere which facilitates learning. Maeda never forces anyone to learn, and allocates jobs which are suited the employee's skill level. The speed of skill improvements depends on the aptitude of individual employees.

The level of engineer skill or ability is measured by the results of official tests. Maeda encourages engineers to take these tests, and coaching classes are held in the factories during weekends. The certificate of Engineer First Class is the target. 30 of Maeda's employees have already passed this examination. If the engineers pass the tests, then Maeda pays the fees for taking the tests.

(3) Skill map

New employees start learning about simple and basic machines and equipment, and having mastered they move on to more difficult ones. Each machine has several functions or operations for which it can be used. When asked to do a job, a certain skill level of engineer is required. For this purpose, skill maps drawn up for each worker are used. It is possible to see at a glance which machine and what kind of functions the engineer can perform.

(4) Proposal system

Maeda has been implementing improvement activities for productivity and quality, and one method of this practice is to solicit proposals from employees. Monetary awards are given, and in case of licenses being obtained, salaries are raised.

2.4.3.3 Characteristics of Maeda's R&D and HRD

As seen earlier, the basis of Maeda's R&D is a combination between technology and craftsmanship; in general, Japanese SMEs stress the latter rather than the former. Not wishing to be a simple subcontractor, the solution is to create products that only Maeda can produce through technology and craftsmanship. New information is obtained through external linkages and this can be said to be one form of formal R&D. In a similar way to Kyokko, Maeda also makes efforts to publicize its level of technology by exhibiting its products or those of consortia at tradeshows.

2.5 Discussion

This section compares the three cases and aims to obtain a comprehensive understanding of the nature of R&D and innovation.

2.5.1 R&D structure

R&D does not simply create something new in terms of technology or engineering, but is related to various aspects of manufacturing, as seen above, and also has related sections or functions attached to it. In addition, Dynic and Kyokko have similar sections, such as production technology, manufacturing technology, quality assurance, design, and so on. These sections are well organized so as to conduct R&D in a coherent manner.

On the other hand, Maeda does not own an R&D section due to its small number of employees, but each engineer is trained to fulfil customer needs. Since the firm manufactures simple parts such as gears, all kinds of requests regarding gears are made to them, and they are required to satisfy customer needs by cultivating their skills and technologies. Although Maeda does not own an R&D center, each craftsman plays this role and other workers are assigned to roles that perform the same functions as sections related to the R&D centers in Dynic and Kyokko. In this sense, whether the R&D is formal or informal, a certain number of related functions is required to conduct R&D. This similarity of R&D structure in the three firms stems from ISO9001, which has standardized the structure and functions of R&D. All three firms have obtained ISO9001.

2.5.2 R&D implementation

R&D practice is different from formal and informal R&D groups. The first step is to find ideas or a seed for innovation. A formal R&D group discovers these seeds by themselves or by collaborating with business partners. Once they find a research theme, they conduct R&D either on their own or by collaborating with business partners. In the case of Dynic, most of the seeds of innovation come from buyers in the form of either claims for better products or changes in the models or specs of final products.

Kyokko and Maeda have a different way of finding R&D ideas. They have been invited to joint research consortia organized by large firms and university laboratories. Both are actively participating in projects such as robotics, medical equipment, aerospace and aircraft, and so on, which are promising areas for next-generation technology. The reason why small SMEs are invited to participate in ultra-high-tech projects is that both firms have superior technology in specific parts. Without these parts, the final products would never be realized. Superior technology in a niche area is a source of further enhancement and widening of technology for these firms. Enhancing and maintaining their own high technology level attracts innovation seeds.

Again, ISO9001 postulates a standardized process on how to conduct R&D once an idea has been found. Dynic and Kyokko have a procedure to take ideas step by step through to realization. The difference between Dynic and Kyokko is in the speed of decision-making. Dynic follows a rather formal procedure for the execution of R&D, while Kyokko is able to make important decisions in regular directors' meetings, for example.

2.5.3 HRD

The three firms have both similar and different attitudes toward HRD, which is related to the characteristics of the firms. Again, HRD takes different forms according to the technology, product, size of the firm, and other factors. The similarity in HRD is that OJT is the main practice. New employees are assigned to specific sections and receive OJT to achieve required skills from senior colleagues. Larger firms have more room for new employees to experience different sections, but Dynic is divided into seven divisions and job rotations are allowed only within a division. Kyokko and Maeda are too small to practice job rotation. Besides OJT, the three firms also have OFFJT for a certain number of days and times a year. Employees generally participate in skill-raising lectures organized by industrial associations related to their work. In the skill-raising process, they are required to achieve certain skills; failure to do so will mean that they are not promoted to higher positions. Dynic, for instance, requires the ability to write a "research report" on a particular job as the first step. The next step is "skill assessment," which evaluates employee ability on a scale from one to five. After passing this, employees can be registered as trainee designers and participate in design as assistants. Maeda has a more intensive OJT system. Since some of its new employees are graduates of regular high schools, not technical high school, they are trained thoroughly on a man-to-man basis and are required to master CAD/CAM as the first step. The basic training method is to become accustomed to writing reports on their design work and to digitalize them. Reports on work procedures, materials, and failures are particularly important, since they can be

referred to later when similar problems occur. The basic training principle is to teach and train the new employees to become top-level craftsmen. The employees are required to master each machine in order, and their performance with each machine is marked up on a skill map. A glance at this map makes it apparent who is able to operate a particular machine and perform a particular function. These skills are reflected in the employees' salaries, which provides them with an incentive to work seriously.

Kyokko has different perspectives toward skill formation, which is a good contrast with Dynic and Maeda. Kyokko also has a similar skill-raising system, but the difference is that this firm hires mid-career specialists. In fact, among R&D researchers, one has a Ph.D. from Tokyo University, and two have an MSc from Kyoto University. In order to recruit these mid-career staff, Kyokko maintains a higher salary level than its competitors. The motivation of skill-raising provides a large proportion of the salary and employees work spontaneously to up-grade their skills. As a result, only one worker has left the firm in 20 years! Kyokko is less active in QC and the proposal system, since employees do their best without resort to these systems.

2.6 Conclusion

The three firms have been compared in the context of R&D and HRD, the patterns of these two mainly depending upon the characteristics of the firms such as the size of firm in terms of the number of employees, type of product and production, and orientation toward high technology. A firm is an organization that yields profits from productive activity and distributes the profits to shareholders, employees, and the firm itself. The firm has to select the best form of management to achieve this. The optimal form of R&D is constructed in this way. Dynic has formal and informal R&D, depending on the risk of the former and the sureness of the latter. Since its products are mainly chemical materials produced in large amounts, reduction of the failure rate is much more certain than risky and costly formal R&D. Kyokko selects formal R&D, since it produces final products and complete parts to its customers. To sell those products, quality backed by technology is essential. Maeda specializes in simple precision gears, which are created by the craftsmanship of its employees. The firm is too small to own an R&D center, but each craftsman considers himself to be a specialist. Kyokko and Maeda are able to elevate their technological level by collaborating with universities and large firms because of the networks created by their technology. During the in-depth interviews, the similarity common to all three firms was found to be ISO9001. The structure and execution of R&D are based on this. ISO9001 is not easy to obtain, but simplifies the complex phenomena of R&D and HRD. Thus, for firms in ASEAN economies, obtaining ISO9001 is strongly recommended for further up-grading.

Chapter 3 Internal Innovation Capability and its Formation in Japanese SEMs

3.1 Introduction

This chapter attempts to clarifies the concept of internal innovation capability which is the basis of whole analysis in this dissertation, and by using this, the innovation process SMEs (Small- and medium-sized enterprises) is analyzed. In particular, this chapter analyzes how SMEs obtain and accumulate information on technology, know-how, the market and consumers, and then assimilate it into their internal capability to create their own products and services, technologies and ideas. That is, this chapter focuses on firms' capability to create innovation, which can be termed as internal innovation capability. There are many sources for promoting this capability, including technological ability, managerial organization to enhance the flow of information and ideas related to innovation, orientation of top management to create innovation, human resources such as top management, engineers, and workers at the job shop. Moreover, SMEs have been absorbing the necessary technology and information from outside firms, including MNCs, universities, regional research institutions, and business organizations, as seen in the previous chapters in this dissertation. These external sources were referred to as linkages. The previous chapters analyzed how these two sources contribute to firms' innovations.

The concept of internal innovation capability contains many factors, including the level of technology, ability and skills of engineers, managerial ability and leadership of top management. Accordingly, it is difficult to identify which factors really contribute to the realization of innovation. In coping with this, the chapter attempts to clarify the concept of the internal innovation capability of firms. In other words, this chapter aims to identify various factors related to creating innovation.

3.2 Internal innovation capability

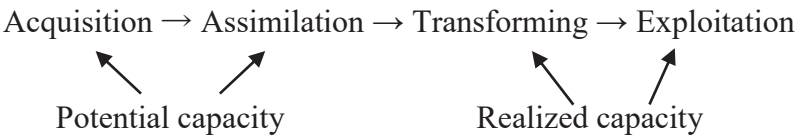
Firstly, the definition of internal innovation capability of firms and factors are presented.

3.2.1 Internal innovation capability in the innovation process

For SMEs which do not have sufficient ability to create new ideas or new concepts are required to obtain new information related to innovation from outside the firms, as Chesbrough (2003) mentioned. Cohen and Levintal (1990) and Zahra and George (2002), for example, consider the innovation process as a obtaining and learning process of such information and emphasize "ability to recognize the value of new information, assimilate it, and apply it to commercial ends." They decomposed the innovation process into for

sub-processes, namely (i) acquisition (absorbing new information; (ii) assimilation (integrating the information with management resources within the company; (iii) transforming (converting the information to innovation; and (iv) exploitation (delivering new products and services to the market). They emphasize that firms have to own specific capacity to observe information in the whole innovation process, and they divided this absorptive capability into *potential* absorptive capacity and *realized* absorptive capacity. The first two of the four stages of the innovation process above need the former capability, whereas the last two stages require the latter. These concepts were expanded in such a way that absorptive capability by including (i) communication with external parties, (ii) know-how and experience within the organization, (iii) diversity and multiplicity of the knowledge structure, and (iv) strategic positioning (Lawson and Samson, 2001; Mariano and Pilar, 2005; Perdomo-Ortiza, Benitob and Galendeb, 2009).

Table 3.1 Innovation process and required capacity (Cohen and Levintal)



As seen in the previous chapters of this dissertation, since the various concepts related internal innovation capability are too abstract to define and use in questionnaire survey and their empirical analysis. Specifically, internal innovation capability includes capabilities related to factors such as technologies that the company own, human resources (human factor), organizational form (organization), and leadership. This chapter attempts to identify the capability of firms to create innovation and postulates the following three layers or factors which contribute to innovation; the "first layer" is exactly internal innovation capability. The first layer consists of the second layer, which are (i) technology; (ii) managerial organization; and (iii) human resources. (i) The technological factor is clearly the basis of innovation. Each of these factors consists of its own detailed sub-factors, which form the "third layer." The examples of the third layer contain as the following factors. The technological factor includes the following factors, for example: (a) ratio of R&D expenditure to sales; (b) the number of intellectual property right owned; and (c) technical and management systems such as R&D. (ii) Managerial organization indicates whether the managerial organization is designed and functioning to encourage exchange and share information among employees or communications inside the firm for

innovation. This second layer consists of the following three third layer factors: (d) practicing QC circle; (e) cross-functional team; (f) information sharing system using ICT; and (g) the traditional background to stimulate discussions and communications among sections of the firms. Finally, the human resources is an important factor for engaging in innovation activities as well as for design and managing R&D, which consist of the following three third layer factors: (h) ability of top management such as degrees or experiences; (i) leadership of top management; (j) degrees and experiences of employees; and (k) the Human Resource Development scheme (HRD) such as OJT (On-the-job training) or OFFJT (Off-the-job training). Table 3.2 shows an example of the tree structure of internal innovation capability.

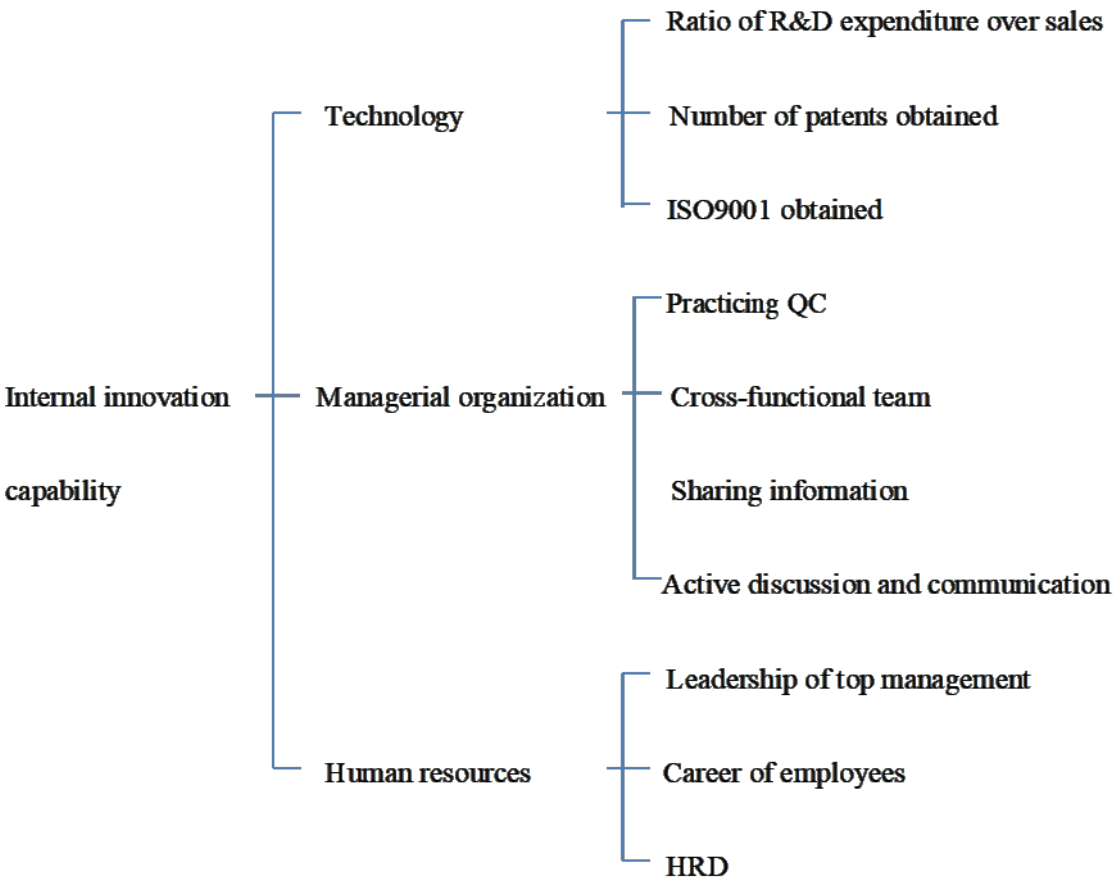
3.2.2 Example of theconstruction of internal innovation capability I: AHP Approach

(1) Concept of AHP

The concept of internal innovation capability contains many factors, including the level of technology, ability and skills of engineers, managerial ability of top management. Accordingly, it is difficult to identify which factors really contribute to the realization of innovation. In coping with this, the construction of an index is rather easy and tractable which is a proxy of the internal innovation capability of firms. In other words, this way is to construct an index from various factors related to creating innovation. In so doing, a rigorous analytical method named AHP (Analytic Hierarchy Process) is applied to construct the index. Let us introduce AHP as an example of method to construct internal innovation capability.

AHP initiated by Saaty (1980), (1986), attempts to give people's decision-making a numerical value, which has been developed and analyzing in Operations Research. For example, when making a purchase, on what basis does a consumer decide? AHP formulates the mechanism of such decision-making. It allows us to give a numerical value to vague parts of people's decision-making, with possible application to a wide array of fields. An individual makes a decision based on his/her own criteria. Normally, not one but several evaluation criteria exist, and these often conflict with each other. In a consumer's decision-making process, the "problem" of what to choose comes first, followed by several "alternatives." AHP attempts to comprehend the process of the decision-making, assuming that there are some criteria relating the specific problem and the alternatives. Thus, AHP's approach is to construct an individual's decision-making according to the hierarchic structure.

Table 3.2 Constituent of internal innovation capability



In order to apply our AHP analysis, we need pair-wise comparisons of all the factors in each layer. That is, taking the value of one factor as one, the value of another factor is measured. To be concrete, scholars or specialists in this filed were asked to choose a number from 1/9, 2/9 …, 8/9, 1, 2, 3 …, 9. If they choose 1, equal importance is placed on two factors. 1/9 (9) implies that its factor is the least (most) important compared to another. Each answer of the pair-wise comparison is termed a "score," which is the basis of weights of factors. The obtained weights of factors of the first and second layers are shown in Table 3. 2, which was an example taken from Tsuji et al. (2011).

Table 3.3 Weights of factors by AHP, an example

Technical factor	0.529084637	R&D investment	0.550325432
		Owing property right	0.293328156
		Technical and management systems	0.156346412
Managerial organization	0.253556004	Practicing QC	0.29619297
		Cross-function team	0.351660652
		Sharing of information	0.352146378
Human resources	0.217359359	Career of COE	0.213007622
		Managerial attitude of CEO	0.562255373
		Career of employee	0.224737005

Source: Tsuji et al. 2011

(2) Distribution of Capability Index

In order to understand the meaning of the index obtain by AHP, an example of the distribution of the internal innovation capability index of the five regions of Indonesia, Thailand, the Philippines, the Ho Chi Minh City area, and the Hanoi area are shown in Figure 3.1, which is based on the weights in Table 3.1. This example is also taken from the same paper (Tsuji et al. 2011). The average value of the index of the five areas is 0.449 and the averages of Indonesia, Thailand, the Philippines, the Ho Chi Minh City area, and the Hanoi area are 0.479, 0.479, 0.384, 0.498, and 0.485, respectively. As for the average value of each, the Ho Chi Minh City area has the largest value, while that of the Philippines is lower than the average. The shapes of distribution of the five areas are also different from the five areas' average. Ho Chi Minh City and Hanoi have more concentrate around their averages, while Indonesia and Thailand are flatter than the five areas' average. We will examine what makes these differences among five areas.

(3) Issues of AHP

Since AHP can single out multiple criterial into one index, AHP is thus a practical method for empirical as well as theoretical studies in Operations Research, but less used in Economics. The reason is clear: AHP is a non-parametric approach and no statistical test of the hypothesis is enabling. For social sciences, statistical test is required for empirical analysis. Besides, AHP requires making pair-wise comparison of alternatives, that is questions, and accordingly the number of alternatives will also increase greatly. In this sense, AHP may not be practical.

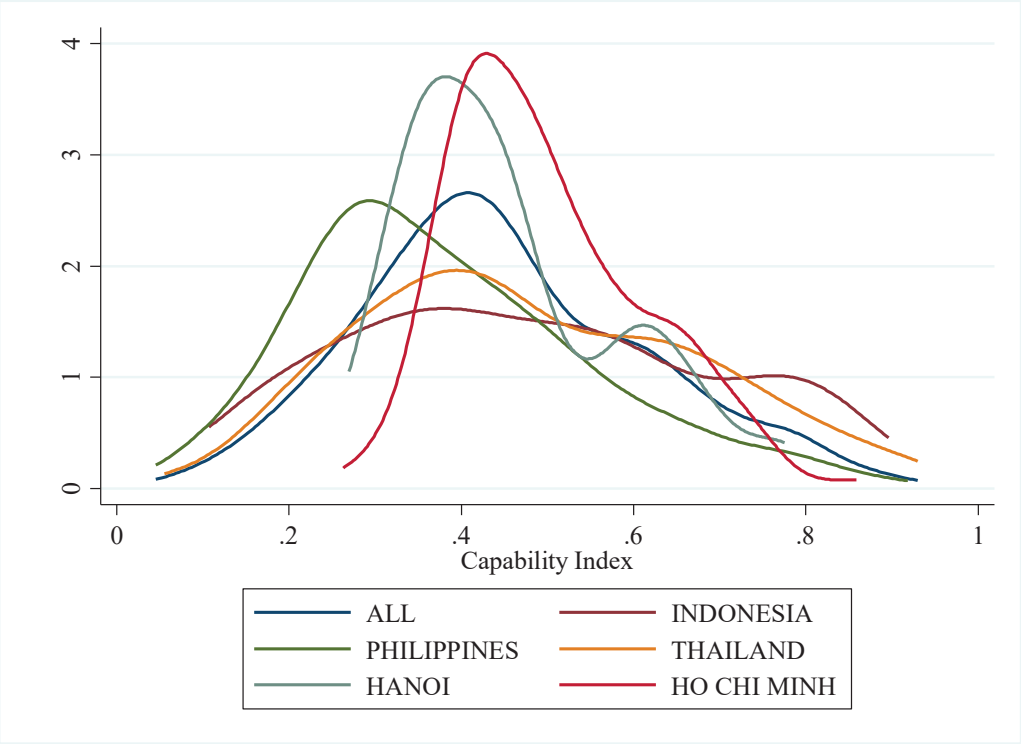


Figure 3.1 Example of the distribution of capability index

3.2.3 Factor analysis

Factor analysis is one of multivariate statistical methods used to examine analyze the relationship between observed variables such as responses to questions and unobserved latent variables that create a commonality. Factor analysis is widely used in social sciences such as psychology, business, and economics. Factor analysis searches for such joint variations from unobserved latent variables. The observed variables are assumed to be expressed as linear combinations of the factors and error terms and factor analysis aims to find how observed variables are reflected by latent variables. There are two major methods in factor analysis, namely exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The former requires no *a priori* assumptions about relationships among factors, but it may lead to measurement without theory. The later, on the other hand, requires some hypothetical model related to observed variables and factors. CFA is used for structural equation modeling to test a hypothetical model in evaluating of relationships between observed and unobserved variables.

This chapter uses SEM as an analytical method and the confirmatory factor analysis is mainly used.

3.3 How internal innovation capability is promoted: case of technology

This section focuses on constructing the internal innovation capability based the mail survey, particularly the level of technology which is one of the important internal innovation capabilities and examines how it promoted by other components of internal innovation capability.

3.3.1 Mail survey and SMEs' characteristics

This section shows how to construct internal innovation capability based on a survey by using factor analysis. Let us briefly introduce our survey conducted in 2008. We selected SMEs which were authorized as "innovative" by the Small and Medium Enterprise Agency, which aims to support SMEs and assist their survival in the current severe circumstances. The Agency authorizes SMEs as innovative and supports the restructuring of their businesses to expand into new fields or the upgrading of their technologies.

The sample SMEs were selected as follows: we calculated the share of each prefecture with regard to the total number of authorized SMEs, and multiplied this by 5,000, which is the total number of mail questionnaires we wanted to send. This results in the number of mails to be sent to each prefecture. Then, we divided this number by the number of years in which there are SMEs authorized according to share, and thereby obtained the number of firms to choose in each prefecture. The questionnaire was then sent in November, 2007 to 5,000 SMEs. A total of 889 valid responses were received. The overall response rate was 17.8%. The replies to this question are summarized in the following tables.

Table 3.3 indicates the distribution of the year of establishment, which is evenly distributed, particularly in total, except over 50 years. Tables 3.4 and 3.5 show the size of SMEs in terms of capital and employees, respectively. The numbers of SMEs, which firm sizes in terms of capital are 10-20 million yen and over 50 million yen, account for more than 50%.

Table 3.4 Year of establishment

	Total	
	freq.	%
0 - 10 years ago	102	11.47
10 - 20 years ago	158	17.77
20 - 30 years ago	132	14.85
30 - 40 years ago	152	17.10
40 - 50 years ago	106	11.92
over 50 years ago	213	23.96
no reply	26	2.92
total	889	100.00

Tables 3.5 Size of SMEs in terms of capital

	Total	
	freq.	%
under 10 million yen	106	11.92
10 - 20 million yen	358	40.27
20 - 30 million yen	130	14.62
30 - 40 million yen	104	11.70
40 - 50 million yen	0	0.00
over 50 million yen	179	20.13
0	3	0.34
no reply	9	1.01
total	889	100.00

Table 3.6 Size of SMEs in terms of employees

	total	
	freq.	%
under 4	67	7.54
4 - 9	155	17.44
10 - 19	192	21.60
20 - 49	251	28.23
50 - 99	149	16.76
over 100	70	7.87
no reply	5	0.56
total	889	100.00

Table 3.7 shows industry; most of the SMEs are engaged in the manufacturing sector, and this bias is often found in the data related to the Small and Medium Enterprise Agency. Table 3.8 explains the specific category within manufacturing, showing that food, metal, general machinery, and electrics are the major industries.

Table 3.7 Category of industry

	Total	
	freq.	%
construction	51	5.74
manufacturing	651	73.23
wholesale/retail	75	8.44
information and communications	20	2.25
traffic	9	1.01
other service industry	58	6.52
others	40	4.50
no reply	4	0.45
total	889	100.00

Table 3.8 Category of manufacturing

	Total	
	freq.	%
Food	80	10.65
Textiles	27	3.60
Wood	23	3.06
Print	32	4.26
Chemistry	15	2.00
Plastic	29	3.86
Rubber	5	0.67
Leather	0	0.00
Steel	14	1.86
Metal	95	12.65
general machinery	76	10.12
Communication	28	3.73
Electric	51	6.79
Transport	26	3.46
precision equipment	41	5.46
Others	105	13.98
no reply	4	0.53
Total	751	100.00

Regarding R&D expenditures, Table3.9 indicates that nearly 50% of SMEs spent less than 5% of total sales on R&D, but that nearly 12% did not invest in R&D. These are because of their small firm size.

Table 3.9 Ratio of R&D expenditures to total sales

	Total	
	freq.	%
under 5%	344	45.81
5 - 10%	126	16.78
10 - 20%	88	11.72
over 20%	42	5.59
0%	87	11.58
no reply	202	26.90
total	889	100.00

3.3.2 Construction of variables

(1) Dependent variables

This chapter aims to examine how technology; one of internal innovation capability, is enhanced by other component of internal innovation capability such as management, organization, and human resources, and the reason the level of technology was selected is that innovation depends heavily on technological strength. Concretely, questions such as “Technology and Research Development,” and “Productivity and Manufacturing Technology” are taken as outcome variables, which were asked in QIII. 4. 3 and QIII. 4. 4, respectively. Respondents were asked to answer in the Likert five scales. The summary statistics of these questions are shown in Table 3.10. From these two observed variables, the dependent variable is constructed and named as the “Technology and R&D.”

(2) Explanatory variables

As shown in Table 3.1, internal capability consists of three second layer and factors in the third layer. Then related variables are taken from the factors other than technological layer. Particularly, we focus on questions related to top management, employees and organizational nature of the firm, which were asked QIV.1 and QIV.3. In this sense, exploratory factor analysis is applied for these two questions and we try to extract latent variables, instead of the usual way such as setting hypothesis first and extracting latent variables by using confirmatory factor analysis. Summary statistics of variables used are indicated in Table 3.10. To identify latent variables from these observed variables, factor analysis was used individually for QIV.1, and QIV. 4. The results are indicated in Table 3.11 and Table 3.12.

Table 3.11 shows that three factors are extracted, namely Factor 1, 2, and 3. The first factor consists of the following five significant questions (observed variables):

QIV.1.7:Your top management keeps employees informed about management/company policies and developments

QIV.1.5: Your top management gives power and responsibility to the offices.

QIV.1.1; Your top management pays attention to how well employees work together

QIV.1.4: Your top management is interested in employees' experience for nurturing

QIV1.8: Your top management encourages employees to expand their skill set.

These express that top management makes effort to provide power and responsibility to sections for self-discipline and autonomy as well as nurture the ability and skills of employees. The latent variable related to these questions is thus termed by "Autonomy."

The second factor consists of following four significant questions (observed variables):

QIV. 1.11: Your top management encourages employees to take risks and challenge themselves

QIV.1.12 Your top management takes the leadership role in the planning of new business

QIV.1.10 Your top management accumulates data on past successes and failures.

QIV.1.9: Your top management promotes competition among employees

Since the critical value of variable is set by more than 0.45, three questions except QIV. 1.11 were rejected. But this latent variable consists of only one observed variable, and thus the second factor cannot be a latent variable.

The third factor consists of following two significant questions (observed variables):

QIV.1.3: Your top management checking quality of working severely.

QIV.1.2 Your top management demands that employees follow routine procedures

Since these are related to monitoring work quality and self-discipline, the latent variable from these observation is referred to as "Monitoring and forced discipline."

Similarly Table 3.12 shows the results of factor analysis for QIV.4. Three factors are extracted, namely Factor 1, 2, and 3. The first factor includes the following three significant questions (observed variables):

QIV.3.2: Employees or organization makes efforts to analyze the successes and failures of past projects.

QIV.3.1: Employees or organization considers employees' spontaneous learning to be an important factor in company development

QIV.3.4: Employees or organization attempts to study not only core technology but also other related types

Since these questions are related to employees' learning activities for enhancing their ability and skills, the latent variable related to these is referred to as "Learning." The second factor contains the following questions:

QIV.3.7: Employees or organization is discussed extensively management
QIV.3.6: Employees or organization discusses or communicate extensively among employees

These indicate the active discussions and communications among top management and employees or among employees. The corresponding latent variable is termed by "Active discussion and communication." Finally the third factor contains includes the following two significant questions:

QIV.3.8: Employees or organization understands what they should do.
QIV.3.10: Employees or organization recognizes that the development of new business is important for the future of the company

These questions ask whether employees recognize their roles properly, and accordingly the latent variable corresponding to these is referred to as "Recognition of their roles."

Table 3.10 Summary statistics

Variable	Obs	Mean	S. D.	Min	Max
Dependent variable					
Internal innovation capability: Technology					
QIII.4.3 Technology and Research Development	868	3.78	0.905	1	5
QIII 4.4 Productivity and Manufacturing Technology	863	3.63	0.967	1	5
Independent Variables					
The top management					
Your top management					
QIV. 1.1 pays attention to how well employees work together.	876	4.059	0.764	1	5
QIV. 1. 2 demands that employees follow routine procedures.	873	3.425	0.888	1	5
QIV. 1. 3 checking quality of working severely.	875	3.679	0.88	1	5
QIV. 1.4 is interested in employees' experience for nurturing.	874	3.709	0.848	1	5
QIV. 1. 5 gives power and responsibility to the offices.	878	4.018	0.736	1	5
QIV. 1. 6 listens to employees' ideas and proposals.	874	4.021	0.726	1	5
QIV. 1.7 keeps employees informed about management/company policies and developments.	873	3.969	0.842	1	5
QIV. 1.8 encourages employees to expand their skill set.	872	3.54	0.78	1	5
QIV. 1.9 promotes competition among employees.	875	3.187	0.85	1	5
QIV. 1.10 accumulates data on past successes and failures.	875	3.465	0.904	1	5
QIV. 1.11 encourages employees to take risks and challenge themselves.	871	3.56	0.873	1	5
QIV. 1.12 takes the leadership role in the planning of new business.	873	3.803	0.911	1	5
Employees and organization					
Your employees or organization					
QIV. 3.1 considers employees' spontaneous learning to be an important factor in company development	875	3.999	0.84	1	5
QIV. 3.2 makes efforts to analyze the successes and failures of past projects.	872	3.495	0.87	1	5
QIV. 3.3 always analyzes competitors.	871	3.046	0.897	1	5
QIV. 3.4 attempts to study not only core technology but also other related types.	871	3.443	0.835	1	5
QIV. 3.5 are able to act on their own, without orders from the management.	873	3.479	0.853	1	5
QIV. 3.6 is discussed extensively among employees.	872	3.288	0.856	1	5
QIV. 3.7 is discussed extensively management.	872	3.399	0.838	1	5
QIV. 3.8 understands what they should do.	874	3.618	0.781	1	5
QIV. 3.9 understands the company's direction.	875	3.655	0.787	1	5
QIV. 3.10 recognizes that the development of new business is important for the future of the company.	871	3.61	0.877	1	5

Table 3.11 Factor analysis for QIV.1

Observation Variables	Factor 1	Factor 2	Factor 3	Communality
Top Management				
QIV.1.7 keeps employees informed about management/company policies and developments.	**0.613**	0.229	0.173	0.458
QIV.1.5 gives power and responsibility to the offices.	**0.610**	0.198	0.096	0.421
QIV.1.1 pays attention to how well employees work together.	**0.553**	0.056	0.245	0.369
QIV.1.4 is interested in employees' experience for nurturing.	**0.537**	0.307	0.192	0.419
QIV.1.8 encourages employees to expand their skill set.	**0.460**	0.253	0.108	0.288
QIV.1.11 encourages employees to take risks and challenge themselves	0.234	**0.868**	0.053	0.810
QIV.1.12 Takes the leadership role in the planning of new business	0.230	0.409	0.078	0.226
QIV.1.10 accumulates data on past successes and failures.	0.188	0.399	0.397	0.352
QIV.1.9 promotes competition among employees.	0.273	0.246	0.330	0.244
QIV.1.3 checking quality of working severely.	0.231	0.114	**0.684**	0.534
QIV.1 .2 demands that employees follow routine procedures.	0.092	0.011	**0.642**	0.420
Variance	1.833	1.406	1.302	
Proportion	16.665	12.779	11.837	
Cumulative	16.665	29.444	41.281	

Table 3.12 Factor analysis for QIV.3

Observation Variables	Factor 1	Factor 2	Factor 3	Communality
Employees or organization				
QIV.3.2 makes efforts to analyze the successes and failures of past projects.	**0.740**	0.201	0.141	0.607
QIV.3.1 considers employees' spontaneous learning to be an important factor in company development	**0.610**	0.246	0.119	0.447
QIV.3.4 attempts to study not only core technology but also other related types	**0.547**	0.185	0.230	0.386
QIV.3.8 understands what they should do.	0.222	**0.726**	0.212	0.622
QIV.3.10 recognizes that the development of new business is important for the future of the company	0.315	**0.490**	0.231	0.393
QIV.3.7 is discussed extensively management.	0.247	0.342	**0.892**	0.974
QIV.3.6 is discussed extensively among employees.	0.285	0.518	**0.454**	0.556
Variance	1.509	1.287	1.188	
Proportion	21.553	18.387	16.974	
Cumulative	21.553	39.940	56.914	

3.4Estimation results

3.4.1 Standardized direct effect

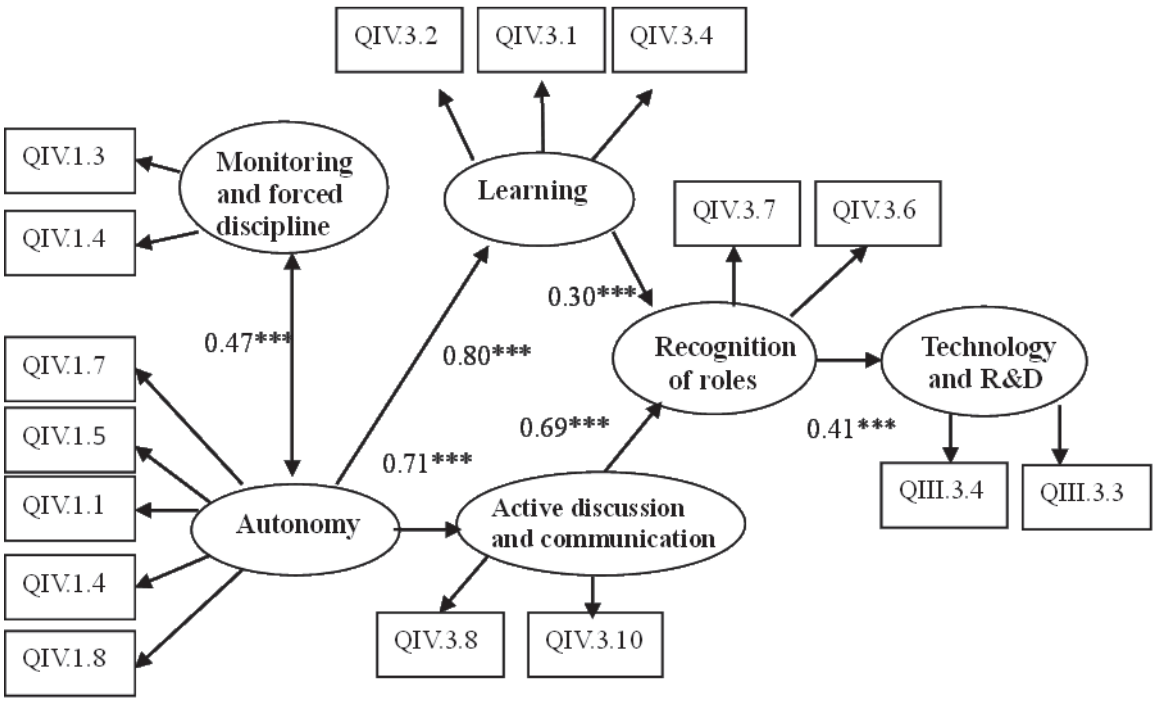
The results of estimation by SEM regard to the standardized direct effect are summarized Table 3.13. The corresponding path diagram is shown in Figure 3.2. All paths connect to latent variables are positively significant. The important observation is the causality among them. The latent variable which initiates all paths to enhance the final latent variable of "Technology" is "Autonomy," which consists of the arrangement of top management to enhance employees' motivation by allowing employees or sections' authority and responsibility, and providing necessary information and boarding experience and career of various jobs and works. This latent variable has two effects to "Learning" and "Active discussions and communications." That is, "Autonomy" promotes their spontaneous learning activities of employees on success or failure of the past projects and necessary technology and knowledge. It is reasonable to consider these enhance employees' ability and skills. "Autonomy" also encourages active discussions among employees, which also activates information flow among them. As seen in the previous chapters, this raises more proposals and suggestions from employees. These two latent variables enhance the latent of "Recognition of their roles," which leads to high motivation and spontaneous effort to elevate their technological ability and skills. On the other hand, the latent variable "Monitoring and forced-discipline" has only correlation with "Autonomy," but no relations with other latent variables, implying that autonomy and self-discipline are much more important for top management.

The causality among the latent variables thus described seems to be consistent with our in-depth interviews and the reality. It should be noted that what are the most important is to provide freedom of decision making as much as possible to the frontline such factories, job shops, and so on. Another extreme management is to monitor employees all the time or force them to obey discipline top management set. The latent variable of "Monitoring and forced discipline" is not significant to affect other latent variable.

Table 3.13 Results of SEM: Standardized direct effect

From	To	Standardizing Coefficient	SE	*t* value	*p* value
Autonomy	Active discussion	0.711***	0.061	14.094	0.000
Autonomy	Learning	0.800***	0.062	13.795	0.000
Active discussion	Recognition of roles	0.687***	0.051	11.448	0.000
Learning	Recognition of roles	0.300***	0.054	5.369	0.000
Recognition of roles	Technology, R&D	0.405***	0.060	8.302	0.000

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively



Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

Figure 3.2 Path diagram

3.4.2 Fitness of the model

The fitness of the SEM model is shown in Table 3.14 which is determined by GFI (goodness-of-fit index) and AGFI (adjusted goodness-of-fit index) which take the value between 0 and 1 indicating criteria of the explanatory power of the model. If GFI ≥ AGFI and both indices are 0.9 or more, the model can be judged as proper. CFI (comparative fit index) evaluates the model in terms of goodness-of-fit showing how much the model is

improved in comparison with the independent model estimated under the assumption that there is no correlation among the observed variables. It takes the value from 0 to 1, and the model is judged as being good fit if CFI is 0.9 or more. Moreover, RMSEA (root mean square error of approximation) is an index that expresses the divergence between the estimated and actual distribution of the model expressed in terms of the amount of degrees of freedom. The model can be judged as good fitness, if it is 0.10 or less. The results show that GFI (0.958), AGFI (0.939), CFI (0.944), and RMSEA (0.053) satisfy all above conditions

Table 3.13 Test statistics

χ^2value	Degree of freedom	p value	GFI	AGFI	CFI	RMSEA	AIC
297.498	84	0.000	0.958	0.939	0.944	0.053	369.482

3.4.3 Standardized indirect effect and total effect

In SEM analysis, standardized direct effect is the most important, but the results of Standardized indirect effect and total effect are stated here. Table 3.14 shows the indirect effect, while Table 3.15 the total effect. All related paths in two tables are positive significant implying that the results previously obtained are supported.

Table 3.14 Standardized indirect effect

From to	Autonomy	Active disussion	Learning	Recognition of roles	Technology and R&D
Active discussion	--	--	--	--	--
Learning	--	--	--	--	--
Recognition of roles	--	0.792***	--	--	--
Technology and R&D	--	0.295***	0.278***	0.122***	--

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

Table 3.15 Standardized total effect

to \ From	Autonomy	Active discussion and communi-cation	Learning	Recognition of roles	Technology and R&D
Active discussion and communication	0.711***	--	--	--	--
Learning	0.800***	--	--	--	--
Recognition of roles	0.729***	0.678***	0.300***	--	--
Technology and R&D	0.295***	0.278***	0.122***	0.405***	--

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

3.4 Discussion

This chapter takes the level of technology or R&D which is one of internal innovation capability as an explained variable and examines how it is promoted by other internal innovation capability; particularly the causality among internal innovation capability is focused. As a result, it is "Autonomy" that is the initial internal innovation capability throughout the process to enhance the level of technology. Since innovation is related to creativity, creativity is promoted by free thinking. However, autonomy is not necessarily admitted as required factor for innovation. Some previous studies emphasize that autonomy, or decentralization in the R&D organization is the one of the essential characteristics for innovation. Tomita (2015), for example, finds the autonomy of researchers in the international R&D institutions of the pharmaceutical industry is an important factor for innovation. Haneda and Ito (2016) also show that the decentralization of decision making among researchers are positively related to process innovation but not product innovation from their empirical study. On the other hand, Argyres and Silverman (2004) assert that the centralization of R&D organizations is more efficient that the decentralization, since the former reduces the transaction costs and is able to cope with wider range of research topics. Lerner and Wulf (2007) demonstrate that long-term incentives of corporate R&D executives are positively significant with innovation and conclude that since the R&D executive in the centralized R&D organization has greater authority and influence over R&D decisions, centralized R&D organizations are more suitable to innovation decentralized R&D organizations. In this study long-term incentives play important role in corporate R&D heads making better decisions over project selection that in turn lead to more productive R&D efforts.

Thus autonomy is not essential for innovation *a priori*, and more research is required to solve this issue.

3.5 Conclusion

This chapter examines the concept of internal innovation capability initiated by Cohen and Levintal (1990) and Zahra and George (2002). To make this concept clearer and more tractable for empirical studies, this chapter identifies internal innovation capability by concrete terms and measures these by questionnaire survey. As a result, six latent variables are extracted by factor analysis, which are "Technology and R&D," "Autonomy," "Monitoring and forced discipline," "Learning," "Active discussion and communication," and "Recognition of roles." Observed variables are selected from the questions of the mail survey. Then taking "Technology and R&D" as an explained variable, a SME model is constructed to explain how "Technology and R&D" is elevated by other five latent variables, and in this SEM analysis, the causality or connectivity among the latent variables is also examined. The result identifies significant paths to outcome of "Technology and R&D," in which "Autonomy" initiates the paths, that is, this is the most important latent variable. Then "Autonomy" promotes "Learning" and "Active discussion and communication," and these two enhances "Recognition of roles." Finally "Recognition of roles" elevates "Technology and R&D." The most important internal innovation capability in the innovation process is freedom and decentralization of employees. Although this finding seems to be consistent our field research stated in Chapter 2 of this dissertation, and to provide one answer to debates on whether decentralization or centralization is better organizational arrangement for promotion of innovation.

Although this chapter has some new findings in innovation studies, it has also some limitations, and need to generalize the model. First, the outcome variable in this model is the level of technology and R&D, but this should be innovation; product as well as process innovation. In other chapters of this dissertation, outcome variable is innovation. Second, more observed variables are necessary. More questions should be added to cover the organizational or human resource management including award scheme, job rotation, cross-functional team, HRD including OJT and other training schemes. Finally, this chapter does not discuss how the conclusion can apply for policy. To date, Japanese SMEs has been suffering from the transformation of the Japanese economy including the aging society, globalization, low economic growth, and so on. Among them, the aging society has been seriously destroying the background of SMEs' strength such as BCP (business continuation plan) and retiring of skilled employees. The results of this chapter may contribute to policy strategy to revival of Japanese SMEs.

Chapter 4. Role of External Linkages and R&D in the Innovation Process of Japanese Small- and Medium-sized Enterprises (SMEs)

4.1 Introduction

The environment surrounding Japan's SMEs is becoming more challenging. The economic structure that serves as the foundation of the SMEs to date is facing accelerating changes. Consequences include risks to business continuity plans (BCPs) such as lack of successors and workers because of a low-birthrate, aging society, a series of management crises embroiling major Japanese firms like Sharp and Toshiba, and furthermore the uninterrupted expansion of major companies overseas. The emergence of the information economy triggered by information and communication technology (ICT), and furthermore, the transition to the knowledge economy are not unique to Japan; they have realized globally common structural changes. However, some of SMEs in Europe and the U.S. themselves take a role of inducing such changes. Venture companies in the IT and biotech industries are especially representative of these SMEs. They are destroying existing industrial structures and creating new products, services, and business models, a phenomenon aptly called creative destruction. SMEs in Japan, on the other hand, can be said to be victims of this process instead of innovators. In the midst of such rapid and turbulent changes, it goes without saying that sustained innovation is required to regain vitality and, furthermore, grow.

Our main research topic has conducted thus far onsite surveys of SMEs inside and outside Japan, questionnaire surveys, and literature reviews to investigate what are needed to foster innovation by SMEs and, to support answering this question, how innovations are produced (Tsuji et al. 2011, 2013a, 2013b, 2016a, 2016b). This chapter seeks to construct a new theory on SME innovation by reviewing and comprehending findings and knowledge obtained to date from a unified perspective. Conventional research on innovation in general has focused thematically on individual factors such as absorptive capability, R&D, and open innovation. While this approach has its advantages, it is critical to research innovation as a single process from a broad perspective and framework. This analyzes how SMEs acquire new information and ideas that are the source of innovation, organize and conduct R&D to integrate these ideas with management resources within the frim, and finally, how they produce the concrete output of these steps that lead to the development of new products. Our research especially seeks to answer what elements are needed in this process, and how they should be combined.

With these questions in mind, the chapter is structured as follows to shed light on the mechanisms of innovation in SMEs. In the next section innovations obtained through

our surveys of SMEs are organized into three types, and their features are described. Section 3 provides hypotheses and models, and in Section 4 these hypotheses are tested. Sections 5 and 6 discuss the estimated results and actual results, and finally offer a conclusion.

4.2 Three types of SME innovation

4.2.1 Factors determining SME innovation

SMEs have various limitations with regard to innovation. They seek to innovate and pursue R&D amid these limitations. Accordingly, before analysis is conducted the factors and limitation conditions determining innovation are clarified. This section summarizes these factors and limitations from the results of past onsite surveys and previous research as follows:

(1) **Abilities of managers**

Like venture companies in the U.S., in Japan's SMEs, managers with outstanding technical or management abilities lead innovation to a greater or lesser extent. These abilities are not just limited to technology, but also include overseeing R&D and human resource development (HRD) and expanding their networks with other companies through activities such as sales.

(2) **Company size**

Company size in terms of capitalization, number of employees, or sales determines innovation in an SME. For example, if an SME seek to have an R&D organization but do not have enough employees, it cannot assign human resources for this purpose. If there are no outstanding personnel, then an SME will tend to focus on improving existing products instead of developing new products.

(3) **Product type**

The type of innovation is determined by whether the product supplied by the SME is the final product, or a completed part, intermediate part, or simple part. If the final product is sold in the market, the SME can develop new products to meet the needs of mass consumers. If it supplies a simple part or raw material, that is incorporated into a final product by a large company. The extent to which the SME can express originality is then limited and it has no choice but to focus on improvement innovation.

(4) **Seeds of innovation**

The innovation type is also determined by whether the innovation can be created from original ideas or ideas obtained from the seeds of other firms. As stated in (1) "Abilities of managers" above, innovation through original ideas is autonomous, and innovation through ideas from other companies is non-autonomous. In the latter case, changes in the model of a final product by a large firm, for example, lead to innovation by the part manufacturer as the changes involve development of new parts. Demands from the buyer to respond to complaints and improve quality also lead to improvement in the supplier. In this way non-autonomous innovation generally spread in accordance with the supply chain. In this chapter, the flow of such information is called the "transaction channel." Furthermore, since the latest technologies are often produced in university labs, collaboration between companies and universities and other research institutions, especially in the form of open innovation, is a focus of attention. Included among these firms are SMEs that actively acquire information by partnering with university labs. This chapter calls such a route of acquiring information the "intellectual channel." How SMEs produce innovation through these three sources of ideas is analyzed in this chapter.

(5) R&D and organizational learning

The innovation process is also called the learning process (Cohen and Levintal, 1990). The process includes the innovation of the final goal from the ideas, that is, sharing of obtained and absorbed information that is needed for innovation within the firm, combining the information with management resources within the firm, and developing a new product. Incorporate in this process are communication within the firm, the speed of decision-making, the organization and methods of R&D, and HRD. The methods of innovation differ depending on the completeness of this process.

4.2.2 Types of innovation in SMEs

With the above discussion as the foundation, this chapter proposes three types of innovations in SMEs: (1) manager-based, (2) improvement-based, and (3) development-based. These types were extracted from factors above considered to be important. Needless to say, these types are mixed in the actual process of innovation. For manager-based innovation, original products are sent to the market through the use of original technologies developed by the founder-type manager himself or herself. In short, it is a top-down process in which the manager is responsible for innovation. Improvement-based innovation stands on the opposite side of manager-based innovation. SMEs that possess this type of innovation are relatively larger in size, producing parts and raw materials, and have departments dedicated to R&D. However, the special characteristic of this type of innovation is that members of a group or team work together on developing

or improving a product at the production site. This team is cross-functional, composed of technology-related departments such as departments for production technology, design, testing, and materials, and in addition, a sales department which deals with the product. Because innovation is often produced from the activities of the onsite production team, this innovation type is called bottom-up (Tsuji et al., 2016b). Development-based innovation can be considered a hybrid of the previous two types. It has a character in between the other two types of innovation in terms of firm size, R&D organization, production method, and HRD. The reason for including this type is that when the percentage of R&D-dedicated employees and R&D investment as a percentage of sales in a firm reach 5 percent or more, the development of new products becomes extremely active. With R&D in its mission statement, such a firm provides research funding and dispatches researchers to university labs, collaborates with universities and related firms and participates in R&D consortiums to develop products and technologies in particular fields, and actively seeks grants and subsidies from the central and local governments.

Table 4.1, which is the same as in the previous chapter, summarizes the characteristics of the above three types of innovation. The purpose of this chapter is to analyze the innovation process for each of the three types, so a discussion of their relative merits is not carried out. However, understanding of these characteristics is beneficial for interpreting the results of empirical analysis as well as for establishing future policy to create innovation.

4.3 Formulation of hypotheses

4.3.1 Analytic framework

Here the analytic framework of this chapter based on the results of previous research is explained. As new information required for innovation is produced outside the firm (Chesbrough, 2003), how the firm handles the information is critical. Cohen and Levintal (1990) and Zahra and George (2002) consider the innovation process as a learning process, which consists of absorbing new information (1. acquisition), integrating the information with management resources within the company (2. assimilation), converting the information (3. transforming), and delivering new products and services to the market (4. exploitation). They emphasize absorptive capability as being critical for innovation and divide it into potential capability and realized capability. The first two of the four stages of the innovation process above need the former capability whereas the last two stages require the latter. Mariano and Pilar (2005) expand absorptive capability by including communication with external parties, know-how and experience within the organization, diversity and multiplicity of the knowledge structure, and strategic positioning. For

analysis, the cause-and-effect relationships between a variety of factors and capabilities were examined (Lawson & Samson, 2001; Perdomo-Ortiza, Benitob & Galendeb, 2009).

In this chapter, since the various concepts mentioned above are abstract, internal innovation is defined in a form that facilitates questionnaire survey responses and their empirical analysis. Specifically, internal innovation capability includes capabilities related to factors such as technologies that the company own, human resources (human factor), organizational form (organization), and leadership. For actual examples of internal innovation capability, see chapter 3 in this dissertation or Tsuji et al (2016a, 2016b).

Table 4.1 Types of innovation

Factor ＼ Type	**Top down**	**Improvement**	**Development**
Firm Scale	Small	Big	Middle
Type of product	Completed product、Completed parts	Simple parts、Material	Completed parts
Production lot	Small	Big	Small or Middle
Production method	Custom production	Mass production	Custom production、OEM
R&D organization	R&D is nothing	R&D organization	R&D organization
Full-time /R&D employee	0	Small	Big
Engineer HRD method	OJT（Density）	OJT、OFFJT	OJT、Detach to university
New employees	High school graduate	University graduate, Master degree	Industry department High school graduate, College of technology, Mid-career recruitment
Idea	Top manager's experience and study	Customer	R&D team, Customer, University etc.
Collaboration partner	Nothing, or other industries firms	Buyer	Other industries firms, university, etc.
Seeds of innovation	Technology	Claim, Model change	Technology
Type of innovation	Product	Process	Product

A critical concept today for advancing innovation is R&D. Like innovation, a great amount of diverse research on R&D has been carried out. The reason is that R&D is risky, and its high rate of failure has drawn the interest of management scholars from the start (Booz, Allen, and Hamilton, 1982; Crawford, 1987; Cooper, 2001; Nadia, 2011; Tomita, 2015). Based on such research, many guidebooks and textbooks on R&D have been published, for example by Crawford (1987, 1997), Smith and Reinertsen (1998), Cooper (2001), Kahn (2013). In general, the R&D process is divided into processes such as conception of ideas, selection for commercial application, development, prototyping, and commercialization (Booz, Allen, and Hamilton, 1982).

Previous research has mainly addressed R&D from the perspective of organizational theory. Studies focused on areas such as acquisition of new information through the R&D organization, sharing of the information between members, and the conversion of the information to knowledge, and furthermore, from tacit knowledge to explicit knowledge. Accordingly two roles are considered critical in the R&D process: the gatekeeper, the key person who incorporates new information, and the transformer, who converts the acquired information into knowledge and transmits it to members in the organization (Freeman, 1979; Harada, 1999, Hirasawa, 2013; Nakauchi, 2014; Tsuji et al. 2016a, Tomita, 2015). To smoothly convey information, trustworthiness between R&D members is a prerequisite (Leven and Cross, 2004; Colquitt and Rodell, 2011). Many of these discussions on R&D consider R&D's success or failure as the outcome of their analyses. However, in this chapter the essence of R&D is not the focus. Instead its relationship to the outcome of R&D in the innovation process is analyzed.

4.3.2 Innovation process

Based on the results of previous research and onsite surveys, this chapter divides the process of innovation into the following stages.

(1) Sources of ideas

The initial stage of innovation is obtaining information and ideas related to new products and services. It is assumed that there are two sources: internal and external to the company. Information related to the latest technologies, markets, etc. is possessed by large companies, universities, and different research institutes. It is absorbed by SMEs using different types of channels. As mentioned above, in this chapter transaction channel and intellectual channel are the two channels for external linkages. In addition, this chapter hypothesizes a manager-based channel through which managers themselves produce ideas. This channel is the source of information internal to the company.

(2) Internal innovation capability and R&D

What bring acquired information to fruition as innovation are the company's innovation capability and R&D. The reason for separating the two factors is that the former indicates disparate basic capabilities within the company and the latter is an organizational capability. Also, as our research has focused on internal innovation capability, this chapter is interested in its relationship to innovation. What is especially a topic of inquiry is the cause-and-effect relationship between innovation capability and R&D. In short, does internal innovation capability determine the level of R&D, or does internal innovation capability increase due to R&D? The previous research to date has not explicitly taken R&D into account. Therefore, our past studies have argued that information from external linkages improve the internal innovation capability (Tsuji et al, 2013b). In this model, this chapter elucidates the causal relationship between internal innovation capability and R&D.

(3) Innovation

As an outcome variable, we use innovation by integrating both product innovation and process innovation. Although they should be isolated outcomes, integrating them is necessary due to the limitations of SEM analysis, that is, a latent variable needs more than two observed variables.

The framework of analysis on the innovation process thus described is elucidated by the following Figure 4.1.

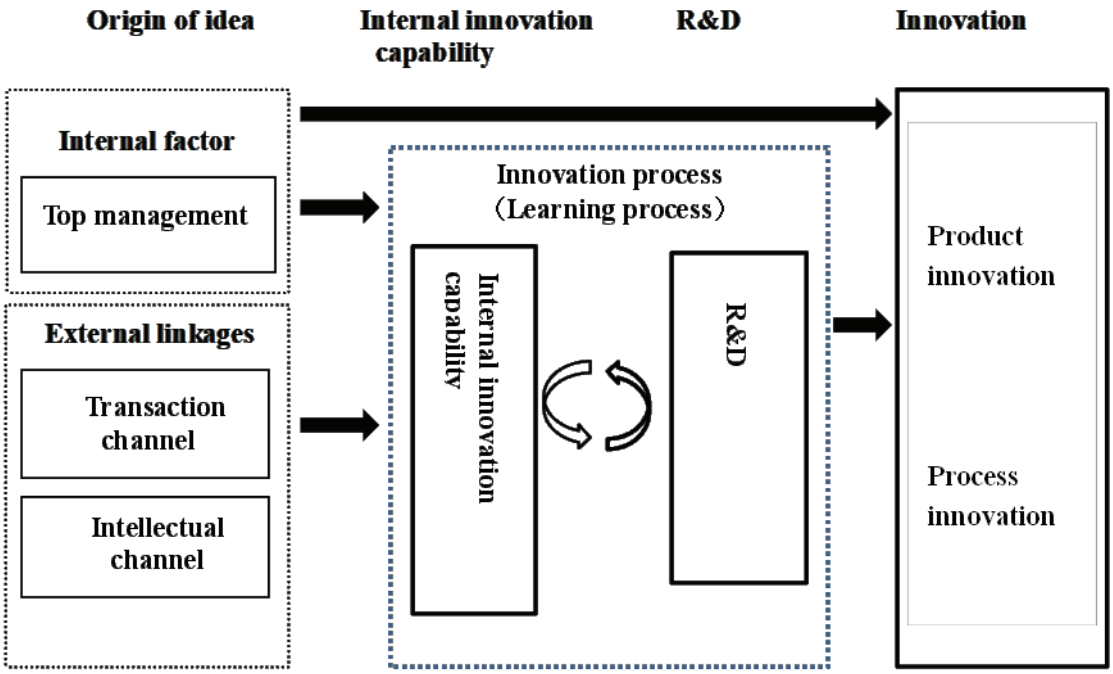


Figure 4.1 Analytical framework of the innovation process

4.3.3 Establishment of hypotheses

From the model diagram shown in Figure 1, the following hypotheses to be tested are set forth. First, for manager-based innovation, it is assumed that in addition to producing direct innovation with technical abilities possessed by the manager himself or herself, the manager demonstrates leadership in the innovation-related organization within the firm. In such case, rather than expressing autocratic power, the manager's leadership has qualities such as nurturing the organization and personnel and coordinating between members and organizations. Such a style of leadership is called "servant leadership" (Greenleaf, 1977). The results of our onsite surveys included several managers who passionately discussed their own management philosophy and human resource development. For these reasons this chapter establishes the following hypotheses with regard to managers.

H1: Top management creates innovations.

H2: Top management leads R&D and influence the organization and implementation of R&D.

This chapter assumes two channels, the transaction channel and the intellectual channel, for external linkages, which are the sources of ideas for innovation. The following two hypotheses regarding the channels are posed:

H3: The transaction channel increases the internal innovation capability and R&D capability of SMEs.

H4: The intellectual channel increases the internal innovation capability and R&D capability of SMEs.

Next, incorporating the results of our research on internal innovation capability and R&D, this chapter assumes that information from external linkages increases internal innovation capability, and, as a result, R&D is stimulated. The following hypotheses are set forth:

H5: Internal innovation capability stimulates R&D.

H6: R&D elevates innovation.

Finally, we integrate the above hypotheses and set forth the following hypothesis.

H7: External linkages promote innovation in SMEs.

The next section develops models to test these hypotheses.

4.4 Data and analytical model

4.4.1 Questionnaire survey

This model is based on the survey conducted in February 2012. In general, a survey is conducted to verify hypothesis, but the data already obtained was used, since the questionnaire is similar to verify the above hypotheses. The samples were selected as follows: From the lists of *Teikoku Data Bank*, 3,959 firms were selected from the manufacturing, construction, information and communications, and service industries. The criteria of the selection is that sample firms have to satisfy the following conditions: (i) unlisted; (ii) the number of employees is more than 20, (iii) earning positive profits in the recent three terms, that is, one year and half, and (iv) the amount of sales is increasing. The reason of these limitations is to reduce the number of samples in the appropriate size. The vail number of responses is 647, and the response rate is 16.2%. The summary statistics is shown in Table 4.2.

Table 4.2 Summary statistics

Outcome Variables					
Innovation	N	Min	Max	Av	S.D.
1. Presence of product innovation	637	0	1	0.67	0.47
2. Presence of process innovation	637	0	1	0.49	0.5
Explanatory Variables					
Top management					
7. The top manager voluntarily shows the idea and decides a new business.	641	1	5	3.71	0.990
8. The top manager takes leading to do new business.	641	1	5	3.89	0.964
5. Propose achievement goal for employees and follow that's outcome to reward.	642	1	5	3.78	0.955
4. Open management outcome to employees	642	1	5	4.10	1.028
3. Employees capability is up by job change.	629	1	5	3.20	1.079
1.Management seeks for short-run profits,	632	1	5	2.84	1.092
2. Management specialized in nich market.	607	1	5	3.21	1.235
6.Management specialized in special technology and product	643	1	5	3.59	1.146
External linkages					
Intellectual channel					
University	647	0	1	0.04	0.2
Public Organization	646	0	1	0.05	0.22
Transaction channel					
Suppliers	647	0	2	0.36	0.624
Customers	647	0	2	0.41	0.656
Technology (Internal capability)					
5. Received technical proposals from the other companies	624	1	5	2.79	1.11
7. Understanding the strong point of the partner, and collaborating in the field of the strong point each other	627	1	5	3.41	1.1
4. Offer own technology for other firms positively.	627	1	5	2.78	1.141
6. Analysis of product and technology data both own and other firms.	624	1	5	2.95	1.085
Owing original technology and development	640	1	5	3.58	0.914
The number of patents (for five years)	523	0	59	1.50	5.207
R&D organizational structure					
1. Decision Making is speedy.	607	1	5	3.58	1.13
2. Give responsibility and authority to R&D department	606	1	5	3.52	1.098
3. Team members' discussion about the agenda each other freely.	606	1	5	3.36	1.066
8. New product and service development is discussed beyond the departments.	606	1	5	3.03	1.210
6. R&D member adopt from internal and external.	604	1	5	2.01	1.100
5. Competitive between R&D members	606	1	5	2.64	0.993
9. Allocate budget based on preference position.	605	1	5	2.77	1.125
10. R&D incentive and awards system	606	1	5	2.57	1.297
R&D implementation					
3. R&D is directly connected to new product and service.	625	1	5	2.86	1.172
2. Basic research and R&D are coordinated.	625	1	5	2.72	1.113
1. The ideas of the new product and service often create in the firm.	627	1	5	3.14	1.136
4. Offer own technology for other firms positively.	627	1	5	2.78	1.141
6.Analysis of product and technology data both	624	1	5	2.95	1.085
5.Accept other firm's technological proposal.	626	1	5	3.40	1.142

7. Collaboration with alliance firms in common strong domain each other	627	1	5	3.41	1.100
9.Target market	624	1	5	2.79	1.110
8. Concentrated on main business, others are outsourcing.	625	1	5	2.93	1.125
10. Many idea is obtained by customers.	628	1	5	3.04	1.073
Individual characteristics					
Year of establishment	626	1854	2011	1969	23.3
Capital (Log)	638	2.3	11.1	7.85	1.02
The number of employees	621	1	600	50.6	51.4
The number of Patents (past five years)	523	0	59	1.5	5.207
The ratio of R&D to Sales	478	0	70	2.6	5.2

4.4.2 Construction of variable

(1) Outcome variable

We take the number of achieved innovation in the questionnaire as an outcome variable, namely respondents were asked whether they achieved innovation during 2006-2010. Particularly, QII.(1) asked whether they supplied new product or service to the market, while QII.(3) asked whether they introduced new production method or new method of marketing. The former is related to product innovation, and the latter is to process innovation. Firms were asked to reply "yes" or "no." The number of positive replies is taken as a variable. More than two-thirds replied "yes" for product innovation, while the more than half replied so for process innovation.

(2) Top management

The ability of top management is not observable, and we asked questions related the nature of this ability, which consists of eight items. Each question requires replying the five-Likert scale from 5 to 1 point. Those are as follows:

QI.1. Management seeks for short-run profits
QI.2. Management specialized in niche market
QI.3. Employees capability is up by job change
QI.4. Open management outcome to employees
QI.5. Propose achievement goal for employees and follow that's outcome to reward
QI.6. Management specialized in special technology and product
QI.7. Top management voluntarily shows the idea and decides a new business
QI.8. Top management takes leading to do new business

By using all these questions, factor analysis of the Likelihood method is conducted. After the Varimax rotation, the result is shown in Table 4.3. Two questions such as "QI.7. Top

management voluntarily shows the idea and decides a new business" and "QI.8. Top management takes leading to do new business" are extracted as significant. The latent variable regarding these is termed by "Top management." These tow observed variables coincide with what we learned from the in-depth interview. The average values of replies to questions 7 and 8 are 3.71 and 3.89, respectively, implying that they are greater than the average.

Table 4.3 Factor analysis for top management

Observation variables	factor 1	factor 2	factor 3	factor 4	communality
7. The top manager voluntarily shows the idea and decides a new business.	**0.897**	0.064	-0.006	0.137	0.828
8. The top manager takes leading to do new business.	**0.796**	0.097	0.012	0.162	0.669
5. Propose achievement goal for employees and follow that's outcome to reward.	0.111	0.993	-0.012	0.010	0.999
4. Open management outcome to employees	0.004	0.445	-0.035	0.177	0.230
3. Employees capability is raised by job rotation.	0.070	0.333	0.035	0.179	0.149
1.Management seeks for short-run profits,	0.003	-0.010	0.999	0.014	0.999
2. Management specialized in niche market.	0.087	0.137	0.034	0.688	0.502
6.Management specialized in special technology and product	0.256	0.252	-0.012	0.573	0.459
Variance	1.529	1.391	1.004	0.911	
Proportion	19.115	17.386	12.549	11.385	
Cumulative	19.115	36.501	49.050	60.435	

(3) External linkages

QIV.(1) asked the sources of information related to innovation such as transaction partners, organizations, universities, and respondents are required to reply "yes" or "no." If they replied "yes" to either buyer or seller, they are considered to obtain information from transaction partners, while if they relied positively to university or public research institutions, they obtained from the intellectual channel. In either case, the number of the positive replies is taken as a value of the variable.

(4) Internal innovation capability (technology)

As seen in Table 3.1 in the previous chapter, internal innovation capability consists of various factors, but the numbers of replies of the questions related to those factors listed in Table 3.1 are small and significant variables were not extracted. Then we focus on questions related to technology, since it is closely related to innovation. Then QIII.(1),

asking whether the following questions hold true to your firm, contains questions related to the technological level of firms, which are as follows:

QIII.1.4. Offer own technology for other firms positively
QIII.1.5. Received technical proposals from the other companies
QIII.1.6. Analysis of product and technology data both own and other firms.
QIII.1.7. Understanding the strong point of the partner, and collaborating in the field of the strong point each other

We also find other following questions related to technology:
Owing original technology and development
The number of patents (for five years)

We apply factor analysis to these questions by using the same method as before, and the result of factor analysis is shown in Table 4.4.

Table 4.4 Factor analysis for internal innovation capability (Technology)

Objective variables	factor 1	factor 2	Communality
5. Received technical proposals from the other firms	**0.849**	-0.258	0.598
7. Understanding the strong point of the partner, and collaborating in the field of the strong point each other field of the strong point each other	**0.545**	0.185	0.418
4. Offer own technology for other firms positively.	**0.488**	0.179	0.346
6. Analysis of product and technology data both own and other firms.	0.188	0.553	0.431
Owing original technology and development	-0.044	0.446	0.316
The number of patents (for five years)	-0.084	0.375	0.121
Variance	1.616	0.613	
Proportion	26.938	10.220	
Cumulative	26.938	37.158	

According to the result of factor analysis, one latent variable is extracted, which consists of "QIII.1.5 Received technical proposals from the other firms" and "QIII.1.7 Understanding the strong point of the partner, and collaborating in the field of the strong point each other." The latent variable from these questions is referred to as "Technology," In particular, QIII.5 implies the possibility that SMEs with the high technical level may be engaged in collaboration with larger firms to which SMEs supply parts and components. This may correspond to SMEs of improvement type.

(5) R&D characteristics

R&D has two characteristics such as R&D organizational structure and R&D implementation, and let us discuss the former. R&D organizational structure was asked in question QIII.(2) to what extent the following items are true for your firm.
Questions are as follows:

QIII.2.1: Decision Making is speedy
QIII.2.2: Give responsibility and authority to R&D department
QIII.2.3: Team members' discussion about the agenda each other freely.
QIII.2.4: Competitive between R&D members
QIII.2.5; R&D member adopt from internal and external sections
QIII.2.6: New product and service development is discussed beyond the departments
QIII.2.7: Allocate budget based on preference position.
QIII.2.8: R&D incentive and awards system

To eight related questions, factor analysis is similarly applied, and the results are shown in Table 4.5. The first factor extracted contains QIII.2.1: Decision Making is speedy, QIII.2.2: Give responsibility and authority to R&D department, and QIII.2.3: Team members' discussion about the agenda each other freely. Particularly, question 2.2 is related to decentralization and autonomy of R&D units. From our field research, it is observed that the speed of decision making is a merit of SMEs. From these, it follows that the latent variable from these observation is referred to as "R&D structure"

Previous papers also discussed about autonomy, and Tomita (2015) and Haneda and Saito (2016) found autonomy as a variable to elevate innovation from Japanese data, whereas Argyres and Silverman (2004) and Lerner and Wulf (2007) claim that centralization in R&D organizations is better to pursuit innovation in terms of efficient allocation of resources and coping with shifts of technologies, markets, and other environments over R&D. This study supports the autonomy as a factor promoting innovation.

Table 4.5 Factor analysis for R&D organizational structure

Objective Variables	Factor 1	Factor 2	communality
1. Decision Making is speedy	**0.968**	-0.194	0.680
2. Give responsibility and authority to R&D department	**0.956**	-0.056	0.832
3. Team members' discussion about the agenda each other freely.	**0.633**	0.330	0.838
8. New product and service development is discussed beyond the departments.	0.141	0.626	0.550
6. R&D member adopt from internal and external.	-0.154	0.544	0.187
5. Competitive between R&D members	0.026	0.653	0.453
9. Allocate budget based on preference position.	0.101	0.654	0.654
10. R&D incentive and awards system	-0.042	0.577	0.297
Variance	4.663	0.502	
Proportion	51.816	5.574	
Cumulative	51.816	57.391	

"QIII.2.3: Team members' discussion about the agenda each other freely" is related to another important nature of R&D, which is mutual understanding and confidence among members in the process of the diffusion of information and knowledge, which is emphasized by Szulanski, Cappetta, and Jensen (2000), Leven and Cross (2004), and Colquitt and Rodell (2011).

To identify another factor related to R&D, QIII.(1) is employed, which consists to the following ten questions on R&D performances and arrangements:

QIII.1.1: The ideas of the new product and service are often create inside the firm
QIII.1.2: Basic research and R&D are coordinated
QIII.1.3. R&D is directly connected to new product and service
QIII.1.4: Offer own technology for other firms positively
QIII.1.5: Accept other firm's technological proposals
QIII.1.6: Analysis of product and technology data both own and others firms
QIII.1.7: Collaboration with alliance firms in common strong domain each other
QIII.1.8: Concentrated on main business, others are outsourcing.
QIII.1.9: Target market
QIII.1.10: Many ideas are obtained by customers

Factor analysis is also applied for these questions, and results are summarized in Table 4.6. The first factor consists of "QIII.1.3. R&D is directly connected to new product and service," "QIII.1.2: Basic research and R&D are coordinated" and "QIII.1.1: The ideas of the new product and service often are create inside the firm." These factors indicate the direction and performance of R&D and accordingly the latent variables based on these observed variables is referred to as "R&D implementation." This variable, in other words,

indicates whether actual R&D leads to achieve innovation, which is an essential question to R&D and various previous papers also analyzed (Leonard-Barton, 1988 ; Iansiti, 1998.). The organizational arrangement or environment to achieve "QIII.1.1: The ideas of the new product and service often are create inside the firm" has been analyzed widely (Sundgren et al., 2005).

Table 4.6 Factor analysis for R&D implementation

Objective Variables	Fact-or 1	Fact-or 2	Fact-or 3	Fact-or 4	Fact-or 5	Commu-nality
3. R&D is directly connected to new product and service.	**0.878**	0.163	0.209	0.052	0.092	0.1224
2. Basic research and R&D are coordinated.	**0.840**	0.138	0.245	0.103	0.044	0.1764
1. The ideas of the new product and service often create in the firm.	**0.571**	0.114	0.218	0.088	0.162	0.5652
4. Offer own technology for other firms positively.	0.173	0.970	0.125	0.104	0.027	0
6. Analysis of product and technology data both	0.302	0.135	0.936	0.084	0.079	0
5. Accept other firm's technological proposal.	0.100	0.345	0.085	**0.537**	0.046	0.5695
7. Collaboration with alliance firms in common strong domain each other	0.111	0.249	0.299	**0.553**	0.158	0.504
9.Target market	0.154	0.024	0.152	0.087	0.674	0.4894
8. Concentrated on main business, others are outsourcing.	0.181	0.157	0.117	0.355	0.339	0.6709
10. Many idea is obtained by customers.	0.178	0.122	0.133	0.168	0.358	0.7601
Variance	2.037	1.241	1.107	0.797	0.770	
Proportion	0.331	0.202	0.194	0.128	0.125	
Cumulative	0.331	0.533	0.728	0.858	0.983	

4.5 Estimation

4.5.1 R&D model

In the actual estimation, two models were examined; one uses only variables related to R&D, while another adds a variable in internal innovation capability. The former is R&D model and aims to examine the role of R&D, whereas the latter is full model, which objective is to examine the whole innovation process. The result of path analysis is shown in Figure 4.3, and Table 4.7-4.9 are estimation results of three effects such as standardized direct, indirect, and total effect calculated by SEM.

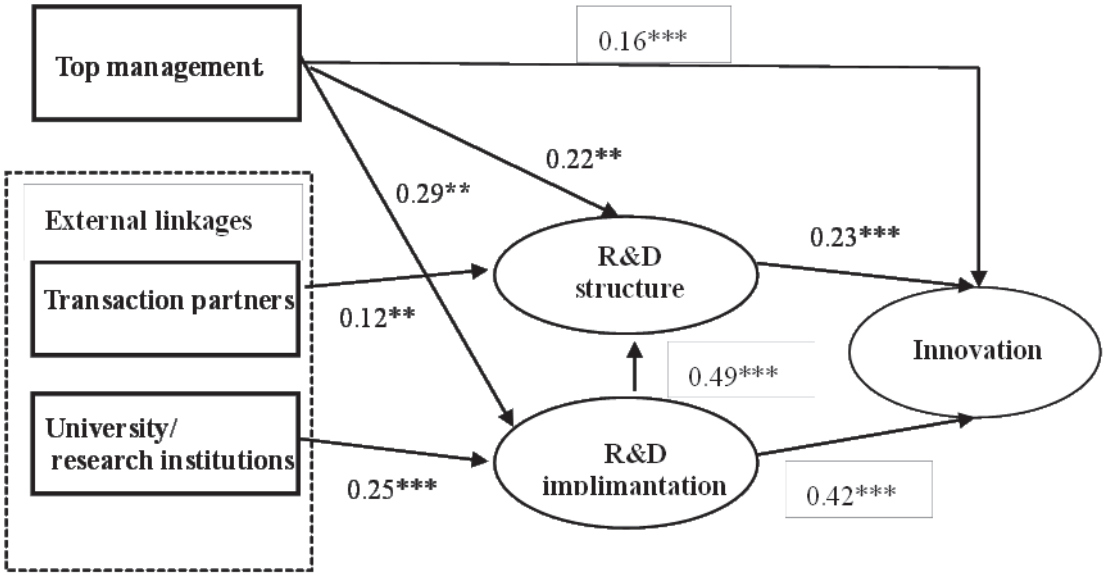
(1) Fitness of model

The fitness of the SEM model is shown in Table 4.10 which is determined by GFI (goodness-of-fit index) and AGFI (adjusted goodness-of-fit index) which take the value between 0 and 1 indicating criteria of the explanatory power of the model. If GFI ≥ AGFI and both indices are 0.9 or more, the model can be judged as proper. CFI (comparative

fit index) evaluates the model in terms of goodness-of-fit showing how much the model is improved in comparison with the independent model estimated under the assumption that there is no correlation among the observed variables. It takes the value from 0 to 1, and the model is judged as being good fit if CFI is 0.9 or more. Moreover, RMSEA (root mean square error of approximation) is an index that expresses the divergence between the estimated and actual distribution of the model expressed in terms of the amount of degrees of freedom. The model can be judged as good fitness, if it is 0.10 or less. The results show that GFI (0.953), AGFI (0.929), CFI (0.953), and RMSEA (0.060) satisfy all above conditions.

(2) Path analysis

Figure 4.2 shows the path diagram obtained from SEM in which only significant paths of the standardized direct effects are drown. Three paths originating from top management are positively significant to all three latent variables. The following characteristics are observed from the path diagram:



Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

Figure 4.2 Path diagram of the R&D model

Table 4.7 Standardized direct effect (R&D model)

From	To	Standardizing Coefficient	SE	*t* -value	*p* -value
Top management	R&D implementation	0.290***	0.247	6.148	0.001
Top management	R&D structure	0.222***	0.048	5.323	0.001
Top management	Innovation	0.160***	0.021	3.073	0.002
Transaction partner	R&D structure	0.122***	0.245	2.071	0.038
University/Public research institution	R&D implementation	0.246***	0.556	2.476	0.013
R&D structure	Innovation	0.225***	0.021	3.753	0.001
R&D implementation	R&D structure	0.485***	0.063	10.503	0.001
R&D implementation	Innovation	0.419***	0.029	6.698	0.001

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

(i) Top management

The all paths from top management to "R&D structure," "R&D implementation," and "Innovation" are positively significant, implying that top management has the most important roles in all aspects of R&D as well as innovation. This is also supported since there is a path directly affecting innovation. Thus these paths indicate the top management-type of innovation. Top management takes leadership of R&D and innovation. This demonstrates **H1** and **H2**.

(ii) Transaction channel

The path from transaction partner is also positively significant to "R&D structure," but not so to "R&D implementation." This implies that trough the transaction channel which is based on the supply chain, information related to constructing R&D units or the framework of R&D units in a concrete way is transferred to SMEs. This implies that this path seems to correspond to innovation of improvement-type.

(iii) Intellectual channel

From "University/public research institutions" there is a significant path to "R&D implementation." This implies that through the intellectual channel, SMEs can learn cutting edge or fundamental technology from universities/research institutions and make use them for commercialization. It can be said that this path can explain innovation of development-type.

(iv) Connectivity

There are separated paths, namely from Transaction partner to R&D structure and from Universities/research institutions to R&D implementation. Two external linkages have different effects.

(v) Relationship between two R&D variables

"R&D implementation" has a positive significant path to "R&D structure," but not vice versa. This indicates that SMEs own the ability related to "R&D implementation," which leads to establish R&D organizational structure. The ability of R&D is more important than its structure. This seems to be consistent with the realty.

The above discussions lead to conclude that both transaction and intellectual channels promote R&D of SEMs and this demonstrates **H3** and **H4**. In the R&D model, internal innovation capability is not contained, and H5 is irrelevant. Since Both R&D latent variables are positively significant to innovation, **H6** and **H7** (External linkages promote innovation in SMEs) are finally verified in the R&D model.

It should be noted that in the standardized indirect effect (Table 4.8) and the standardized total effect (Table 4.9), all paths are positively significant and the above discussions are certainly held

Table 4.8 Standardizing indirect effect (R&D model)

From / to	Transaction partner	University/ public research instiution	Top management	R&D implimentation
R&D organizational characteristics	--	0.119***	0.141**	--
Innovation	0.028***	0.130***	0.203***	0.109***

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

Table 4.9 Standardizing total effect (R&D model)

From / to	Transaction partner	University / public laboratory institution	Top management	R&D implementation	R&D structure
R&D implementation	--	0.246***	0.29***	--	--
R&D structure	0.122***	0.119***	0.363***	--	--
Innovation	0.028***	0.130***	0.363***	0.528***	0.225***

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

Table 4.10 Fitness of model (R&D model)

χ^2value	Degree of freedom	p value	GFI	AGFI	CFI	RMSEA	AIC
228.075	69	0.000	0.953	0.929	0.953	0.060	300.075

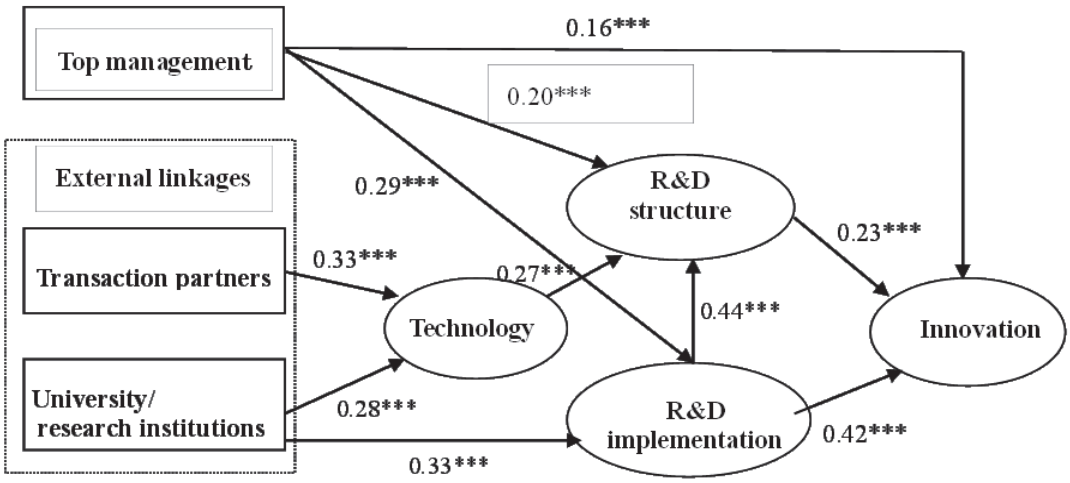
Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

4.5.2 Full model

The model with additional internal innovation capability is termed by the full model. By this addition, the mode contains two sub-process related to internal innovation capabilities as well R&D, which leads to more detailed analysis of SMEs' innovation process. The path diagram is expressed in Figure 4.3 and estimation results are summarized in Table 4.11, 4.12, and 4.13. Similar to the previous section, the fitness of the model is shown in Table 4.14, and all related tests related to fitness are satisfied.

(1) Path diagram and standardized direct effect

Full model adds one variable to the R&D model, which is the latent variable of "technology," which indicates firm's technological ability to collaborate with external lonkages. As already explained, mother companies may not accept SMEs as subcontractors, if they do not own sufficient technological capability. Since all definition and contents of the latent variables are already explained, the remaining issues are an analytical interests related to the following: (i) the cause-and-effect relationship among the latent variables, namely it must be identified which variables are causes and which are results; and (ii) which latent variable initiates the while process, as seen in Chapter 3, "Autonomy" is located first in the process, which shows it is the most important in the process. The path diagram and the estimation results of standardized direct effect are shown in Figure 4.2 and Table 4.11, respectively.



Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

Figure 4.2 Path diagram of the full model

Table 4.11 Standardized direct effect (full model)

From	To	Standardizing Coefficient	SE	*t*-value	*p*-value
Top management	R&D structure	0.204***	0.047	4.951	0.001
Top management	R&D implementation	0.285***	0.040	6.074	0.001
Top management	innovation	0.158***	0.021	3.060	0.002
Transaction partner	technology	0.334***	0.288	2.735	0.006
University/ public research institution	technology	0.278***	0.744	3.170	0.002
University/ public research institution	R&D implementation	0.331***	0.618	3.583	0.001
Technology	R&D structure	0.270***	0.059	4.766	0.001
R&D structure	Innovation	0.228***	0.020	3.896	0.001
R&D implementation	R&D structure	0.442***	0.060	9.773	0.001
R&D implementation	innovation	0.418***	0.029	6.751	0.001

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

At first, the path diagram of the full model seems not to be different much, even if a new latent variable of technology is added. Interesting observations are as follows:

(i) Top management

Again, three paths from top management to two R&D latent variables and innovation are positively significant, implying that top management plays an essential role in the full

model. This shows that these paths are reflected from the innovation of top management-type. The season why the path to "Technology" is not significant is clear. In this type of innovation, owner is also an engineer and he/she directly contributes innovation.

(ii) Causal relationship

The new latent variable of technology is found to be the first among all latent variables due to the results of SEM. It is technology that SEMs have to elevate to connect with external linkages. This indicates that the level of technology is the most important, which leads to R&D. The causal relationship is not vice versa. This is the same results as our previous studies (Tsuji et al, 2013). This is also consistent with observations from our field research.

(iii) Transaction channel

Path from transaction partner is not different from the R&D model, that is, Transaction partner affect only R&D organizational structure trough Technology, and finally affect to Innovation. This is reasonable, since to connect transaction partner it is the level of technology, not detailed R&D organizations in SMEs. Again, this paths from the transaction channel to innovation indicate the innovation of improvement-type.

(iv) Intellectual channel

As stated earlier, laboratories of universities or research institutions own the latest technology and it is mandatory for firms which seeks to develop technology to connect to such laboratories. By connecting to them, SMEs learn technology directly as well as implementation of R&D. The latter is the same as in the R&D model. These paths represent innovation thus induced as innovation of development-type.

(v) Relationship between two R&D variables

This is exactly the same as the R&D model.

Table 4.12 Standardized indirect effect (full model)

To	From	Transaction partner	University/ public research institution	Top management	technology	R&D implimenta-tion
R&D structure		0.090***	0.076***	0.204***	--	--
Innovation		0.21***	0.189***	0.352***	0.062***	0.519***

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

Table 4.13 Standardized total effect (full model)

To	From	Transaction partner	University/	Top manage-ment	technology	R&D implementa-tion	R&D structure

		public research institution				
technology	0.334***	0.278***	--	--	--	--
R&D implementation	--	0.331***	0.285***	--	--	--
R&D structure	0.090***	0.221***	0.330***	0.270***	0.442***	--
Innovation	0.21***	0.189***	0.352***	0.062***	0.519***	0.228***

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

Table 4.14 Fitness of model (full model)

χ^2value	Degree of freedom	p value	GFI	AGFI	CFI	RMSEA	AIC
300.912	94	0	0.946	0.922	0.943	0.058	384.912

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

(2) Total effect and verification of hypotheses

Table 4. 12 and Table 4.13 show standardized indirect and total effects, which show all related paths are positively significant.

Regarding hypotheses stated earlier, all effects from top management and external linkages are positively significant, which demonstrate **H3** and **H4**. As explained earlier, technology activates two categories of R&D, implying **H5** is verified. Finally since two categories of R&D enhance innovation, this demonstrates **H6**. Accordingly, external linkages are verified to promote innovation, which shows **H7**.

4.6 Discussion

This chapter studies thus far using two models how SMEs obtain information outside the firm, integrate it with domestic resources they own, and achieve innovation. In two models, they hypotheses proposed are verified. Here in this section, by comparing the conclusions obtained in this chapter with those of previous papers, we clarify characteristics of the models. First, regarding top management-type of innovation, the conclusions we obtained are similar to those of our previous studies and other literature. Since Schumpeter, innovators who are full of venture spirit take risks and challenge to innovation are prerequisite for the theory of innovation. This study, on the other hand, does not assume these managers, but we attempt to extract from data the role of top management in the innovation process as innovators. Second, this study demonstrates that, in two channels such as transaction and intellectual, R&D's contents and effects to innovation are different. In particular, from the transaction channel, the autonomy of R&D organizations and mutual understanding and confidence among related engineers in SMEs are found important, whereas in the intellectual channel, the level of technology

and R&D orientation or implementation are essential. The connectivity to external linkages is similar to results obtained by other studies (Dyer and Nobeoka, 2000; Todo, Matous, and Inoue, 2016; Tsuji et al, 2016a). However, this study is a bit different from others in the context organization and structure to achieve better performances. Some of the variables listed in the questions shown in Table 4.5 are not significant, which are summarized as follows:

QIII.2.4: Competition among R&D members
QIII.2.5; R&D members are selected from internal and external sections
QIII.2.6: New product and service development is discussed beyond the departments
QIII.2.7: Allocate budget based on preferences
QIII.2.8: R&D incentive and awards system

Other studies emphasized cross-functional teams as well as QC (Tsuji et al., 2013a, 2016a, 2016b), Award scheme to provide incentives (Lerner and Wulf, 2007), employment scheme such as job rotations, promotion, and wages and salaries (Haneda and Ito, 2016). These differences are considered due to the framework of this study such that R&D is examined in the whole process of innovation from the origins of ideas to the final outcome of innovation. On the other hand, others focused and emphasized particular or individual issues. It is required for us to enhance questionnaire or analytical tools.

In the full model, it is technology that absorbs new information owned by external linkages, and technology in the context is one of internal innovation capability. In this sense, innovation is achieved by absorbing new information and transforming it to knowledge by R&D and sharing among members. R&D does not necessarily enhance technology. Thus this study demonstrates that our fundamental causality in the innovation process such as external linkages → internal innovation capability → R&D → innovation is still valid. In two channels, the level of technology as an internal innovation capability is essential and with absorptive capability SMEs can obtain new information (Cohen and Levinthal, 1990; Tsuji et al. 2013a, 2016a; Tomita, 2015).

4.7 Conclusion

The characteristics of this chapter lie in the facts that based on our field research, the models are constructed to verify how actual innovation and R&D are conducted in SMEs and what are essential factors for achieving them. This study classifies innovation models into three types such as top management, improvement, and development and discusses how these three types are different in one model. As a result, we obtain some different results from those of previous papers.

This study, however, owns some limitations which are solved by future analysis. Those are as follows: (i) this paper cannot identify gate keepers or transformers which previous papers aimed to identify; (ii) further studies have to focus on the transforming information to knowledge, bridging the technology and market, combining basic and applied R&D, and nurturing human resources to contribute to these.

Another requirement for further study should be focused on policy, which is not discussed here in detail. Our in-depth interviews found that instead of large amount of subsides, SMEs want small subsides to support for investment in new fields or for exhibitions in the trade shows. SMEs of development-type tend to own specific technologies, but due to human power and financial capability they cannot advertise their technologies to other firms, nor expand their technologies. To exhibit their products and technologies in trade shows or exhibitions are good opportunities for them. There must be some policy measures to cope with this and the accumulation of basic research would solve the issues.

Chapter 5 Connectivity in the Technology Transfer Process among Local ASEAN Firms

5.1 Introduction

This chapter aims to analyze the role of human factor in innovation process in local as well as global firms located in four ASEAN economies, namely Indonesia, Thailand, the Philippines, and Vietnam. The innovation process inside the firm consists of absorptive and transforming processes. Since new information related to technology, consumer's needs, etc. which is necessary for innovation mainly comes from outside the firm (Chesbrough 2003), it is first required to obtain such information, and then integrate it with indigenous resources that the firm owns for innovation. The resources for innovation which firms own are referred to as internal innovation capability, or innovation capability for short, which is defined as an integrated ability of a firm to create innovation which consists of all resources, core competence, or competitiveness. In more detail, internal capability includes the technological level such as the number of patients, production and R&D facilities, human resources such as the number of engineers with higher degrees or skills, the level of craftsmanship, and work ethics, and organizational nature such as communication between workers and top management, speed of decision-making, and leadership of top management. Innovation capability is also divided into two categories, namely absorptive and transforming capabilities. The firms have to nature and enhance these two capabilities for successful innovation. This chapter attempts to identify essential factors which promote these capabilities and as a result those are human factors and organizational learning process inside the firm.

In developing countries, MNCs have superiority in technology, know-how, and management, and local firms have to absorb those capabilities from them. Before absorbing new information, local firms have to initiate the connectivity to MNCs through which locals obtain the necessary information. In this context, this chapter adds some new insight into the analysis in terms of connectivity. In the earlier studies on the innovation process back in the 1960s or 1970s, the personnel who fulfilled functions such as connecting with outside entities and introducing new information were termed as "gatekeepers." In those studies, the establishment of connectivity between providers and recipients of information via communication has been focused. In other words, "trustworthiness" between them is required for transferring information, which is based on their intimacy and mutual respect regarding their ability, common thought or values, etc., (Allen, 1977; Leven and Cross 2001; Colquitt and Rodell, 2011). Gatekeepers thus have enough professional skills and knowledge to avoid misunderstandings and can

connect organizations by dissolving barriers between them. In this sense, this chapter primarily aims to identify these persons from the survey data of four ASEAN counties.

5.2 Literature review

Traditionally, absorptive capability was developed by Cohen and Levinthal (1990), and Zahra and George (2002), for example. Zahra and George (2002) defines it as a firm's ability to reorganize the value of new external knowledge, assimilate to commercial ends. Our previous studies, for example, identified some channels via the human factor (Tsuji et al, 2011, 2013, 2014; Machikita and Ueki, 2015). One such channel is through guest engineers dispatched by MNCs or sent to MNCs from local firms; those engineers obtain new technology, which leads to enhance innovation capability.

Among literature on the innovation process or internal capability related to the less developed economies, Ernest (2002) emphasizes blending diverse international and domestic sources of knowledge and making use of international linkages. Kesidoua and Szirmai (2008) also specifies two types of knowledge spillover in the Uruguay software industry; local and international, and they obtained the conclusion that the latter is more important than the former. Pietrobelli and Rabellotti (2011) shows international knowledge spillover via the global value chain which enhance innovation in the less developed economies. Srholec (2011) and Mkandawire (2007) take social factors such as human capital or skill formation in the innovation process into consideration. Chen and Puttitanun (2005) examines the relationship between innovation and intellectual property rights.

5.3 Hypothesis to be tested

This section discusses hypotheses to be tested. The hypotheses are constructed based on our previous studies.

The agents that own this information is referred to as "external linkages," which are identified by the following three categories: MNCs, local firms, and public research organizations and universities. The issues of external linkages are related to the question as to whether internal innovation capability is a result of external linkages, or vice versa. Our answer to this question obtained by our previous studies is the former (Tsuji et al, 2011, 2013, and 2014). This therefore postulates the first hypothesis:

Hypothesis I: External linkages promote internal innovation capability and accordingly enhance innovation.

In the framework of analysis, this chapter does not discuss how firms establish the ties with other firms avoiding the issue of firm-to-firm matching. Even the underlying

assumption does not exclude some persons who take initiatives to introduce new information. They are referred to as human factor in this paper, and typical examples are gatekeepers of early studies in the 1970s, while they are dispatched or guest engineers, and top management who used to worked in MNCs in our previous studies (Tsuji et al, 2011, 2013, 2014; Machikita and Ueki, 2015). Based on these discussions, this chapter proposes two different categories of connectivity depending on the level of intimacy, proximity, ability, or expertise. Accordingly, the following hypothesis is postulated as the first category:

Hypothesis II: Top management or factory managers who experienced working with MNCs are key factors to construct the connectivity to MNCs.

This hypothesis includes factory managers as gatekeepers, since they are more concerned with technology than top management. The hypothesis is thus related to the global trend of regions, since Western MNCs invested heavily in the regions indicating technology transfers through the human factor. On the other hand, some locality or proximity among human factor can be considered, that is, local employees of both firms can easily develop intimacy. This proximity of human factor leads to the following second category of hypothesis:

Hypothesis III: Indigenous employees assist to construct the connectivity to other local firms.

Observing the process after information is introduced in the above process, new information has to be diffused and shared among suitable employees engaged in R&D sections. The research on the diffusion process, particularly to whom and how new information is diffused is based on who talks to whom or who organizes research meetings and by examining the number of conversations, etc. Personnel who conduct these activities are referred to as “transformer” or “mediator” (Freeman, 1979). In particular, gatekeepers and transformers are the same persons. Thus, the following hypotheses are proposed:

Hypothesis IV: Working experience with MNCs promotes organizational learning.
Hypothesis V: Indigenous employees promote organizational learning.

The following hypothesis shows the relationship between organizational learning and innovation. Since organizational learning plays an important function in the innovation process, as Cohen and Levinthal (1990), Zahra and George (2002), and Christensen and Kaufman (2009) emphasized, this postulates the last hypothesis.

Hypothesis VI: Organizational learning enhances innovation.

In what follows, the hypotheses are examined by using SEM.

5.4 Data and Methodology

5.4.1 Surveys

This chapter is based on mail surveys and phone interviews, which were conducted with 1,232 companies in the Hanoi area and 1,000 in the Ho Chi Minh City area, Vietnam; 239 in the Batangas and other areas in the Philippines; 437 in the Jabodetbek area, Indonesia; and 878 in Greater Bangkok, Thailand. The surveys were conducted from 2012 to 2013. The numbers of valid responses were 149 from the Hanoi area (12.09%), 171 from Ho Chi Minh City (17.10%), 157 from Indonesia (35.93%), 237 from the Philippines (99.16%), and 284 from Thailand (32.35%). The way to select samples was different from the countries, that is, Vietnam and The Philippines answered across regions, while Indonesia and Thailand answered industries. In Table 5.1 shows the results of surveys.

Table 5.1 Number of sending out surveys and valid response rates

	The Philippines		Thailand		
	Batangas and others		Bangkok		
Number of sending out a survey (across regions or industries)	Total	239	Total		878
	Batangas	13.81%	Mail survey		500
	Cavite	43.51%		Automotive industry	212
	Quezon	4.18%		Textile industry	50
	Rizal	25.10%		Electronic industry	69
	Laguna	13.39%		Stock Exchange of Thailand	169
			Phone interview		78
			Direct handout		300
Number of responses (across regions or industries)	Total	239	Total		290
			Mail survey		29
			Phone interview		41
			Direct handout		220
Response rate	100%		Total		32.34%
			Mail survey		6%
			Phone interview		52.56%
			Direct handout		73.33%
Valid response rate	Rate (237/239)	99.16%	Rate (284/878)		32.35%
	Total	237	Total		284
			Mail survey		26
			Phone interview		38
			Direct handout		211

Table 5.1 Number of sending out surveys and valid response rates (Continued)

	Vietnam				Indonesia	
	Ha Noi		Ho Chi Minh		Jabodetabek area	
Number of sending out the survey (across regions or industries)	Total	1,132	Total	1,000	Total	437
	Ha Noi	300	Ho Chi Minh	300	Leather and leather goods	
	Bac Ninh	250	Ba Ria-Vung Tau	100	Wood, wooden products-not furniture and wickerwork	
	Bac Giang	100	Binh Duong	200	Paper and paper products	
	Vinh Phuc	150	Dong Nai	370	Coal, petroleum, natural gas and nuclear	
	Hung Yen	200	Long An	30		
	Hai Phong	50				
	Nam Dinh	50				
	Thai Nguyen	32				
	Total	154	Total	175	Total	157

Number of responses (across regions or industries)	Ha Noi	33	Ho Chi Minh	40		
	Bac Ninh	37	Ba Ria-Vung Tau	20		
	Bac Giang	13	Binh Duong	48		
	Vinh Phuc	24	Dong Nai	64		
	Hung Yen	35	Long An	3		
	Hai Phong	8				
	Nam Dinh	1				
	Thai Nguyen	3				
Response rate	13.60%		17.50%		35.90%	
Valid response rate	Rate (149/1132)	13.16%	Rate (171/1000)	17.10%	Rate (157/437)	35.93%
	Total	149	Total	171	Total	157
	Ha Noi	33	Ho Chi Minh	40		
	Bac Ninh	37	Ba Ria-Vung Tau	19		
	Bac Giang	11	Binh Duong	46		
	Vinh Phuc	23	Dong Nai	64		
	Hung Yen	35	Long An	2		
	Hai Phong	8				
	Nam Dinh	1				
	Thai Nguyen	1				

Notes: Vietnam and The Philippines answered across regions. Indonesia and Thailand answered industries.

5.4.2 Profile of firms' responses

Here some of related survey results are elucidated to clarify the profiles of responded firms.

(1) Year of establishment

Table 5.2 indicates that 50.5% of Vietnamese, 23.7% of Indonesian, 26.1% of Filipino, and 22.7% of Thai firms replied that they started operating between 2001 and 2010. Those that had started between 1991 and 2000 included 44.6% Filipino, 32.0% Thai, 29.7% Vietnamese, and 36.0% Indonesian firms. These results depend on when economic growth started in each economy.

Table 5.2 Year of establishment

Year of establishment	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
- 1970	14	6.6	6	4.3	3	3.3	28	14.4	51	8.0
1971 - 1980	11	5.2	19	13.7	6	6.5	12	6.2	48	7.5
1981 - 1990	14	6.6	29	20.9	18	19.6	34	17.5	95	14.9
1991 - 2000	63	29.7	50	36.0	41	44.6	62	32.0	216	33.9
2001 - 2010	107	50.5	33	23.7	24	26.1	44	22.7	208	32.7
2011 -	3	1.4	2	1.4	0	0.0	14	7.2	19	3.0
Total	212	100.0	139	100.0	92	100.0	222	100.0	637	100.0

(2) Type of establishment

Table 5.3 shows the type of establishment. Most firms are established for factories or plants in the Philippines (98.9%) and Indonesia (86.3%). The share of the type of headquarters or main office is very small.

Table 5.3 Type of establishment

Type of establishment	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Headquarters/Main office	63	29.7	13	9.4	0	0.0	74	33.9	150	22.7
Regional Headquarters	16	7.5	3	2.2	0	0.0	8	3.7	27	4.1
Factory/Plant	131	61.8	120	86.3	91	98.9	98	45.0	440	66.6
Branch Office/Sales Office	2	0.9	3	2.2	1	1.1	38	17.4	44	6.7
Total	212	100	139	100	92	100.0	218	100.0	661	100.0

(3) Capital structure

Table 5.4 shows that most firms are 100% locally owned in all countries: Vietnam (76.9%), Indonesia (66.2%), the Philippines (40.2%), and Thailand (84.0%). The second biggest category is 100% foreign-owned (MNC): Vietnam (17.5%), Indonesia (19.4%), the Philippines (34.8%), and Thailand (11.4%).

Table 5.4 Capital structure of establishments at present

The capital structure of your establishment at present	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
100% Locally-owned	163	76.9	92	66.2	37	40.2	184	84.0	476	71.9
100% Foreign-owned (MNC)	37	17.5	27	19.4	32	34.8	25	11.4	121	18.3
Joint Venture (JV, Locally and Foreign-owned)	12	5.7	20	14.4	23	25.0	10	4.6	65	9.8
Total	212	100.0	139	100.0	92	100.0	219	100.0	662	100.0

(4) Major foreign investors

Table 5.5 shows that Japanese are the major foreign investors in Indonesia (21.6%) and the Philippines (30.4%), whereas in Vietnam, Taiwanese are the major investors (7.5%) and Japanese are second (6.1%). Besides Japanese, South Korean and Filipino investors are notable in the Philippines (13.0%).

Table 5.5 Major foreign investors

The major foreign investors	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Indonesian investors	0	0.0	7	5.0	1	1.1	1	0.5	9	1.4
Filipino investors	0	0.0	0	0.0	12	13.0	5	2.3	17	2.6
Thai investors	0	0.0	1	0.7	1	1.1	9	4.1	11	1.7
Vietnamese investors	0	0.0	0	0.0	0	0.0	3	1.4	3	0.5
Malaysian investors	1	0.5	0	0.0	0	0.0	2	0.9	3	0.5
Singaporean investors	2	0.9	3	2.2	2	2.2	2	0.9	9	1.4
Chinese investors	4	1.9	0	0.0	4	4.3	5	2.3	13	2.0
Japanese investors	13	6.1	30	21.6	28	30.4	17	7.7	88	13.3
South Korean investors	6	2.8	5	3.6	12	13.0	2	0.9	25	3.8
Taiwanese investors	16	7.5	0	0.0	7	7.6	2	0.9	25	3.8
American investors	4	1.9	2	1.4	4	4.3	2	0.9	12	1.8
European investors	5	2.4	5	3.6	1	1.1	3	1.4	14	2.1
Other investors	1	0.5	1	0.7	0	0.0	6	2.7	8	1.2

Note: multiple answers

(5) Number of full-time employees

Table 5.6 illustrates the distribution of firm size in terms of full-time employees. Almost half of the firms have 20 to 199 employees, except Vietnamese firms. In Vietnam, the largest category is from 100 to 199 employees (19.8%), that is, the Vietnamese firms that responded belong to the category of large firms. In Thailand, about 50% of firms have less than 100 employees and the same can be said of Filipino firms, where the number is about 42.3%.

Table 5.6 Number of full-time employees

No. of full-time employees	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
1 - 19 persons	3	1.4	11	7.9	5	5.4	49	22.8	68	10.3
20 - 49	12	5.7	13	9.4	12	13.0	37	17.2	74	11.2
50 - 99	28	13.2	22	15.8	22	23.9	29	13.5	101	15.3
100 - 199	42	19.8	31	22.3	17	18.5	27	12.6	117	17.8
200 - 299	31	14.6	14	10.1	8	8.7	11	5.1	64	9.7
300 - 399	11	5.2	11	7.9	4	4.3	7	3.3	33	5.0
400 - 499	9	4.2	12	8.6	4	4.3	8	3.7	33	5.0
500 - 999	22	10.4	11	7.9	10	10.9	17	7.9	60	9.1
1,000 - 1,499	17	8.0	3	2.2	5	5.4	5	2.3	30	4.6
1,500 - 1,999	7	3.3	5	3.6	3	3.3	1	0.5	16	2.4
2,000 and above	30	14.2	6	4.3	2	2.2	24	11.2	62	9.4
Total	212	100.0	139	100.0	92	100.0	215	100.0	658	100.0

(6) Total assets

Table 5.7 shows the distribution of firm size in terms of total assets. Responding firms that have assets exceeding USD 1 million constitute 57.5%. In particular, the largest category in Indonesia (27.3%), the Philippines (22.8%), and Thailand (21.8%) comprises 10 million and above.

(7) Main products

Table 5.8 shows the main products of firms at present. The percentages of firms' "final products" are the highest in four economies, especially that of the Philippines (71.79%), which is higher than the other three countries. This is followed by "components and parts." On the other hand, "raw material processing" is higher in Indonesia (25.9%) and Vietnam (20.3%).

Table 5.7 Total assets

Total assets	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Less than 10,000	2	0.9	3	2.2	2	2.2	3	1.5	10	1.5
10,000 - 24,999	4	1.9	1	0.7	1	1.1	5	2.4	11	1.7
25,000 - 49,999	3	1.4	5	3.6	3	3.3	17	8.3	28	4.3
50,000 - 74,999	6	2.8	11	7.9	2	2.2	4	1.9	23	3.5
75,000 - 99,999	13	6.1	3	2.2	3	3.3	7	3.4	26	4.0
100,000 - 499,000	14	6.6	24	17.3	18	19.6	36	17.5	92	14.2
500,000 - 999,999	33	15.6	15	10.8	11	12.0	27	13.1	86	13.3
1 million - 4.9 mil.	60	28.3	26	18.7	19	20.7	37	18.0	142	21.9
5 mil. - 9.9 mil.	35	16.5	13	9.4	12	13.0	25	12.1	85	13.1
10 million and above	42	19.8	38	27.3	21	22.8	45	21.8	146	22.5
Total	212	100.0	139	100.0	92	100.0	206	100.0	649	100.0

Table 5.8 Main products

Main products at present	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Raw materials	7	3.3	6	4.3	2	2.2	32	14.8	47	7.1
Raw material processing	43	20.3	36	25.9	3	3.3	26	12.0	108	16.4
Components and parts	76	35.8	16	11.5	21	22.8	47	21.8	160	24.3
Final products	86	40.6	81	58.3	66	71.7	111	51.4	344	52.2
Total	212	100.0	139	100.0	92	100.0	216	100.0	659	100.0

(8) Functions

Table 5.9 shows the functions carried out by firms at present. In Vietnam (84.4%) and the Philippines (84.8%), "procurement of raw materials, parts" constitutes a large part of

firms' functions. This is followed by "marketing, sales promotion" in Vietnam, Thailand, and Indonesia.

Table 5.9 Functions carried out by establishments

Carried out functions by your establishment	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Procurement of raw materials, parts	179	84.4	56	40.3	78	84.8	81	42.9	394	62.3
Logistics/Distribution	97	45.8	19	13.7	0	0.0	30	16.7	146	23.4
IT system development/maintenance	21	10.0	1	0.7	0	0.0	11	6.0	33	5.3
After-sales service	46	21.8	6	4.3	0	0.0	32	17.4	84	13.4
Marketing, sales promotion	111	52.4	67	48.2	0	0.0	69	36.9	247	39.2
Others	10	4.7	92	66.2	0	0.0	22	12.2	124	19.9

Note: multiple answers.

(8) Main business activity

Table 5.10 shows the main business activity. For Vietnam, this consists of "metal products" (12.7%), "plastic and rubber products" (11.8%), and "food, beverages, and tobacco" (11.3%), whereas in Indonesia, "other business activities" (21.6%) is the largest. The Philippines has "food, beverages, and tobacco" (14.1%), "plastic, rubber products" (12.0%), whereas Thailand has "other business activities" (16.4%), "automobile, auto parts" (13.6%), and "other electronics and components" (10.0%).

Table 5.10 Main business activity of establishment

Main business activity at present	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Food, beverages, tobacco	24	11.3	24	17.3	13	14.1	21	9.5	82	12.4
Textiles	17	8.0	9	6.5	2	2.2	10	4.5	38	5.7
Apparel, leather	2	0.9	6	4.3	9	9.8	4	1.8	21	3.2
Footwear	6	2.8	2	1.4	1	1.1	0	0.0	9	1.4
Wood, wood products	4	1.9	3	2.2	1	1.1	13	5.9	21	3.2
Paper, paper products, printing	13	6.1	5	3.6	2	2.2	12	5.5	32	4.8
Chemicals, chemical products	9	4.2	5	3.6	4	4.3	3	1.4	21	3.2
Plastic, rubber products	25	11.8	20	14.4	11	12.0	14	6.4	70	10.6
Other non-metallic mineral products	0	0.0	1	0.7	7	7.6	4	1.8	12	1.8
Iron, steel	6	2.8	2	1.4	3	3.3	20	9.1	31	4.7
Non-ferrous metals	3	1.4	0	0.0	0	0.0	3	1.4	6	0.9
Metal products	27	12.7	4	2.9	4	4.3	11	5.0	46	6.9
Machinery, equipment, tools	15	7.1	9	6.5	9	9.8	4	1.8	37	5.6
Computers & computer parts	1	0.5	0	0.0	5	5.4	8	3.6	14	2.1
Other electronics & components	18	8.5	7	5.0	9	9.8	22	10.0	56	8.4
Precision instruments	2	0.9	1	0.7	2	2.2	1	0.5	6	0.9
Automobile, auto parts	12	5.7	5	3.6	4	4.3	30	13.6	51	7.7
Other transportation equipments and parts	12	5.7	3	2.2	2	2.2	4	1.8	21	3.2
Handicraft	14	6.6	3	2.2	1	1.1	0	0.0	18	2.7
Other business activity	2	0.9	30	21.6	3	3.3	36	16.4	71	10.7
Total	212	100	139	100	92	100	220	100	663	100

5.4.3 Methodology

This chapter employs SEM (structural equation model) or CSA (covariance structural analysis), which enables a study of the relationship among various variables that are related to each other. SEM is said to be a mixture of factor analysis and regression analysis. Thus, SEM analysis can be used even for cases in which the variables are endogenous and the usual least squares cannot be applied. The idea of SEM was initially proposed as CSA by Bock (1960) and developed by Bock and Bargmann (1966) in order to solve issues related to multivariate analysis. Later, Bagozzi (1980) and Bollenn (1989) termed this as SEM.

5.4.4 Model

To analyze the above research question, a model is constructed to examine the following relationships between latent variables which are related to the hypotheses stated earlier:

1. External linkages such as MNCs and Public research organization promote working experience of top management and factory managers with MNCs which assists the connectivity with MNCs (Hypothesis I and II).
2. External linkages such as Locals promote Indigenous employees to assist the

connectivity with local firms (Hypothesis III).

3. Working experience with MNCs and Indigenous employees both promote organizational learning (Hypothesis IV and V).
4. Organizational learning enhances Product innovation (hypothesis VI).

The above relationships are summarized in Figure 3.1.

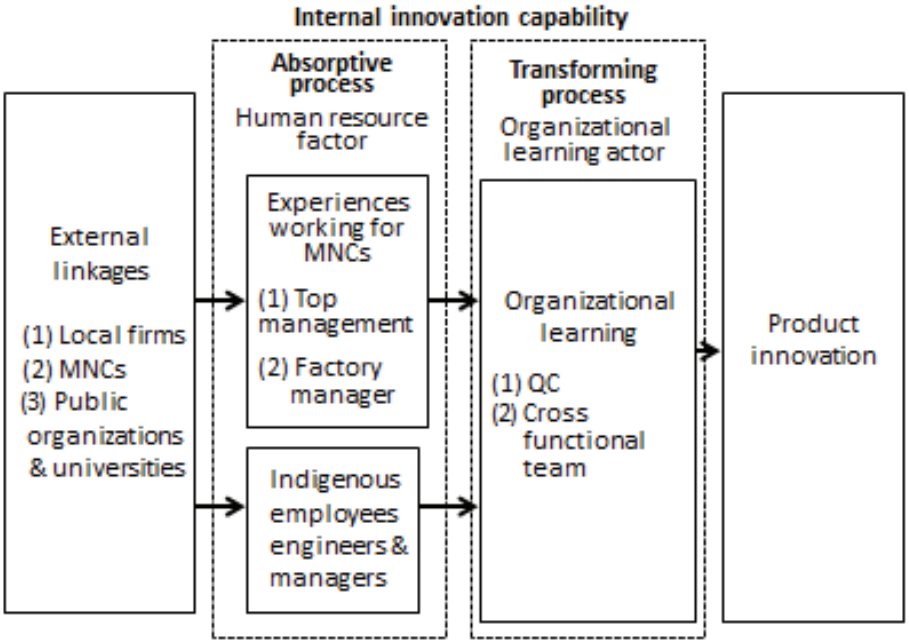


Figure 5.1 Relationship of factors

5.5 Construction of variables

5.5.1 Outcome variables: product innovation

The construction of variables related to product innovation is based on Q13 which consist of the following four categories of innovation:

(1) Innovation type I: Introduced a new product, redesigning packaging or significantly changing appearance design of your existing products

(2) Innovation Type II: Introduced a new product, significantly improving your existing products with respect to its capabilities, user friendliness, components, subsystems, etc.

(3) Innovation Type III: Development of a totally new product based on the “existing” technologies for your establishment

(4) Innovation Type IV: Development of a totally new product based on “new” technologies you’re your establishment

The respondents are asked for each category whether they achieved, tried, or not tried yet. In the case of achieved, two points are given; if they tried, one point is given; and those who have not tried yet are indicated by zero. The responses to Q13 by country are shown Table 5.11.

Table 5.11 Situation of product innovation by country

		Vietnam		Indonesia		Philippines		Thailand		Total	
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Tried to introduce a new product in last 2 years	**Yes**	198	93.4	90	64.7	91	100.0	117	52.7	496	74.7
	No	14	6.6	49	35.3	0	0.0	105	47.3	168	25.3
	Total	212	100.0	139	100.0	91	100.0	222	100.0	664	100.0
Type I Redesigning packaging or significantly changing appearance design	**Achieved**	149	70.3	54	38.8	60	65.2	63	28.4	326	49.0
	Tried	44	20.8	14	10.1	23	25.0	40	18.0	121	18.2
	Not tried yet	19	9.0	71	51.1	9	9.8	119	53.6	218	32.8
	Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0
Type II Introduced a new product, significantly improving existing products	**Achieved**	77	36.3	62	44.6	62	67.4	65	29.3	266	40.0
	Tried	84	39.6	16	11.5	26	28.3	41	18.5	167	25.1
	Not tried yet	51	24.1	61	43.9	4	4.3	116	52.3	232	34.9
	Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0
Type III Development of a totally new product based on the "existing" technologies	**Achieved**	39	18.4	43	30.9	48	52.2	63	28.4	193	29.0
	Tried	82	38.7	23	16.5	27	29.3	45	20.3	177	26.6
	Not tried yet	91	42.9	73	52.5	17	18.5	114	51.4	295	44.4
	Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0
Type IV New product based on new technologies	**Achieved**	17	8.0	36	25.9	36	39.1	55	24.8	144	21.7
	Tried	61	28.8	23	16.5	29	31.5	43	19.4	156	23.5
	Not tried yet	134	63.2	80	57.6	27	29.3	124	55.9	365	54.9
	Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0

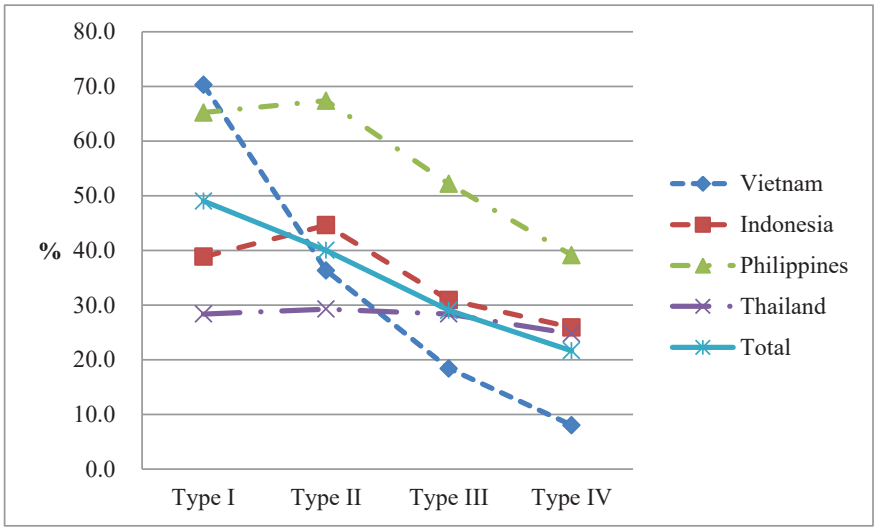
Note: The total number of valid reply is 998 and that of the above sample 665. Accordingly, the number of samples which do not achieve any of four categories of innovation is 333.

To extract outcome variable, factor analysis of promax rotation is employed with respect to the above four questions,. Consequently, it converges to one factor, which is named as "product innovation." The result of factor analysis is shown in Table 5.12.

The innovation situation of individual country is summarized in Figure 5.2, showing that since the quality of innovation increases from Type I to Type IV, the numbers of innovation of the category is reversely decreased. The average curve exactly follows this characteristic. The distribution of Vietnam is similar to the average. However, in Indonesia and the Philippines, Type II has a peak, and in case of Thailand, the peak is located on Type III. The average of four countries coincides with the general case.

Table 5.12 Result of Factor Analysis: Product Innovation

	Common factor Product innovation
Q13.1. Introduced a new product, redesigning packaging or significantly changing appearance design of your existing products	.698
Q13.2. Introduced a new product, significantly improving your existing products with respect to its capabilities, user friendliness, components, subsystems, etc.	.847
Q13.3. Development of a totally new product based on the "existing" technologies for your establishment	.854
Q13.4. Development of a totally new product based on "new" technologies for your establishment	.736
Cronbach's α	.861



Type I Redesigning packaging or significantly changing appearance design
Type II Significantly improving existing products
Type III New product based on the existing technologies
Type IV New product based on new technologies

Figure 5.2: Distribution of innovation by country

5.5.2 Explanatory variables

(1) External linkages

The latent variables of external linkages are constructed in the following manner. With respect to questions regarding external linkages such as locals, MNCs, and public research organization and university asked Q.23.5-11, the respondents are asked to rate

according to five scales: 4. Very important, 3. Somewhat important, 2. Not very important, 1. Not important, and 0. Not practice. The scores are scaled from 0 to 4 points. To examine the situation of connectivity of respondents in more detail, let us see Q23.5-11 carefully, which are summarized as follows:

a. Local firms

Q23.5. Local customer (100% local capital)

Q23.6. Local supplier (100% local capital)

b. MNCs

Q23.8. MNC/JV supplier located in your country

Q23.7. MNC (100% non-local capital)/Joint Venture (JV) customer located in your country

Q23.9. MNC/JV customer located in a foreign country

Q23.10. MNC/JV supplier located in a foreign country

c. Public organization and university

Q23.13. University or public research institute

Q23.12. Local business organization

Q23.11. Public organization (government, public agency, public financial institution)

Respondents were asked whether external linkages are important for innovation in the Likert five scales. In the pooled data of the four economies, “final consumer” (57.1%), “local customer with 100% local capital” (42.4%), “competitor” (38.3%), and “buyer or trading company (35.7%)” are ranked in order of high importance, where percentages in the parentheses are those replied the highest important.

(1-1) Local firms

To see the relationship with other agents for innovation by country in more detail, let us examine some of important questions related to this chapter. First two tables are importance of local firms as customers and suppliers to respondents. Table 5.13 and 5.14 are related to local customers and local suppliers, respectively. In both tables, 73-80 percent of respondents of all countries replied that these kinds of local firms are important (somewhat or very) for innovation. It should be noted that only less than five percent of respondents replied no relationship, that is, almost all somehow connected with other locals. Firms in the Philippines and Thailand show the greatest percentages for very important. Table 5.15 indicates importance of local suppliers. The percentages of important (somewhat or very) for innovation are slightly small than those of Table 5.13,

and Indonesia and the Philippines show the greatest figures for very important. These findings are important for analyzing the connectivity with other firms for innovation, which is a main theme of this chapter.

Table 5.13 Importance of local customers (100% local capital) for innovation

Local customer (100% local capital)	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Not Practicing	0	0.0	8	5.8	12	13.0	8	3.6	28	4.2
Not important	21	9.9	2	1.4	6	6.5	9	4.1	38	5.7
Not very important	28	13.2	3	2.2	9	9.8	39	17.6	79	11.9
Somewhat important	83	39.2	63	45.3	21	22.8	71	32.0	238	35.8
Very important	80	37.7	63	45.3	44	47.8	95	42.8	282	42.4
Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0

Table 5.14 Importance of local suppliers (100% local capital) for innovation

Local supplier	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Not Practicing	8	3.8	4	2.9	5	5.4	13	5.9	30	4.5
Not important	15	7.1	3	2.2	4	4.3	15	6.8	37	5.6
Not very important	42	19.8	3	2.2	14	15.2	52	23.4	111	16.7
Somewhat important	118	55.7	76	54.7	31	33.7	84	37.8	309	46.5
Very important	29	13.7	53	38.1	38	41.3	58	26.1	178	26.8
Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0

(1-2) MNCs

Here how important respondents consider MNCs customer and suppliers located in the same country in more details. Table 5.15 and 5.16 show their replies to MNCs customers and suppliers, respectively. In both tables, 55-60 percent of respondents replied MNCs are somewhat or very important for innovation. The percentages are smaller than those on locals. On the other hand, one-fourth of respondents replied Not practicing or Not important. This indicates that the number of respondents which have connectivity with MNCs is smaller than those of locals. Particularly, Vietnam firms have the greatest percentages for MNCs customers and suppliers and then the smallest for Not practicing or Not important, implying that Vietnam firms seem to connect heavily with MNCs.

Table 5.15 Importance of MNCs customer located in country for innovation

MNC/JV customer located in country	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Not Practicing	4	1.9	40	28.8	28	30.4	40	18.0	112	16.8
Not important	13	6.1	7	5.0	4	4.3	40	18.0	64	9.6
Not very important	31	14.6	10	7.2	12	13.0	41	18.5	94	14.1
Somewhat important	86	40.6	46	33.1	29	31.5	52	23.4	213	32.0
Very important	78	36.8	36	25.9	19	20.7	49	22.1	182	27.4
Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0

Table 5.16 Important of MNCs supplier located in country for innovation

MNC/JV supplier located in country	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Not Practicing	3	1.4	40	28.8	28	30.4	39	17.6	110	16.5
Not important	15	7.1	8	5.8	4	4.3	39	17.6	66	9.9
Not very important	48	22.6	12	8.6	9	9.8	43	19.4	112	16.8
Somewhat important	117	55.2	46	33.1	32	34.8	57	25.7	252	37.9
Very important	29	13.7	33	23.7	19	20.7	44	19.8	125	18.8
Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0

(1-3) Public organization and university

The following tables of 5.17, 5.18, and 5.19 show connectivity with public organization, local business organization, and university for innovation, respectively. In the first two tables, about 60 percent of respondents replied that public organization and local business organization are somewhat or very important. In Table 5.17, Thailand shows the smallest, while in Table 5.18 Vietnam the smallest. Regarding university or public research institute, the percentages of somewhat or very important is smaller than 45, which is also smaller than the previous two categories by 10 percentage points.

As seen in the previous chapters, the collaborating channel to obtain information related to innovation through supply chain is termed by the transaction channel, whereas the channel though research and development with collaborating with universities and research institutes is termed by the transaction channel. From these data of the surveys, it follows that the transaction channel is nearly twice stronger than the intellectual channel in these ASEAN countries. This is clear contrast with Japanese SMEs analyzed Chapter 3 and 4.

These results are obtained by observing the data, but in the next sub-section, much more rigorous analysis will be addressed.

Table 5. 17 Importance of public organization for innovation

Public organization	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Not Practicing	7	3.3	21	15.1	23	25.0	28	12.6	79	11.9
Not important	21	9.9	8	5.8	3	3.3	37	16.7	69	10.4
Not very important	47	22.2	13	9.4	6	6.5	62	27.9	128	19.2
Somewhat important	131	61.8	68	48.9	36	39.1	59	26.6	294	44.2
Very important	6	2.8	29	20.9	24	26.1	36	16.2	95	14.3
Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0

Table 5.18 Importance of local business organization for innovation

Local business organization	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Not Practicing	10	4.7	15	10.8	24	26.1	10	4.5	59	8.9
Not important	15	7.1	8	5.8	4	4.3	22	9.9	49	7.4
Not very important	90	42.5	17	12.2	12	13.0	41	18.5	160	24.1
Somewhat important	96	45.3	67	48.2	30	32.6	88	39.6	281	42.3
Very important	1	0.5	32	23.0	22	23.9	61	27.5	116	17.4
Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0

Table 5.19 Importance of university or public research institute for innovation

University or public research institute	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Not Practicing	22	10.4	23	16.5	30	32.6	43	19.4	118	17.7
Not important	29	13.7	12	8.6	6	6.5	47	21.2	94	14.1
Not very important	73	34.4	18	12.9	12	13.0	53	23.9	156	23.5
Somewhat important	84	39.6	66	47.5	31	33.7	57	25.7	238	35.8
Very important	4	1.9	20	14.4	13	14.1	22	9.9	59	8.9
Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0

(2-4) Factor analysis for latent variable of external linkages

According to replies for Q23.5-11, and other data discussed above, factor analysis is conducted. The result of factor analysis is shown in Table 5.20. Three factors, that is, “Local firms,” “MNCs,” and “Public organization and university” are extracted.

Table 5.20 Result of factor analysis: External linkages

	Common factors		
	Local firms	MNCs	Public organizations & universities
Q23.5. Local customer (100% local capital)	**.734**	-.039	.066
Q23.6. Local supplier	**.648**	.060	.036
Q23.8. MNC/JV supplier located in Vietnam	.131	**.886**	-.111
Q23.7. MNC (100% non-local capital)/Joint Venture (JV) customer located in your country	.141	**.916**	-.098
Q23.9. MNC/JV customer located in a foreign country	-.248	**.766**	.184
Q23.10. MNC/JV supplier located in a foreign country	-.047	**.784**	.095
Q23.13. University or public research institute	.015	.095	**.701**
Q23.12. Local business organization	.180	-.068	**.714**
Q23.11. Public organization (government, public agency, public financial institution)	-.039	.007	**.775**
Factor correlation matrix			
1	1.000	.214	.417
2	.214	1.000	.495
3	.417	.495	1.000
Cronbach's α	.698	.906	.802

(2) Internal innovation capability

Here we summarized replies of respondents related to questions regarding internal innovation capability, which consists of QC (quality control) and cross-functional team.

(2-1) Organizational learning

First we examine QC and the questions regarding QC are summarized as follows:

Q22.2. Does your establishment operate a QC circle

Q22.3. Does your establishment have a system/practice to disseminate successful experiences of a QC circle group across your establishment?

Q22.4. Does your establishment have a system/practice to learn from successful experiences of a QC circle group of your customer/supplier?

Q22.5. Does your establishment have a system/practice to share successful experiences of a QC circle group of your establishment with your customer/supplier?

If respondents replied "Yes," then the score is 1, if otherwise, it is 0. Accordingly, this variable takes values from 0 to 5.

According to the responses to QC, the practice of QC is summarizes in Table 5.21 indicating that more than 50% of in four countries are practicing. QC is widely spread in these regions.

Table 5.21 QC (Quality Control)

QC and delivery management	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Adopted 3S or 5S (Seiri, Seiton, Seisou, Seiketsu, Shitsuke)	116	54.7	109	78.4	74	80.4	161	72.5	460	69.2
Operate a QC circle	130	61.3	120	86.3	73	79.3	148	66.7	471	70.8
To disseminate successful experiences of a QC circle across your establishment	82	38.7	98	70.5	69	75.0	115	51.8	364	54.7
To learn from successful experiences of a QC circle group	52	24.5	86	61.9	71	77.2	131	59.0	340	51.1
To share successful experiences of a QC circle group of your establishment with your customer/supplier	29	13.7	75	54.0	66	71.7	117	52.7	287	43.2
Employee suggestion programs	102	48.1	123	88.5	77	84.6	171	77.0	473	71.2
Provide groups of employees with rewards for suggestions/QC circle activities	86	40.6	91	65.5	54	58.7	136	61.3	367	55.2
Provide individual employees with rewards for suggestions/QC circle activities	90	42.5	96	69.1	55	59.8	142	64.0	383	57.6

Note: *multiple answers.

(2-2) Cross-functional team

This variable is constructed from Q21, and the questions are limited to the areas related to product innovation, namely 2. Market Research, 3. Research, 4. Development, 11. Sales and Marketing. The questions are shown as follows:

Q21. Cross-functional team for Introduction of New Product or Process: Which departments are involved in a Cross-functional team that your establishment organizes to introduce a new product or process?

2. Market Research, 3. Research, 4. Development, 11. Sales & Marketing

If respondents replied “Yes,” then the score is 1, if otherwise, it is 0. Accordingly, this variable takes values from 0 to 5. The diffusion of cross-functional team in these regions

is shown in Table 5.22, indicating that it is less spread than QC. Particularly, in the following business works such as Market Research, Research, Development, Production Engineering, Manufacturing, and Sales and marketing, cross-functional team is being practicing in four countries.

Table 5.22 Situation of cross-functional team by country

Cross-functional team	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
No team	61	28.8	37	26.6	15	16.3	88	39.6	201	30.2
Market Research	81	38.2	32	23.0	12	13.0	35	15.8	160	24.1
Research	95	44.8	36	25.9	17	18.5	14	6.3	162	24.4
Development	102	48.1	41	29.5	25	27.2	20	9.0	188	28.3
Production Engineering	67	31.6	41	29.5	35	38.0	21	9.5	164	24.7
Manufacturing	86	40.6	54	38.8	0	0.0	28	12.6	168	29.3
Quality Control	66	31.1	70	50.4	0	0.0	25	11.3	161	28.1
Procurement	18	8.5	32	23.0	0	0.0	18	8.1	68	11.9
Accounting	7	3.3	20	14.4	0	0.0	21	9.5	48	8.4
Human Resources	10	4.7	29	20.9	14	15.2	19	8.6	72	10.8
Sales & Marketing	21	9.9	69	49.6	46	50.0	50	22.5	186	28.0
Logistics/Distribution	17	8.0	20	14.4	16	17.4	4	1.8	57	8.6
IT System	4	1.9	13	9.4	7	7.6	11	5.0	35	5.3
Others, specify	3	1.4	2	1.4	2	2.2	0	0.0	7	1.1

Note: *multiple answers.

(3) Human factor

(3-1) Working experience with MNCs

The questions concerning backgrounds of top management and factory managers include Q30 and Q31–Q43, which are as follows:

Q30.10. Does the top management have working experience with MNCs?

Q31.3. Does the factory manager have working experience with for MNCs?

If respondents reply "Yes," then a score of 1 is given, and 0 otherwise. Table 5.23 shows that "experience of top management having worked for MNCs/JVs" is the largest in the Philippines (43.5%). About one-third of top management in these areas has working experience with MNCs/JVs, which shows that MNCs have important role of diffusion of managerial abilities to local firms. In Table 5.24 indicates the same data for factory manager class, and almost of factory managers in countries except Thailand have working experiences for MNCs. This indicates that firms tend to hire those persons as factory managers.

Table 5.23 Experiences working for MNCs of top management

Experiences Working for MNCs/JVs of the Top Management	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Yes	70	33.0	35	25.2	40	43.5	73	32.9	218	32.8
No	142	67.0	104	74.8	52	56.5	149	67.1	447	67.2
Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0

Table 5.24 Factory manager has experiences working for MNCs

Experiences of factory manager working for MNCs	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Yes	212	100.0	139	100.0	91	98.9	144	65.8	586	88.5
No	0	0.0	0	0.0	1	1.1	75	34.2	76	11.5
Total	212	100.0	139	100.0	92	100.0	219	100.0	662	100.0

Note: *multiple answers

(3-2) Indigenous employees

This variable is based on Q32: "What percent of engineers/line managers/managers are indigenous?" The respondents were asked to choose one among five categories such as (0) 0-19%-1, (1) 20-39%, (2) 40-59%, (3) 60-79%, (4), 80-99%, (5) 100%. The scores of these questions coincide with the number of answers, that is, 100% is given 5, and so on. This variable takes values from 0 to 5. Table 5.25 and 5.26 summarize responses to engineers and line managers/managers, respectively. Both are similar to one another, since there are two peaks: one is less than 59% and another is 100%. In Indonesia and the Philippines, their firms are polarized between "0% and 19%" and "100%." While Thailand also has such a polarization, its distribution is more evenly placed in the middle percentages. On average, more than one-third of respondents hire only local engineers and line managers/managers. It seems difficult to hire those with working experiences for MNCs, showing shortage of those workers in these regions.

Table 5.25 Percentage of indigenous engineers

Percentage of indigenous engineers	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
0-19%	0	0.0	13	9.4	25	27.2	115	51.8	153	23.0
20-39%	33	15.6	2	1.4	3	3.3	36	16.2	74	11.1
40-59%	67	31.6	3	2.2	0	0.0	13	5.9	83	12.5
60-79%	48	22.6	0	0.0	2	2.2	9	4.1	59	8.9
80-99%	31	14.6	14	10.1	5	5.4	17	7.7	67	10.1
100%	33	15.6	107	77.0	57	62.0	32	14.4	229	34.4
Total	212	100.0	139	100.0	92	100.0	222	0.0	665	100.0

Table 5.26 Percentage of indigenous line managers, or leader class

Percentage of indigenous line managers, or leader class	Vietnam		Indonesia		Philippines		Thailand		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
0-19%	10	4.7	12	8.6	12	13.0	75	33.8	109	16.4
20-39%	40	18.9	1	0.7	4	4.3	57	25.7	102	15.3
40-59%	87	41.0	3	2.2	2	2.2	24	10.8	116	17.4
60-79%	38	17.9	1	0.7	0	0.0	15	6.8	54	8.1
80-99%	10	4.7	14	10.1	6	6.5	12	5.4	42	6.3
100%	27	12.7	108	77.7	68	73.9	39	17.6	242	36.4
Total	212	100.0	139	100.0	92	100.0	222	100.0	665	100.0

In the next sub-section, empirical analysis baes on the SEM will be conducted, and prior to this, the basic statistics of the above variables is summarized in Table 5.26.

Table 5.27 Summary statistics

		N	Min	Max	Ave.	S.D.
Product innovation	Q13.1. Introduced a new product, redesigning packaging or significantly changing appearance design of your existing products	665	0	2	1.16	.890
	Q13.2. Introduced a new product, significantly improving your existing products with respect to its capabilities, user friendliness, components, subsystems, etc.	665	0	2	1.05	.865
	Q13.3. Development of a totally new product based on the "existing" technologies for your establishment	665	0	2	.85	.843
	Q13.4. Development of a totally new product based on "new" technologies for your establishment	665	0	2	.67	.810
Cross functional team	Q21.2. Market Research	665	0	1	.24	.428
	Q21.3. Research	665	0	1	.24	.430
	Q21.4. Development	665	0	1	.28	.451
	Q21.11. Sales & Marketing	665	0	1	.28	.449
QC	Q22.2. Does your establishment operate a QC circle	665	0	1	.71	.455
	Q22.3. Does your establishment have a system/practice to disseminate successful experiences of a QC circle group across your establishment?	665	0	1	.55	.498
	Q22.4. Does your establishment have a system/practice to learn from successful experiences of a QC circle group of your customer/supplier?	665	0	1	.51	.500
	Q22.5. Does your establishment have a system/practice to share successful experiences of a QC circle group of your establishment with your customer/supplier?	665	0	1	.43	.496
External linkage	Q23.5. Local customer (100% local capital)	665	0	4	3.06	1.071
	Q23.6. Local supplier	665	0	4	2.85	1.021
	Q23.7. MNC (100% non-local capital)/Joint Venture (JV) customer located in your country	665	0	4	2.43	1.414
	Q23.8. MNC/JV supplier located in your country	665	0	4	2.32	1.338
	Q23.9. MNC/JV customer located in a foreign country	665	0	4	2.34	1.442
	Q23.10. MNC/JV supplier located in a foreign country	665	0	4	2.23	1.378
	Q23.11. Public organization (government, public agency, public financial institution)	665	0	4	2.39	1.202
	Q23.12. Local business organization	665	0	4	2.52	1.131
	Q23.13. University or Public Research Institute	665	0	4	2.04	1.251
Experiences working for MNCs	Q30.10 Top management	665	0	1	.33	.470
	Q31.1 Factory manager	665	0	1	.32	.469
Indigenous employees	Q32.1. Engineers	790	0	5	2.84	1.975
	Q32.2. Line managers, or leader class	790	0	5	2.90	1.906
	Q32.3. Managers	790	0	5	2.90	1.935

5.6 Estimation results

5.6.1 Results

The result of SEM is summarized in Table 5.27, and the path diagram is shown in Figure 5.3. Working experience with MNCs is a significant factor for connecting to MNCs and public organizations and universities, whereas indigenous employees are mediators for connecting with locals. The relationship between locals and working experience with MNCs, and that between MNCs and indigenous employees are not significant. Other latent variables such as working experience with MNCs, indigenous employees, and organizational learning are positively significant to innovation.

5.6.2 Fitness of the model

The fitness of the SEM model is shown in Table 5.28 which is determined by GFI (goodness-of-fit index) and AGFI (adjusted goodness-of-fit index) which take the value between 0 and 1 indicating criteria of the explanatory power of the model. If GFI ≥ AGFI and both indices are 0.9 or more, the model can be judged as proper. CFI (comparative fit index) evaluates the model in terms of goodness-of-fit showing how much the model is improved in comparison with the independent model estimated under the assumption that there is no correlation among the observed variables. It takes the value from 0 to 1, and the model is judged as being good fit if CFI is 0.9 or more. Moreover, RMSEA (root mean square error of approximation) is an index that expresses the divergence between the estimated and actual distribution of the model expressed in terms of the amount of degrees of freedom. The model can be judged as good fitness, if it is 0.10 or less. The results show that GFI (0.935), AGFI (0.909), CFI (0.953), and RMSEA (0.055) satisfy all above conditions.

Table 5.28 Result of structural equation modeling

From	To	Standardizing Coefficient	SE	Test statistic	*p* value
Local firms	Experiences working for MNCs/JVs	-0.249	0.025	-3.158	0.002***
MNCs	Experiences working for MNCs/JVs	0.499	0.019	6.019	0.000***
Public organizations & universities	Experiences working for MNCs/JVs	0.138	0.021	1.674	0.094*
Local firms	Indigenous employees	0.216	0.116	4.155	0.000***
MNCs	Indigenous employees	-0.217	0.076	-4.691	000***
Experiences working for MNCs/JVs	Organizational learning	0.492	0.298	4.659	000***
Indigenous employees	Organizational learning	0.201	0.025	3.206	0.001***
Organizational learning	Product innovation	0.587	0.086	5.25	0.000***

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively.

Table 5.29 Fitness of model

χ^2 value	Degree of freedom	p value	GFI	AGFI	CFI	RMSEA	AIC
453.066	149	0	0.935	0.909	0.953	0.055	575.066

5.7 Discussion: Direct and indirect effects on innovation

5.7.1 Calculation of effects

The analysis thus far focuses only on the direct effects, which are defined as effect between factors directly connected as shown in Figure 5.3. In SEM analysis, the direct effect is the most important, whereas the indirect effect is also considered as supplementary information. There also exist other indirect effects which are defined as the relationship between two factors indirectly connected via other factors. The number of indirect effects is the same as direct factors connected to an original factor. For example, MNCs has two indirect effects of routes via Working experience with MNCs and Indigenous employees. Total effects are the sum of direct and indirect effects with all routes. The indirect effect and total effects are shown in Table 5.29 and Table 5.30, respectively.

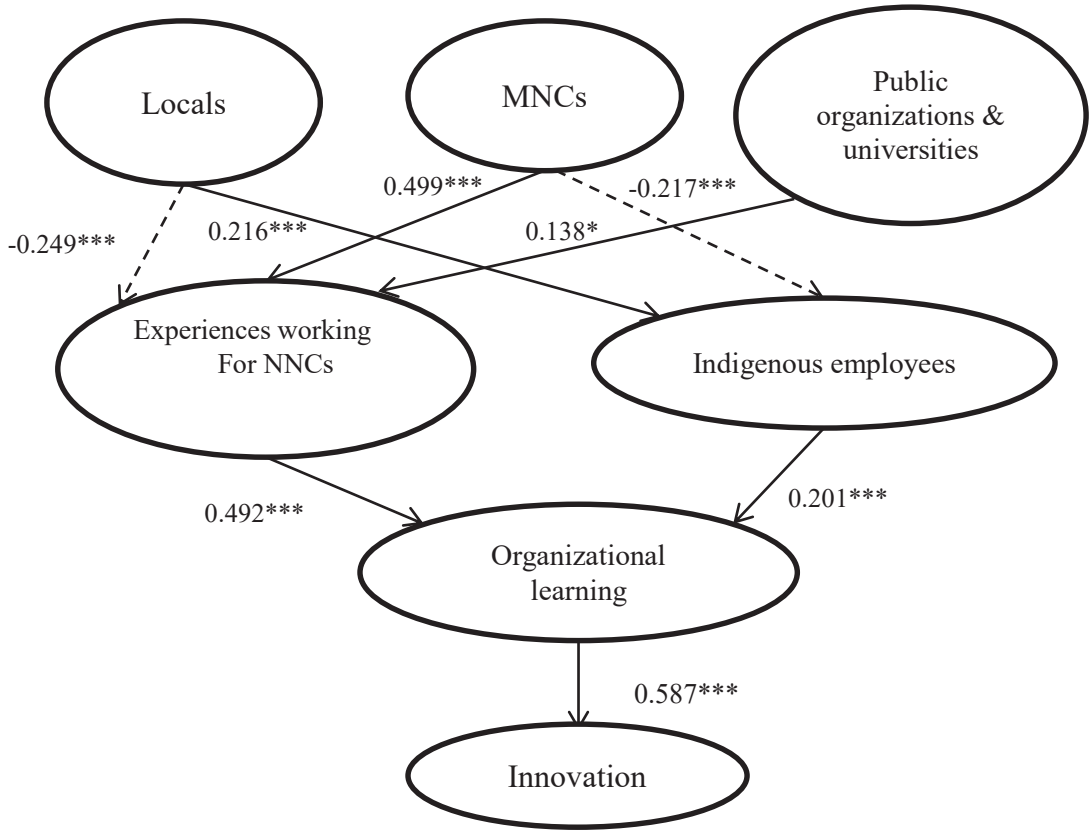


Figure 5.3: Path diagram of estimation

Table 5.30 Standardizing indirect effects

To \ From	Local firms	MNCs	Public organizations & universities	Experiences working for MNCs	Indigenous employees	Organizational learning
Experiences working for MNCs/JVs	0	0	0	0	0	0
Indigenous employees	0	0	0	0	0	0
Organizational learning	-0.073***	0.208***	0.054	0	0	0
Innovation	-0.043***	0.122***	0.032	0.289***	0.118***	0

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

Accordingly, the total effects of three linkages to final outcome of innovation are obtained as follows:

Table 5.31 Standardizing total effects

To \ From	Locals	MNCs	Public organizations & universities	Experiences working for MNCs/JVs	Indigenous employees	Organizational learning
Experiences working for MNCs/JVs	-0.252***	0.498***	0.141*	0	0	0
Indigenous employees	0.253***	-0.183***	-0.078	0	0	0
Organizational learning	-0.073***	0.208***	0.054	0.493***	0.201***	0
Innovation	-0.043***	0.122***	0.032	0.289***	0.118***	0.587***

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively

5.7.2 Verification of Hypotheses

The above results lead to following verification of hypotheses; it follows from the calculation in the previous section that the total effects of external linkages of MNCs and public organization and universities, except Locals, are positively significant to Innovation, implying that Hypothesis I is partially demonstrated. The path diagram of Figure 3.3 shows that MNCs has a positive significant path to Working experience, indicating that Hypothesis II is verified. Again, the path from Locals to Indigenous employees is positively significant, implying that Hypothesis III is satisfied. The paths from Working experience with MNCs and Indigenous employees to organizational learning are positively significant, indicating that Hypotheses IV and V are verified. Finally, the path from Organizational learning to Innovation is positively significant, demonstrating that Hypothesis III is demonstrated. Except the hypotheses related to Locals to Working experience with MNCs and Locals to Indigenous employees, all others hypotheses are fully verified.

5.7.3 Important factors to innovation

The previous analysis of direct and indirect effects has an important implication to the innovation process of local firms in the regions. The innovation process is divided into two parts: absorption and integration sub-processes. Among three external linkages, comparing the total effects on innovation, MNCs has the largest impact, followed by public organizations and universities. Locals have a negative effect. From this, it follows

that the connectivity with MNCs are the most important to achieve innovation. This finding is consistent with our previous papers (Tsuji et al 2013b, 2014; Machikita and Ueki, 2015). The merit of this chapter, however, lies in the fact that local firms in the regions are also an important factor for innovation. The above papers found that MNCs are factors enhancing innovation by promoting the internal innovation capability via obtaining new information on technologies and market, but on the other hand the roles of local firms were not found to be important. The analysis of this chapter shows that by connecting with other local firms via the human network of indigenous employees, local firms learn with each other learning practices such as QC or cross-functional activities, for example.

Regarding absorption of information related to innovation, this chapter focuses on gatekeepers, that is, persons who mediate between external linkages and firms. This chapter identifies two kinds of human factors such as top management and factory managers who have working experience with MNCs and indigenous employees such as managers, engineers, and line managers, or leaders class who are of the same nationalities. The conclusion obtained from the analysis indicates that the best gatekeepers corresponding to external linkages for the connectivity with MNCs and public organizations and universities are top management and factory managers who have working experience with MNCs, whereas for the connectivity to locals, indigenous employees such as local engineers, managers, and line leaders are the best.

Regarding the integration process, the learning process such as organizational learning has the largest impact on innovation, although it is directly related to innovation. This chapter focused on QC and cross-functional team in the R&D process and found to be an important factor, which has the largest impact on innovation. Knowledge management inside the firm is essential.

5.8 Conclusion

As discussed in the previous sections, by employing SEM, the innovation process of firms in the ASEAN countries are analyzed. In particular, the analysis shows two channels, or matching between working experience with MNCs and MNCs, and between indigenous employees and locals. The total effects of two channels on innovation are opposite: the former has a positive value, whereas the latter has a negative value. Based on these results, the policy implications indicate that MNCs are important sources of innovation, and therefore, central as well as local governments will have to invite them to their regions. This is a traditional policy that developing countries have been targeting. The analysis here provides a theoretical and empirical background.

Another policy implication comes from the analysis of public organizations and universities, which has a positive total effect on innovation, but it has an effect via working experience with MNCs. A policy has to target to develop a channel between public organizations and universities and locals. This is a construction of open innovation system in the regions (Chesbrough, 2003, 2006a). This is, however, a difficult task; we asked in the questionnaire whether respondents consider public organizations and universities as important sources of information. The figures are different in countries, but the percentage of reply "very important" is less than 10% on average. It seems to take long way for open innovation to spread widely.

The analysis has some limitations, which are expected to be overcome in the future research. In particular, the assimilating process inside the firms needs further development. This chapter examines cross-functional team and QC as latent variables, but there must be more ways to conduct R&D activities inside the firm. Previous studies such as Freeman (1979) analyze how R&D activities are conducted, particularly how information flows from gatekeepers to individual researchers inside one firm (Freeman, 1979). This chapter analyzes the data of whole country, and it is much more difficult to identify the information flow.

Our interviews with engineers of MNCs located in ASEAN regions show that local engineers tend to move from MNCs to local firms to seek better working conditions, although MNCs wish to retain these good engineers. This is a pattern of traditional technology transfers, but through this channel, the number of such engineers becomes less than what locals require. In order for the regions to transform to knowledge-based economy, this is an obstacle to be solved.

Chapter 6 Innovation Process with Formal or Informal R&D among Firms in ASEAN Countries

6.1 Introduction

For further economic development in ASEAN economies, transformation from simple production bases, known by terms such as the "factory of the world," to "knowledge economies" is mandatory. Particularly, the upgrading of SMEs in these regions is an urgent prerequisite for overall macroeconomic development. In this regard, in order to postulate the basic behavior of firms toward innovation, the innovation process and internal capability for innovation inside the firm must be clarified. The innovation process was defined and studied by Cohen and Levinthal (1990), Zahra and George (2002), for example. Firms must elevate their abilities in all four dimensions to promote innovation, which is referred to as internal capability for innovation including an integrated ability of a firm to create innovation which consists of all resources, core competence, or competitiveness, as noted by Mariano and Pilar (2005), Lawson and Samson (2001), and Perdomo-Ortiza, Benitob, Galendeb (2009). In more detail, internal capability includes the technological level, such as the number of patents; production facilities; human resources, such as the number of engineers with higher degrees or skills; and the level of craftsmanship; and organizational aspects, such as communication between workers and top management, speed of decision-making, and top management leadership.

The above innovation process can be viewed and analyzed from the R&D activity. Similarly to the above four sub-processes, the R&D process can be decomposed into the following sub-processes: (i) Idea generation; (ii) Screening Business Analysis; (iii) Development; (iv) Testing; (v) Commercialization (Booz, Allen and Hamilton, 1982). In this R&D process, the internal innovation capability plays essential role to achieve innovation. R&D is one of the riskiest among businesses which a failure rate is somewhere in order of 25 to 45 percent (Crawford, 1987; Cooper, 2001), or for every seven new product ideas, about four enter development, one and a half are launched, and only one succeeds (Nadia, 2011). Because of this nature of R&D, numerous text books and handbooks have been publishing for firms including Crawford (1987, 1997), Smith and Reinertsen (1998), Cooper (2001), and Kahn (2013). All these books and other academic papers examine *formal* R&D (Bhuiyan, 2011).

This chapter, however, focuses not only on formal R&D activities, which are defined as those related to the enhancement and empowerment of all elements of internal innovation capability but also on informal R&D. The latter indicates firms do not have systematic organizations or arrangements to conduct R&D to elevate internal capability.

This paper examines the innovation process of SMEs in the ASEAN countries which are too small to own specific sections or units for R&D. Our field research more than ten years found there are two kinds of R&D, namely formal and informal. Accordingly the research questions of the chapter are whether there are differences in the process and performances for innovation between two types of R&D activity.

This chapter consists of the following sections: The next section identifies the nature of informal R&D based on the surveys of firms actively pursuing innovation. A summary of the data obtained by research teams in five countries is provided in Section 4.3. Methodology and models to be estimated are discussed in Section 4.4. The estimation results and their implications are presented in Section 4.5. Brief conclusions and directions for further research are provided in the final section.

6.2 Nature of informal R&D activity

6.2.1 Informal R&D

It is natural to think that smaller local SMEs cannot afford to own R&D divisions, or laboratories. The reasons are clear; they are short of investment funds, R&D personnel, and the basic level of technology. Even under these circumstances, there are many SMEs which have successfully achieved innovation. Although these SMEs do not own specific R&D facilities, they somehow conducted similar activities. Thus we define R&D activities which are not conducted by specified in-house organizations, departments, or sections of firms as informal R&D activities. These two categories of R&D activities are thought to be the same in terms of objectives and contents, the only differences being found in the way they are conducted. To grasp the nature of informal R&D activities, field surveys were conducted in the different economies. The following discussions are based on the field surveys.

Informal R&D is categorized by the types (a) top-down and (b) bottom-up. The former implies that the R&D activity is directed by the owner of the SME, whereas the latter implies that they are conducted through the initiative of personnel or workers engaged in the production processes or in job-shops.

6.2.2 Top-down informal R&D

This type of R&D is characterized by the leadership of the SME owner, who plays an essential role in the whole innovation process. The owner is generally an engineer with knowledge, skills, ideas, and experience, and at the same time he is capable of managing all aspects of a firm, including marketing, HRD, and so on. He can directly and independently invent new products and discover new production processes. In addition to engineering ability, he also has a passion and high motivation toward innovation. He

is more interested in creating something new rather than making improvements, and thus this type of informal R&D can be applicable to product innovation. Typical examples of these owners are those of start-ups or venture businesses. There are two sub-categories in this type; one upgrades the same technology or the same kind of product, whereas the other shifts the domain of the product in the process of upgrading.

It is also noted that the owners belonging to this category were intensely committed to nurturing their employees by telling employees about their experiences, how to obtain skills and know-how, and how to maintain their attitudes toward innovation. These owners also made efforts to converse with their employees. Since the firms are not large enough to employ college graduates, various types of on-the-job training are inevitable. This type of leader is referred to as a "servant leader," as initiated by Greenleaf (1977).

Regarding the factors of breakthrough, in addition to owners finding new ideas or new technology, advice from university professors and customers, such as large firms, are noticeable. This does not occur through long-term or formal collaboration with the advice-givers, but rather through *ad hoc* consultation.

6.3 Bottom-up informal R&D

Innovation due to this type of informal R&D comes from the manufacturing sites or job-shops. Reducing production costs is mandatory for SMEs to increase profits. Cost reductions can be achieved at the manufacturing site by reducing the production failure rate, speedup, or savings in materials, labor, energy, and so on. Another way to reduce costs is speedup at the manufacturing site. Reductions in failure rate, for example, can be achieved through simple efforts made by workers as well as top management by means of 5S, QC, and by training that entails very little cost. That is, these can be tried by all kind of SMEs. In this sense, what innovation in this type of informal R&D seeks is process innovation such as the improvement of production processes (*Kaizen*).

Regarding the factors that promote informal R&D in addition to the reduction of the failure rate or speedup of production, these come from customers who use the products including (a) model changes in the final product, (b) claims from customers, and (c) improvement of product quality. At the time of a model change in the customer's final product, SMEs which supply materials or parts have to change their products, which, in a sense, is their innovation. That is, innovation indicated in one firm is transmitted to other firms via the supply chain. Due to customer claims regarding quality, SMEs as parts suppliers are required to improve their manufacturing process, which also implies process innovation. Thus this type of informal R&D tends to create mainly process innovation, and accordingly innovation of this kind can be termed "*non-autonomous*," whereas that achieved by top-down R&D is termed "*autonomous*."

The implementation of this kind of informal R&D can be found in R&D team consisting of three kinds of members or specialists, namely those who have come from the (a) manufacturing, (b) technology, and (c) marketing sections. The members from (a) are in charge of a particular section of the manufacturing process, those from (b) are specialists in wider or general production technology, and those from (c) are sales personnel who take responsibility for selling the particular materials or parts. This team works together to handle claims or proposals from customers. The team is precisely cross-functional, which was the target of our previous studies and which we have continuously analyzed.

Another important feature of bottom-up informal R&D is record keeping. All trials and discussions in the team, whether they lead to success of failure, were recorded in digitalized form. The aims of this record are to share information on trial and error among members and for future reference. When the team comes across some problem, members can check the record to find similar cases and solutions from past experience. Table6.1 summarizes the above discussion.

Table 6.1 Differences and similarities of the two types of informal R&D

	Top-down type	**Bottom-up type**
Leadership	Top management	Team at the workplace
Specialty of leader	Engineer	Engineer and marketing
Type of innovation I	Product innovation	Process innovation
Type of innovation II	Radical	Gradual, improvement
Size of firm	Small	Medium (or large)
Type of production	Build-to-order	Make-to-stock, or mass
QC	Less active	Active
Initiation	Ideas of top management	Customer's model change, claims, requests for improvement
Motivation	Autonomous	Non-autonomous
Breakthrough	Make their own efforts to solve problems, advice from university researchers, consultants	Members' efforts, advice from outside specialists, checking past records
Origin of ideas	Experience, study, intuition	Team discussion, study, experience
	Similarities	
	Technology conferences ISO9000 5S	

6.4 Research questions

Based on the above discussions on the ways of conducting R&D activities, the research questions of this chapter are summarized as follows:

RQ I: The informal and formal R&D groups have different innovation processes

RQ II: What are the factors of production innovation for the formal and informal R&D Groups: Are there any difference between them?

RQ III: What are the factors of process innovation for the formal and informal R&D Groups: Are there any difference between them?

6.5 Summary of data and construction of variables

6.5.1 Surveys conducted

This chapter is based on mail surveys and phone interviews conducted with firms in four ASEAN economies, such as Vietnam, Indonesia, Laos, the Philippines, and Thailand from 2013 to 2014, amounting to 152 in the Hanoi area and 161 in the Ho Chi Minh City area, Vietnam; 200 in the Batangas and neighboring areas in the Philippines; 181 in the Jabodetbek area, Indonesia; and 160 in Greater Bangkok, Thailand. The surveys were conducted from November 2013 to January 2014. The total number of valid responses from these areas was 1,061.

6.5.1.1 Characteristics of the respondent firms

(1) Year of establishment

Table 3 indicates that 48.4% of Vietnamese, 42.5% of Lao firms replied that they started operating between 2001 and 2010. Those that started between 1991 and 2000 included 43.0% of the Filipino, 35.9% of the Thai, and 35.4% of the Indonesian firms. Concerning Thai and Indonesian firms, 26.5%, and 17.6% of Filipino firms replied that their establishment dated from between 1981 and 1990 and that they had had more years of operation compared to firms in other countries that were established less than 20 years ago. These results depend on when economic growth started in each economy.

Regarding the year of establishment by industry, 36.5% of firms, which belong to the formal R&D group, were established in 2001-2010, while firms in the informal R&D group amount to 33.6%. Among firms established after 2011, 5.4% had formal R&D, and 10.4% had informal R&D, implying that the formal R&D firms had a more formally structured management system than the informal R&D firms.

ble 6.2 Year of establishment

Year of establishment		Vietnam		Indonesia		Thailand		Philippines		Laos		Total	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Formal R&D	-1970	17	6.6	7	6.3	7	9.1	5	6.9	0	0.0	36	6.0
	1971-1980	17	6.6	19	17.0	5	6.5	4	5.6	2	2.5	47	7.9
	1981-1990	19	7.4	29	25.9	9	11.7	17	23.6	7	8.9	81	13.6
	1991-2000	77	30.0	38	33.9	20	26.0	26	36.1	22	27.8	183	30.7
	2001-2010	121	47.1	18	16.1	24	31.2	20	27.8	35	44.3	218	36.5
	2011-	6	2.3	1	0.9	12	15.6	0	0.0	13	16.5	32	5.4
	Total	257	100.0	112	100.0	77	100.0	72	100.0	79	100.0	597	100.0
Informal R&D	-1970	1	2.0	3	4.3	2	3.1	2	1.7	1	0.8	9	2.1
	1971-1980	2	4.1	6	8.7	2	3.1	6	5.0	1	0.8	17	3.9
	1981-1990	4	8.2	19	27.5	5	7.7	17	14.0	6	4.7	51	11.8
	1991-2000	12	24.5	26	37.7	31	47.7	57	47.1	39	30.5	165	38.2
	2001-2010	27	55.1	13	18.8	15	23.1	37	30.6	53	41.4	145	33.6
	2011-	3	6.1	2	2.9	10	15.4	2	1.7	28	21.9	45	10.4
	Total	49	100.0	69	100.0	65	100.0	121	100.0	128	100.0	432	100.0
All Firms	-1970	18	5.9	10	5.5	9	6.3	7	3.6	1	0.5	45	4.4
	1971-1980	19	6.2	25	13.8	7	4.9	10	5.2	3	1.4	64	6.2
	1981-1990	23	7.5	48	26.5	14	9.9	34	17.6	13	6.3	132	12.8
	1991-2000	89	29.1	64	35.4	51	35.9	83	43.0	61	29.5	348	33.8
	2001-2010	148	48.4	31	17.1	39	27.5	57	29.5	88	42.5	363	35.3
	2011-	9	2.9	3	1.7	22	15.5	2	1.0	41	19.8	77	7.5
	Total	306	100.0	181	100.0	142	100.0	193	100.0	207	100.0	1029	100.0

(2) Ownership

Table 4 shows that most firms were 100% locally owned in all the countries: Thailand (91.0%), Vietnam (75.7%), Indonesia (64.6%), the Philippines (48.7%), and Laos (60.9%). The second largest category was 100% foreign-owned (MNC): the Philippines (30.6%), Laos (25.1%), Vietnam (18.2%), and Indonesia (18.8%). In the Philippines, however, joint ventures (local and foreign-owned) amounted to 20.7%.

In the formal R&D group, 68.3% are locally owned, and in the informal R&D group this proportion was 68.0%. On the other hand, joint ventures (local and foreign-owned) occupied 13.0% in the formal R&D group, while in the informal R&D group, joint ventures accounted for 11.1%.

Table 6.3 Capital structure of establishments at present

	Capital Structure of Establishment	Vietnam		Indonesia		Thailand		Philippines		Laos		Total	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Formal R&D	100% Locally-owned	203	77.5	65	58.0	72	86.7	32	44.4	43	54.4	415	68.3
	100% Foreign-owned (MNC)	43	16.4	25	22.3	3	3.6	22	30.6	21	26.6	114	18.8
	Joint Venture (JV),	16	6.1	22	19.6	8	9.6	18	25.0	15	19.0	79	13.0
	Total	262	100.0	112	100.0	83	100.0	72	100.0	79	100.0	608	100.0
Informal R&D	100% Locally-owned	34	66.7	52	75.4	69	95.8	62	51.2	83	64.8	300	68.0
	100% Foreign-owned (MNC)	14	27.5	9	13.0	1	1.4	37	30.6	31	24.2	92	20.9
	Joint Venture (JV)	3	5.9	8	11.6	2	2.8	22	18.2	14	10.9	49	11.1
	Total	51	100.0	69	100.0	72	100.0	121	100.0	128	100.0	441	100.0
All Firms	100% Locally-owned	237	75.7	117	64.6	141	91.0	94	48.7	126	60.9	715	68.2
	100% Foreign-owned (MNC)	57	18.2	34	18.8	4	2.6	59	30.6	52	25.1	206	19.6
	Joint Venture (JV)	19	6.1	30	16.6	10	6.5	40	20.7	29	14.0	128	12.2
	Total	313	100.0	181	100.0	155	100.0	193	100.0	207	100.0	1049	100.0

(3) Firm size

Table 6.5 shows the size distribution of firms in terms of total assets and that 22.4% of responding firms had assets from USD1 million to USD4.9 million. However, the largest category in the Philippines and Laos was from USD100,000 to USD499,999 (24.2%, 28.5%). For Thailand, it was either from USD1 million to USD4.9 million (22.2%) or from USD100,000 to USD499,999 (18.5%). On the other hand, the largest category in Vietnam and Indonesia was USD10 million and above (32.9%, 24.3). 27.5% of firms in the formal R&D group had assets of more than USD10 million, followed by 22.7% with USD100,000-499,999. On the other hand, in the informal R&D group, 22.3% had from USD100,000 to USD499,999, followed by 22.1% with USD1 million to USD4.9 million.

Table 6.4 Total assets

	Total assets	Vietnam		Indonesia		Thailand		Philippines		Laos		Total	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Formal R&D	Less than 10,000	0	0.0	0	0.0	0	0.0	1	1.4	1	1.3	2	0.3
	10,000-24,999	0	0.0	0	0.0	0	0.0	4	5.6	3	3.8	7	1.2
	25,000-49,999	2	0.8	2	1.8	5	6.7	2	2.8	2	2.5	13	2.2
	50,000-74,999	7	2.7	3	2.7	5	6.7	1	1.4	4	5.1	20	3.3
	75,000-99,999	7	2.7	4	3.6	4	5.3	4	5.6	1	1.3	20	3.3
	100,000-499,999	15	5.7	15	13.4	13	17.3	17	23.6	18	22.8	78	13.0
	500,000-999,999	31	11.8	14	12.5	8	10.7	6	8.3	17	21.5	76	12.7
	1 million-4.9 mil.	64	24.4	28	25.0	19	25.3	12	16.7	13	16.5	136	22.7
	5 mil.-9.9 mil.	42	16.0	13	11.6	7	9.3	13	18.1	8	10.1	83	13.8
	10 million and above	94	35.9	33	29.5	14	18.7	12	16.7	12	15.2	165	27.5
	Total	262	100.0	112	100.0	75	100.0	72	100.0	79	100.0	600	100.0
Informal R&D	Less than 10,000	0	0.0	1	1.4	4	6.7	3	2.5	9	7.0	17	4.0
	10,000-24,999	0	0.0	4	5.8	3	5.0	10	8.5	4	3.1	21	4.9
	25,000-49,999	1	2.0	6	8.7	3	5.0	12	10.2	5	3.9	27	6.3
	50,000-74,999	2	3.9	5	7.2	10	16.7	3	2.5	9	7.0	29	6.8
	75,000-99,999	2	3.9	8	11.6	7	11.7	6	5.1	10	7.8	33	7.7
	100,000-499,999	4	7.8	9	13.0	12	20.0	29	24.6	41	32.0	95	22.3
	500,000-999,999	6	11.8	8	11.6	4	6.7	11	9.3	19	14.8	48	11.3
	1 million-4.9 mil.	23	45.1	15	21.7	11	18.3	25	21.2	20	15.6	94	22.1
	5 mil.-9.9 mil.	4	7.8	2	2.9	4	6.7	10	8.5	4	3.1	24	5.6
	10 million and above	9	17.6	11	15.9	2	3.3	9	7.6	7	5.5	38	8.9
	Total	51	100.0	69	100.0	60	100.0	118	100.0	128	100.0	426	100.0
All Firms	Less than 10,000	0	0.0	1	0.6	4	3.0	4	2.1	10	4.8	19	1.9
	10,000-24,999	0	0.0	4	2.2	3	2.2	14	7.4	7	3.4	28	2.7
	25,000-49,999	3	1.0	8	4.4	8	5.9	14	7.4	7	3.4	40	3.9
	50,000-74,999	9	2.9	8	4.4	15	11.1	4	2.1	13	6.3	49	4.8
	75,000-99,999	9	2.9	12	6.6	11	8.1	10	5.3	11	5.3	53	5.2
	100,000-499,999	19	6.1	24	13.3	25	18.5	46	24.2	59	28.5	173	16.9
	500,000-999,999	37	11.8	22	12.2	12	8.9	17	8.9	36	17.4	124	12.1
	1 million-4.9 mil.	87	27.8	43	23.8	30	22.2	37	19.5	33	15.9	230	22.4
	5 mil.-9.9 mil.	46	14.7	15	8.3	11	8.1	23	12.1	12	5.8	107	10.4
	10 million and above	103	32.9	44	24.3	16	11.9	21	11.1	19	9.2	203	19.8
	Total	313	100.0	181	100.0	135	100.0	190	100.0	207	100.0	1026	100.0

Table 6.4 indicates the size distribution of firms in terms of full-time employees and that almost half of the firms had 1 to 99 employees, except the Vietnamese firms. In Vietnam, the largest category was from 100 to 199 employees (21.1%), that is, the firms in Vietnam that replied belong to the category of larger firms.

34.2% of firms in the formal R&D group had less than 99 employees, while in the other industries those firms were about 66.9% implying that firms in the informal R&D group were smaller than those in other industries.

Table 6.5 Number of full-time employees

No. of full-time employees		Vietnam		Indonesia		Thailand		Philippines		Laos		Total	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Formal R&D	1-19 persons	1	0.4	7	6.3	18	22.0	3	4.2	24	30.4	53	8.7
	20-49	14	5.3	8	7.1	12	14.6	13	18.1	21	26.6	68	11.2
	50-99	31	11.8	15	13.4	14	17.1	18	25.0	9	11.4	87	14.3
	100-199	56	21.4	22	19.6	12	14.6	18	25.0	13	16.5	121	19.9
	200-299	36	13.7	15	13.4	9	11.0	2	2.8	3	3.8	65	10.7
	300-399	24	9.2	8	7.1	2	2.4	3	4.2	0	0.0	37	6.1
	400-499	15	5.7	7	6.3	1	1.2	1	1.4	2	2.5	26	4.3
	500-999	35	13.4	15	13.4	0	0.0	8	11.1	4	5.1	62	10.2
	1,000-1,499	19	7.3	10	8.9	5	6.1	3	4.2	1	1.3	38	6.3
	1,500-1,999	9	3.4	2	1.8	0	0.0	2	2.8	2	2.5	15	2.5
	2,000 and above	22	8.4	3	2.7	9	11.0	1	1.4	0	0.0	35	5.8
	Total	262	100.0	112	100.0	82	100.0	72	100.0	79	100.0	607	100.0
Informal R&D	1-19 persons	1	2.0	10	14.5	35	48.6	18	14.9	55	43.0	119	27.0
	20-49	7	13.7	19	27.5	15	20.8	31	25.6	27	21.1	99	22.4
	50-99	11	21.6	18	26.1	12	16.7	22	18.2	14	10.9	77	17.5
	100-199	10	19.6	7	10.1	7	9.7	20	16.5	13	10.2	57	12.9
	200-299	8	15.7	4	5.8	0	0.0	11	9.1	7	5.5	30	6.8
	300-399	3	5.9	5	7.2	2	2.8	2	1.7	6	4.7	18	4.1
	400-499	3	5.9	0	0.0	0	0.0	3	2.5	1	0.8	7	1.6
	500-999	3	5.9	1	1.4	0	0.0	8	6.6	5	3.9	17	3.9
	1,000-1,499	3	5.9	2	2.9	0	0.0	2	1.7	0	0.0	7	1.6
	1,500-1,999	1	2.0	1	1.4	0	0.0	1	0.8	0	0.0	3	0.7
	2,000 and above	1	2.0	2	2.9	1	1.4	3	2.5	0	0.0	7	1.6
	Total	51	100.0	69	100.0	72	100.0	121	100.0	128	100.0	441	100.0
All Firms	1-19 persons	2	0.6	17	9.4	53	34.4	21	10.9	79	38.2	172	16.4
	20-49	21	6.7	27	14.9	27	17.5	44	22.8	48	23.2	167	15.9
	50-99	42	13.4	33	18.2	26	16.9	40	20.7	23	11.1	164	15.6
	100-199	66	21.1	29	16.0	19	12.3	38	19.7	26	12.6	178	17.0
	200-299	44	14.1	19	10.5	9	5.8	13	6.7	10	4.8	95	9.1
	300-399	27	8.6	13	7.2	4	2.6	5	2.6	6	2.9	55	5.2
	400-499	18	5.8	7	3.9	1	0.6	4	2.1	3	1.4	33	3.1
	500-999	38	12.1	16	8.8	0	0.0	16	8.3	9	4.3	79	7.5
	1,000-1,499	22	7.0	12	6.6	5	3.2	5	2.6	1	0.5	45	4.3
	1,500-1,999	10	3.2	3	1.7	0	0.0	3	1.6	2	1.0	18	1.7
	2,000 and above	23	7.3	5	2.8	10	6.5	4	2.1	0	0.0	42	4.0
	Total	313	100.0	181	100.0	154	100.0	193	100.0	207	100.0	1048	100.0

This chapter categorizes R&D activities into two types, formal and informal R&D; accordingly the firms were also divided into formal and informal R&D group. The firms that replied “No” to both of the questions asked about whether they have an R&D budget (**Q19.1.**), and specific personnel who are engaged in only R&D activities (**Q19.3.**). As shown in Table 6.2, the number of firms analyzed in this chapter sample was 608 (58.0%) in the formal R&D group, 441 (42.0%) in the Informal R&D group, and 1,049 in total. Regarding the size of the firms, 50 % of formal R&D firms have smaller than 200 employees, while that of informal R&D has smaller than 50 employees. In terms of assets, two thirds of Formal R&D are larger than 1 milloin-5 million USD, whereas two thirds

of Formal R&D own less than those amount. The informal R&D firms have much smaller than the formal group.

Table 6.6 Types of R&D group by country

Type of R&D	Vietnam		Indonesia		Thailand		Philippines		Laos		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq.	%	Freq.	%
Formal R&D	262	83.7	112	61.9	83	53.5	72	37.3	79	38.2	608	58.0
Informal R&D	51	16.3	69	38.1	72	46.5	121	62.7	128	61.8	441	42.0
Total	313	100.	181	100.	155	100.	193	100.	207	100.	1049	100.

6.5.2 Construction of outcome variables

6.5.2.1 Product innovation

The construction of variables related to product innovation is based on the following four categories of innovation:

(1) Product innovation Type I: Introduction of a new product, redesigning packaging or significantly changing the appearance design of your existing products
(2) Product innovation Type II: Introduction of a new product, significantly improving your existing products with respect to their capabilities, user friendliness, components, subsystems, etc.
(3) Product innovation Type III: Development of a totally new product based on the "existing" technologies at your establishment
(4) Product innovation Type IV: Development of a totally new product based on "new" technologies at your establishment

These are based on "**Q13**. Have you tried to introduce a new product in the last two years (2013-2014)?" For each category, the respondents were asked whether they had (i) achieved, (ii) attempted, or (iii) not attempted the innovation. If respondents had achieved the innovation, two points are given; if they had attempted the innovation, one point is given; and those who had not yet attempted the innovation are indicated by zero. Figure 1 indicates product innovation by countries without making difference between two groups. The vertical axis of both figures indicates the percent of forms responded to (i) achieved.

6.5.2.2. Process innovation

In the surveys, 11 categories of process innovation were asked, but in this paper, the

following four process innovations were selected, since they showed some clear distinction between two groups:

(1) Process innovation Type I: Decreased shipping of defective products
(2) Process innovation Type II: Reduced raw materials and energy usage
(3) Process innovation Type III: Reduced lead time to introduce a new product
(4) Process innovation Type IV: Reduced labor input (man-hour)

For each category of process innovations, the respondents were asked whether they had achieved (i) much, (ii) somewhat, (iii) little, or (iv) not achieved. Similar to product innovation, if respondents had achieved process innovation much, three points are given; if they had achieved the process innovation somewhat, two point is given; and those who had achieved little, one point is given; not achieved the innovation are indicated by zero.

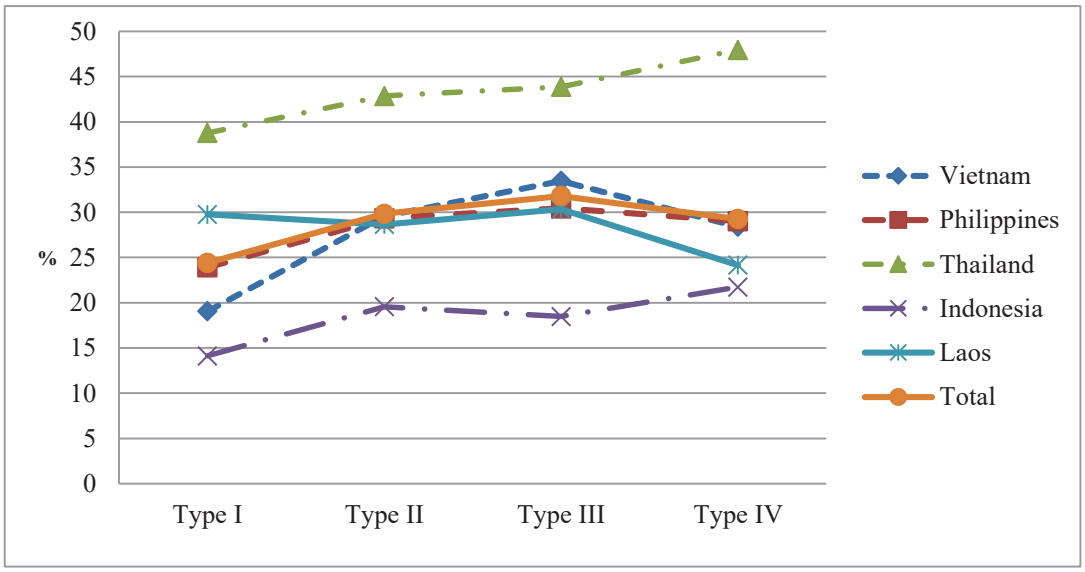


Figure 6.1 Product innovation by country

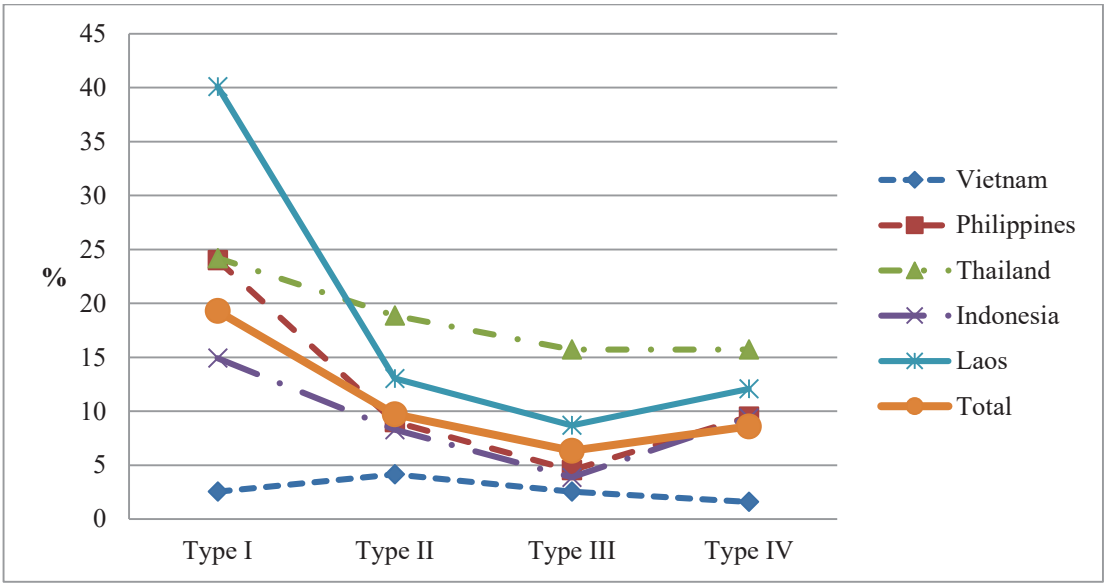


Figure 6.2 Process innovation by country

6.5.2.3 Explanatory variables

The previous study used the categories of explanatory variables such as Cross functional team, QC, Human factors such working experience's for MNCs, and so on (Tsuji et al. 2016). This chapter also basically follows those variables.

6.5.2.3.1 Technology:

The technological level of a firm can be indexed by the number of patents obtained, the amount of R&D investment made, or the quality of equipment used in the manufacturing process. This study focuses only on the ISO9000 series and ISO14000 series, since the number of explanatory variables is large and there are other variables which we wish to highlight in this paper. In the actual estimation, only ISO9000 were employed, since variables related to technology are not significant. This will be discussed in more detail in what follows.

6.5.2.3.2 Human factors:

In the previous papers, human factors are discussed from the various aspects which include labor mobility (Kesidoua and Szirmai, 2008), spillovers (Görg and Strobl, 2005; Balsvik 2011; Poole, 2013) or leadership of R&D team (Sarin and McDermott 2003; Wong and Tong, 2012) in the high-tech industries. The questions related to human factors in this paper confine to those related manager classes and aim obtain the abilities of

employees, but these are not in general observable. The questions thus asked subjects to focus on their career backgrounds, or current positions. The variables employed for estimation are based on the following questions:

Q19.3. Does your establishment develop personnel to take charge of R&D at present?
Q30.1. Does your establishment have a factory manager?
Q30.3. Does the factory manager have experience of working for MNCs?
Q34. Have you recruited a new production line manager from MNCs in the last three years?

6.5.2.3.3 Organizational factors

Since innovation or R&D are conducted with various teams, groups, or units, conflicts among them are easily occurred, and to avoid such conflicts managerial arrangements or organizations are required for conducting R&D coherently. Daniel (1961) and Rockart (1979), for example, asserted that related organizations need to clarify factors that are critical to the success of the R&D process, since failure to achieve coherency would result in organizational failure. The questions related to organizational factors in this paper thus aim to obtain information on whether firms as a whole are systematically and coherently conducting R&D or innovation activities. This factor contains activities which are summarized as follows:

(1) Top management leadership

This is an important factor particularly for the informal R&D group, as already mentioned. Innovation in SMEs is mainly led by the owners of firms, particularly SMEs with top-down type. The top management leadership contains ability to establish D&R strategy, to encourage related teams or personnel, to avoid conflicts among related groups, to evaluate their performance, etc. Greenleaf (1977) referred their ability to avoid conflicts and coordination failure to as *Servant Leadership.* Since the top management leadership is unobservable, it is obtained from the following questions, which are also related to top management backgrounds, such as education or past experience:

Q29.5. Did your top management study outside his/her home country?
Q29.6. Was or is the top manager an engineer?
Q29.8. Does the top manager have experience of working for MNCs?
Q30.1. Does your establishment have a factory manager?

In actual estimation, Q29.8 and Q30.1 are employed, since appointing a factory

manager is considered to be one of their leadership.

(2) Cross-functional team

This is an organizational arrangement for the exchange, dissimulation and sharing of different views or opinions from different sections of a firm that are related to innovation and which become a basis for creating new ideas. The heterogeneity of ideas or thought tends to create something new through communication. The role of cross-functional teams has been recognized not only in the context of innovation but also solving problems in general. Besides previous studies discussed the conditions on which cross-functional teams work. There were empirical studies; Blindenbach-Driessen, (2015) demonstrated the positive relationship between the cross-functional team and innovation by saying that the existence of cross-functional team is not sufficient for successful innovation. Hirunyawipada, Beyerlein, and Blankson, (2010) identified the conditions for teams to works such as task cohesion, interpersonal cohesion, and transformational leadership and the qualification of team members such as common knowledge, functional expertise, and their positions in the network. Again, this factor is unobservable, and the following question is used as a proxy:

Q19.5. Do your R&D personnel have regular meetings to discuss/share their common problems or solutions?

Q21. Cross-functional team for the introduction of a new product or process: Which departments are involved in the cross-functional team that your establishment organizes to introduce a new product or process?

Q21.1. No team

Q21.5. Production Engineering, **Q21.6.** Manufacturing, and **Q21.11.** Sales & Marketing

From the survey data, the percentages of firms which are practicing following three cross-functional teams are summarized in Table 6.7 implying that the formal R&D group has greater percentages than the informal R&D group. This seems to be due to the firm size.

Table 6.7 Cross- functional team

	Informal R&D	Formal R&D
Research	2.7	26.0
Development	6.3	38.8
Sales & marketing	25.4	40.3

The above questions investigate whether the firm has this characteristic. In the estimation, “No team” and “Cross-functional team (production engineers, manufacturing, and sales & marketing)” are used, and the latter consists of personnel who are “production engineers, manufacturing, and sales & marketing.” This is due to the in-depth interview with *Dynic*, which has already been explained. The role of marketing section was emphasized by De Luca and Atuahene-Gima (2007) which obtained the conclusion such that market knowledge and cross-functional collaboration are two fundamental resources for successful product innovation. They identified the mechanisms which combine these two.

(3) QC (Quality Control)

Although QC does not directly contribute to innovation, new ideas related to innovation, particularly related to process innovation, can be obtained through small group activities. Since the improvement of product quality is a part of process innovation, the outcome of QC is equal to innovation itself. The questions used for this factor are as follows:

Q22.2. Does your establishment operate a QC circle?
Q22.9. Has your establishment adopted statistical quality control?
Q22.7. Group rewards for suggestions or QC

From the data, actual practices of QC on two groups are shown in Table 6.8, and the formal R&D Group has greater percentages in three kinds of QC, implying that this group is more active in QC, since its firm size is greater than the informal R&D group.

Table 6.8 QC

	Informal R&D (%)	Formal R&D (%)
QC	53.7	73.4
Statistical QC	41.8	62.6
Group rewards for QC	42.5	56.5

(4) Learning Process

This role of the learning process is to share the success experiences among related personnel engaged in R&D activities, and consists of the following questions. There is no need to explain why they are included, except for "5S." This is one of basic attitudes that employees must own.

Q. 22.1. 5S

Q.32. Worker training program

Q.33. HRD program for blue-collar workers, such as cross-training or job rotation

(5) IT Use:

IT use is now popular and necessary among SMEs in these areas, and it is important to examine whether or not IT promotes R&D activities, since IT supports employees in dissimulating their experiences and sharing them with others (Idota, Bunno, and Tsuji, 2015a; 2015b; 2015c; Idota et al. 2015).

Q28.2. Has your establishment introduced the following IT systems?

Internal use of IT:

5. Enterprise Resources Planning (ERP), 6. Customer Relationship Management (CRM), 7. Computer Aided Design (CAD) / Computer Aided Manufacturing (CAM), 8. Groupware, 9. Intra-Social Networking Services (SNS)

External use of IT

1. Business-to-Business e-commerce (B2B), 2. Business to Consumer e-commerce, 3. Electronic Data Interchange (EDI), 4. Supply Chain Management (SCM), 10. Public SNS

IT all

The variable "IT all" includes all of the internal and external uses of IT and its value is the number of items of questions which are true to the firm. In estimation, we use IT all as a variable.

The summary statistics of the above variables are shown in Table 6.9.

6.5.3 Method of estimation

Ordered probit estimation on product innovation is conducted for *each* type of innovation to identify factors to achieve particular type innovation, and explained variables are relies such as 2 for "achieved," 1 for "attempted," and 0 for "not attempted."

Ordered probit estimation on product innovation is conducted for *each* type of innovation to identify factors to achieve particular type innovation, and explained variables are relies such as 2 for "achieved," 1 for "attempted," and 0 for "not attempted." The rationale of this methodology lies in the category of innovation. We assume that up-grading innovation from Type I to Type II, from Type II to Type III, and so on are so drastic changes for local firms in these areas that ordered probit analysis might not capture essential factors for innovation. Actually the estimation in this way did not bring reasonable results. Thus up-grading from "not attempted" to "attempted," or from "attempted" to "achieved" seems not difficult for them and can capture the desired results. Accordingly, this method is adopted

Table 6.9 Summary statistics

		N	mean	sd	min	Max
	Outcome variables					
Product innovation	Type Ir	717	1.396	0.775	0	2
	Type II:	717	1.333	0.769	0	2
	Type III:	718	1.111	0.819	0	2
	Type IV	718	0.802	0.818	0	2
Process innovation	Type I:	1,058	1.394	1.053	0	3
	Type II:	1,060	1.197	0.966	0	3
	Type III:	1,058	0.960	0.931	0	3
	Type IV:	1,060	1.084	0.963	0	3
	Explanatory variables					
Technology	ISO9000	1,056	0.419	0.494	0	1
Human factor	Educated personnel in charge of R&D	1,050	0.430	0.495	0	1
	Appointing factory manager	1,058	0.674	0.469	0	1
	Factory manager has experiences working for MNCs	780	0.388	0.488	0	1
	Recruited new production line manager from MNCs last 3 years	1,057	0.250	0.433	0	1
Leadership of top management	Top manager is/was an engineer	1,058	0.674	0.469	0	1
	CEO has experiences working for MNCs	1,056	0.386	0.487	0	1
Cross-functional team	Do your R&D personnel have regular meetings to discuss/share their common problems or solutions?	1,051	0.460	0.499	0	1
	Cross functional team	1,061	0.694	0.461	0	1
	Cross functional team (Engineering, Manufacturing, Sale &11 Marketing)	1,061	0.899	0.957	0	3
QC	Practicing QC	1,061	0.654	0.476	0	1
	Statistical QC	1,059	0.541	0.499	0	1
	Group rewards for suggestion or QC	1,060	0.508	0.500	0	1
Learning process	5S	1,061	0.545	0.498	0	1
	Training program for workers	1,059	0.475	0.500	0	1
	HRD program for blue-collar workers such as cross-training or job rotation	1,058	0.575	0.495	0	1
IT	IT all	1,007	1.975	1.883	0	10

Note: The total number of valid reply is 1,061 and that of firms achieved product innovation is 718. Accordingly, the number of samples which do not achieve any of four categories of innovation is 343.

6.6 Result of estimation

6.6.1 Product innovation

The results of estimations for product innovation are summarized in Table 6.10. Firm characteristics are omitted for simplicity. First, common significant variables promoting product innovation for both R&D groups are as follows:

(i) "Group rewards for suggestions or QC" for innovation Types I,
(ii) "IT all" for Type I.
(iii) "Operate QC" for Type IV

From these, it is difficult to obtain clear and unified explanation. But it can be said that the formal and informal R&D groups have different innovation patterns, since there are only few common significant variables for each type, implying the informal and formal R&D groups operate under different processes for product innovation. This answers **RQ I:** the informal and formal R&D groups have different innovation processes for product innovation

Next, let us focus on each group separately. The formal R&D group has the following significant variables common to more than two types of product innovation:

(i) Cross-functional team such as "Production Engineering, Manufacturing, and Sales & Marketing" for innovation Types I, II, and III
(ii) "QC practice" for Type IV
(iii) "IT use" for Type I and II

From these observations, it follows that the factors such as Cross-functional team, QC practice, and IT use, but QC and IT are significant as common factors. These two may not genuine factors. Then, "Cross-functional team" is idenfied only in the formal R&D group. These variables are similar to variables that were identified to promote innovation obtained in the authors' previous studies (Idota, et al. 2015;Tsuji, et al. 2016), implying that the previous studies seemed to be focused on firms conducting formal R&D activities. Moreover, since there are no significant variables related to top management, innovation in this group is mainly enhanced by employee participation, which seems to consistent with our field research discussed in this chapter as well as Chapter 2. More precisely, SMEs of bottom-up type or Dynic emphasizes cross-functional team and QC. Accordingly this estimation results support our observations from field research.

Regarding the informal R&D Group, the only factor common to more than two types is:

(i) "HRD program for workers" for Type II, III and IV

HRD is the most important factors for this group, which is different from the formal R&D group. These are answers to **RQII (**What are the factors of production innovation for the formal and informal R&D Groups: Are there any difference between them?). These results seem to coincide with the nature of top-down type discussed in this chapter and with Maeda's HRD discussed in Chapter 2. This difference seems to be due to the size of the firms; the size of informal group is too small to organize systematic cross-functional teams, and innovation depends on the skills and know-how of line workers. As emphasized in Chapter 2, training, either OTJ and OFFTJ, are important tools for enhancing skills of workers .

6.6.2 Process innovation

The estimation results on process innovation are summarized in Table 6.11. One common variable which is significant to both informal and formal innovation is "**Q29.6.** Was or is the top manager an engineer?" implying top management leadership in technological matters for process innovation. This answers **RQI** for process innovation. Let us examine the results for each group separately. For the informal R&D group, the followings are common to more than two types of innovation:

(i) "QC" is significant for all types
(ii) "COE is an engineer" is significant for Type II and III

Thus process innovation is promoted by the COE's ability as an engineer, and employee QC practice. The latter is a fundamental activity for improvement, which leads to process innovation. This result seems consistent with field research on Maeda Precision Manufacturing in Chapter 2.

As for the formal R&D group, significant variables are found only in Type II and III. The only significant variable which is common to more than two types is:

(i) "HRD program for workers" for Type II and III

This result seems consistent with field research on Maeda Precision Manufacturing in Chapter 2. "Size of firm in terms of total assets" for Type II, III, and IV is also significant, although it is skipped in the table. Process innovation in the formal R&D group is thus promoted by collaboration between top management and employees. The results of process innovation show that the number of significant variables is small due to the small number of samples. Whether the hypotheses are verified or not requires further

examination. These are answer to **RQIII:** What are the factors of process innovation for the formal and informal R&D Groups: Are there any difference between them?

As Table 6.11 shows that the estimation results for process innovation by the same model identify not only factors such as top management ability as engineers and working experience at MNCs but also employee QC and training programs, although they are related more to Type II and III. It should be noted that cross-functional teams are not significant, which needs further elaboration.

6.7 Ordered probit through four types of product innovation

The above estimation is based on ordered probit for firms in each type, that is, what are factors for firms to achieve particular types of innovation. Although this is important, we also have to identify factors which enable to elevate firms to higher type of innovation. To do this, ordered probit analysis including four types innovation for product innovation, and we selected firms which responded to "achieved" innovation in each innovation type. The estimation results are shown in Table 6.12. For firms to upgrade to the higher stage innovation, "Cross-functional teams" are most important for both groups. For informal R&D group, "ISO9000" and "statistical QC" are two significant factors. For the formal R&D group, "5S"is a factor of innovation which characterizes firms achieving the lower level of innovation, since its sign is negative. Although these factors identifies are different from the previous estimations, they provide the interesting observation.

6.8 Discussion

Innovation through informal and formal R&D has been one of the research topics, and there are accumulated academic papers, in which they are referred to as non-R&D and R&D, respectively. Jensen et al. (2008) reformulated two kind R&D activities as ideal mode: the science, technology and innovation (STI) mode and the doing, Using, and Interacting (DUI) mode. The former is dominated by scientific and technical knowledge which is related to formal process of R&D, while the latter is characterized as informal process of learning and experienced-based skills and know-how (Joerg Thome, 2017). The definition proposed seems to be reasonable; however, non-R&D activity contains some ambiguity. Even formal R&D in the high-tech, bio, automobile industries, for example, involves interactions among researchers such as leadership and communications, salary or award system, and the process converting non-tact knowledge (Lee and Walsh, 2016; Lopez-Rodorigez and Martinez-Lopez, 2017). This study defines informal and formal R&D based on whether they are conducted by both of specific R&D personnel and R&D budget. Although this definition seems to be rough, it is convenient for the questionnaire survey; the accurate but complicated questions are hardly understood by a

person who is asked to reply. The areas and firms which this study targets are less developing countries and SMEs, and simplified definition are practically useful.

The papers mentioned above focus on EU firms with data collected by established organizations, while in the less developed economies such data are hardly available. Empirical studies this paper follows have some meaning in this situation. Since there is no study targeting SMEs in ASEAN, the results obtained are good contrast with the EU studies. Particular, this study identified more concrete factors to promote innovation such as cross-functional teams and HRD, which are not obtained by other research.

6.8 Conclusion

The objectives of this chapter are to examine whether two groups of ASEAN local firms have different R&D activities for achieving innovation. The firms are categorized into two groups depending on whether or not they own specific R&D sections or units. The underlying hypotheses are that the formal group is characterized by the same process as obtained by previous studies, namely innovations are promoted by technology, human factors, and organizational arrangements. The informal group has a process due to shortages in human resources, investment funds, or a low level of technology. Based on field research, these firms conduct innovation through the leadership of owner who dominates the firm in terms of technology, ideas, experience, and so on. Besides, cross-functional teams of employees discussing, dissimulating, and sharing their ideas, experiences and skills among the members is another factor promoting innovation. Since the firm size is small, top management can participate in the team and the joint effort of employer and employees promotes innovation.

Although the roles of top management in the innovation process were recognized, they were not particularly emphasized by the previous studies. The study of connectivity (Tsuji et al. 2016) identified these roles in the context of the information transmission channel, that is, the route of information flow between MNCs and top management who used to work at MNCs. On the other hand, the role of top management in the innovation process in small SMEs is particularly extracted in this chapter. The cross-functional team, training of workers, and QC practices were found to be three major factors prompting innovation in the previous studies. These are also confirmed by this study.

The limitations of this study that are required to be solved in further studies are as follows:

(1) Number of samples: The number of samples related to the informal group is too small to conduct statistical analysis. Further efforts on the survey method for focusing on small SMEs are required.

(2) Estimation method: The estimation method in this chapter aims rather to find factors which make a difference in the innovation process, but more suitable methods are required to test the hypotheses.
(3) Channels as to how factors affect innovation: The identification of how different factors affect innovation is also important; for example, how a cross-functional team dissimulating ideas and experiences affects innovation is not solved yet. This can be examined by the cross term of two variables. What kind of organizational arrangements can elevate employee ability for innovation is a similar kind of problem that needs to be analyzed.
(4) External linkages: This chapter focuses on the internal innovation process and is less concerned with external linkages, which played important role in the previous studies. The introduction of external linkages into the model may yield different results, though the analysis would become much more difficult and complex.

Table 6.10 Estimation result of product innovation

Variables		Type I		Type II		Type III		Type IV	
		Informal R&D	Formal R&D	Informal R&D	Formal R&D	Informal R&D	Formal R&D	Informal R&D	Formal R&D
Technology	ISO9000	0.271	-0.0674	0.478**	-0.0513	0.178	0.316**	0.322	-0.00737
		(0.244)	(0.145)	(0.233)	(0.136)	(0.226)	(0.129)	(0.230)	(0.132)
Human factor	Factory manager	0.206	0.0304	0.289	0.0650	0.134	-0.0274	0.0626	-0.303**
		(0.212)	(0.149)	(0.202)	(0.140)	(0.202)	(0.138)	(0.213)	(0.144)
Leadership of top management	CEO has experiences working for MNCs	-0.220	-0.0181	-0.137	-0.121	0.300	-0.00242	0.308	0.116
		(0.213)	(0.128)	(0.205)	(0.122)	(0.199)	(0.117)	(0.205)	(0.118)
Cross functional team	Cross functional team(Engineering Manufacturing Sale & Marketing)	0.188	0.169**	0.156	0.200***	0.0159	0.110*	0.177	0.0787
		(0.141)	(0.0705)	(0.135)	(0.0666)	(0.129)	(0.0641)	(0.132)	(0.0652)
	R&D personnel have regular meetings to discuss/share their common problems or solutions	0.0615	-0.135	0.286	-0.190	0.304	0.00373	0.334	0.137
		(0.250)	(0.144)	(0.245)	(0.134)	(0.243)	(0.128)	(0.255)	(0.132)
QC	QC	-0.280	0.0164	0.0625	-0.0807	0.312	0.328**	0.424**	0.356**
		(0.210)	(0.151)	(0.203)	(0.144)	(0.203)	(0.138)	(0.211)	(0.146)
	Statistical QC	-0.547**	-0.0572	-0.153	-0.156	0.0204	0.127	-0.164	-0.0971
		(0.270)	(0.163)	(0.249)	(0.153)	(0.251)	(0.144)	(0.264)	(0.148)
	group rewards for suggestion or QC	0.536**	0.320**	0.0439	0.442***	-0.0281	0.131	0.181	0.242*
		(0.245)	(0.148)	(0.236)	(0.141)	(0.232)	(0.134)	(0.238)	(0.137)
Learning process	5S	0.243	0.152	-0.188	0.121	-0.258	-0.00807	-0.261	0.124
		(0.254)	(0.144)	(0.237)	(0.136)	(0.236)	(0.131)	(0.242)	(0.133)
	HRD program for blue-collar workers such as cross-training or job rotation	0.237	-0.122	0.357*	-0.0391	0.447**	-0.0793	0.729***	0.0404
		(0.210)	(0.143)	(0.200)	(0.133)	(0.199)	(0.129)	(0.208)	(0.131)
IT use	IT all	0.253***	0.0745**	0.0772	0.0980***	0.0656	0.0476	-0.0963	0.0425
		(0.0768)	(0.0325)	(0.0684)	(0.0319)	(0.0694)	(0.0301)	(0.0693)	(0.0295)
Observations		207	456	207	456	208	456	207	457
Pseudo R-squared		0.186	0.0949	0.121	0.0825	0.130	0.0823	0.140	0.132
Log likelihood		-179.9	-351.1	-197.3	-388.2	-195.9	-445.9	-180.6	-426.6

Table 6.11 Estimation result of process innovation

VARIABLES		Type I		Type II		Type III		Type IV	
		Informal R&D	Formal R&D	Informal R&D	Formal R&D	Informal R&D	Formal R&D	Informal R&D	Formal R&D
Technology	ISO9000	0.190	0.145	0.287*	0.0270	0.0938	-0.0385	0.210	0.156
		(0.156)	(0.108)	(0.157)	(0.109)	(0.162)	(0.110)	(0.157)	(0.109)
Human factor	Educated personnel in charge of R&D	-0.0851	-0.102	0.108	-0.147	0.00411	-0.0910	0.0480	-0.0748
		(0.185)	(0.106)	(0.185)	(0.107)	(0.194)	(0.108)	(0.185)	(0.107)
	Factory manager	-0.114	-0.0898	-0.0251	0.0318	-0.250*	0.00352	-0.207	-0.165
		(0.138)	(0.117)	(0.138)	(0.117)	(0.146)	(0.118)	(0.140)	(0.116)
	Recruited new production line manager from MNCs last 3 years	0.375	0.305	-0.0616	0.807*	-0.650	-0.0251	-0.249	0.534
		(0.701)	(0.441)	(0.696)	(0.443)	(0.742)	(0.447)	(0.697)	(0.442)
Leadership of top management	CEO studied outside home country	0.271*	0.0286	0.125	-0.0589	-0.00468	0.105	0.00486	0.0742
		(0.155)	(0.122)	(0.155)	(0.123)	(0.161)	(0.125)	(0.156)	(0.122)
	CEO is to was engineer	0.106	0.0280	0.173**	-0.00381	0.194**	0.105**	0.0965	0.0497
		(0.0745)	(0.0445)	(0.0743)	(0.0448)	(0.0762)	(0.0447)	(0.0743)	(0.0442)
	CEO has experiences working for MNCs	-0.0892	0.0122	-0.0215	0.193**	0.0399	0.122	-0.0606	0.0885
		(0.138)	(0.0963)	(0.138)	(0.0971)	(0.142)	(0.0980)	(0.138)	(0.0971)
Cross functional team	Cross functional team(Engineering Manufacturing Sale & Marketing)	-0.0287	0.0493	0.00974	0.0510	0.0936	0.0468	-0.0158	0.0815
		(0.0758)	(0.0524)	(0.0765)	(0.0526)	(0.0780)	(0.0533)	(0.0760)	(0.0528)
QC	QC	0.362***	0.0647	0.372***	0.00228	0.438***	-0.0958	0.244*	-0.0510
		(0.140)	(0.118)	(0.141)	(0.118)	(0.147)	(0.119)	(0.141)	(0.118)
Learning Process	5S	-0.0203	0.0273	0.0660	0.0983	-0.199	0.123	0.238	0.0457
		(0.149)	(0.110)	(0.149)	(0.110)	(0.155)	(0.112)	(0.149)	(0.111)
	Training program for workers	-0.129	-0.00756	-0.265**	0.297***	-0.177	0.242**	0.0240	0.0512
		(0.130)	(0.106)	(0.130)	(0.106)	(0.136)	(0.108)	(0.130)	(0.106)
IT use	Internal IT	0.0732	0.0753	-0.263*	0.276**	0.166	0.181	-0.0388	0.0465
		(0.148)	(0.114)	(0.147)	(0.115)	(0.155)	(0.117)	(0.148)	(0.115)
Observations		382	569	383	570	381	570	383	570
Pseudo R-squared		0.0664	0.0642	0.0532	0.0820	0.0683	0.0663	0.0333	0.0462
Log likelihood		-492.2	-725	-465.1	-690.6	-420	-666.3	-476.7	-698.4

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively.

Table 6.12 Result of ordered probit through types of innovation

Explanatory variables		Informal R&D	Formal R&D	Total
Technology	Q18.1. ISO9000	0.0654*** (0.3215)	0.0723 (0.1354)	-0.0853 (0.1155)
Human factor	Q30.1. Factory manager	(omitted)0	-0.0833 (0.1457)	-0.0970 (0.1199)
Leadership of top management	Q29.8. CEO has experiences working for MNCs	0.0896 (0.2419)	0.0566 (0.1210)	0.0839 (0.1035)
Cross functional team	Q18 Cross functional team (Q18.5. Engineering, Q18.6. Manufacturing, Q18.11. Sale & Marketing)	0.9239 (0.5773)	-0.0682 (0.0658)	-0.0523 (0.0590)
	Q19.5. R&D personnel have regular meetings to discuss/share their common problems or solutions	0.0884** (0.2424)	0.3926*** (0.1389)	0.3229*** (0.1162)
QC	Q19.4. Practicing QC	-0.2956 (0.2980)	0.0688 (0.0469)	0.0614 (0.0388)
	Q22.9. Statistical QC	0.3127* (0.2545)	0.2473 (0.2417)	0.1047** (0.2082)
	Q22.7. Group rewards for suggestion or QC	-0.1569 (0.1715)	0.2241 (0.1580)	0.3100 (0.1333)
Learning process	Q22.1. 5S	0.1686 (0.0856)	-0.2000** (0.0878)	-0.1217 (0.0763)
	Q33. HRD program for blue-collar workers such as cross-training or job rotation	-0.0374 (0.1202)	0.0312 (0.1346)	0.0543 (0.1124)
IT use	Q28 IT all	-0.3700 (0.1461)	-0.0272	-0.0369 (0.0262)

Note: ***, ** and * indicate levels of significance of 1%, 5%, and 10%, respectively.

Chapter 7 Conclusion of this dissertation

The innovation process of SMEs as well as large firms has been analyzing many years and thus various research results have been accumulated as well. Under these circumstances, this dissertation also attempts to study innovation. The reasons are clear, that is, there are still many empty areas for research which previous papers did not fully clarify yet. The characteristics of this dissertation lie in the following points:

(i) The target of research is the innovation as well as R&D process as a whole, in which various factors related to innovation are interrelated complexly and it is quite important to disentangle complex issues and identify which are causes and which are results. In particular, factors for innovation contain technology, managerial organizations, organizational learning, HRD, connectivity with outside organizations such as business partners or universities. However, too many factors in a model make it difficult to obtain clear and reasonable results, and we face dilemma to choose a wider or concise model. The models in this dissertation, in this sense, contain "moderate" number of variables which makes models to be tractable to analyze and therefore we obtain fairly new research results which are not obtained thus far.

(ii) This study is based on the three important research consistencies, namely firstly theoretical analysis based on previous literature, secondary data obtained by field research, surveys, in-depth interviews, and thirdly solid methods of empirical studies such as regressions and SEM. The most useful is field research visiting many SMEs and interviewed with various owners, engineers, marketing personnel, and so on. What we learned from these surveys yield ideas of research and became a basis of models. One of the examples is three categories of innovation or R&D processes discussed in Chapter 2 and 4. During interviews, we believed these three are the types of innovation of SMEs and we could focus on exact key issues.

(iii) The contemporary issues to empirical research are endogeneity and the causality among explanatory variables. There is various software to take care of these issues in estimation. However, it is difficult to employ regression analysis because of these problems. This study makes use of SEM and we could avoid technical issues related to empirical analysis. The models in the chapters identified the causal relationships among variables.

The new results this study achieved are as follows: (i) Even small-sized firms with less than 100 employees have been achieving unique products which were created by the craftsmanship. The firm is too small to own an R&D center, but each craftsman considers himself to be a specialist. They have been elevating their technological level by

collaborating with universities and large firms because of the networks created by their technology. The size of the firm is an important variable to chase innovation, this obstacle can be overcome. (ii) This study obtains the following two findings. One is to identify two channels to transfer new information and resulting so-called gatekeepers. ASEAN SMEs have “transaction channel” and “intellectual channel,” and gatekeepers are top management who own experiences of working MNCs for the latter channel, whereas ingenious workers are for the formers. Another is the two categories of R&D for SMES, namely the formal R&D group and the informal R&D group, and SMEs with informal R&D group can also achieve innovation similar to the formal R&D firms. But their processes of innovation and factors to promote innovation are different. For the formal R&D group cross functional team (Engineering Manufacturing Sale & Marketing) and QC are key variables for product innovation, while the informal R&D group, it is HRD. These results coincide with the results of field research, namely Dynic is the case of the former, while Maeda Precision Manufacturing is the latter.

Finally, it is better to compare results obtain from Japanese SMEs and ASEAN SMEs, since this dissertation contains research in these two areas. First, some differences are found in sources of innovation. Japanese SMEs have higher technological level and are connected various external linkages not only larger firms (transaction channel) but also universities and public research institutes. Even small SMEs like Maeda analyzed in Chapter 2 have ties with various university laboratories and surprisingly university researchers rely of Maeda’s technology. The reasons are clear; Maeda owns specific technologies which other SMEs do not own. Japan has more SMEs with top management-type. SMEs in ASEAN, on the other hand, obtain new information through MNCs; through the transaction channel, not through the intellectual channel. This difference is due to the technological gap between SMEs in two regions.

The analysis has some limitations, which are expected to be overcome in the future research. In particular, the assimilating process inside the firms needs further development. This chapter examines cross-functional team and QC as latent variables, but there must be more ways to conduct R&D activities inside the firm. Policy measures to promote innovation for SMEs are also our target of the future research.

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Appendix to Chapter 3

2007 Innovation survey in small and medium enterprises

Person we should contact if there are any queries regarding the form:

Please write your contact information

Company Name			
Name of Respondent		Title/Position	
E-mail			

I. Profile of Your Establishment

(1)Established year		(2)Asset	
(3) Number of full-time employees (Persons)	1. Under 4persons 2. 4-9 persons 3. 10-19 persons 4. 20-49 persons 5. 50-99 persons 6. Over 100 persons		
(4) Main business activity of your establishment at present	1.construction 2.manufacturing 3.wholesale/retail 4.information and communications 5.traffic 6.other service industry 7.others		
	1. Food, beverages, tobacco 2. Textiles 3. Apparel, leather 4. Footwear 5. Wood, wood products 6. Paper, paper products, printing 7. Chemicals, chemical products 8. Plastic, rubber products 9. Other non-metallic mineral products 10. Iron, steel 11. Non-ferrous metals 12. Metal products 13. Machinery, equipment, tools 14. Computers & computer parts		
(5) What does your establishment mainly produce at present	1. Raw materials 2. Raw material processing 3. Components and parts 4. Final products		
(6) Sales	1. Under 50 million 2. 50-under100 million 3. 100-under300million 4. 300-under 500million 5.500-under 1billion 6. Over 1billion		
(7) Sales change	1.decrease 2. Same 3. increase		
(8) Did your establishment posted profit, loss, or break-even result in your accounting year	1.profit 2. Break-even 3. loss		
(9)R&D cost ratio(%)	R&D cost/ Sales		

II. Business environment

Items	5. Strongly agree	4. Agree	3. Undecided	2. Disagree	1. Strongly disagree
1. Model change is so fast in main product and service	5	4	3	2	1
2. Product manufacturing method and service launch method in main market is so fast to change.	5	4	3	2	1
3. It is difficult to predict change of the sales destination.	5	4	3	2	1
4. It is difficult to predict demand in main product and service.	5	4	3	2	1
5. It is easy to predict competitor's activities.	5	4	3	2	1
6. Our industry is too competitive at present.	5	4	3	2	1
7. There are much investment and business chance in industry at present.	5	4	3	2	1
8. You can control the business environment to be competitive advantage.	5	4	3	2	1
9. It is necessary for us to change marketing method frequently to respond the industry or competitors at present.	5	4	3	2	1
10.It is continuing to decrease main transactions	5	4	3	2	1

2 Select three important factors in your management

1. New product / service development
2. New technology development
3. Pioneering new customers
4. Deepening of existing business partners
5. Collaboration with other companies ·(Collaboration)
6. Collaborative research with universities / public research institutions · Technology transfer
7. Accumulation and utilization of technology and know-how
8. Introduction of management method utilizing consultants etc.
9. Intellectual property rights
10. Sharing information
11. Enhancement of human resource education
12. Utilization of mid-career hires
13. Utilization of IT
14. Introduction of internal venture system
15. Introduction of a performance reward system
16. Delegation of authority
17. QC activity
18. Other ( )

3. Select your Management Strategy at present

1. We are emphasizing expansion and enhancement of existing business.
2. Emphasis is placed on areas that can make full use of experience in technology and R & D.
3. Emphasis is placed on sales experience and areas that make full use of distribution channels.
4. Emphasis is placed on areas that can simultaneously make use of both technical and sales aspects.
5. We focus on growing markets and growth products and emphasize new fields.
6. We do not follow a fixed strategy and respond flexibly each time.
7. Other ( )

III. The strength of your company in a competitive situation

Items	Somewhat stronger	←	Undecided	→	Somewhat weaker
(1) Attractiveness of products and services	5	4	3	2	1
(2) ability to solve problems, ability to propose	5	4	3	2	1
(3) Technological capabilities, R & D capabilities	5	4	3	2	1
(4) Production and manufacturing technology	5	4	3	2	1
(5) Design power	5	4	3	2	1
(6) Market research (information gathering and analysis) ability	5	4	3	2	1

(7) Sales force	5	4	3	2	1
(8) Human resources abilities (including human resource development skills)	5	4	3	2	1
(9) Capital procurement power	5	4	3	2	1
(10) Networking ability with outside	5	4	3	2	1
(11) Organizational capabilities (cohesion and behavior)	5	4	3	2	1
(12) Reliability such as compliance with quality and delivery date	5	4	3	2	1
(13) Cost resilience	5	4	3	2	1
(14) Price determination power of products and services	5	4	3	2	1

IV.Climate and organization that creates innovation

1 Features of your organization (management)

Items	5.Strongly agree	4.Agree	3. Undecided	2. Disagree	1. Strongly disagree
1.pays attention to how well employees work together.	5	4	3	2	1
2. demands that employees follow routine procedures.	5	4	3	2	1
3. checking quality of working severely.	5	4	3	2	1
4. is interested in employees' experience for nurturing.	5	4	3	2	1
5. gives power and responsibility to the offices.	5	4	3	2	1
6. listens to employees' ideas and proposals.	5	4	3	2	1
7. keeps employees informed about management/company policies and developments.	5	4	3	2	1
8. encourages employees to expand their skill set.	5	4	3	2	1
9. promotes competition among employees.	5	4	3	2	1
10. accumulates data on past successes and failures.	5	4	3	2	1
11. encourages employees to take risks and challenge themselves.	5	4	3	2	1
12. takes the leadership role in the planning of new business.	5	4	3	2	1

2. Your basic business direction

Items	5.Strongly agree	4.Agree	3. Undecided	2. Disagree	1. Strongly disagree
1. Actively trying new ideas and methods.	5	4	3	2	1
2. To create new technology rather than skill of existing technology.	5	4	3	2	1
3. We are trying to introduce new products ahead of our competitors.	5	4	3	2	1
4. We spend a lot of budget on R & D expenses.	5	4	3	2	1
5. Promote sales of existing products rather than developing new products.	5	4	3	2	1
6. We believe that environmental changes are more opportunities than threats.	5	4	3	2	1
7. Prior to other companies, new strategic actions are often taken.	5	4	3	2	1
8. Take action in anticipation of the future business environment.	5	4	3	2	1

3. Characteristics of your organization (employee)

Items	5.Strongly agree	4.Agree	3. Undecided	2. Disagree	1. Strongly disagree
1. considers employees' spontaneous learning to be an important factor in company development	5	4	3	2	1
2. makes efforts to analyze the successes and failures of past projects.	5	4	3	2	1
3. always analyzes competitors.	5	4	3	2	1
4. attempts to study not only core technology but also other related types.	5	4	3	2	1
5. are able to act on their own, without orders from the management.	5	4	3	2	1

6. is discussed extensively among employees.	5	4	3	2	1
7. is discussed extensively management.	5	4	3	2	1
8. understands what they should do.	5	4	3	2	1
9. understands the company's direction.	5	4	3	2	1
10. recognizes that the development of new business is important for the future of the company	5	4	3	2	1

V.Innovation occurrence status and achievement

1. Select Innovation Type

1. Upgraded (from mere subcontractor processing industry to intermediate goods producer, intermediate goods producer to final product producer
   From simple work to complicated work)
2. Started production and provision of new products and services
3. We introduced a new production method and method or sales method · provision method (eg introduction of CAD / CAM, introduction of cell production method, Shortening distribution channels, Internet sales, etc.)
4. Developed new sales outlets 5. I got a new supplier
6. We realized a new organization (new department in charge of R & D, in-house venture etc.)
7. I did not do the above

(1) Jan **2005-Sep 2007**

Answer	1	2	3	4	5	6	7

(2) Jan **2002-Dec 2004**

Answer	1	2	3	4	5	6	7

(3) Jan **1999-Dec 2001**

Answer	1	2	3	4	5	6	7

(4) Before **1988**

Answer	1 1	2	3	4	5	6	7

2. Change factors for your company
   1. Cost consciousness of employees
   2. Competitive awareness of employees
   3. Employee's sense of solidarity
   4. Employee skills and skills
   5. Integrity between employees and management
   6. Aggressiveness of employees to work
   7. Management viewpoint of employees
   8. Management awareness of business
   9. Employee's employee
   10. Management speed of decision making
   11. Social credit quality
   12. Management ability to achieve targets
   13. Recognition of importance of know-how / information use
   14. Recognition of importance of IT
   15. Suppliers · Sales Cooperative relationship with the future
   16. Other ( )
   17. Nothing in particular

VI. Effect of ew Business and New Project

1. Cost consciousness of employees
2. Competitive awareness of employees
3. Employee's sense of solidarity
4. Employee skills and skills
5. Integrity between employees and management
6. Aggressiveness of employees to work
7. Management viewpoint of employees
8. Management awareness of business1
9. Employee's employee

10. Management speed of decision making
11. Social credit quality
12. Management ability to achieve targets
13. Recognition of importance of know-how / information use
14. Recognition of importance of IT
15. Suppliers · Sales Cooperative relationship with the future
16. Other ( )
17. Nothing in particular

Appendix to Chapter 4

2012 Innovation activities survey

Person we should contact if there are any queries regarding the form:
Please write your contact information

Company Name			
Name of Respondent		Title/Position	
E-mail			

I. Ask about your company's management behavior and characteristics**.**

(1) Management and Management Policy

(1-1) Which of the following is the top executive age?

1. 20's 2.30's 3.40's 4.50's 5.60's 6.70 years and over

(1-2) Whether management has arrived at the top of management by either:

1. It was established by himself 2. It was handed over from the founder (family) 3. Promoted from within the company (non-cognate) 4. Head hunting from outside 5. Other ( )

(1-3) How many years has passed since management got into top management?

1. Less than 3 years 2. Less than 3 - 5 years 3. Less than 5-10 years 4. Less than 10-20 years 5. Less than 20 - 30 years 6. Over 30 years

(1-4) Is your chief executive coming from the technical department or the administrative department?

1. Technical 2. Administrative

(1-5) Management Behavior

	5. Strongly agree	4. Agree	3. Undecided	2. Disagree	1. Strongly disagree
1.Management seeks for short-run profits,	5	4	3	2	1
2. Management specialized in nich market.	5	4	3	2	1
3. Employees capability is up by job change.	5	4	3	2	1
4. Open management outcome to employees	5	4	3	2	1
5. Propose achievement goal for employees and follow that's outcome to reward.	5	4	3	2	1
6.Management specialized in special technology and product	5	4	3	2	1
7. The top manager voluntarily shows the idea and decides a new business.	5	4	3	2	1
8. The top manager takes leading to do new business.	5	4	3	2	1

(2) Employee Behavior

	5. Strongly agree	4. Agree	3. Undecided	2. Disagree	1. Strongly disagree
1 Employees understand company goals	5	4	3	2	1
2 Employees are proud of their company	5	4	3	2	1
3 Employees do not come up with ideas for business	5	4	3	2	1
4 Employees understand their strengths (core competence and skills)	5	4	3	2	1
5 Employees resist new investments	5	4	3	2	1
6 There is an atmosphere that makes it easy for colleagues to consult about work problems	5	4	3	2	1
7 subordinates reluctant to talk with their boss	5	4	3	2	1
8 Employees are doing their jobs without concern overtime	5	4	3	2	1
9 Employees understand scenes where their own technology and products / parts are used	5	4	3	2	1
10 Even though employees are not directly related to their work, they are helping when others have problems with their work	5	4	3	2	1

(3) The strength of your company in a competitive situation

	Somewhat stronger	←	Undecide	→	Somewhat weaker
1 Power to create new products and new services	**5**	**4**	**3**	**2**	**1**
2 Ability to solve problems of business partners, ability to propose	**5**	**4**	**3**	**2**	**1**
3 Unique technological capabilities as the core and R & D capabilities	5	4	3	2	1
4 Breadth of Knowledge (Knowledge of various industries and fields)	5	4	3	2	1
5 Depth of knowledge (expertise of individual knowledge)	5	4	3	2	1
6 Ability to collect and analyze market information	5	4	3	2	1
7 Diversity of sales partners (transactions with various industry companies)	5	4	3	2	1
8 Ability to disseminate information on own products and services	5	4	3	2	1
9 Power to build a network with outside	5	4	3	2	1
10 Cohesion and behavior as an organization	5	4	3	2	1
11 Ventilation of the organization	5	4	3	2	1
12 Leadership of management	5	4	3	2	1
13 Ability to draw employees' motivation and ability	5	4	3	2	1
14 Employee awareness of duties and capacity building	5	4	3	2	1
15 Expertise and skills possessed by individual employees	5	4	3	2	1
16 Ability to independently manufacture necessary equipment such as machinery	5	4	3	2	1

II. Management Innovation (Initiatives for Innovation)

(1) Presence of product innovation(2005-2010)

1. No 2. Yes

(2) Presence of process innovation

1 No 2.Yes

III. Development of new products / new services of your company

(1) R&D implementation

	5. Strongly agree	4. Agree	3. Undecided	2. Disagree	1. Strongly disagree
1. The ideas of the new product and service often create in the firm.	5	4	3	2	1
2. Basic research and R&D are coordinated.	5	4	3	2	1
3. R&D is directly connected to new product and service.	5	4	3	2	1
4. Offer own technology for other firms positively.	5	4	3	2	1
5.Accept other firm's technological proposal.	5	4	3	2	1
6.Analysis of product and technology data both	5	4	3	2	1
7. Collaboration with alliance firms in common strong domain each other	5	4	3	2	1
8. Concentrated on main business, others are outsourcing.	5	4	3	2	1
9.Target market	5	4	3	2	1
10. Many idea is obtained by customers.	5	4	3	2	1

(2) R&D organizational structure

	5. Strongly agree	4. Agree	3. Undecided	2. Disagree	1. Strongly disagree
1. Decision Making is speedy.	5	4	3	2	1
2. Give responsibility and authority to R&D department	5	4	3	2	1
3. Team members' discussion about the agenda each other freely.	5	4	3	2	1
4 Management also actively participates in the project	5	4	3	2	1
5. Competitive between R&D members	5	4	3	2	1
6. R&D member adopt from internal and external.	5	4	3	2	1
8. New product and service development is discussed beyond the departments.	5	4	3	2	1
9. Allocate budget based on preference position.	5	4	3	2	1
10. R&D incentive and awards system	5	4	3	2	1

IV. Development of new products and services with other companies / organization

When your company to develop new products and services, who is the partner often work together.
1. Suppliers in the region
2. Suppliers outside the region
3. Sales destinations within the region
4. Sales destinations outside the region
5. Peers in the region
6. Companies outside the region
7. Parent companies and subsidiaries
8. Introduction companies from intermediary companies
9. Colleges in the region
10. Universities outside the region
11. Regional public research institutions
12. Regional economic organizations (Chamber of Commerce and Industry Etc.)
13. Other ( )

V. Management issue
1. Sluggish demand
2. Intensified competition
3. Yen appreciation
4. Responding to customer needs
5. Aging and updating facilities
6. Equipment excessive
7. Increase in raw materials and parts prices
8. Burden of office factory rental fees
9. Excessive debt Interest rate burden
10. Difficulties in borrowing business funds
11. Difficulty in securing employees
12. Improvement of employee's ability
13. Lack of successors
14. Lack of skill succession
15. Overseas relocation of suppliers
16. Overseas relocation of sales parties
17. Impact of the earthquake
18. Bankruptcy of major customers
19. Other ( )

VI. Your company's overview

(1) Established year		**(2)** Asset	
(3) Number of employees	Full time( ) Part time ( ) 【Number of hired midway in the last three years is all】**( )** 【Number of foreign nationals who have a master's degree or higher degree】 **( )**		
(4) Industrial	**1.** Manufacturing **2.** information and communications 3. service 4.other**s** **( )**		
(5) main sales partner	1.manifacuring 2.other business branch 3.consumer 4.other ( )		

(6) sales in 2010		(7) salesin2005（5years ago）	
(8)sales-profit in 2010		(9)sales-profit in 2005 （5years ago）	
(10)number of parents		(11)number of patents for 5years	
(12) R&D expense ratio(%)	R&D expense/ Sales		
(13)chang in R&D expense in this 3years	1. decrease 2. same 3. increase		
(14)new product and new service/sales in 2010	（ ） % in 2010		

Appendix to Chapter 5

ERIA 2013 Establishment Survey in Area, Country

Person we should contact if there are any queries regarding the form:

Please write your contact information

Company Name			
Address			
Name of Respondent		Title/Position	
Tel		E-mail	
Website			

ERIA 2013 Establishment Survey in Area, Country

A: Profile of Your Establishment

Q1. When, how and where was your establishment founded and location of your establishment at present

Q1.1. When was your company established in your Country?		Year:
Q1.2. Did your establishment spin-off from a multinational firm?		1.☐ Yes 2.☐ No
Q1.3. Location of your establishment?	1. Province	
	2. City/Municipality	
	3. Industrial park	
Q1.4. Is your establishment state-owned?	1.☐ Yes	2.☐ Formerly state-owned 3.☐ No

Q2. What is the type of your establishment? (Please tick ONE appropriate box)

1.☐ Headquarters/Main office 2.☐ Regional Headquarters 3.☐ Factory/Plant 4.☐ Branch Office/Sales Office

Q2.1. Are the following functions are undertaken by your establishment or by your parent firm? Please tick an appropriate box?

	1. Only by yourself	2. Mainly by yourself	3. Mainly by parent firm	4. Only by parent firm
Q2.1.1.Product development	1.☐	2.☐	3.☐	4.☐
Q2.1.2.Process development	1.☐	2.☐	3.☐	4.☐
Q2.1.3.Supplier selection	1.☐	2.☐	3.☐	4.☐
Q2.1.4.Capital investment	1.☐	2.☐	3.☐	4.☐

Q3. Capital structure of your establishment at present?

Q3.1. What is the capital structure of your establishment at present? (Please tick ONE appropriate box)

1.☐ 100% Locally-owned (→**Go to Q4**) 2.☐ 100% Foreign-owned (MNC) 3. ☐ Joint Venture (JV, Locally and Foreign-owned)

Q3.2. If your establishment is 100% Foreign-owned or Joint Venture, what are nationalities of the major FOREIGN investors? (Please mark (X) or tick ALL appropriate boxes)

1.☐ Indonesian 2.☐ Filipino 3.☐ Thai 4.☐ Vietnamese 5.☐ Malaysian 6.☐ Singaporean 7.☐ Chinese
8.☐ Japanese 9.☐ South Korean 10.☐ Taiwanese 11.☐ American 12.☐ European 13.☐ Other, specify: _____

Q4. Size of your establishment at present (Please tick ONE appropriate box)

Q4.1. Number of full-time employees (Persons)			**Q4.2.** Total Assets (US$)		
1.☐ 1-19 persons	5.☐ 200-299	9.☐ 1,000-1,499	1.☐ Less than 10,000	5.☐ 75,000-99,999	9.☐ 5 mil.-9.9 mil.
2.☐ 20-49	6.☐ 300-399	10.☐ 1,500-1,999	2.☐ 10,000-24,999	6.☐ 100,000-499,999	10.☐ 10 million and
3.☐ 50-99	7.☐ 400-499	11.☐ 2,000 and	3.☐ 25,000-49,999	7.☐ 500,000-999,999	above
4.☐ 100-199	8.☐ 500-999	above	4.☐ 50,000-74,999	8.☐ 1 million-4.9 mil.	

Q5. Main business activity of your establishment at present? (Please tick ONE appropriate box)

1.☐ Food, beverages, tobacco	8.☐ Plastic, rubber products	15.☐ Other electronics & components
2.☐ Textiles	9.☐ Other non-metallic mineral products	16.☐ Precision instruments
3.☐ Apparel, leather	10.☐ Iron, steel	17.☐ Automobile, auto parts
4.☐ Footwear	11.☐ Non-ferrous metals	18.☐ Other transportation equipments
5.☐ Wood, wood products	12.☐ Metal products	and parts
6.☐ Paper, paper products, printing	13.☐ Machinery, equipment, tools	19.☐ Handicraft
7.☐ Chemicals, chemical products	14.☐ Computers & computer parts	20.☐ Other, specify: _____

Q6. What does your establishment mainly produce at present? (Please tick ONE of the most appropriate boxes)

1.☐ Raw materials 2.☐ Raw material processing 3.☐ Components and parts 4.☐ Final products

Q7. What functions are carried out by your establishment at present?

1.☐ Procurement of raw materials, parts	2.☐ Logistics/Distribution	3.☐ IT system development/maintenance
4.☐ After-sales services	5.☐ Marketing, sales promotion	6.☐ Others, specify: _____

Q8. Is your establishment an OEM (Original Equipment Manufacturer), manufacturing products under your buyer's brand name?	1.☐ Yes 2.☐ No
Q9. Does your establishment manufacture products according to your own design or drawings?	1.☐ Yes 2.☐ No

Q10. Average product life cycle in your industry: How often are new products released? (Please tick ONE appropriate box)

1.☐ Custom-made	2.☐ Every 6 months or less	3.☐ Every 7-11 months	4.☐ Every 1-2 years
5.☐ Every 3-4 years	6.☐ Every 5-6 years	7.☐ Every 7 years or more	

Q11. Annual Changes in Business performance at present (Please tick ONE appropriate box)

Q11.1. Sales	1.☐ Substantial Increase	2.☐ increase	3.☐ almost same	4.☐ decrease	5. ☐ Substantial decrease
Q11.2. Profit	1.☐ Substantial Increase	2.☐ increase	3.☐ almost same	4.☐ decrease	5. ☐ Substantial decrease
Q11.3. Export value	1.☐ Substantial Increase	2.☐ increase	3.☐ almost same	4.☐ decrease	5. ☐ Substantial decrease
Q11.4. Production cost	1.☐ Substantial Increase	2.☐ increase	3.☐ almost same	4.☐ decrease	5. ☐ Substantial decrease
Q11.5. Labor productivity	1.☐ Substantial Increase	2.☐ increase	3.☐ almost same	4.☐ decrease	5. ☐ Substantial decrease
Q11.6. Number of buyers	1.☐ Substantial Increase	2.☐ increase	3.☐ almost same	4.☐ decrease	5. ☐ Substantial decrease

Q11.7. Did your establishment posted profit, loss, or break-even result in your accounting year 2011 and 2012?	**In 2011**	1.☐ Profit 2.☐ Break-even 3.☐ Loss
	In 2012	1.☐ Profit 2.☐ Break-even 3.☐ Loss

Q12.Has your establishment increased or decreased the number of buyers/suppliers in the last two years (2012-13)?

Q12.1. Change in the number of buyers in 2012-2013	1.☐ Increased 2.☐ Same 3.☐ Decreased
Q12.2. Change in the number of supplier in 2012-2013	1.☐ Increased 2.☐ Same 3.☐ Decreased

B: Achievements for Upgrading and Innovation

Q13. Have you tried to introduce a new product in the last 2 years (2012-13)?		1.☐ Yes (→Q13.1) 2.☐ No (→Q14)
Q13.1. Introduced a new product, redesigning packaging or significantly changing appearance design of your existing products		1.☐ Achieved 2.☐ Tried 3.☐ not tried yet
Q13.2. Introduced a new product, significantly improving your existing products with respect to its capabilities, user friendliness, components, subsystems, etc.		1.☐ Achieved 2.☐ Tried 3.☐ not tried yet
Q13.3. Development of a totally new product based on the "existing" technologies for your establishment		1.☐ Achieved 2.☐ Tried 3.☐ not tried yet
Q13.4. Development of a totally new product based on "new" technologies for your establishment		1.☐ Achieved 2.☐ Tried 3.☐ not tried yet
Q13.5. To which market was the new product shipped (if introduced)?	1. Existing market where your establishment is operating	1.☐ Yes 2.☐ No
	2. New market to your establishment	1.☐ Yes 2.☐ No
Q13.6. Which is the main target market of the new product		1.☐ Domestic 2.☐ Other ASEAN 3.☐ East Asia 4.☐ Europe or US 5.☐ Others
Q13.7. Degree of innovativeness of your new products: **Have you achieved a breakthrough product innovation?** (Please tick ONE appropriate box)		1.☐ Strongly disagree 2.☐ Disagree 3.☐ Undecided 4.☐ Agree 5.☐ Strongly agree
Q13.8. Who developed these new products? (Please tick ALL appropriate boxes)		1.☐ Your establishment by itself 2.☐ Your establishment's group (head office, subsidiaries, etc.) 3.☐ Your establishment with corporate buyers 4.☐ Your establishment with suppliers

	5.☐ Adapted/modified goods originally invented by other firms

Q14.Intellectual property right (Please tick ONE appropriate boxes)

Q14.1. Does your establishment hold an intellectual property right (patent, utility model, trade mark)?	1.☐ Yes 2.☐ No
Q14.2. Did you obtain an intellectual property right in the last 2 years (2012-2013)?	1.☐ Yes 2.☐ No

Q15. Has your establishment reduced the followings in the last 2 years (2012-2013)?

Q15.1. Decreased production of defective products	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.2. Decreased shipping of defective products	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.3. Reduced raw materials and energy usage	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.4. Reduced labor input (man-hour)	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.5. Reduced lead time to introduce a new product	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.6. Reduced unscheduled line stop	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.7. Reduced worker's injuries or plant accidents	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.8. Reduced delivery delay	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.9. Reduced prices of your main products	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.10. Reduced variation in product quality.	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.11. Reduced time to changeover(converting production line)	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much

Q16. Have you adopted new or significantly improved methods for the following managements in 2012-2013?

Q16.1. Production	1.☐ Achieved 2.☐ Tried 3.☐ not tried yet
Q16.2. Procurement, outsourcing	1.☐ Achieved 2.☐ Tried 3.☐ not tried yet
Q16.3. Business process re-engineering	1.☐ Achieved 2.☐ Tried 3.☐ not tried yet
Q16.4. Sales promotion	1.☐ Achieved 2.☐ Tried 3.☐ not tried yet
Q16.5. Sales management	1.☐ Achieved 2.☐ Tried 3.☐ not tried yet
Q16.6. Inventory control	1.☐ Achieved 2.☐ Tried 3.☐ not tried yet
Q16.7. Logistics	1.☐ Achieved 2.☐ Tried 3.☐ not tried yet
Q16.8. Accounting	1.☐ Achieved 2.☐ Tried 3.☐ not tried yet

Q17 Has your establishment adopted the following international standard? If YES, when did your establishment adopt it?

Q17.1. ISO 9000 series (ISO 9000/9001)	1.☐ Yes → Year:	2.☐ Not adopted yet
Q17.2. ISO 14000 series (ISO 14000/14001)	1.☐ Yes → Year:	2.☐ Not adopted yet

Q18. Requirement for Adoption of ISO9000/9001 and/or 14000/ 14001. (Please tick ONE appropriate box)

Q18.1. Do your business customers/buyers require your establishment to adopt ISO?	1.☐Only ISO9000/9001 2.☐Only ISO14000/14001 3.☐Both 4.☐None
Q18.2. Does your establishment require your suppliers to adopt ISO?	1.☐Only ISO9000/9001 2.☐Only ISO14000/14001 3.☐Both 4.☐None

C: Internal Source of Information and Activities for Upgrading and Innovation

Q19. Does your establish carry out R&D activities? (Please tick ONE appropriate box)

Q19.1. The ratio between R&D expenditure and sales at present?	0.☐ No Expenditure 1.☐ Less than 0.5% 2.☐ 0.5-0.99% 3.☐ 1% and more

Q19.2. When did your establishment start R&D activities?	0.☐ Not yet 1.☐ before 1990 2.☐ 1990-94 3.☐ 1995-99 4.☐ 2000-04 5.☐ 2005-9 6.☐ 2010-13

Q20. What are your funding sources for product/process improvements? (Please tick ALL appropriate boxes)

1.☐ Personal savings of top management	2.☐ Family	3.☐ Friends
4.☐ Private bank (collateralized loan)	5.☐ Private bank (uncollateralized loan)	6.☐ Public bank
7.☐ Non-bank financial institutions	8.☐ Local authority (loan, subsidies)	9.☐ Retained earnings
10.☐ Parent firm, group firm	11.☐ Business customer/Buyer	12.☐ Supplier
13.☐ Trading firm	14.☐ Personal investor (including Angel)	15.☐ Others, specify: _____

Q20.1. Does your establishment utilize a public loan or credit guarantee program?	1.☐ Yes 2.☐ No
Q20.2. Does your establishment utilize a preferential tax treatment?	1.☐ Yes 2.☐ No

Q21. Cross-Functional Team for Introduction of New Product or Process: Which departments are involved in a cross-functional team that your establishment organizes to introduce a new product or process? (Please tick ALL appropriate boxes)

1.☐ No team	4.☐ Development	7.☐ Quality Control	10.☐ Human Resources	13.☐ IT System
2.☐ Market Research	5.☐ Production Engineering	8.☐ Procurement	11.☐ Sales & Marketing	14.☐ Others, specify:
3.☐ Research	6.☐ Manufacturing	9.☐ Accounting	12.☐ Logistics/Distribution	_____

Q22. Quality Control (QC)

Q22.1. Has your establishment adopted so called 3S or 5S (Seiri, Seiton, Seisou, Seiketsu, Shitsuke)?	1.☐ Yes 2.☐ No
Q22.2. Does your establishment operate a QC circle	1.☐ Yes 2.☐ No
Q22.3. Does your establishment have a system/practice to disseminate successful experiences of a QC circle group across your establishment?	1.☐ Yes 2.☐ No
Q22.4. Does your establishment have a system/practice to learn from successful experiences of a QC circle group of your customer/supplier?	1.☐ Yes 2.☐ No
Q22.5. Does your establishment have a system/practice to share successful experiences of a QC circle group of your establishment with your customer/supplier?	1.☐ Yes 2.☐ No
Q22.6. Does your establishment have employee suggestion programs for improvements?	1.☐ Yes 2.☐ No
Q22.7. Does your establishment provide groups of employees with rewards for suggestions/QC circle activities?	1.☐ Yes 2.☐ No
Q22.8. Does your establishment provide individual employees with rewards for suggestions/QC circle activities?	1.☐ Yes 2.☐ No

D: External Sources of New Technologies and Information for Upgrading and Innovation

Q23. Does the external source important for upgrading/innovation? (Please tick ONE appropriate box)

External source of technologies and information	0. Not Practicing	1. Not important	2. Not very important	3. Somewhat important	4. Very important
Q23.1. Final Consumer	☐	☐	☐	☐	☐
Q23.2. Competitor	☐	☐	☐	☐	☐
Q23.3. Buyer or trading company	☐	☐	☐	☐	☐
Q23.4. Consultant	☐	☐	☐	☐	☐
Q23.5. Local customer (100% local capital)	☐	☐	☐	☐	☐
Q23.6. Local supplier	☐	☐	☐	☐	☐
Q23.7. MNC (100% non-local capital)/Joint Venture (JV) customer located in your country	☐	☐	☐	☐	☐
Q23.8. MNC/JV supplier located in your country	☐	☐	☐	☐	☐
Q23.9. MNC/JV customer located in a foreign country	☐	☐	☐	☐	☐
Q23.10. MNC/JV supplier located in a foreign country	☐	☐	☐	☐	☐
Q23.11. Public organization (government, public agency, public financial institution)	☐	☐	☐	☐	☐
Q23.12. Local business organization	☐	☐	☐	☐	☐

Q23.13. University or Public Research Institute	☐ ☐ ☐ ☐ ☐

Q24. Interactions with engineers of your production partners (Customer and/or Supplier) (Please tick ONE appropriate box).

Q24.1. Does your establishment accept resident/guest engineers from your supplier?	1.☐ Yes 2.☐ No
Q24.2. Does your establishment dispatch resident/guest engineers to your supplier?	1.☐ Yes 2.☐ No
Q24.3. Does your establishment accept resident/guest engineers from your corporate customer?	1.☐ Yes 2.☐ No
Q24.4. Does your establishment dispatch resident/guest engineers to your corporate customer?	1.☐ Yes 2.☐ No

Q25. Licensing and technology transfer

Q25.1. Were you granted a license to patented inventions from other parties in the last 2 year (2012-2013) ?	1.☐ Yes 2.☐ No
Q25.2. Were you granted a license to non-patented inventions or know-how from other parties in the last 2 year (2012-2013)?	1.☐ Yes 2.☐ No
Q25.3. Have your patented/non-patented technologies ever been leaked through your former employees?	1.☐ Yes 2.☐ No
Q25.4. Have your patented/non-patented technologies ever been leaked through your corporate buyers?	1.☐ Yes 2.☐ No
Q25.5. Have your patented/non-patented technologies ever been leaked through your suppliers?	1.☐ Yes 2.☐ No
Q25.6. Have your scientists or engineers ever been headhunted by your competitors?	1.☐ Yes 2.☐ No
Q25.7. Have you had illegal/unauthorized access to your information system?	1.☐ Yes 2.☐ No

E. Capital Goods

Q26. Investments in capital goods

Q26.1. Has your establishment made capital investments for the following purposes in the last 2 years (2012-2013)? **(Please tick ALL of the appropriate boxes., If no investment →Q26.2)**	1.☐ Production of new goods/services 2.☐ Expanding production capacity 3.☐ Replacing production facilities
Q26.2. Has your establishment made investments in the following capital goods in the last 2 years (2012-2013)? **(Please tick ALL of the appropriate boxes., If no investment →Q26.3)**	1.☐ Modified existing capital goods 2.☐ Introduced new capital goods 3.☐ Increased degree of automation of production process 4.☐ Equipment or system for monitoring production lines 5.☐ R&D facilities 6.☐ Testing facilities/laboratories 7.☐ Logistics
Q26.3. Have you been given tax incentives for capital investments in the last two years (2012-13)?	1.☐ Yes 2.☐ No
Q26.4. Have you obtained public loans/credit guarantee for capital investments in last two years (2012-13)?	1.☐ Yes 2.☐ No

F. Information Technology (IT) and Management

Q27.1. The ratio between IT expenditure and sales at present?	0.☐ No Expenditure	1.☐ Less than 0.5%		
	2.☐ 0.5-0.99%	3.☐ 1% and more		
Q27.2. When did your establishment start investing in IT?	0.☐ Not yet	1.☐ before 1990	2.☐ 1990-94	3.☐ 1995-99
	4.☐ 2000-04	5.☐ 2005-9	6.☐ 2010-13	

Q27.3. Has your established introduced the following IT systems? (Please tick ALL of the appropriate boxes, if none→Q28)

1.☐ Business-to-Business Electronic commerce (B2B E-commerce)	2.☐ Business to Consumer (B2C) E-commerce
3.☐ Electronic Data Interchange (EDI)	4.☐ Supply Chain Management (SCM)
5.☐ Enterprise Resources Planning (ERP)	6.☐ Customer Relationship Management (CRM)
7.☐ Computer Aided Design (CAD)/ Computer Aided Manufacturing (CAM)	8.☐ Groupware
9.☐ Intra-Social Networking Services (SNS)	10.☐ Public SNS

Q28. Human resources for IT system management:

Q28.1. Does your establishment have a chief information officer (CIO)?	1.☐ Yes 2.☐ No
Q28.2. Does your establishment hire an IT consultant?	1.☐ Yes 2.☐ No
Q28.3. Does your establishment give your employees IT-related training?	1.☐ Yes 2.☐ No

Q29. Does your establishment share information on success/failure of your establishment/other firms? (Please tick ALL appropriate boxes. If "None/No sharing", please go to Q30.)

1.☐ Success of your establishment 2.☐ Failure of your establishment 3.☐ Success of other firms 4.☐ Failure of other firms

G: Human Resources Management for Upgrading and Innovation

Q30. Backgrounds of your establishment's top management (CEO) (Please tick ONE appropriate box)

Q30.1. Country origin of the top management	1.☐ Local 2.☐ Foreign country (Specify: _____)
Q30.2. Age of your establishment's top management	1.☐20s 2.☐30s 3.☐40s 4.☐50s 5.☐ 60s 6.☐70s or over
Q30.3. How many years does your top management serve as the current position?	1.☐ 1 year or less 2.☐ 2-3 years 3.☐ 4-6 years 4.☐ 7-9 years 5.☐ 10-12 years 6.☐ 13-15 years 7.☐ 16 years or more
Q30.4. What is the educational record of your top management?	1.☐ Bachelor 2.☐ Master 3.☐ Ph.D. 4.☐ Other
Q30.5. Did your top study outside his/her home country?	1.☐ Yes (→Q30.5.1.) 2.☐ No (→Q30.6.)
Q30.5.1. Where did your establishment's top management study?	1.☐ Australia 2.☐ Singapore 3.☐ Malaysia 4.☐ China 5.☐ Japan 6.☐ United States 7.☐ Europe 8.☐ Other, specify: _____
Q30.6. Was or Is the top management an engineer?	1.☐ Yes 2.☐ No
Q30.7. How did the top management get promoted to the present position?	1.☐ Succession of family's business 2.☐ Founder 3.☐ Spin-off or headhunted from a multinational, joint venture or local large firm 4.☐ Dispatched by headquarter/ mother company 5.☐ Internal promotion
Q30.8. How long does your top management work for your firm?	1.☐ 1 year or less 2.☐ 2-3 years 3.☐ 4-6 years 4.☐ 7-9 years 5.☐ 10-12 years 6.☐ 13-15 years 5.☐ 16-25 years 6.☐ 26-35 years 7.☐ 35 years or more
Q30.9. What particular functions have the top management performed in your firm? (Please tick ALL appropriate boxes. If none→Q30.10)	1.☐ Planning 2.☐ Financing/Accounting 3.☐ Sales/Marketing 4.☐ R&D 5.☐ Procurement 6.☐ Quality Control 7.☐ Production 8.☐ Personnel affairs 9.☐ Legal
Q30.10. Does the top management have experiences working for MNCs/Joint Ventures (JVs)?	1.☐ Yes (→Q30.10.1-Q30.10.3) 2.☐ No(→Q31)
Q30.10.1. What are nationalities of the MNCs/JVs your top management worked for? (Please mark (X) or tick ALL appropriate boxes)	1.☐ Indonesian 2.☐ Filipino 3.☐ Thai 4.☐ Vietnamese 5.☐ Malaysian 6.☐ Singaporean 7.☐ Chinese 8.☐ Hong Kong 9.☐ South Korean 10.☐ Japanese 11.☐ Taiwanese 12.☐ American 13.☐ European 14.☐ Other: Specify _____
Q30.10.2. How long did the top management work for the MNCs/JVs?	1.☐ 1-4 years 2.☐ 5-9 yrs 3.☐ 10-14 yrs 4.☐ 15yrs and over
Q30.10.3. What were major functions which the top management performed in the MNCs/JVs? (Please tick ALL appropriate boxes. If none→Q31)	1.☐ Planning 2.☐ Financing/Accounting 3.☐ Sales/Marketing 4.☐ R&D 5.☐ Procurement 6.☐ Quality Control 7.☐ Production 8.☐ Personnel affairs 9.☐ Legal

Q31-Q34. Employees (Please tick ONE appropriate box)

Q31. Background of establishment's factory manager

Q31.1. Does your establishment have a factory manager?	1.☐ Yes (→Q31.2-Q31.3.1) 2.☐ No(→Q32)
Q31.2. Country origin of the factory manager	1.☐ Local 2.☐ Foreign country (Specify: _____)
Q31.3. Does the factory manager have experiences working for MNCs/Joint Ventures (JVs)?	1.☐ Yes (→Q31.3.1) 2.☐ No(→Q32)
Q31.3.1. What are nationalities of the MNCs/JVs in which your factory manager worked for? (Please mark (X) or tick ALL appropriate boxes)	1.☐ Indonesian 2.☐ Filipino 3.☐ Thai 4.☐ Vietnamese 5.☐ Malaysian 6.☐ Singaporean 7.☐ Chinese 8.☐ Hong Kong 9.☐ South Korean 10.☐ Japanese 11.☐ Taiwanese 12.☐ American 13.☐ European 14.☐ Other: Specify _____

Q32. How many percent of engineers/line managers/managers are indigenous (local people)?

Q32.1. Engineers	0.☐ 0-19%	1.☐ 20-39%	2.☐ 40-59%	3.☐ 60-79%	4.☐ 80-99%	5.☐ 100%
Q32.2. Line managers, or leader class	0.☐ 0-19%	1.☐ 20-39%	2.☐ 40-59%	3.☐ 60-79%	4.☐ 80-99%	5.☐ 100%
Q32.3. Managers	0.☐ 0-19%	1.☐ 20-39%	2.☐ 40-59%	3.☐ 60-79%	4.☐ 80-99%	5.☐ 100%

Q33. Do you have a training program for blue-collar workers to upgrade specialized skills?	1.☐ Yes 2.☐ No
Q34. Do you have a HRD program for blue-collar workers to provide cross-training/job rotation?	1.☐ Yes 2.☐ No

H: (Q35) Self-assessment of Your Establishment's Capability (Please tick ONE appropriate box)

Note: 1=Strongly Disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strong agree	1=Strongly Disagree	2=Disagree	3=Undecided	4=Agree	5=Strong agree
Q35.1. Your establishment has a capability to identify and acquire externally generated knowledge that is crucial to your operation?	1.☐	2.☐	3.☐	4.☐	5.☐

Q35.2. Your establishment has a capability, or routines and processes, to analyze, process, interpret, and understand externally generated knowledge obtained from external sources.	1.☐ 2.☐ 3.☐ 4.☐ 5.☐
Q35.3. Your establishment has a capability to develop and refine the routines that facilitate combining its existing internally-available knowledge and the externally generated knowledge.	1.☐ 2.☐ 3.☐ 4.☐ 5.☐
Q35.4. Your establishment has a capability to incorporate the externally generated knowledge into your operation, new products, processes or new organizational forms.	1.☐ 2.☐ 3.☐ 4.☐ 5.☐

I: (Q36) Corporate Social Responsibility (CSR) for Product Safety (e.g. chemical substances, medicines, fertilizer in products or processes) and Environmental Sustainability

Q36.1. Does your establishment assess and ensure the safety of inputs purchased from suppliers?	1.☐ Yes 2.☐ No
Q36.2. Does your establishment assess and ensure the safety of your products?	1.☐ Yes 2.☐ No
Q36.3. Does your establishment keep record of inputs quality, inspection results by item?	1.☐ Yes 2.☐ No
Q36.4. Do you keep updated information about regulations related to the safety of your products?	1.☐ Yes 2.☐ No
Q36.5. Do you provide your suppliers with technical assistances to ensure the safety of inputs?	1.☐ Yes 2.☐ No
Q36.6. Do you provide your suppliers with raw materials or other inputs to ensure the product safety?	1.☐ Yes 2.☐ No
Q36.7. Do you conduct audit at your supplier's site to ensure the safety of your products?	1.☐ Yes 2.☐ No
Q36.8. Have your products been rejected by your corporate customers/buyers because of their product safety-related requirements in the last two years (2012-2013)?	1.☐ Yes 2.☐ No
Q36.9. Have your establishment rejected products delivered from your suppliers because of your product safety-related requirements in the last two years (2012-2013)?	1.☐ Yes 2.☐ No
Q36.10. Does your establishment have a CSR procurement policy or guidelines?	1.☐ Yes 2.☐ No
Q36.11. Does your establishment have a green procurement policy or standards?	1.☐ Yes 2.☐ No

Q36.12. How important for your establishment is product safety?	3.☐ Very Important	2.☐ Moderately important	1.☐ Unimportant
Q36.13. How important for your establishment to procure materials from suppliers who respect environmental preservation?	3.☐ Very Important	2.☐ Moderately important	1.☐ Unimportant

J: (Q37) Supply Chain Risk Management and Business Continuity Planning (BCP)

Q37.1. Has your establishment developed a plan to enable the rapid recovery, restoration and continuation of your operations under adverse conditions such as damage to critical infrastructure (machines, IT systems, etc.), accident and disaster happened in "your site"?	1.☐ Yes 2.☐ No
Q37.2. Has your establishment developed a plan to enable the rapid recovery, restoration and continuation of your operations under adverse conditions happened in "your supplier's site"?	1.☐ Yes 2.☐ No

K: Business Linkages with Main Corporate Customer and Supplier at Present

Q38. Profiles of your most important customer/supplier & business linkages with them (Please tick ONE appropriate box)

	Most important customer (c)	**Most important supplier (s)**
Q38.1. How important the corporate customer/supplier is? (% of total sales/purchase)	1.☐ 10% or less 4.☐ 31-40% 2.☐ 11-20% 5.☐ 41-50% 3.☐ 21-30% 6.☐ 51-100%	1.☐ 10% or less 4.☐ 31-40% 2.☐ 11-20% 5.☐ 41-50% 3.☐ 21-30% 6.☐ 51-100%
Q38.2. Does your establishment sell/buy customized or standard products	1.☐ Customized 2.☐ Standard	1.☐ Customized 2.☐ Standard
Q38.3. What is the capital structure of the corporate customer/suppler?	1.☐ 100% locally owned 2.☐ 100% foreign owned 3.☐ Joint Venture	1.☐ 100% locally owned 2.☐ 100% foreign owned 3.☐ Joint Venture
Q38.4. Does your establishment have a capital tie-up with the corporate customer/supplier?	1.☐ Yes (With capital tie-up) 0.☐ No (Without capital tie-up)	1.☐ Yes (With capital tie-up) 0.☐ No (Without capital tie-up)
Q38.5. Duration of the relationship with the corporate customer/supplier	1.☐ Less than 3 months 2.☐ 3-6 months 3.☐ 7months- less than 1 year 4.☐ 1-3 years 5.☐ 4-6 years 6.☐ 7-9 years 7.☐ 10 years or more	1.☐ Less than 3 months 2.☐ 3-6 months 3.☐ 7months- less than 1 year 4.☐ 1-3 years 5.☐ 4-6 years 6.☐ 7-9 years 7.☐ 10 years or more
Q38.6. Employment size of the corporate customer/supplier	1.☐ 99 or less employees 2.☐ 100- 199 employees 3.☐ 200- 299 employees 4.☐ 300 to 999 employees 5.☐ 1000 and above	1.☐ 99 or less employees 2.☐ 100- 199 employees 3.☐ 200- 299 employees 4.☐ 300 to 999 employees 5.☐ 1000 and above

Q38.7. Function carried out by the corporate customer/supplier	1.☐ Production (raw materials) 2.☐ Raw material processing 3.☐ Production (components/parts) 4.☐ Production (final products) 5.☐ Others	1.☐ Production (raw materials) 2.☐ Raw material processing 3.☐ Production (components/parts) 4.☐ Production (final products) 5.☐ Others
Q38.8. Please indicate distance (kilo meter) from your establishment to the corporate customer/supplier.	1.☐ 0- 10 km 2.☐ 11- 25 3.☐ 26- 50 4.☐ 51-100 5.☐ 101-200 6.☐ 201-300 7.☐ 301-400 8.☐ 401-500 9.☐ 501- 1,000 10.☐ 1,001-2,000 11.☐ 2,001 or more	1.☐ 0- 10 km 2.☐ 11- 25 3.☐ 26- 50 4.☐ 51-100 5.☐ 101-200 6.☐ 201-300 7.☐ 301-400 8.☐ 401-500 9.☐ 501- 1,000 10.☐ 1,001-2,000 11.☐ 2,001 or more
Q38.9. Please indicate frequency of shipping/receiving cargo	1.☐ A few times in a day 2.☐ Once a day 3.☐ A few times in a week 4.☐ Once a week 5.☐ Once a month 6.☐ Sporadic	1.☐ A few times in a day 2.☐ Once a day 3.☐ A few times in a week 4.☐ Once a week 5.☐ Once a month 6.☐ Sporadic
Q38.10. Does your establishment require the customer/supplier to adopt ISO9000/14000?	1.☐ only ISO9000 2.☐ only ISO14000 3.☐ Both 4.☐ No	1.☐ only ISO9000 2.☐ only ISO14000 3.☐ Both 4.☐ No
Q38.11. Does the customer/supplier require your establishment to adopt ISO9000/14000?	1.☐ only ISO9000 2.☐ only ISO14000 3.☐ Both 4.☐ No	1.☐ only ISO9000 2.☐ only ISO14000 3.☐ Both 4.☐ No
Q38.12. Does your establishment dispatch an engineer to the corporate customer/supplier?	1.☐ Yes (→Q38.12.1) 2.☐ No (→Q38.13)	1.☐ Yes (→Q38.12.1) 2.☐ No (→Q38.13)
Q38.12.1. How long totally in a year does the engineer of your establishment stay in the corporate customer/supplier?	1.☐1 day 2.☐1 week or less 3.☐1 month or less 4.☐2-3 months 5.☐4-6 months 6.☐7-12 months	1.☐1 day 2.☐1 week or less 3.☐1 month or less 4.☐2-3 months 5.☐4-6 months 6.☐7-12 months
Q38.13. Does the corporate customer/supplier dispatch an engineer to your establishment?	1.☐ Yes (→Q38.13.1) 2.☐ No (→Q38.14)	1.☐ Yes (→Q38.13.1) 2.☐ No (→Q38.14)
Q38.13.1. How long totally in a year does an engineer of the corporate customer/supplier stay in your establishment?	1.☐1 day 2.☐1 week or less 3.☐1 month or less 4.☐2-3 months 5.☐4-6 months 6.☐7-12 months	1.☐1 day 2.☐1 week or less 3.☐1 month or less 4.☐2-3 months 5.☐4-6 months 6.☐7-12 months
Q38.14. Do you provide any training to the main corporate customer/supplier?	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No
Q38.15. Do you receive any training from the main corporate customer/supplier?	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No
Q38.16. Have you agreed with the main customer/supplier to conduct a supplier audit?	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No
Q38.17. Do you design a new product with the main corporate customer/supplier?	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No
Q38.18. Does the main corporate customer/supplier conduct R&D?	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No
Q38.19. Has the main corporate customer/supplier granted to you a license to use their patented or non-patented inventions?	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No
	Most important customer (c)	**Most important supplier (s)**

Q38.20. Have you granted the main corporate customer/supplier a license to use your patented or non-patented inventions?	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No
Q38.21. Do you interchange purchase orders (PO) with the customer/supplier via the Internet?	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No
Q38.22. What kind of information does your establishment share with your main corporate customer/supplier?	1.☐ Production plan 2.☐ Procurement forecast 3.☐ Inventory 4.☐ Shipping schedule 5.☐ Kamban or its equivalent for just-in-time delivery 6.☐ Product development 7.☐ Schedule of new product release 8.☐ Chemical substances in products/production process	1.☐ Production plan 2.☐ Procurement forecast 3.☐ Inventory 4.☐ Shipping schedule 5.☐ Kamban or its equivalent for just-in-time delivery 6.☐ Product development 7.☐ Schedule of new product release 8.☐ Chemical substances in products/production process
Q38.23. Does your main customer/supplier assess or ensure the safety of inputs purchased from their suppliers? (e.g. chemical substances in inputs)	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No
Q38.24. Does your main customer/supplier assess or ensure the safety of their products? (e.g. chemical substances in products)	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No
Q38.25. Does your main customer/supplier have a green procurement policy?	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No
Q38.26. Does your main customer/supplier have a CSR procurement policy?	1.☐ Yes 2.☐ No	1.☐ Yes 2.☐ No
(NOTE: Location of the customer/supplier)	(to be answered in Q41)	(to be answered Q44)

L. Geographical Distribution of Production Networks (Please refer to the country/region ID codes below to answer Q39-46).

ID	Country/Region	ID	Country/Region	ID	Country/Region
1.	Indonesia	8.	Malaysia	15.	South Korea
2.	Philippines	9.	Cambodia	16.	Taiwan
3.	Thailand	10.	Lao PDR	17.	India
4.	Vietnam (Greater Hanoi)	11.	Myanmar	18.	Australia or New Zealand
5.	Vietnam (Greater Ho Chi Minh)	12.	China (Mainland)	19.	United States
6.	Vietnam (Central/other regions)	13.	Hong Kong	20.	Europe
7.	Singapore	14.	Japan	21.	Rest of the World

Q39. Do you have affiliates in the countries/regions above? (Please tick ALL appropriate boxes. If not, please go to Q40)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q40. Which are the THREE (3) most important markets of your products? (Please tick up to THREE appropriate boxes)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q41. Where is the most important corporate customer (in Q38) located? (Please tick ONE appropriate box)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q42. If you have secured new corporate customers in the last 2 years (2012-13), where are they located? Please tick ALL appropriate boxes below. If Not, please go to Q43.

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q43. Which are the THREE (3) most important sources of your inputs? (Please tick up to THREE appropriate boxes)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q44. Where is the most important supplier (in Q38) located? (Please tick ONE of the appropriate boxes)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q45. If you have secured new suppliers in the last 2 years (2012-13), where are they located? Please tick ALL of the appropriate boxes below. If Not, please go to Q46.

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q46. Has your establishment "ever" been rejected imports of your shipment by customs authorizes in the regions/countries listed below? (Please tick ALL of the appropriate boxes)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q47. How important for your establishment are intra-firm transactions? (Please tick up ONE appropriate box)

Q47.1. Procurement of inputs from parent or group firms	0.☐0%	1.☐1-24%	2.☐25-49%	3.☐50-74%	4.☐75-99% 5.☐100%
Q47.2. Shipment of products to parent or group firms	0.☐0%	1.☐1-24%	2.☐25-49%	3.☐50-74%	4.☐75-99% 5.☐100%

Appendix to Chapter 6

ERIA FY2014 (2014-2015) Establishment Survey in Area, Country

Person we should contact if there are any queries regarding the form:

Please write your contact information

Company Name			
Address			
Name of Respondent		Title/Position	
Tel		E-mail	
Website			

FY2014 (2014-2015) Establishment Survey in Area, Country

A: Profile of Your Establishment

Q1. When, how and where was your establishment founded and location of your establishment at present

Q1.1. When was your company established in your country?		Year:
Q1.2. Did your establishment spin-off from a multinational firm?		1.☐ Yes 0.☐ No
Q1.3. Location of your establishment?	1. Province	
	2. City/Municipality	
	3. Industrial park	
Q1.4. Is your establishment state-owned?	1.☐ Yes 2.☐ Formerly state-owned 0.☐ No	

Q2. What is the type of your establishment? (Please tick ONE appropriate box)

1.☐ Headquarters/Main office 2.☐ Regional Headquarters 3.☐ Factory/Plant 4.☐ Branch Office/Sales Office

Q2.1. Are the following functions undertaken by your establishment? Please tick all appropriate box.

1.☐ Product development 2.☐ Process development 3.☐ Supplier selection 4.☐ Capital investment

Q3. Capital structure of your establishment at present?

Q3.1. What is the capital structure of your establishment at present? (Please tick ONE appropriate box)

1.☐ 100% Locally-owned (→**Go to Q4**) 2.☐ 100% Foreign-owned (MNC) 3. ☐ Joint Venture (JV, Locally and Foreign-owned)

Q3.2. If your establishment is 100% Foreign-owned or Joint Venture, what are nationalities of the major FOREIGN investors? (Please mark (X) or tick ALL appropriate boxes)

1.☐ Indonesian 2.☐ Filipino 3.☐ Thai 4.☐ Vietnamese 5.☐ Malaysian 6.☐ Singaporean 7.☐ Chinese
8.☐ Japanese 9.☐ South Korean 10.☐ Taiwanese 11.☐ American 12.☐ European 13.☐ Other, specify: _____

Q4. Size of your establishment at present (Please tick ONE appropriate box)

Q4.1. Number of full-time employees (Persons)			**Q4.2.** Total Assets (US$)		
1.☐ 1-19 persons	5.☐ 200-299	9.☐ 1,000-1,499	1.☐ Less than 10,000	5.☐ 75,000-99,999	9.☐ 5 mil.-9.9 mil.
2.☐ 20-49	6.☐ 300-399	10.☐ 1,500-1,999	2.☐ 10,000-24,999	6.☐ 100,000-499,999	10.☐ 10 million and above
3.☐ 50-99	7.☐ 400-499	11.☐ 2,000 and above	3.☐ 25,000-49,999	7.☐ 500,000-999,999	
4.☐ 100-199	8.☐ 500-999		4.☐ 50,000-74,999	8.☐ 1 million-4.9 mil.	

Q5. Main business activity of your establishment at present? (Please tick ONE appropriate box)

1.☐ Food, beverages, tobacco	8.☐ Plastic, rubber products	15.☐ Other electronics & components
2.☐ Textiles	9.☐ Other non-metallic mineral products	16.☐ Precision instruments
3.☐ Apparel, leather	10.☐ Iron, steel	17.☐ Automobile, auto parts
4.☐ Footwear	11.☐ Non-ferrous metals	18.☐ Other transportation equipments and parts
5.☐ Wood, wood products	12.☐ Metal products	
6.☐ Paper, paper products, printing	13.☐ Machinery, equipment, tools	19.☐ Handicraft
7.☐ Chemicals, chemical products	14.☐ Computers & computer parts	20.☐ Other, specify: _____

Q6. What does your establishment mainly produce at present? (Please tick ONE of the most appropriate boxes)

1.☐ Raw materials 2.☐ Raw material processing 3.☐ Components and parts 4.☐ Final products

Q7. What functions are carried out by your establishment at present?

1.☐ Procurement of raw materials, parts 2.☐ Logistics/Distribution 3.☐ IT system development/maintenance
4.☐ After-sales services 5.☐ Marketing, sales promotion 6.☐ Others, specify: _____

Q8. Is your establishment an OEM that produces products under your customer's brand name?	1.☐ Yes 0.☐ No
Q9. Does your establishment manufacture products according to your own design or drawings?	1.☐ Yes 0.☐ No

Q10. Average product life cycle in your industry: How often are new products released? (Please tick ONE appropriate box)

1.☐ Custom-made 2.☐ Every 6 months or less 3.☐ Every 7-11 months 4.☐ Every 1-2 years
5.☐ Every 3-4 years 6.☐ Every 5-6 years 7.☐ Every 7 years or more

Q11. Annual Changes in Business performance at present (Please tick ONE appropriate box)

Q11.1. Sales	1.☐ Substantial Increase	2.☐ increase	3.☐ almost same	4.☐ decrease	5.☐ Substantial decrease
Q11.2. Profits	1.☐ Substantial Increase	2.☐ increase	3.☐ almost same	4.☐ decrease	5.☐ Substantial decrease
Q11.3. Export value	1.☐ Substantial Increase	2.☐ increase	3.☐ almost same	4.☐ decrease	5.☐ Substantial decrease
Q11.4. Production cost	1.☐ Substantial Increase	2.☐ increase	3.☐ almost same	4.☐ decrease	5.☐ Substantial decrease
Q11.5. Labor productivity	1.☐ Substantial Increase	2.☐ increase	3.☐ almost same	4.☐ decrease	5.☐ Substantial decrease

Q11.6. Did your establishment posted profit, loss, or break-even result in your accounting year 2012 (**Q11.6.1)** and 2013 (**Q11.6.2)**?	**In 2012**	1.☐ Profit 2.☐ Break-even 3.☐ Loss
	In 2013	1.☐ Profit 2.☐ Break-even 3.☐ Loss

Q12.Has your establishment increased or decreased the number of customers/suppliers in the last two years (2013-14)?

Q12.1. Number of customers	1.☐ Substantial Increase	2.☐ increase	3.☐ same	4.☐ decrease	5.☐ Substantial decrease
Q12.2. Number of suppliers	1.☐ Substantial Increase	2.☐ increase	3.☐ same	4.☐ decrease	5.☐ Substantial decrease

B: Achievements for Upgrading and Innovation

Q13. Have you tried to introduce a new product in the last 2 years (2013-14)?	1.☐ Yes (→Q13.1) 0.☐ No (→Q14)
Q13.1. Introduced a new product, redesigning packaging or significantly changing appearance design of your existing products	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet
Q13.2. Introduced a new product, significantly improving your existing products with respect to its capabilities, user friendliness, components, subsystems, etc.	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet
Q13.3. Development of a totally new product based on the "existing" technologies for your establishment	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet
Q13.4. Development of a totally new product based on "new" technologies for your establishment	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet

Q13.5. To which market was the new product shipped (if introduced)?	1. Existing market where your establishment is operating	1.☐ Yes	0.☐ No
	2. New market to your establishment	1.☐ Yes	0.☐ No

Q13.6. Which is the main target market of the new product	1.☐ Domestic 2.☐ Other ASEAN 3.☐ East Asia 4.☐ Europe or US 5.☐ Others
Q13.7. Who developed these new products? (Please tick ALL appropriate boxes)	1.☐ Your establishment by itself 2.☐ Your establishment's group (head office, subsidiaries, etc.) 3.☐ Your establishment with corporate customers 4.☐ Your establishment with suppliers 5.☐ Adapted/modified goods originally invented by other firms

Q14.Intellectual property right (Please tick ONE appropriate boxes)

Q14.1. Does your establishment hold an intellectual property right (patent, utility model, trade mark)?	1.☐ Yes 0.☐ No
Q14.2. Did you obtain an intellectual property right in the last 2 years (2013-2014)?	1.☐ Yes 0.☐ No

Q15. Has your establishment reduced the followings in the last 2 years (2013-2014)?

Q15.1. Decreased production of defective products	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.2. Decreased shipping of defective products	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.3. Reduced raw materials and energy usage	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.4. Reduced labor input (man-hour)	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.5. Reduced lead time to introduce a new product	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.6. Reduced unscheduled line stop	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.7. Reduced worker's injuries or plant accidents	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.8. Reduced delivery delay	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.9. Reduced prices of your main products	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.10. Reduced variation in product quality.	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much
Q15.11. Reduced time to changeover (converting production line)	0.☐ No	1.☐ Little 2.☐ Somewhat 3.☐ much

Q16. Have you adopted new or significantly improved methods for the following managements in 2013-2014?

Q16.1. Production	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet
Q16.2. Procurement, outsourcing	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet
Q16.3. Business process re-engineering	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet
Q16.4. Sales promotion	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet
Q16.5. Sales management	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet
Q16.6. Inventory control	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet
Q16.7. Logistics	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet
Q16.8. Accounting	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet
Q16.9. IT system	1.☐ Achieved 2.☐ Tried 0.☐ not tried yet

Q17 Has your establishment adopted the following international standard? If YES, when did your establishment adopt it?

Q17.1. ISO 9000 series (ISO 9000/9001)	1.☐ Yes → Year:	0.☐ Not adopted yet
Q17.2. ISO 14000 series (ISO 14000/14001)	1.☐ Yes → Year:	0.☐ Not adopted yet

Q18. Requirement for Adoption of ISO9000/9001 and/or 14000/ 14001. (Please tick ONE appropriate box)

Q18.1. Do your business customers require your establishment to adopt ISO?	1.☐Only ISO9000/9001 2.☐Only ISO14000/14001 3.☐Both 4.☐None
Q18.2. Does your establishment require your suppliers to adopt ISO?	1.☐Only ISO9000/9001 2.☐Only ISO14000/14001 3.☐Both 4.☐None

C: Internal Source of Information and Activities for Upgrading and Innovation

Q19. Does your establish carry out R&D activities? (Please tick ONE appropriate box)

Q19.1. The ratio between R&D expenditure and sales at present?	0.☐ No Expenditure 2.☐ 0.5-0.99%	1.☐ Less than 0.5% 3.☐ 1% and more
Q19.2. When did your establishment start R&D activities?	0.☐ Not yet 1.☐ before 1990 2.☐ 1990-94 3.☐ 1995-99 4.☐ 2000-04 5.☐ 2005-9 6.☐ 2010-14	
Q19.3. Does your establishment develop personnel in charge of R&D at present?		1.☐ Yes 0.☐ No
Q19.4. Does your establishment conduct small group activities among R&D personnel?		1.☐ Yes 0.☐ No
Q19.5. Do your R&D personnel have regular meetings to discuss/share their common problems or solutions?		1.☐ Yes 0.☐ No

Q20. What are your funding sources for product/process improvements? (Please tick ALL appropriate boxes)

1.☐ Personal savings of top management	2.☐ Family	3.☐ Friends
4.☐ Private bank (collateralized loan)	5.☐ Private bank (uncollateralized loan)	6.☐ Public bank
7.☐ Non-bank financial institutions	8.☐ Local authority (loan, subsidies)	9.☐ Retained earnings
10.☐ Parent firm, group firm	11.☐ Corporate customer	12.☐ Supplier
13.☐ Trading firm	14.☐ Personal investor (including Angel)	15.☐ Others, specify: _____

Q20.1. Does your establishment utilize a public loan or credit guarantee program?	1.☐ Yes	0.☐ No
Q20.2. Does your establishment utilize a preferential tax treatment?	1.☐ Yes	0.☐ No

Q21. Cross-functional team for introduction of new product or process: Which departments are involved in a cross-functional team that your establishment organizes to introduce a new product or process? (Please tick ALL appropriate boxes)

1.☐ No team	4.☐ Development	7.☐ Quality Control	10.☐ Human Resources	13.☐ IT System
2.☐ Market Research	5.☐ Production Engineering	8.☐ Procurement	11.☐ Sales & Marketing	14.☐ Others, specify:
3.☐ Research	6.☐ Manufacturing	9.☐ Accounting	12.☐ Logistics/Distribution	_____

Q22. Quality Control (QC)

Q22.1. Has your establishment adopted so called 3S or 5S (Seiri, Seiton, Seisou, Seiketsu, Shitsuke)?	1.☐ Yes	0.☐ No
Q22.2. Does your establishment operate a QC circle	1.☐ Yes	0.☐ No
Q22.3. Does your establishment have a system/practice to disseminate successful experiences of a QC circle group across your establishment?	1.☐ Yes	0.☐ No
Q22.4. Does your establishment have a system/practice to learn from successful experiences of a QC circle group of your customer/supplier?	1.☐ Yes	0.☐ No
Q22.5. Does your establishment have a system/practice to share successful experiences of a QC circle group of your establishment with your customer/supplier?	1.☐ Yes	0.☐ No
Q22.6. Does your establishment have employee suggestion programs for improvements?	1.☐ Yes	0.☐ No
Q22.7. Does your establishment provide groups of employees with rewards for suggestions/QC activities?	1.☐ Yes	0.☐ No
Q22.8. Does your establishment provide individual employees with rewards for suggestions/QC activities?	1.☐ Yes	0.☐ No
Q22.9. Has your establishment adopted statistical quality control?	1.☐ Yes	0.☐ No

D: External Sources of New Technologies and Information for Upgrading and Innovation

Q23. Does the external source important for upgrading/innovation? (Please tick ONE appropriate box)

External source of technologies and information	0. Not Practicing	1. Not important	2. Not very important	3. Somewhat important	4. Very important
Q23.1. Final consumer	☐	☐	☐	☐	☐
Q23.2. Competitor	☐	☐	☐	☐	☐
Q23.3. Trading company	☐	☐	☐	☐	☐
Q23.4. Consultant	☐	☐	☐	☐	☐
Q23.5. Local customer (100% local capital)	☐	☐	☐	☐	☐
Q23.6. Local supplier	☐	☐	☐	☐	☐
Q23.7. MNC (100% non-local capital)/Joint Venture (JV) customer located in your country	☐	☐	☐	☐	☐
Q23.8. MNC/JV supplier located in your country	☐	☐	☐	☐	☐
Q23.9. MNC/JV customer located in a foreign country	☐	☐	☐	☐	☐
Q23.10. MNC/JV supplier located in a foreign country	☐	☐	☐	☐	☐
Q23.11. Public organization (government, public agency, public financial institution)	☐	☐	☐	☐	☐
Q23.12. Local business organization	☐	☐	☐	☐	☐
Q23.13. University or public research institute	☐	☐	☐	☐	☐

Q24. Interactions with engineers of your production partners (Customer and/or Supplier) (Please tick ONE appropriate box).

Q24.1. Does your establishment accept resident/guest engineers from your supplier?	1.☐ Yes	0.☐ No
Q24.2. Does your establishment dispatch resident/guest engineers to your supplier?	1.☐ Yes	0.☐ No
Q24.3. Does your establishment accept resident/guest engineers from your corporate customer?	1.☐ Yes	0.☐ No
Q24.4. Does your establishment dispatch resident/guest engineers to your corporate customer?	1.☐ Yes	0.☐ No
Q24.5. Does your establishment have research meetings with other firms?	1.☐ Yes	0.☐ No

Q25. Has your establishment formed business alliances for the following purposes? (Please tick ALL appropriate boxes).

Q25.1. Technical tie-up with	1.☐ local firm	2.☐ domestic MNC	3.☐ foreign MNC	0.☐ None
Q25.2. Sales cooperation with	1.☐ local firm	2.☐ domestic MNC	3.☐ foreign MNC	0.☐ None
Q25.3. Joint purchasing with	1.☐ local firm	2.☐ domestic MNC	3.☐ foreign MNC	0.☐ None
Q25.4. Establishment of a joint venture with	1.☐ local firm	2.☐ domestic MNC	3.☐ foreign MNC	0.☐ None
Q25.5. Acceptance of R&D personnel/engineers/manager from	1.☐ local firm	2.☐ domestic MNC	3.☐ foreign MNC	0.☐ None
Q25.6. Dispatch of R&D personnel/engineers/manager to	1.☐ local firm	2.☐ domestic MNC	3.☐ foreign MNC	0.☐ None
Q25.7. Acceptance of top management from	1.☐ local firm	2.☐ domestic MNC	3.☐ foreign MNC	0.☐ None
Q25.8. Dispatch of top management to	1.☐ local firm	2.☐ domestic MNC	3.☐ foreign MNC	0.☐ None
Q25.9. M&A to obtain	1.☐ local firm	2.☐ domestic MNC	3.☐ foreign MNC	0.☐ None

Q26. Licensing and technology transfer

Q26.1. Were you granted a license to patented inventions from other parties in the last 2 year (2013-2014)?	1.☐ Yes 0.☐ No
Q26.2. Were you granted a license to non-patented inventions or know-how from other parties in the last 2 year (2013-2014)?	1.☐ Yes 0.☐ No

E. (Q27) Investments in Equipment for Technology Upgrading

Q27.1. Has your establishment purchased equipment for the following purposes in the last 2 years (2013-2014)? **(Please tick ALL of the appropriate boxes. If no investment →Q27.2)**	1.☐ Production of new goods/services 2.☐ Expanding production capacity 3.☐ Replacing production facilities 4.☐ Modified existing capital goods 5.☐ R&D facilities and/or testing facilities/laboratories
Q27.2. Have you been given tax incentives for purchasing equipment in the last two years (2013-14)?	1.☐ Yes 0.☐ No
Q27.3. Have you obtained public loans/credit guarantee for purchasing equipment in last two years (2013-14)?	1.☐ Yes 0.☐ No

F. (Q28) Information Technology (IT) and Management

Q28.1. The ratio between IT expenditure and sales at present?	0.☐ No Expenditure	1.☐ Less than 0.5%
	2.☐ 0.5-0.99%	3.☐ 1% and more

Q28.2. Has your established introduced the following IT systems? (Please tick ALL of the appropriate boxes, if none→Q29)

1.☐ Business-to-Business Electronic commerce (B2B E-commerce)	2.☐ Business to Consumer (B2C) E-commerce
3.☐ Electronic Data Interchange (EDI)	4.☐ Supply Chain Management (SCM)
5.☐ Enterprise Resources Planning (ERP)	6.☐ Customer Relationship Management (CRM)
7.☐ Computer Aided Design (CAD)/ Computer Aided Manufacturing (CAM)	8.☐ Groupware
9.☐ Intra-Social Networking Services (SNS)	10.☐ Public SNS

G: Human Resources and Human Resource Development (HRD) for Upgrading and Innovation

Q29. Backgrounds of your establishment's top management (CEO) (Please tick ONE appropriate box)

Q29.1. Country origin of the top management	1.☐ Local 2.☐ Foreign country (Specify: _____)
Q29.2. Age of your establishment's top management	1.☐20s 2.☐30s 3.☐40s 4.☐50s 5.☐ 60s 6.☐70s or over
Q29.3. How many years does your top management serve as the current position?	1.☐ 1 year or less 2.☐ 2-3 years 3.☐ 4-6 years 4.☐ 7-9 years 5.☐ 10-12 years 6.☐ 13-15 years 7.☐ 16 years or more
Q29.4. What is the educational record of your top management?	1.☐ Bachelor 2.☐ Master 3.☐ Ph.D. 4.☐ Other
Q29.5. Did your top study outside his/her home country?	1.☐ Yes 0.☐ No
Q29.6. Was or Is the top management an engineer?	1.☐ Yes 0.☐ No
Q29.7. How did the top management get promoted to the present position?	1.☐ Succession of family's business 2.☐ Founder 3.☐ Spin-off or headhunted from a multinational, joint venture or local large firm 4.☐ Dispatched by headquarter/ mother company 5.☐ Internal promotion
Q29.8. Does the top management have experiences working for MNCs/Joint Ventures (JVs)?	1.☐ Yes (→Q29.8.1-Q29.8.2) 0.☐ No(→Q30)
Q29.8.1. How long did the top management work for the MNCs/JVs?	1.☐ 1-4 years 2.☐ 5-9 yrs 3.☐ 10-14 yrs 4.☐ 15yrs and over
Q29.8.2. What were major functions which the top management performed in the MNCs/JVs? (Please tick ALL appropriate boxes. If none→Q30)	1.☐ Planning 2.☐ Financing/Accounting 3.☐ Sales/Marketing 4.☐ R&D 5.☐ Procurement 6.☐ Quality Control 7.☐ Production 8.☐ Personnel affairs 9.☐ Legal

Q30-Q35. Employees (Please tick ONE appropriate box)

Q30. Background of establishment's factory manager

Q30.1. Does your establishment have a factory manager?	1.☐ Yes (→Q30.2-Q30.3) 0.☐ No(→Q31)
Q30.2. Country origin of the factory manager	1.☐ Local 2.☐ Foreign country (Specify: _____)
Q30.3. Does the factory manager have experiences working for MNCs/Joint Ventures (JVs)?	1.☐ Yes 0.☐ No

Q31. How many percent of engineers/line managers/ are indigenous (local people)?

Q31.1. Engineers	0.☐ 0-19%	1.☐ 20-39%	2.☐ 40-59%	3.☐ 60-79%	4.☐ 80-99%	5.☐ 100%
Q31.2. Line managers, or leader class	0.☐ 0-19%	1.☐ 20-39%	2.☐ 40-59%	3.☐ 60-79%	4.☐ 80-99%	5.☐ 100%
Q31.3. Managers	0.☐ 0-19%	1.☐ 20-39%	2.☐ 40-59%	3.☐ 60-79%	4.☐ 80-99%	5.☐ 100%

Q32. Do you have a training program for workers to upgrade reading, writing, and calculating?	1.☐ Yes 0.☐ No
Q33. Do you have a HRD program for blue-collar workers to provide cross-training/job rotation?	1.☐ Yes 0.☐ No
Q34. Have you recruited a new production line manager from MNCs or JVs last three years?	1.☐ Yes 0.☐ No
Q35. Have you recruited a new accounting manager from MNCs or JVs last three years?	1.☐ Yes 0.☐ No

H: (Q36) Corporate Social Responsibility (CSR) and Environmental Sustainability

Q36.1. Does your establishment have a CSR procurement policy or guidelines?	1.☐ Yes 0.☐ No
Q36.2. Does your establishment have a green procurement policy or standards?	1.☐ Yes 0.☐ No

I: Business Linkages with Main Corporate Customer and Supplier at Present

Q37. Profiles of your most important customer/supplier & business linkages with them (Please tick ONE appropriate box)

Please answer Q38, considering one customer and one supplier that are the most important for your business.

	Most important customer (c)	**Most important supplier (s)**
Q37.1. How important the corporate customer/supplier is? (% of total sales/purchase)	1.☐ 10% or less 4.☐ 31-40% 2.☐ 11-20% 5.☐ 41-50% 3.☐ 21-30% 6.☐ 51-100%	1.☐ 10% or less 4.☐ 31-40% 2.☐ 11-20% 5.☐ 41-50% 3.☐ 21-30% 6.☐ 51-100%
Q37.2. Does your establishment sell/buy customized or standard products	1.☐ Customized 2.☐ Standard	1.☐ Customized 2.☐ Standard
Q37.3. What is the capital structure of the corporate customer/suppler?	1.☐ 100% locally private owned 2.☐ 100% foreign owned 3.☐ Joint Venture 4.☐ (Formerly) State-owned	1.☐ 100% locally private owned 2.☐ 100% foreign owned 3.☐ Joint Venture 4.☐ (Formerly) State-owned
Q37.4. Does your establishment have a capital tie-up with the corporate customer/supplier?	1.☐ Yes (With capital tie-up) 0.☐ No (Without capital tie-up)	1.☐ Yes (With capital tie-up) 0.☐ No (Without capital tie-up)
Q37.5. Duration of the relationship with the corporate customer/supplier	1.☐ Less than 3 months 2.☐ 3-6 months 3.☐ 7months- less than 1 year 4.☐ 1-3 years 5.☐ 4-6 years 6.☐ 7-9 years 7.☐ 10 years or more	1.☐ Less than 3 months 2.☐ 3-6 months 3.☐ 7months- less than 1 year 4.☐ 1-3 years 5.☐ 4-6 years 6.☐ 7-9 years 7.☐ 10 years or more
Q37.6. Employment size of the corporate customer/supplier	1.☐ 99 or less employees 2.☐ 100- 199 employees 3.☐ 200- 299 employees 4.☐ 300 to 999 employees 5.☐ 1000 and above	1.☐ 99 or less employees 2.☐ 100- 199 employees 3.☐ 200- 299 employees 4.☐ 300 to 999 employees 5.☐ 1000 and above
Q37.7. Main function carried out by the corporate customer/supplier **(Please tick all appropriate boxes)**	1.☐ Production (raw materials) 2.☐ Raw material processing 3.☐ Production (components/parts) 4.☐ Production (final products) 5.☐ Trading 6.☐ Others	1.☐ Production (raw materials) 2.☐ Raw material processing 3.☐ Production (components/parts) 4.☐ Production (final products) 5.☐ Trading 6.☐ Others
Q37.8. Please indicate distance (kilo meter) from your establishment to the corporate customer/supplier.	1.☐ 0- 10 km 7.☐ 301-400 2.☐ 11- 25 8.☐ 401-500 3.☐ 26- 50 9.☐ 501- 1,000 4.☐ 51-100 10.☐ 1,001-2,000 5.☐ 101-200 11.☐ 2,001 or 6.☐ 201-300 more	1.☐ 0- 10 km 7.☐ 301-400 2.☐ 11- 25 8.☐ 401-500 3.☐ 26- 50 9.☐ 501- 1,000 4.☐ 51-100 10.☐ 1,001-2,000 5.☐ 101-200 11.☐ 2,001 or 6.☐ 201-300 more
Q37.9. Please indicate frequency of shipping/receiving cargo	1.☐ A few times in a day 2.☐ Once a day 3.☐ A few times in a week 4.☐ Once a week 5.☐ Once a month 6.☐ Sporadic	1.☐ A few times in a day 2.☐ Once a day 3.☐ A few times in a week 4.☐ Once a week 5.☐ Once a month 6.☐ Sporadic
Q37.10. Does your establishment require the customer/supplier to adopt ISO9000/14000?	1.☐ only ISO9000 3.☐ Both 2.☐ only ISO14000 0.☐ No	1.☐ only ISO9000 3.☐ Both 2.☐ only ISO14000 0.☐ No
Q37.11. Does the customer/supplier require your establishment to adopt ISO9000/14000?	1.☐ only ISO9000 3.☐ Both 2.☐ only ISO14000 0.☐ No	1.☐ only ISO9000 3.☐ Both 2.☐ only ISO14000 0.☐ No
Q37.12. Does your establishment dispatch personnel to the corporate customer/supplier?	1.☐ Yes (→Q37.12.1) 0.☐ No (→Q37.13)	1.☐ Yes (→Q37.12.1) 0.☐ No (→Q37.13)
Q37.12.1. Expertise of the personnel **(Please tick all appropriate boxes)**	1.☐ Quality control 2.☐ Cost control 3.☐ Delivery, inventory control 4.☐ R&D 5.☐ Planning 6.☐ Others	1.☐ Quality control 2.☐ Cost control 3.☐ Delivery, inventory control 4.☐ R&D 5.☐ Planning 6.☐ Others
Q37.13. Does the corporate customer/supplier dispatch personnel to your establishment?	1.☐ Yes (→Q37.13.1) 0.☐ No (→Q37.14)	1.☐ Yes (→Q37.13.1) 0.☐ No (→Q37.14)
Q37.13.1. Expertise of the personnel **(Please tick all appropriate boxes)**	1.☐ Quality control 2.☐ Cost control 3.☐ Delivery, inventory control 4.☐ R&D 5.☐ Planning 6.☐ Others	1.☐ Quality control 2.☐ Cost control 3.☐ Delivery, inventory control 4.☐ R&D 5.☐ Planning 6.☐ Others
Q37.14. Do you provide any training to the main corporate customer/supplier?	1.☐ Yes 0.☐ No	1.☐ Yes 0.☐ No
Q37.15. Do you receive any training from the main corporate customer/supplier?	1.☐ Yes 0.☐ No	1.☐ Yes 0.☐ No

	Most important customer (c)		Most important supplier (s)	
Q37.16. Do you dispatch your top managerial class to the main corporate customer/supplier?	1.☐ Yes	0.☐ No	1.☐ Yes	0.☐ No
Q37.17. Do you receive top managerial class from the main corporate customer /supplier?	1.☐ Yes	0.☐ No	1.☐ Yes	0.☐ No
Q37.18. Do you design a new product with the main corporate customer/supplier?	1.☐ Yes	0.☐ No	1.☐ Yes	0.☐ No
Q37.19. Does the main corporate customer/supplier conduct R&D?	1.☐ Yes	0.☐ No	1.☐ Yes	0.☐ No
Q37.20. Has the main corporate customer/supplier granted to you a license to use their patented or non-patented inventions?	1.☐ Yes	0.☐ No	1.☐ Yes	0.☐ No
Q37.21. Have you granted the main corporate customer/supplier a license to use your patented or non-patented inventions?	1.☐ Yes	0.☐ No	1.☐ Yes	0.☐ No
Q37.22. Does your establishment have research meetings with customer/supplier firms?	1.☐ Yes	0.☐ No	1.☐ Yes	0.☐ No
Q37.23. Does your main customer/supplier have a green procurement policy?	1.☐ Yes	0.☐ No	1.☐ Yes	0.☐ No
Q37.24. Does your main customer/supplier have a CSR procurement policy?	1.☐ Yes	0.☐ No	1.☐ Yes	0.☐ No
Q37.25. How long does it take from your establishment to your main customer/supplier by the transportation mode that your employees normally use to meet your customer or supplier? **(Please specify average trip time)**	[ ] hours		[ ] hours	
(NOTE: Location of the customer/supplier)	(to be answered in Q40)		(to be answered Q43)	

L. Geographical Distribution of Production Networks (Please refer to the country/region ID codes below to answer Q38-45).

ID	Country/Region	ID	Country/Region	ID	Country/Region
1.	Indonesia	8.	Malaysia	15.	South Korea
2.	Philippines	9.	Cambodia	16.	Taiwan
3.	Thailand	10.	Lao PDR	17.	India
4.	Vietnam (Greater Hanoi)	11.	Myanmar	18.	Australia or New Zealand
5.	Vietnam (Greater Ho Chi Minh)	12.	China (Mainland)	19.	United States
6.	Vietnam (Central/other regions)	13.	Hong Kong	20.	Europe
7.	Singapore	14.	Japan	21.	Rest of the World

Q38. Do you have affiliates in the countries/regions above? (Please tick ALL appropriate boxes. If not, please go to Q39)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q39. Which are the THREE (3) most important markets of your products? (Please tick up to THREE appropriate boxes)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q40. Where is the most important corporate customer (in Q37) located? (Please tick ONE appropriate box)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q41. If you have secured new corporate customers in the last 2 years (2013-14), where are they located? Please tick ALL appropriate boxes below. If Not, please go to Q42.

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q42. Which are the THREE (3) most important sources of your inputs? (Please tick up to THREE appropriate boxes)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q43. Where is the most important supplier (in Q37) located? (Please tick ONE of the appropriate boxes)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q44. If you have secured new suppliers in the last 2 years (2013-14), where are they located? Please tick ALL of the appropriate boxes below. If Not, please go to Q45.

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q45. If you have installed productive machines in the last 2 years (2013-2014), which country/region were they made in? (Please tick up to THREE appropriate boxes). If Not, please go to Q46.

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q46. How important for your establishment are intra-firm transactions? (Please tick up ONE appropriate box)

Q46.1. Procurement of inputs from parent or group firms	0.☐0%	1.☐1-24%	2.☐25-49%	3.☐50-74%	4.☐75-99% 5.☐100%
Q46.2. Shipment of products to parent or group firms	0.☐0%	1.☐1-24%	2.☐25-49%	3.☐50-74%	4.☐75-99% 5.☐100%

J. Services provided by Public Research Institutes

Q47. Have you used the following service that public research institutes provide in the last 2 years (2013-2014)?							
Q48. How do you evaluate the quality of the following service? (1=very poor; 2=not good; 3=all right; 4=Good; 5=Excellent)							
	Q47. Usage		**Q48.** Quality of Service 1=very poor; 2=not good; 3=all right; 4=Good; 5=Excellent				
1. Contracted research and development	1.☐ Yes	0.☐ No	1.☐	2.☐	3.☐	4.☐	5.☐
2. Joint research and development	1.☐ Yes	0.☐ No	1.☐	2.☐	3.☐	4.☐	5.☐
3. Technical consultation	1.☐ Yes	0.☐ No	1.☐	2.☐	3.☐	4.☐	5.☐
4. Testing and laboratory services	1.☐ Yes	0.☐ No	1.☐	2.☐	3.☐	4.☐	5.☐
5. Rental of instruments and testing machines	1.☐ Yes	0.☐ No	1.☐	2.☐	3.☐	4.☐	5.☐
6. Technical seminars and trainings	1.☐ Yes	0.☐ No	1.☐	2.☐	3.☐	4.☐	5.☐
7. Information on foreign technical standards	1.☐ Yes	0.☐ No	1.☐	2.☐	3.☐	4.☐	5.☐

K. Factors that affect your decision on location choice and investment (Please choose up to THREE most important factors).

	1st	2nd	3rd
Q49. Please specify from the list below the three most important factors in your firm's decision to locate your operation in the current site at the time when you were established?			
Q50. Please specify the three most important factors in your firm's decision to expand/upgrade your operation in the current site?			

1. Tax incentives	13. Availability of natural resources as inputs
2. Liberal trade policy, FTA	14. Availability of low-cost labor or lower minimum wages
3. Simple and transparent export/import procedures	15. Availability of skilled labor/expert
4. Local content requirement, Rules of origin	16. Current and potential size of the domestic market
5. Transport infrastructure (road, port, etc.)	17. Concentration of supporting industries
6. Electricity, water, other utilities	18. Proximity to your supplier
7. Availability of land	19. Proximity to your customer
8. Quality of services of industrial estate, rental factory	20. Request by your customer
9. Legal and regulatory infrastructure	21. Access to information on technologies
10. Liberalized banking and financial sector	22. Political stability
11. Fewer foreign currency restrictions	23. Living conditions
12. Liberal foreign ownership rules	24. Agglomeration of various firms