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Exploration *through* Exploitation in the Internationalization of Product Development Teams: The Case of Japanese Automakers in the Mid-1990s

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Exploration *through* Exploitation in the Internationalization of Product Development Teams:

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Abstract

Based on quantitative and qualitative analyses of eight development projects, the present paper suggests that transferring organizational routines to a local development center to utilize home-country knowledge (i.e., exploitation) and the acquisition of local knowledge (i.e., exploration) are not necessarily mutually exclusive activities. We suggest that a mechanism may exist by which the discovery of knowledge occurs to the extent that routines are transferred. Our hypothesis may be summarized as follows. (1) There is a complementary relationship between the transfer of organizational patterns and routines from a home country to a local country and the exploration and acquisition of local knowledge. (2) Complementary interaction is driven as a firm engages in new local-capability-building modeled on home-country capabilities. (3) Appropriate goals for the international distribution of development teams may need to include the setting of learning opportunities with due consideration given to the ex-post stickiness of local capabilities.

Keywords

internationalization, R&D, multinational corporation (MNC), product-development teams, development projects, auto parts

I. Introduction[1]

The purpose of this paper is to investigate the mechanism by which decisions are made regarding the spatial distribution of product development teams. The paper also analyzes the relationship between the geographical allocation of product development projects and the overseas capability building of a firm. In particular, the paper suggests that the utilization of home-country knowledge (i.e., exploitation) by transferring organizational routines to a local entity and the acquisition of local knowledge (i.e., exploration) are not necessarily mutually exclusive activities. Rather, this paper shows that a mechanism may exist by which the discovery of knowledge occurs to the extent that routines are transferred.

In the product development process, a wide variety of knowledge and information (e.g., newly developed technology, customer tastes, production methods at the place of production, supplier's technology and production methods, etc.) is searched for and utilized for problem solving (Clark and Fujimoto, 1991). When products target multiple markets around the world or product development centers have been globalized, this knowledge and information will necessarily be internationally dispersed. In such cases, the development of means to transfer and deploy such knowledge and information becomes an important managerial concern (Subramaniam and Venkatraman, 2001).

One mechanism that is used to pursue the transfer and deployment of knowledge and information is an

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[1] This discussion paper is a manuscript in its draft form and should only be cited with permission. Please direct inquiries and comments to <<daniel@econ.shinshu-u.ac.jp>>. The authors would like to express their appreciation to the various firms and managers that cooperated with the research upon which this paper is based. This present paper is a revised version of a paper presented on August 29, 2004, at the Mitsubishi Bank Foundation Conference held at the Toray Human Resource Development Center in Mishima (Shizuoka Prefecture, Japan) where many helpful comments were received.

international product-development team comprised of members, often of different nationalities, who are assigned work in geographically separate development centers. These team members work together to solve problems and attempt to introduce internationally dispersed difficult-to-transfer knowledge into the product development process. Globalization of the product-development activities of MNCs, such as through the use of product-development teams, has been the subject of much research (e.g., Bartlett and Ghoshal, 1989; Kuemmerle, 1999; Subramaniam and Venkatraman, 2001). The decision on how to distribute internationally the members of a development team has become an important issue in the strategic allocation of a firm's resources.

This issue, however, has not been adequately addressed in the literature. With the exception of a few studies that have examined development projects or development teams (e.g., Subramaniam and Venkatraman, 2001)[2], research on factors that influence the international distribution of R&D resources has tended to use the industry or firm as the level of analysis. We may summarize the factors that this stream of research has found to influence R&D distribution into the following four items: (1) linkage of R&D with overseas markets; (2) linkage of R&D with overseas manufacturing facilities; (3) linkage of R&D with overseas universities and other technology sources; and (4) the benefit centralizing R&D in a single location (negative effect) (cf., Mansfield et al., 1979; Hirschey and Caves, 1981; Pearce, 1989; Odagiri and Yasuda, 1996; Florida, 1997)[3].

[2] Subramaniam and Venkatraman (2001) view cross-national development teams as a rich media of information exchange and analyze the relationship between such teams and the tacitness of overseas information. They show that when there is 'fit' between these two factors higher product development performance results. Apart from this work, the authors have found no other notable studies on this topic.

[3] In their seminal work on the determining factors of R&D globalization, Mansfield et al. (1979) showed that the ratio of R&D conducted overseas by an American firm had a positive effect on the firm's overseas sales, specifically on the sales of overseas subsidiaries. Hirschey and Caves (1981) found that R&D globalization is influenced by factors such as the ratio of local production in overseas sales, the presence of economies of scale in R&D (negative effect), and the degree to which it is necessary for a product to be adapted to a local market. They also found that overseas and domestic R&D have a complementary relationship, and that domestic R&D is generally selected when basic research is relatively important or when major changes to a product are needed. Pearce (1989) investigated the relationship between a firm's level of local production and its local R&D expenditure.

More recent work has broadly verified that overseas R&D is used as a means to acquire new technological knowledge and capabilities. Various studies have found that the local technological level functions as a determining factor for the globalization of R&D. For example, in his survey of the U.S. research centers of foreign companies, Florida (1997) verified that technological orientations (e.g., development of new products, the

These studies have analyzed the internationalization of R&D as cumulative average values, and have not been able to investigate the actual influence exerted by each factor. The studies have also not examined more micro levels of analysis, such as a development team, where actual decisions on how to distribute or allocate specific human resource are generally carried out.

In an effort to address this hole in the literature, the present paper investigates the international distribution of the development activities of various product-development projects executed by Japanese automakers in the mid-1990s. Data on auto part units (i.e., part systems) that were developed within a project are first used to infer where team members were internationally situated based on where the development activities for that part unit were performed. The data are then used to determine which aspects of the part units and their development processes influence the international distribution of development activities.

By analyzing the international distribution of development teams at the part systems level, it becomes possible to consider more clearly identify the factors that influence the international distribution of R&D and how these factors actually exert their influence. The study allows us to consider the effects of such factors as the selection of a part unit's internal layout, the parts connection with the eternal environment, and an automaker's relationship with a supplier. The aim of this research is to provide a more micro-level understanding as an empirical foundation to the current industry- and corporate-level analyses of the international division of R&D labor.

To achieve this aim, the paper uses quantitative data to search for factors that influence the international distribution of development teams. Next, qualitative data largely based on interviews conducted by the first author are used to explore the mechanism by which the factors exert their influence.[4] The paper is organized as

acquisition of science and technology information) were strong motivations for such centers. Odagiri and Yasuda (1996) showed that many of the above relationships also held for Japanese firms.

[4] Interviews were conducted between 1997 and 2002 with 29 individuals from a total of 6 firms. Most

follows. The next section reviews the relevant literature on the globalization of product development and the concepts of exploitation and exploration. The following section briefly explains the paper's data, its source, how it has been quantitatively analyzed, and the results that have been obtained. An analysis based on the qualitative data is then introduced. Finally, the paper closes with a discussion of the overall findings of this research and the implications.

II. Internationalization of Product Development, Exploration, and Exploitation

The existing literature on the motivation to internationalize product development approaches the issue from the perspective of the function and responsibilities of overseas development centers. We may divide the body of research into two groups. For example, Dunning (1988, 1998) employs the traditional company-specific-advantages perspective to suggest that one motivation for an overseas R&D center is to adapt home-country advantages to a local country, and uses the traditional location-specific perspective to suggest that another motivation is to acquire local specific knowledge to be used in the building up of a firm's advantages.

Bartlett and Ghoshal (1989) state that the fundamentally different roles of R&D centers established to transfer/adapt technology and those established to acquire technology will cause substantial differences in the source of knowledge that centers need to acquire and posses. Kuemmerle (1999) finds that different functions of overseas R&D centers, namely either exploiting or augmenting home-base advantages, influence the factors that determine the international distribution of firm's development resources. Each of these researches are based on the thinking that the function and organization of an overseas subsidiary must be made to fit with the environment or capabilities of a host country. They implicitly assume that exploiting existing

interviewees were either project managers or managers in a research center.

knowledge or capabilities and searching for new knowledge are mutually exclusive activities.

This implicit assumption of mutual exclusivity is supported by March (1991), which introduced the concept of an adaptive system (e.g., a firm) switching between two behavioral modes: exploiting existing organizational routines and searching for new routines. In the implementation of existing routines, firms have a tendency to search in the vicinity of existing routines until a satisficing alternative is achieved. However, if local search does not yield solutions that can sufficiently achieve targets, firms will widen their search for alternatives and the simultaneous experimentation with multiple alternatives may be pursued.[5] March (1991) called the former behavioral mode "exploitation" and the latter "exploration."

Exploitation refers to the refinement and extension of existing capabilities, technologies, and paradigms. Exploration refers to experimentation with new alternatives. Different levels of standardization of organizational behavior are required for exploitation and exploration. This difference in the required level of standardization connects to the logic that an R&D center's function and responsibilities should be decided based on the environment and capabilities of a host country and that the purpose for transferring advantages and searching for new knowledge will be different for each of a company's overseas R&D centers.

On the other hand, a limited number of studies focus on the learning that may be accumulated inside of a firm and suggest that the function and responsibilities of an overseas R&D center may evolve over time (Rondstadt, 1978; Hakanson and Nobel, 1993; Malnight, 1995). If the function and responsibilities of an overseas R&D center may change through ongoing firm learning, then the relationship between exploitation and exploration becomes ambiguous. These two concepts, while distinct, do not necessarily have to be

[5] To increase the rigor of this discussion the distinction between local and non-local must be made clear. The research stream on the boundaries of search behaviors is related to the issue of routinized search, and it is clear that choosing a standard for distinguishing between local and non-local is a non-trivial task. For example, a firm's technological search behavior may occur even inside of a firm, and it may extend beyond firm boundaries even when technological regions are the same (Rosenkoph and Nerkar, 2001). For the purposes of this paper, however, we provisionally set aside this issue as an area for future research.

mutually exclusive. It is possible a complementary relationship may exist between them, such as exploration occurring as exploitation is pursued.

Recent research on changes in organizational routines indirectly supports the contention that there may be a complementary relationship between exploration and exploitation. Stuart and Podolny (1996) find that even search in the vicinity of local capabilities and knowledge resulted in changes in organizational routines, as search outcomes are reflected in the rewriting of routines. Some researchers view organizational routines as containing within them opportunities for change to be introduced (Pentland and Rueter, 1994; Feldman, 2000).

Pentland and Rueter (1994) consider organizational routines to be the processes by which organizational behavior is chosen from a set of possibilities that have been produced by the "grammar" that guides personal action. In other words, they define a routine not as mindless repetitive work, but rather as "effortful accomplishment." Feldman (2000) concurs with this description of organizational routines and examines the feedback effect of the outcomes of organizational routines. From such feedback an organization can assess the sufficiency of an idea and obtain opportunities to produce new resources, among other benefits. If, as this research stream suggest, there are many ways in which opportunities for change may be introduced as organizational routines are executed, then it is possible that new knowledge may be obtainable through the exploitation of these routines. As such, it is conceivable that exploitation and exploration may be complementary.

In this paper, we show such exploration through exploitation does indeed exist by identifying the motivations and mechanisms of the internationalization of product development teams. The remainder of the paper illustrates that the exploitation of organizational routines through the transfer of knowledge to a local country and the acquisition of knowledge in a local country are not necessarily mutually exclusive. Rather, we show that mechanism may exist where the acquisition and use of local knowledge occurs to the extent that routines are transferred to a local country.

III. International Distribution of Development Team Activities and Its Determinants

1. Research setting and data

This paper investigates the international product-development projects of Japanese automakers in the mid-1990s. An automobile typically is made up of some 40,000 to 50,000 individual parts, and thus is a highly complex product to develop. In order to reduce complexity in such complex product development, design and engineering activities within an automaker are generally conducted by various departments that specialize in a particular function, such as engine, body, electrical systems, etc. However, to enhance the competitiveness of a product, it is necessary to achieve a high level of product integrity through the integration of these functions (Clark and Fujimoto, 1990).

Typically product development organizations in automakers are organized in a matrix form, where functional departments are crossed with development projects with one project usually corresponding to one model (Clark and Fujimoto, 1991; Cusumano and Nobeoka, 1998). With the aim of producing a fully consistent product, each development project integrates and packages the knowledge possessed by many different functional departments and suppliers into the final version of a new vehicle. This research is concerned with development projects in which members were located in Japan and another country other than Japan.

The development activities that are considered in this research are contained within the development cycle of: design, prototyping, testing, and evaluation. In order to reduce complexity in our analysis, we have left out other important development activities, such as product concept generation, product planning, production process engineering, etc. Thus, our consideration of development activities is narrower than what is found in Clark and Fujimoto (1991).

The broad-based globalization of the product development activities of Japanese automakers began in the 1990s, shortly after these companies began the large-scale globalization of their production activities in the 1980s. For example, the number of people assigned to the North American R&D centers of Japanese automakers increased dramatically throughout the 1990s (Figure 1). Looking in detail at the case of Honda, in the late 1980s the company began by using its U.S. development center in a supporting role of its new product development. The first product led by the U.S. side was introduced to the market in 1996. This product was highly evaluated as a North American-specific model. Toyota and Nissan also increased their development centers near Detroit in the 1990s (Table 1), and around this time these facilities began to take responsibility for some of the North American-specific models of these firms.

<<Figure 1>>

<<Table 1>>

As mentioned earlier, this paper first utilizes a quantitative approach to reveal the phenomenon in question. The data used in this analysis was gathered through a questionnaire survey distributed in 1997 and 1998 to six automakers which were asked to select a representative development project (or projects) that met the following three conditions: (1) the primary market targeted by the vehicle was a first-world country/region other than Japan, (2) the vehicle was to be produced (assembled) in a manufacturing facility located in the target country/region, (3) the target country/region participated in some way in the vehicle's product development activities.

In order to reduce any effects due to differences in the period in which the development activities were conducted, the project population was limited to those projects that developed a vehicle model that was introduced into the market between 1995 and 1997. To further reduce sampling bias, companies that selected multiple projects were asked to choose projects that targeted different countries/regions.

Four automakers returned completed questionnaires for a single project, and two automakers returned completed questionnaires for two separate projects. So, responses were obtained for a total of 8 projects from 6 automakers. In each case, the project manager who had been in charge of the entire project completed the questionnaire.

Detailed data was obtained for 14 different part units in each project, for a total of 112 part units covered.[6] The part units that were surveyed were selected during a pilot study. The questionnaire also inquired about the extent to which product development activities for each part unit were conducted in Japan or overseas.

Both before and after the survey was distributed, numerous research visits were made to the automakers' headquarters, Japanese R&D centers, and overseas R&D centers to interview managers and engineers in the relevant departments. A pilot study was conducted before the questionnaire was written to determine the appropriate level of analysis for the study and to investigate what would constitute appropriate

[6] The 14 part units were: engine, underbody (front), underbody (middle), underbody (rear), transmission/transaxle, suspension (front), suspension (rear), steering, braking, engine control, external upper-body, interior/trim, seats, instrument panel. Theses part units, while not an inclusive list of all parts of a vehicle, cover the most important functions and provide the fundamental basis for product differentiation in the auto industry.

survey methodology. The pilot study also sought to inquire as to how the special characteristics of the auto industry might influence the spatial distribution of development project activity. Follow-up interviews conducted after the survey was distributed were used to investigate the process by which determining factors exerted influence and to explore the underlying mechanism by which this influence was exerted.

2. Specification of variables

Multiple regression analysis was conducted. The extent to which a part unit's development activities were conducted in Japan or overseas was set as the dependant variable. The distributed location of development activity can be considered a proxy for the international distribution of a development team. The total number of engineering processes (steps) that were required to develop a part unit was used as the basis for determining the extent to which a part unit was developed in Japan or overseas. The project manager was asked to circle the appropriate number from 1 to 5 for each part unit: 1 if all of the process steps were carried out in Japan, 3 if half of the process steps were carried out in Japan and half in the local country, and 5 if all of the process steps were carried out in the local country.

Factors related to the part units that could influence the international distribution of development activities in the Japanese auto industry were determined based on a literature review and the pilot study. Six variables were ultimately selected: *design for local adaptation*, *local production*, *production outsourcing*, *supplier participation*, *advanced engineering*, and *concurrent development*. These were used as explanatory variables (dummy variables) and listed on the questionnaire as yes/no questions.[7] The following paragraphs describe each variable and explain how it was operationalized.

[7] Only one question was used for each variable. However, each question simply inquired about a specific factual item. A project manager from one company verified that the question syntax accurately reflected the question intent. As such, it was deemed that there would not be any significant problems with construct validity.

The *design for local adaptation* variable captured whether knowledge related to the local market was actively utilized in the part unit's development.[8] It represents a factor that is frequently cited in the literature as a determinant of the international distribution of development activities. There is a deep relationship between this factor and a product's fit with customer needs. Local market needs are met in the auto industry through design changes or new designs being created for the purpose of meeting local needs.

It is important to recognize that local adaptation is ultimately a concept that is based on a company's perception of local customers. Development activities that are performed in response such perceptions are generally viewed as "local adaptation." However, we cannot exclude the possibility that a local adaptation might sometimes be an unintended but realized result, that is, an emergent phenomenon (Sugiyama, 2001b). As such, specifying the "adaptation" concept is an inherently difficult endeavor. Nevertheless, for the sake of expediency, in this paper we specify local adaptation as an intended design activity. In detail, the respondent was first asked the reason why a design change or new design was executed. If the respondent answered that there was the intent to adapt to meet customer needs, then the *design for local adaptation* variable was set at 1. If the design change or new design was executed without the explicit intent to adapt to meet local customer needs, then this dummy variable was set at 0.

The *local production* variable captured the connection between the place where a part unit would be manufactured and spatial distribution of the development team. In the product development of recent years, designs that are easy to manufacture ("design for manufacturing") is very important for realizing production efficiency and high quality (Clark and Fujimoto, 1991). To achieve this, it is necessary to have frequent communication between part designers and the production department that will manufacture (assemble) the

8 The *design for local adaptation* variable is the only variable that is related to the product market. The reason for this is that the act of designing for local needs requires that many different types of market information be integrated.

part. The place where a part unit would be manufactured was used to verify if the place of part-unit production was located near to where development activities was performed. If the part unit was produced overseas, then the *local production* variable was set at 1. If the part unit was produced in Japan, then this dummy variable was set at 0.

The *production outsourcing* and *supplier participation* (i.e., development outsourcing) variables represent factors that are often cited in the literature as determinants of the spatial distribution of development activities. The issue of the boundary of the firm has been the subject of much attention in recent years. It has been shown that outsourcing decisions have an important relationship with firm competitiveness (Nishiguchi, 1994; Takeishi, 2002). As such, it was deemed necessary to verify if the production of a part unit was done in-house or by a supplier. If a supplier produced the part unit, then the *production outsourcing* variable was set at 1. If the automaker produced the part unit in-house, then this dummy variable was set at 0.

The relatively high level of development participation of suppliers has been identified as a source of the competitiveness of Japanese automakers in particular, and more generally, the effect of supplier participation on development performance has been supported by the literature (Clark and Fujimoto, 1991). If a supplier participated in the development of a part unit by performing the detailed drawing of the part's design, the *supplier participation* variable was set at 1. If the detailed design work was performed by the automaker, then this variable was set at 0.

The *advanced engineering* and *concurrent development* variables were used to represent the presence of economies of scale provided by a consolidated R&D centers. The concentrated development of advanced technology is considered a benefit of having a consolidated R&D center. With few exceptions, the advanced engineering development centers of Japanese firms, including Japanese suppliers, are located in their research centers in Japan. It was expected that this factor would influence the international distribution of development teams toward Japan.[9] If the advanced engineering development work of an automaker or supplier was utilized in the part unit, then the *advanced engineering* variable was set at 1. If no advanced engineering work was utilized, then this dummy variable was set at 0.

The influence of concurrent development was assessed with the second variable that represented the benefit of doing consolidated R&D. In particular, the mid-1990s was a period in which many Japanese automakers promoted inter-project coordination and integration to commonize designs and to achieve other purposes. The benefit of concurrent development among development projects has been empirically verified (Cusumano and Nobeoka, 1998). As such, we deemed it important to verify this factor in our study. If the part unit was common with that of another model being concurrently developed, then the *concurrent development* variable was set to 1. If the part unit was not common, then this dummy variable was set to 0.[10]

The statistical overviews of each project are show in Table 2.[11] From this chart is clear that there are large differences in the international distributions of the development activities of these overseas production models of Japanese automaker in the mid-1990s. The projects that were covered in this survey each had a different role to fulfill in the context of the automaker's larger product development context, and it is possible that these different project roles influenced the distribution of development activity. To check for project-specific differences, we introduced project dummy variables into our analysis.

[9] The literature highlights the importance of the connection between local development and local universities and other technological centers. However, at the time this survey was conducted, there were very few cases where automakers perceived the need to form a connection with local universities or other technological centers. As such, this factor was not included in this survey.

[10] Concurrent development is defined here as the existence of overlap between the development periods of separate projects.

[11] Since the amount of development activities (i.e., the number of process steps) was different for each part unit, simple averages are not the most appropriate measure. However, in the absence of a valid weighting standard that could be used in place of simple averages, they are used for expediency.

<<Table 2>>

3. Results

Model 1 assesses the influence of the project dummy variables only. Model 2 contains all of the variables. The correlation matrix of the variables in Model 2 is shown in Table 3. The regression results of both Models 1 and 2 are shown in Table 4.

<<Table 3>>

<<Table 4>>

The F value for Model 1 is significant at the 1% level, verifying the overall influence of the project dummy variables. The adjusted R^2 for Model 1 is 0.387 indicating that the project dummies explain much of the variation among projects. This suggests that even for relatively similar development projects (e.g., overseas market targeted, overseas production), firm differences among automakers and differences in project strategies have a rather large influence on the international distribution of development activities.

This large effect of firm and project strategy differences may be caused by differences in the capability levels of overseas development centers and in the scope of the target markets. Even if projects are similar, wide differences in the capability levels of local development centers may make it such that some automakers were simply unable to perform some development activities abroad. In addition, although the survey covered models that were all targeted primarily at a local market, some of them were closer to local-market-specific models, while others were also positioned to target global markets. For Firm Z such a difference in the targeted markets of its products seems to have strongly influenced the international distribution of the development activities of each project. For the model that would be assembled globally, a higher proportion of development activities were executed in Japan even though a local market was targeted as the primarily market.

We would only expect the project dummies to show any significant effect, however, if development teams were organized and functioned at least to some degree at the project level. However, the characteristics of an automobile's integral product architecture tend to drive such project level management (Clark and Fujimoto, 1990, 1991; Fujimoto, 2002). The core parts of an automobile have a high level of interdependency, and are thus usually developed together and a whole. It is relatively difficult to insert new technological elements as independent "modules" into an existing automobile design. New core parts, in particular, need to be developed to a certain extent as parts of a whole, rather than as independent parts (Henderson and Clark, 1990).

Turning to Model 2, we can see that the adjusted R^2 has increased to 0.627 from the 0.387 value of Model 1. Thus, the fit of the second model is greatly improved over the first. At the individual variable level, *local production* and *supplier participation* are significant at the 1% level. *Design for local adaptation* and *advanced engineering* are significant at the 5% level. The model did not verify any significant explanatory power for the *concurrent development* and *production outsourcing* variables.

The validity of the local production variable verifies that the location or nationality of the production source exerted an influence on the international distribution of development activities at the part unit level. The lack of significance for the production outsourcing variable suggests that the firm boundary may not exert much influence on the international distribution of development work. On the other hand, the influence of local supplier participation was verified, even after controlling for local production. The significance of the design for local adaptation variable verifies the influence of the active utilization local market knowledge in a part unit's development.

For the two variables that captured the scale effect of consolidated R&D, the results verified that there is a strong tendency to locate development activity in Japan if advanced engineering is used in a part unit. However, the significance of concurrent development could not be verified. The lack of significance of the concurrent development variable may suggest an improvement in the capability of development teams to share designs even when coordination across development teams must be done over spatial distances. At one company, design work could be managed overseas from the point when advanced engineering had been completed, which is generally still considered a relatively low level of technological maturity. In the initial years when the companies had little experience performing overseas R&D, local development centers were only able to perform development work on relatively mature technologies. However, this limitation appears to be lessening as the development capabilities of overseas development centers improve.

The quantitative analysis described above verifies the factors that influence the international distribution of development work of Japanese automakers in the 1990s. This result shows the influences of the various factors on the distribution of development work; however, it does not explain the mechanism by which these factors exert their influences. The following section primarily uses interview data to consider how the formative processes by which the relationships between the various factors and development activity distribution are created.

IV. The Mechanism Behind the Revealed Distribution

1. Capability in Japan as the base for utilizing local knowledge

An interview survey was conducted between 1998 and 2002 to illuminate the mechanism by which influence is exerted by the variables that the quantitative analysis found to be significant in explaining the international distribution of development activities. Very interesting results were obtained. Initially, the authors expected that the observed phenomenon could be explained based on the establishment of appropriate communication channels according to the stickiness of local knowledge and information. However, the interview findings did not support this way of thinking. Rather, it was found that local knowledge was discovered through the stimulation caused by the penetration of home-country organizational patterns into a local development center. Subsequent utilization of this knowledge in development work established a dynamic relationship between the influencing factors and the distribution of development activities.

The influences of two of the three variables that the previous analysis found to push the localization of development activities, *design for local adaptation* and *supplier participation,* are described next. In doing so, we seek to explain the relationship between these variables and the transfer of home-country capabilities to a local development center in order to acquire local knowledge.

Design for local adaptation and knowledge about customer needs

Interview results confirmed the findings of the quantitative analysis regarding the positive effect of design work for local adaptation on the international distribution of development activities. For example, in multiple projects part units that are more easily influenced by local driving conditions or local customer tastes (i.e., suspension, parts related to external and internal styling, etc.), development work was frequently done locally.

One reason that was frequently cited for locating development team members in local development centers was to incorporate local standards of evaluation into the part unit's design. One manager in a U.S. development center described these evaluation standards as the “wisdom of daily life” possessed by engineers who lived in the local environment. This knowledge possessed by those who live in a particular locale is knowledge or information based on first-hand experience and is difficult to suppress.

For example, people in Japan can roughly imagine what it is like to live in artic regions, such as those found in Alaska or Finland, but few have actual experience living in such an environment. Due to this lack of first-hand experience, an automobile developer from Japan will tend to underestimate or take too lightly the effects such a harsh environment can have on vehicle performance or durability. Similarly, an engineer in an automaker's growing U.S. R&D center explained how difficult it was to try to convince Japanese engineers in Japan how people in the U.S. regard the locking of a car's doors and trunk. Differences in the general personal security conditions of Japan and the U.S. made it very difficult for the U.S. side to explain convincingly how often Americans tend to lock their cars and how being able to control the locking and unlocking of a car by remote control could be an important feature to local users. At the time, the members of the U.S. R&D center were ultimately largely unable to communicate this knowledge to the firm's Japanese engineers in Japan.[12]

Nevertheless, viewing a local R&D center simply as a means by which to acquire local "wisdom" appears to fall short in explaining the observed reality. While interviewees did indeed seek to acquire such local knowledge and information through overseas R&D centers, they sought another, more important, goal at the same time. This second pursuit was of a phenomenon that can be likened to a "chemical reaction," which is explained below.

An interviewee in one of the companies surveyed described the job of a Japanese engineer dispatched to an overseas R&D center as getting the local designers in charge of styling to understand a project's technical limitations.[13] During the period when a local R&D center only had a design department

[12] Source: Interview with Ron D'Amico of the Nissan Technology Center North America (August 9, 2000).
[13] A designer as described in this paper is generally an industrial designer who is responsible for the whole or some part of a vehicle's exterior styling or interior design.

without much engineering capacity, designers would present various advanced concepts. However, often these proposals would lack sufficient technical design consideration, requiring major revisions when the development work reached the detailed technical design stage.

By establishing a local design department that could present product concepts, automakers succeeded in picking up emerging local market needs. However, problems existed in realizing these concepts in the downstream product development processes. By subsequently locating more product engineers in a local development center, technical limitations could be communicated more accurately and timely to local designers. This resulted in the creation of concepts that better took into account technical limitations and ultimately improved design proposals that could lead to products in which local needs and sensibilities were more directly reflected.

Another example that illustrates how local development capability can become a base for the generation of local knowledge is the interpretative process by which a brand image is incorporated into a product as it is designed and engineered. A Japanese manager who spent a long time in charge of an automaker's design and engineering management in its U.S. development center described this process as follows.

> In short, the kind of capability that is produced by local execution of a project is that people in the local development center become able to understand what "producing a car" (*kuruma tsukuri*) means to that automaker. Which requirements must be met? Where the envelope should be pushed? Or why does a firm put such an emphasis on some particular standard in some particular area? These kinds of questions get answered as work is being performed. As people in the local development center experience the cycle of releasing a model into the market and having it evaluated there, they become able to share the values and internal standards of product

evaluation of the firm. They become able to share these values not based on understanding derived from some manual, but rather through intuition. Such knowledge leads to more forward-looking or positive types of discussions on how to improve product appeal and quality. These kinds of discussions would occur even when only Americans were participating, that is, without the presence of any Japanese people.

For local R&D members to understand the relationship between brand image in a local market and product engineering, it is necessary for their judgments, which are based on massive amounts of context-specific background knowledge, to be subjected to the objective screening process of market evaluation. It is true that one of the reasons for performing development activities abroad is to utilize the interpretative capability of local engineers with their "wisdom of daily living" regarding local market needs. However, it is not a matter of simply "interpreting" local needs but also of utilizing, verifying, and linking such information with the accumulated knowledge stored up in an automaker, all done in the appropriate local context.

It would not be accurate to say that the knowledge that exists in the local country simply is equivocal and thus difficult to make explicit. Rather, it is only after knowledge that a company has accumulated in its home country has been transferred to the local country and reinterpreted by the local side, that sticky local knowledge is generated and reflected in a project. Thus we may say that local market knowledge is not "sitting there" simply waiting to be picked up, but rather is "produced" as existing development routines are performed in the context of the local environment.

Local supplier knowledge and supplier participation

In order to utilize the knowledge possessed by local suppliers, an important key was the degree of penetration of an automaker's organizational routines and inter-organizational patterns that were transferred to the local country. This was similar to the design for local adaptation case described above.

Local suppliers possess knowledge about part technology and production techniques that appeal to the unique customer tastes of a country or region. In developed countries and regions such as the U.S. or Europe, where automakers already have an established history, market tastes are frequently different from Japan for part units that are highly design-orientated, such as external upper-body and interior. For products that are aimed at overseas markets it is necessary for these differences to be properly reflected in product designs. Since local supplier tend to have long histories of producing parts that meet local tastes, they often have extensive accumulated technological know-how on parts that work well in a local market. A project manager from one automaker described this as follows.

> The technology of American suppliers, such as for assembly methods or selection of materials, is subtly different from that of Japanese suppliers. For example, for door side protection in Japan push molding is used, but in the U.S. it's done by heat forming. One of the reasons we seek increased development in the U.S. is to grasp this (type of technological difference).

In order to utilize the knowledge of local suppliers, Japanese automakers need to transfer to the local country the organizational patterns and inter-organizational routines related to the high level of supplier participation in their vehicle development done in Japan. As is the case in Japan, it is better if this participation of local suppliers occurs from the early stages of a development project.

Early participation by suppliers allows them to acquire information about the automaker's product at an early stage. This permits the supplier to join with the automaker in solving problems related to product technology trends, production issues, or in other areas. Many Japanese automakers make extensive use of early participation of suppliers, sometimes bringing "guest engineers" from a supplier into an R&D center to work closely together with an automaker's engineers. Solving problems earlier in the development process reduces developmental costs and lead time (Thomke and Fujimoto, 2000).

One surveyed automaker acquired advanced technological information of local suppliers by hosting suppler exhibitions inside of its local R&D center and by requiring suppliers to submit 5-year development plans. This allowed the automaker to understand the technological capabilities of local suppliers and better incorporate their leading technologies into developmental cycles. By routinizing such activities, an automaker can pursue product development that better takes into account future cost and functional changes, while suppliers can proceed with technological development that more closely reflects directions in which an automaker is heading.

The examples described above show how improving the local capabilities of an automaker may enhance the potential to acquire local knowledge. Built-up local capabilities can be understood to be bundles of routines and knowledge that have been reinterpreted within the local environment (von Krogh, Ichijo, and Nonaka, 2000; Asakawa, 2001) and may be viewed as a foundational base for acquiring local sticky knowledge. In other words, we can say that there is a complementary relationship between the capability level that has been built up locally and the potential to acquire local knowledge.

2. Capability-building process

How then can these local capabilities be built? This section discusses the capability building process in the case of supplier participation in the North America as revealed in the interviews.

The process by which routines and patterns of high supplier participation were transferred by Japanese automakers to North America began with the search for local suppliers who would be willing to participate in product development in this way. Japanese automakers started to build up their North American development centers in the 1980s. At the time, it was typically the case that even for those types of parts that had been developed in Japan with a high level of supplier participation, the U.S. Big Three (GM, Ford, and Chrysler) would tend to source such parts from American suppliers only after the detailed design work had been completed internally by the automaker. As a result, it was often the case that few U.S. suppliers were able to handle the supplier participation requests of the Japanese automakers. Frequently the best Japanese automakers could do was to choose suppliers that seemed to hold the potential to be able to handle this kind of work one day, and then go through the laborious process of assisting these suppliers in building up their developmental capabilities.

For many of the surveyed automakers, initially the principal work of their local product development organizations was simply to find suppliers that would be able to produce parts that met the required quality standards. In this early phase when local development centers were being established and automakers had only limited experience operating them, generally an automaker would lend already completed drawings to a local supplier. The local supplier would then manufacture the part. In such cases, it was impossible for the local knowledge possessed by the supplier to be reflected in the drawings since the drawings were already finished. The most promising of these local suppliers were retained and after quality and cost issues were addressed, organizational and inter-organizational routines related to supplier participation were subsequently transferred to these suppliers. For these routines to be transferred, it was necessary for an automaker and a local supplier to iterate problem-solving cycles and routinize the inter-organizational solving of problems. This could only be done after the automaker had found local suppliers that would be capable of building up such a capability.

To further explore these issues, we considered the cases where parts were procured from a Japanese supplier with operations in a local market as compared to purely local suppliers[14]. Differences were revealed in the relationships of each group to some of the explanatory variables. As is shown in Tables 5 and 6, the local operations of the Japanese suppliers were much more likely to have engaged in supplier participation and worked on parts that involved advanced engineering.

<<Table 5>>

<<Table 6>>

We may interpret these results in the following way. To be able to perform activities that required a higher technological level (e.g., engage in supplier participation, handle advanced engineering parts), a supplier needed to possess more complex organizational routines. However, since most local suppliers had not yet fully established such routines, there was a strong tendency for automakers to select Japanese suppliers that already possessed these routines. In this way, the quantitative data can also been understood as suggesting that it takes time for routines related to supplier participation and the handling of advanced engineering parts to be transferred overseas.

The various obstacles to the transfer of these routines can be categorized into two types. First, there are the obstacles that exist inside the automaker. Since routinized behaviors and perceptive frameworks of an automaker had largely become implicit parts of an automakers way of doing business, it was often difficult for

[14] To test this argument, we limited the data used in Section III to only those samples representing part units that were manufactured by a supplier.

an automaker to grasp the relationship of these behaviors and frameworks to its competitive advantages. Thus, there were even instances where the side that was responsible for transferring the routines did not understand their structural composition or importance to competitiveness.

In the process of preparing to transfer overseas its routines related to supplier participation, one automaker discovered that there were many tacit assumptions shared between the automaker and its suppliers. An automaker engineer in charge of increasing ratio of parts procured locally described this as follows.

> "We would ask (a local supplier) to build a prototype part, and we would discover that the part did not come out the way the design blueprint said it should. The reason for this was that in Japan even if one of our internal engineers didn't draw in all of the part details, the supplier would fill in the details and build the part just right. So, (after we started working with local suppliers) we had to start to once again draw (part designs) in fine detail."

Another example of a shared assumption was the expectation regarding how a supplier would participate in parts development. It was typical for a Japanese supplier to naturally engage in active participation in the development process, expressing opinions and making numerous suggestions. Automakers and suppliers in Japan had become used to such systematic patterned behavior and felt it to be completely ordinary. American suppliers, on the other hand, would typically participate in parts development only when specifically asked to do so. Furthermore, the participation of the American supplier would usually only result in an opinion or suggestion when very precise requests were made. Thus, Japanese automakers had to put much effort into building up a pro-active structural capacity in local suppliers.

The second category of obstacles to the transfer of complex supplier management routines to local suppliers are those that are caused by the difficulty of convincing local suppliers of the advantages of these routines. For example, one automaker experienced such a problem with a U.S. supplier of resin parts. The automaker was aware of the logic behind the advantages of its supplier management routines. Nevertheless, the company was unable to overcome the routinized behavioral tendencies of the local supplier.

This local supplier had typically done business with the Big Three, which would generally procure parts with extremely detailed standards. It was not uncommon for such requirements to explicitly specify the exact manufacturer and product name of the material to be used in making the part. The Japanese automaker on the other hand would generally only give basic specifications to a supplier and would evaluate the supplier based on the supplier's ability to meet the performance targets. A supplier would search on its own for the optimal choice of part materials in order to achieve these performance targets. The Japanese automaker needed to convince the local resin supplier of the advantages of this method of procurement, but ultimately was unable to do so. A manager from the automaker described the situation as follows.

> Our way of thinking was that as long as the quality and cost requirements were met, whatever method was fine with us. Even in cases that did not involve 'black box' parts, where we did the detailed designing of the part, the selection of materials was left to the supplier. Because this style of development was the norm in Japan, suppliers came to be equipped with the capability of delivering high quality (parts). In a way, you could say that we (automakers) were dependant to a degree (on our suppliers) in our product development. In the U.S., where this style of development was not the norm and suppliers lacked this capability. In the end (the supplier) couldn't accept this style (of parts procurement).

As can be seen in this episode there are many steps involved in the transfer of routines related to supplier management to a local country. As an automaker searches for transferable knowledge, it must first perceive the existence of key organizational routines. The automaker must also accurately grasp and judge difference between suppliers in Japan and those in the local country. Finally, the automaker must be able to convince local suppliers of the advantages of its style of part procurement.

One effective way of overcoming these obstacles was to utilize relationships that were embedded in the local country's social structure. Many Japanese suppliers hired away American engineers from various American manufacturing companies. Of these American engineers, especially those who had previously worked in an auto parts supplier usually had a good understanding of supplier technology and production capabilities. Since these engineers deeply comprehended how to evaluate and assess suppliers, their opinions were generally very highly regarded by Japanese automakers. The personal networks of these individuals were also quite important. Through their contacts, and often through their personal introductions, automakers could get in touch with reliable suppliers that might have the potential to work well within the inter-organizational routines that the automakers sought to transfer to the local country. The supplier management routines that gradually began to emerge once the local social structure had been taken into account were somewhat different from the Japanese routines in Japan that had been their template. As such, it is not surprising that various differences in the resultant capabilities also emerged.

As has been described above, the transfer of organizational routines that form the basis of organizational capabilities is made up of many sub-processes, including: reworking search activities, becoming aware once again of tacit internal routines, verifying competitive advantages by making comparisons, persuading people to change, and incorporating local social structures. The capability to stimulate the knowledge activities of a supplier would seem to be a capability that is built up in steps by going through various processes from local search activities to the routinization of inter-firm behaviors. Through the presence of different participants across the supplier-automaker interface routines are repeatedly re-worked and re-rountinized. Knowledge and routines that are acquired through problem solving become the base for subsequent problem solving. Local product development capabilities can be understood as being built up as they are used for engaging in search and problem-solving activities over and over again with each new product development project.

3. The ex-post stickiness of capabilities and appropriate learning opportunities

The foregoing discussion suggests that it may be better to view the reason for establishing a local development center not solely as a means to acquire local knowledge that "exists there," but also to develop an understanding that emphasizes the importance of building a strong base to acquire this knowledge by promoting interaction between a local development center and local knowledge. As such, the goal of local development would include creating appropriate opportunities for capability building.

Behind this capability-building purpose lies the logic that suggests that capabilities once they are built up will be sticky, that is, difficult to transfer outside of the local development organization. As mentioned before, product development capabilities are built up as past problem solving is routinized. Thus, the output of problem solving is not only part designs. Secondary by-products are the capabilities that are produced by the individual internalization of knowledge and the generation of organizational routines. The knowledge and experience that are acquired by performing problem solving are internalized and rationalized within an organization (or between organizations) and may only be transferred with difficulty. In this way, iterating problem solving cycles may produce sticky capabilities that are difficult to transfer after the fact.

Capabilities that are acquired by engaging in local product development are capabilities that have been re-routinized locally and that include local participants and local social structures. As a result, not only do such capabilities become a base for future problem solving, but also a base for interactions that may produce new knowledge. If it is the case that engaging in local product development can produce capabilities that may be used in future product development, then it may be reasonable to perform some types of development work locally even if the particular project would not necessarily require the work to be done locally.

There were some actual cases where projects were selected to utilize local development centers in order to create appropriate learning opportunities, which required that various project requirements be set aside. For example, in one case Honda explicitly selected a model to be developed locally that was well suited for capability building. In deciding which body type of the 1990 Accord to develop in the U.S., Honda chose the technically more difficult wagon over the coupe. This choice was made to give the U.S. development center a challenge that would fit well with Honda's capability development purposes. This can be understood as an example of a company taking into consideration the local capability level, but at the same time giving a slightly higher development challenge.

At another automaker, upper management decided in the middle of a project to involve an overseas development center. In this case, after the product plan had already been fixed, the vice president in charge of technology suggested that the U.S. development center be allowed to do the rest of the development work. His reasoning included the clear desire to grow the capabilities of the automaker's North American development center.

In this way, each of these firms did not seek to minimize knowledge-transfer costs based solely on the degree of knowledge stickiness they sought to acquire in the local country, but rather they also took into consideration the knowledge that would be utilized after the routines were transferred and made decisions based in part on the appropriateness of the learning opportunities that would be created. In this way, minimizing knowledge-transfer costs at the single project level was not pursued.

V. Conclusion

By examining the internationalization of product development activities by Japanese automakers, this paper examined which development factors influenced a development team's international distribution for eight actual product development distributions observed in the real world. Based on this finding, we developed a hypothesis about the mechanism by which the factors exerted their influence. Our hypothesis may be summarized as follows. (1) There is a complementary relationship between the transfer of organizational patterns and routines from a home country to a local country and the exploration and acquisition of local knowledge. (2) Complementary interaction is driven as a firm engages in new local capability building modeled on home-country capabilities. (3) Goals for the international distribution of development teams include the setting of appropriate learning opportunities with due consideration given to the ex-post stickiness of local capabilities.

The existing literature has made the implicit assumption that organizational attributes such as communication structures should be set in relation to the cost of knowledge transfer (i.e., the level of knowledge stickiness caused by knowledge attributes such as tacit-ness and complexity). That is, organizational attributes should be adjusted to match knowledge attributes. This way of thinking assumes that knowledge attributes are caused by exogenous factors and are fixed. As such, an organization should achieve the necessary level of fit by changing that which is less costly to control. Once this level of fit is set, product development should be managed accordingly. In short, this perspective claims that the higher the level of fit the greater the possibility for effective product development. Such a logic in none other than the "fit" of contingency theory.

In contrast to this dominant view, this paper has used a case-based approach to demonstrate an alternate logic, that is, one of dynamic enactment. The paper has described how, in order to take advantage of sticky knowledge, routines may be transplanted overseas and that the act of doing this transfer may create opportunities for discovering new knowledge. Firm behavior made based on this alternative way of thinking may appear to result in poor fit when viewed from the dominant perspective of matching firm behavior with the environment. However, if the emphasis is on capability building, a firm may choose to develop a product locally even when doing so will create such an imbalance.

A superior product cannot be developed simply by having a good understanding of local conditions. Only after a local organization has sufficiently mastered the distinctive organizational routines of a firm, is it possible for local knowledge to be strongly reflected in a product. The logic of dynamism says that raising the internal capability level of a firm will cause change in the external environment and that this change will drive subsequent learning. Contained within this way of thinking is the idea of making positive use of interactions with the external environment. Rather than the view a firm as going abroad to acquire resources that already "exist" in a local country, it may be more appropriate to see overseas expansion as "creating" the very resources that a firm desires.

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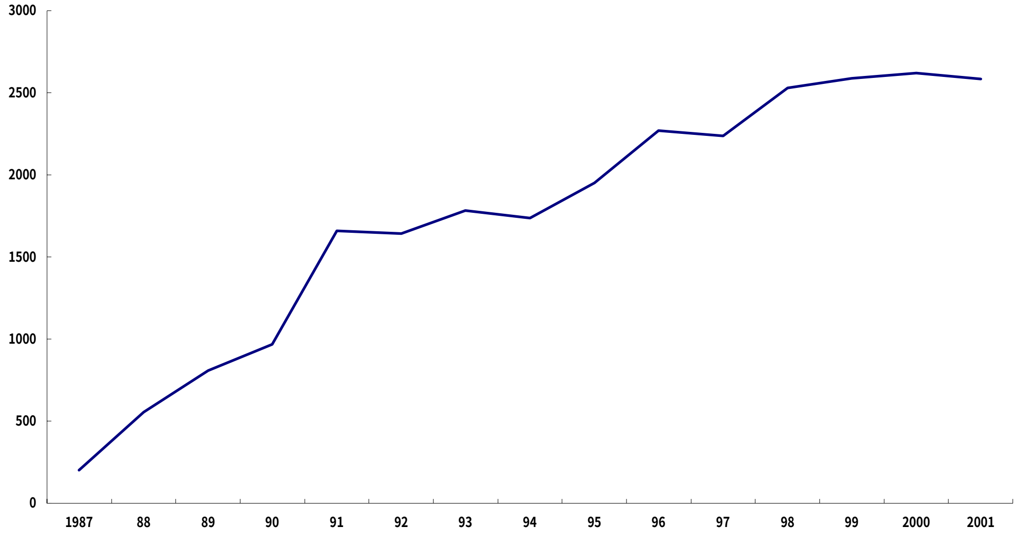
Figure 1 Growth in the number of employee at the North American R&D centers of Japanese automakers



Source: Compiled by the authors from Japan Automobile Manufacturers Association yearbooks (*Nihon no jidousha kougyou* [The Motor Industry of Japan])

Table 1 Number of employees at North American R&D centers (by automaker)

	1991	1995	1999
Toyota	323	410	583
Nissan	470	508	568
Honda	420	680	1100
Mitsubishi	120	133	113
Mazda	220	146	135
Isuzu	90	40	50
Fuji Heavy (Subaru)	15	35	40

Source: Compiled by the authors from Japan Automobile Manufacturers Association yearbooks (*Nihon no jidousha kougyou* [The Motor Industry of Japan])

Table 2 Outline of Surveyed Projects

Model	Auto-Maker	Year Introduced to Market	Type	Primary Market	International Division of Development Activities	
					Average	Standard Deviation
A	U	1996	Sedan	N. Am	1.79	1.26
B	V	1997	Sedan	N. Am	1.79	0.41
C	V	1996	Sedan	Global	2.36	0.71
D	W	1997	Sedan	N. Am	1.86	0.83
E	X	1995	Sedan	Europe	1.64	1.23
F	Y	1997	SUV	Global	1.71	0.45
G	Z	1997	Sedan	N. Am	1.71	0.45
H	Z	1996	Coupe	N. Am	4.14	1.35

Table 3 Correlation matrix

Variable	1	2	3	4	5	6	7
1. development distribution	—						
2. design for local adaptation	0.205*	—					
3. supplier participation	0.243*	0.043	—				
4. production outsourcing	0.273**	0.130	0.581**	—			
5. local production	0.294**	0.156	0.065	0.279**	—		
6. advanced engineering	-0.077	-0.073	0.304**	0.318**	0.167	—	
7. concurrent development	-0.231*	-0.202*	-0.230*	0.023	-0.085	0.092	—

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

Table 4 Multiple-regression analysis of distribution of product development activities

	Model 1	Model 2
Constant	2.125* (23.62)	0.995** (4.362)
Project (dummy)	significant	significant
Design for local adaptation	—	0.415* (2.530)
Supplier participation	—	0.740** (3.445)
Production outsourcing	—	-0.117 (-0.523)
Local production	—	0.932** (3.784)
Advanced engineering	—	-0.686* (-2.529)
Concurrent development	—	-0.071 (-0.266)
Adjusted R^2	0.387	0.627
F-value	11.02**	14.72**

*: p<0.05, **: p<0.01 ( ) contain the t-values

Table 5 Relationship between supply nationality and supplier participation

		Suppler Participation		Total
		No	Yes	
Supplier nationality	Local	24 (32.4%)	18 (24.3%)	42 (56.7%)
	Japanese	8 (10.8%)	24 (32.5%)	32 (43.3%)
Total		32 (43.2%)	42 (56.8%)	74

χ^2=7.877 p=0.005

Table 6 Relationship between supplier nationality and advanced engineering

		Advanced Engineering		Total
		No	Yes	
Supplier Nationality	Local	40 (54.0%)	2 (2.7%)	42 (56.7%)
	Japanese	17 (23.0%)	15 (20.3%)	32 (43.3%)
Total		57 (77.0%)	17 (23.0%)	74

χ^2=19.447 $p<0.001$