Enhancing Product Development Capabilities via Knowledge Management: A Case Study of Wistron

Kai-Lin Wu, Graduate Institute of Business Administration, Fu Jen Catholic University, Taiwan

ABSTRACT

In recent years in-depth research regarding how knowledge management process affects the enhancement of product development capabilities has been still limited, so the study adopts the single-case-study method and applies the model of Probst et al. (2002) to investigate the knowledge management practices within the R&D Department of Wistron, a laptop computer ODM. The research outcome reveals that three main sources of knowledge goals are customers, suppliers, and set within Wistron. As for knowledge identification, there are four ways to access: specialized research department, database, online learning platform, and interactions between departments; As for knowledge acquisition, there are two primary knowledge providers: customers and suppliers; There are three directions in knowledge development: the cultivation of staff creativity, the cultivation of the staff’s problem solving, and innovation in problem solving; In knowledge sharing and distribution, there are four methods: through project and mobile dispatch, distributing one laptop computer for every person, the database and online learning, and the best practices of sharing; There are two coordination methods in knowledge utilization: culture and coordination of learning activities; In knowledge retention, the management emphasizes four foci: knowledge transfer, retention, experience heritage, the management and access of the existing technical knowledge; In knowledge assessment, the management depends mainly on quantitative indicators with the support of qualitative measures. Therefore, this study concludes Wistron has effectively implemented these eight steps of knowledge management process to enhance its product development capabilities. Another important finding is that Wistron draws on six types of integration to promote knowledge integration which transforms further to organizational capability. With enhanced organizational capability, product development capabilities improve significantly.

Keywords: Knowledge Management, Knowledge Management Process, Product Development Capabilities, Knowledge Integration, Organizational Capability

INTRODUCTION

In the emerging development of global information technology industry, Taiwanese firms create outstanding performance in terms of hardware volume sales. The major businesses come from OEM (Original Equipment Manufacturing) or ODM (Own Designing and Manufacturing) sales. Among all electronic products manufactured by Taiwanese firms, laptop computer ranks first in terms of volume sales (MIC, 2010). Ernst (2000) and Hobday (1995) claimed that OEM/ODM alliances have been a critical business type in the progress of Taiwanese information technology industry. When Taiwanese firms engaged in cross-border OEM/ODM alliances, there are opportunities to acquire cutting-edge technologies and knowledge and to enhance product development capabilities. Chen and Lee (1997) also indicated that ODM firms can experience internal learning and then learn more advanced product technology via OEM alliances, therefore enhancing their capabilities. But they did not mention how the examined firms enhance their own capabilities. Zhou (1998) found that Taiwanese information technology firms enhanced their operating capabilities via learning mechanism during OEM/ODM alliance, but in her exploratory study she didn’t explain the dynamic processes concerning how to enhance the operating capabilities mentioned. Sher et al. (2003) explored Taiwanese firms that engaged in different linkage of international resources, learning capability and relational capability to the influences of firm’s capabilities enhancement. The final conclusion was that firms’ learning capabilities and relational capabilities were key factors to enhance firm capabilities. The characteristics of different linkage of international resources can affect the enhancement of firm’s capabilities too. Even though they has been further divided
firm capabilities into three main categories—research and development, manufacturing, and marketing, they failed to further explain the dynamic process of enhancement of research and development capability. Chu and Huang (2002) explored how OEM/ODM firms developed their internal capabilities through cross-border strategic alliances, found that developing firm capabilities can be seen as a process of organizational learning and identified the learning process as two steps called “knowledge transfer from activities in the alliance” and “the establishment or strengthening of firm capability”. Although this research specified two steps in the process of enhancing firm capabilities and induced the determinants about the formation of these two steps from literature, it still lacks empirical research to corroborate its reasoning. Marsh and Stock (2003) took the perspective of experience learned in project management to conduct research about product development capabilities and realized that although ODM/OEM alliances offer a chance for OEM/ODM to access or acquire customers’ knowledge or technology, the overall firm capability is not necessarily enhanced. ODM/OEM should regard this chance as an activity of organizational learning or knowledge management. In other words, during the ODM/OEM alliance, firms should emphasize how to implement knowledge management in order to convert acquired new knowledge into their own capabilities through knowledge management practices such as digestion, assimilation, preservation and distribution. This research proposed five steps, including knowledge acquisition, knowledge distribution, knowledge interpretation, knowledge preservation and knowledge application, to enhance firm capabilities; however, empirical evidence is still not available. So it is hard to understand the genuine process of the enhancement of firm capability. Following the same idea, Huang (2006) took the perspective of knowledge management to study how four Taiwanese information electronic firms enhanced their own product development capabilities through ODM/OEM alliances. This study shows that firms can definitely enhance their own product development capabilities. Although this study has focused on the process of enhancing product development capabilities, it just divided this process briefly into three steps: knowledge acquisition in the ODM/OEM alliance, internal knowledge processing and knowledge application in individual ODM/OEMs. It is still unable to capture the subtleness and completeness of knowledge management process model so that the nuance in dynamic process of enhancing product development capabilities through knowledge management process is still not identified.

In order to fill the research gaps mentioned above, the author of this paper claims the research about a more complete and detailed knowledge management process model to enhance product development capabilities is necessary. On the other hand, currently the research targeting product development capabilities of research and development department is still immature, so the author proposes to investigate a single company for this issue and takes Wistron Corporation, the third largest laptop computer manufacturer in the world, as a subject of analysis to elaborate successful product development capabilities. From the perspective of knowledge management process, the author tries to develop propositions to contribute to establishing theories.

THEORETICAL BACKGROUND

Nature of Capability and Product Development Capabilities

According to the resource-based view, the acquisition of competitive advantage of firms originated from its distinctive capabilities (Peteraf, 1993; Wernerfelt, 1984). On the other hand, advocates of capability-based view asserted that firm capability is the main source of sustainable competitive advantage (Mahoney, 1995; Teece et al.,1997). Grant (1996a, b) stated that firm capability is an ability to engage in the management or organizational procedures of value-added activities by effectively integrating specialized knowledge of diverse backgrounds.

Brown and Eisenhardt (1995) claimed that as for the product effectiveness of product development performance, the emphasis should be on that if product concept can match market needs with the extended development of company competency. Hsu (2003) explored that Taiwanese firms learn customer’s knowledge, know-how and establish product development capabilities in OEM/ODM alliance from capability development view. Ulrich and Eppinger (2008) indicated that “Development Capability” is the experience oriented from development team and company to enable them to better develop future product. Development capability is an asset the firm can use to develop products more efficiently and economically in the future. Marsh and Stock (2003) indicated that new product development requires the combination of knowledge and skills required to perform useful actions to solve ill-structured problems related to
concept development, product planning, product and process engineering, pilot production and ramp-up, and market introduction. The solution to these ill-structured problems depends on previous experience, formal knowledge, and specific and unmodified or tacit capabilities of the organization members. Because specific firm resources play a significant role in success or failure for new product development, both Zou & Cavusgil (2002) and de Brentani & Kleinschmidt (2004) indicated that the critical organizational factors influencing new product development were corporate culture, past experience, tacit knowledge, traditional practices and methods, and commitment from top management to ensure success. Because product development capabilities mentioned by Marsh and Stock (2003) refer to such capabilities as: product concept, product cosmetic design, internal designer, system integration, product function test, and product development process. These capabilities are highly demanded by research and development department. The study finally adopted the statement from Marsh and Stock (2003) about product development capabilities.

**Knowledge Management Process Perspective**

Among scholars in the area of knowledge management process, Leonard-Barton (1995) proposed knowledge acquisition, collaboration, combination, integration, and utilization from innovation perspectives. Alavi and Leidner (2001) suggested from information-processing procedures: creation, storage and retrieval, transfer, and application. Gilbert and Cordey-Hayes (1996) attributed knowledge transfer to compensation of knowledge gap and suggested a five-step model: acquisition, communication, application, acceptance, and assimilation in order to reach the goal via dynamic learning. Davenport and Prusak (1998) identified three main tasks of knowledge management: generation, coding/coordination, and transfer. Gold et al. (2001) claimed that knowledge management process can be divided into creation, transfer, application and protection and emphasized application to compensate. Nonaka’s (1994) study explored knowledge creation process. From the perspective of information processing, Probst et al. (2002) described a complete knowledge management process constituting eight steps: 1. knowledge goals, 2. knowledge identification, 3. knowledge acquisition, 4. knowledge development, 5. knowledge sharing and distribution, 6. knowledge utilization, 7. knowledge retention, and 8. knowledge assessment. The argument ranging from establishing goals to measuring results is quite complete but lacks empirical support. Dalkir (2005) appreciated that knowledge can generate strategic advantages. So he started from the statement “knowledge is a valuable asset” to propose “an integrated model of knowledge cycle”. There are three steps contained in the model: knowledge capture and/or creation, knowledge sharing and dissemination, and knowledge acquisition and application. Becerra-Fernandez and Sabherwal (2010) postulated four knowledge management processes: discovery (including combination and socialization), capture (including externalization and internalization), sharing (including socialization and exchange), and application (including direction and routine) from the view of cost effectiveness and unit goal attainment, but they have not been substantiated. Folkens and Spiliopoulou (2004) eventually concluded that Probst et al. (2002)” Building blocks of knowledge management is the most appropriate and widely accepted model from the perspective of knowledge management, simply it was goal-oriented and logical with eight management tasks.” Having compared the monograph mentioned above and considered the need for case study method, this author finally adopts the Probst et al. (2002) model shown as figure 1:
This study hereby preceded literature review accompanying with related theories needed as follows:

**Knowledge Goals**

Probst et al. (2002) proposed three levels for knowledge goals: normative goal, strategic goal, and operational goal. Normative knowledge goals pertain to a general vision of company policy and all aspects of corporate culture; Strategic knowledge goals are then set for long-term programs aimed at realizing the vision; Operational knowledge goals help to ensure that strategic programs are implemented in daily company activities. Ideally, knowledge goals at all three levels should complement one another and should contribute jointly to the realization of company goals.

**Knowledge Identification**

Having finished the establishment of knowledge goals, we should review internal and external side of the organization. Probst et al. (2002) indicated that clarifying internal knowledge means to identify the present situation, i.e. let organization realize its core competency, what competencies it owns and how these competencies help its competition, and to identify external knowledge. Probst et al. (2002) indicated the first step is to systematically examine related knowledge incumbent and propose the concept of knowledge gap to help business develop alternatives to fill the gaps. Liebowitz (1999) concluded that there are three important tasks: core competencies, strategy, and knowledge domains for knowledge identification in his suggestion of eight-step process for knowledge management. Cross and Sivaloganathan (2007) suggested five methods to identify specialist knowledge: logbook analysis, stakeholder interviews, process diagrams, project deliverables and meeting minutes, and ongoing capture and maintenance.

**Knowledge Acquisition**

With the rapid growth and fragmentation of knowledge, companies are usually unable to develop the know-how that they need on their own. Companies must make right choices on external knowledge markets to gain access to essential expert and expertise; hence Probst et al. (2002) claimed knowledge acquisition was acquiring knowledge from outside. He also explained that companies may acquire the following knowledge on external knowledge markets: (1) the knowledge of external experts; (2) the knowledge of other firms; (3) the knowledge of stakeholders; (4) knowledge products.
How to obtain the essential knowledge? Davenport and Prusak (1998) pointed out six ways to generate knowledge: acquisition, rental, dedicated resources, fusion, adaptation, and network. Among the six, acquisition and rental belong to this section. Acquisition means to buy an organization. Rental means to hire external specialist which is always the most direct and effective way; others lie in next section. Additionally, we roughly classify that there are three main sources of knowledge acquisition from literature review (Wu and Hsu, 2001; Huang, 2006): customers, vendors, in-house development by OEM/ODM firms. Huang (2006) conducted his research with four Taiwanese information technology firms through in-depth interviews. Finally he found four kinds of interactive learning mechanism: technology sharing between firms, personnel visits between firms, collaboration in problem solving, and joint development of new products.

Marsh and Stock (2003) pointed out as the organization engages in new product development process, problem may come from the lack of technological knowledge to meet market demand, the lack of developed markets for a given technical feature, and/or on other types of uncertainty associated with product development. Therefore, the acquisition of knowledge is a critical component of advancing an organization’s knowledge to solve problems in the new product development. They also ascertained that the acquisition of knowledge generated in prior projects can form the basis for the incremental and iterative process of developing the new capabilities necessary in new product development. Marsh and Stock (2003) summarized that the project audit, databases in computer-aided designer (CAD) systems, engineering notebooks, collections of test and experimental results, market research and results of market tests, project management databases and other activities will all be important to the acquisition of knowledge from prior new product develop (NPD) projects.

Finally, Cohen and Levinthal’s (1990) research about main activities of research department focused on how to acquire external knowledge systematically, but not on how to engage in new procedures and product study from internal sources. This research implied that researcher can come up with solutions through studying expert’s monograph rather than through experimenting. Their findings emphasized the unique potential about acquisition of external knowledge.

**Knowledge Development**

Besides knowledge acquisition in previous section, there are four ways to generate knowledge- dedicated resources, fusion, adaptation, and network. Dedicated resources include establishing accountability of units or groups. The need for every company to set up research and development department is a good example in order to develop new knowledge used in new product. Fusion is an action from management authority to bring people with different backgrounds together to work on a problem or project for forming a holistic answer. This viewpoint is identical with what Leonard-Barton (1998) mentioned “creative abrasion” which is a way to find out answer through common effort for specific program; Adaptation means to develop new knowledge to adapt external changing environment in advance and to inspire a sense of crisis to better react to unexpected events; Network means to utilize internal ways of communication within organization to generate new knowledge. Furthermore, Johnson (2009) indicated in response to the elimination of middle management and recent changes in organization structures, the growth of information technology, and increasingly competitive global economy, effectively managing knowledge network has become more important within recent years.

Probst et al. (2002) claimed that knowledge development is the most important building block in the knowledge management process. Knowledge development includes the management efforts which intend to obtain lacking capability or the ideas that have not existed. Because product innovations become more complex today, knowledge development has been promoted from individual level to collective level to precisely match customers’ needs. Probst et al. (2002) suggested four ways to develop collective knowledge: Think Tanks, Learning Arenas, Lessons Learned, and Scenario Techniques. Probst et al. (2002) explained that the most likely scenario to develop collective knowledge is a number of groups in the modern organization. When creating the environment for promoting knowledge development, the management should reward more to the achievement of group cooperation. They indicated that group members can pioneer new technology together, analyze culture, improve efficiency of research procedures, and develop sales strategy. Groups become more dependable when it comes to the important tasks and projects. The group performance of these tasks usually brings in new knowledge to the organization and expands abilities at individual level. Huang’s (2006)
study found that Taiwan OEM/ODM firms would set up cross-functional project team to ensure the communication of product development at each phase with customers in order to avoid deviations from customers’ expectations. Folkens and Spiliopoulou (2004) studied knowledge management system with perspective of measurement afterwards, pointing out that emergence of new concept could occur every corner within the company. They recognized that knowledge creativity is not always exclusivity within certain departments (e.g. research and development department) and suggested that management authorities adopt cross-functional project team to eliminate this constraint.

**Knowledge Sharing/ Distribution**

Probst et al. (2002) recognized that knowledge sharing and distribution is about organization and communication of knowledge asset owned by individual or organization to potential users. Many companies realize the importance of distributing knowledge to the appropriate user. Knowledge sharing and distribution occupied significant position in knowledge management and could be used to strengthen competition elements such as time and quality.

Marsh and Stock (2003) explained that the distribution of knowledge is central to the interactive, problem-solving process of new product development. This knowledge may exist across functional, geographical, or organizational levels.

**Knowledge Utilization**

Although finishing above steps, companies cannot capture the value of knowledge until knowledge is fully utilized. Shin et al. (2001) pointed out knowledge utilization is used to build the position of competitive advantage and explained that the key is how to integrate internal and external knowledge into the organization for the purpose of competitive advantages. A company may have outstanding processes to identify and develop knowledge and still fail. If it does not apply its new knowledge, no benefit is achieved and the effort was non-rewarding. All building blocks of knowledge management must be directed towards the efficient use of individual and organizational knowledge in order to reach goals; therefore, Probst et al. (2002) claimed “knowledge in action is the most meaningful measure of successful knowledge management, since the productive application of knowledge is the only way to translate it into visible results”. Additionally, Marsh and Stock (2003) indicated when an organization meets problem and then seeks solution in the process of product development, it may use the acquired knowledge. They explained recently to deepen and enhance the current action for settlement of the issues encountered.

**Knowledge Retention**

For an organization hoping to manage its knowledge to access in the future, Probst et al. (2002) suggested to master at least three basic processes in knowledge management: (1) select; (2) store; (3) update. Marsh and Stock’s (2003) study indicated managers should engage in setup three types of database for knowledge retention: (1) databases of technical and marketing information from prior projects; (2) databases of job performance reports; (3) databases of seminars and workshop related to technological issues and advances.

When an organization accumulates plenty of knowledge, it may be easier to learn and create new knowledge. Organization memory is a basic reference point for an organization to think about new methods and is helpful to inspire new ideas. Organizational memory is derived from knowledge storage of organizational history that is beneficial to current decision-making; therefore, Walsh and Ungson (1991) suggested three imperatives for considering organizational memory: (1) fully specify the locus of organizational memory (i.e., its retention structure); (2) examine the process by which information can be acquired, stored, and retrieved from this retention structure; (3) investigate precise ways by which the use of memory is consequential to organizational outcome and performance.

**Knowledge Assessment**

From the knowledge goal section we know the first step for successful knowledge management is to establish knowledge goals. In order to measure the extent of knowledge management implementation, we should quantify and objectify knowledge, which mean to separate it from particular situations, times, and people. Similarly, knowledge can only be recorded indirectly with limited precision. Because it is not easy to quantify knowledge, Probst et al. (2002)
suggested two phases to evaluate knowledge process: (1) changes in knowledge base must be made; (2) changes that can be interpreted in relation to knowledge goals. The two phases often incur misunderstanding because evaluating knowledge does not mean calculating its momentary values. They mean to decide whether or not knowledge goals have been met. If an organization fails to measure its knowledge and the ways in which it has changed, the cycle of knowledge management remains incomplete; Additionally, Probst et al. (2002) suggest different measurement for different level of knowledge goals. For instance, in order to measure whether an organization owns a culture of perceiving knowledge, the best way is to visit and observe its employees. When measuring strategic knowledge goals, we should pay attention to changes in vital competencies. When approaching knowledge goals, management should not be regarded simply as a system of goal-setting and testing. It should create environments to promote attainment of the objectives.

Knowledge measurement provides information to managers for their decision-making about knowledge management. The result of knowledge management procedures can show viable areas of knowledge management that is multi-dimensional and be divided into quantitative and qualitative indicators. In the measurement of knowledge, Kaplan and Norton (1992) pointed out balanced scorecard that represents four perspectives: customers, finance, internal business processes, and employee learning and growth to provide linkage between company activity and knowledge management; therefore Probst et al. (2002) considered balanced scorecard is a strategic management tool that seeks to link company activities to knowledge assessment.

RESEARCH METHOD

Case Selection

This paper aims to explore how the research and development department of OEM/ODM firm enhances product development capabilities with the perspective of knowledge management process. Therefore, “exploratory research: in-depth interview method” is applied. The author intends to capture the current situation by in-depth interviews and field observation and to further analyze it with relevant theories. Finally the author tries to derive propositions and to reach conclusions and suggestions.

This subject company is selected based on Eisenhardt’s (1989) principles of case selection. The author identifies the targeted population – laptop computer ODM firms of Taiwanese high-tech electronics and information industry since the single industry may encounter lower variations and benefit external validity. This study follows the principle of theoretical sampling (Eisenhardt, 1989) to select companies researched. The selection criteria are: (1) the leader of Taiwan laptop computer manufacturers; (2) the candidate firms should own product development capabilities. Wistron Corporation is chosen simply because it is one of four leaders of Taiwan laptop computer ODM firms. Its audited financial statement of 2009 shows its dollar sales of laptop computer account for 17.7% of global sales of laptop computer. Moreover, Wistron Corporation inherits the research and development capability from Acer Computer which built worldwide coverage of research and development and enjoyed ingrained culture of repair and maintenance services (http://www.wistron.com.tw). That’s why Wistron Corporation is representative of this study.

Data Collection

Both in-depth interviews and gathering of secondary data are two major research methods for this paper. Data gathering includes primary and secondary data. Other than primary data from in-depth interviews, industry background and overview, Wistron official website, annual reports, registration statements and academic thesis and journals are broadly referenced in order to objectively understand different dimensions of Wistron Corporation such as OEM/ODM business model, strategic positioning and product development capabilities.

Primary data was originated from the in-depth interview with Chief of Staff Office Mr. L, General Manager Mr. S and Manager Mr. C of Notebook B.U.I., Senior Director of Hard Ware R&D Center of Notebook B.U.I. Mr. I and Head of Division of Training & Development Center Mr. C. Before each company visit, the author forwarded interview guideline to interviewees for preparations in advance. Three interviews were held with 10 different interviewees during Feb. 1999. Each interview lasted three hours and conversations were arranged into literal scripts. The author also sent e-mails for important details and followed up by telephone. Meanwhile the database for this case visits was built in
order to increase reliability (Yin, 1994).

As for the completeness of data collection, Theoretical Saturation is used as a guideline (Glaser and Strauss, 1967). Additionally, this study implements data analysis by combining data collected and analysis process (Glaser and Strauss, 1967) to enrich the content of the case.

CASE DESCRIPTION

About the Case Company

Wistron Corporation, formerly known as Acer Computer Co., Ltd., is composed of three departments, including Design and R&D, Manufacturing, and After-sale Service. Formally founded in 2001, the company was listed in 2003 and currently has a capital of NTD18.64 billion, and 4,360 employees. It is one of the leading information and telecommunication (IT) product professional design and OEM/ODM factories in Taiwan and the world and also one of the four leading manufacturers of laptop computer, with 3 R&D support centers, 2 technology parks, 5 manufacturing bases, 6 customer service centers, and 4 global servicing centers spread around the world. The laptop computer is the company’s main product and accounts for 80% of revenues, while the other products account for 20% (http://www.wistron.com.tw).

INTRODUCTION OF INTERVIEWS

Knowledge Goals

This study found from the interviews that the sequence to establish the knowledge goal starts from the whole company with an annual overall knowledge goal, which is displayed in the balanced scorecard, such as assuming the total number of patent cases for the whole year. This overall goal will be classified into each project from the top downwards. On the balanced scorecard, the standard value of the overall knowledge goal is constructed based on two elements: the first is the establishment of the analysis unit, and second is the sources of knowledge goal, so that it can successfully implement the knowledge that should be shared by each individual in various departments or each project, as described below.

First of all, the knowledge goal is built on the basis of two analysis units: first is the project team, which is a design-oriented cross-functional team and of the organization type grouped for a temporary task for the promotion of about 30 projects a year. Wistron proposed to establish such a project team to provide a complete service to the customer’s orders of new products within the period from the quotation till the end of the product life cycle, and in each stage of the Product Development Process within every project team; Wistron set a knowledge goal for each key issue. For example, there are indicators to measure key issues, such as power consumption, performance, and prices, for the laptop computer system as proposed in the knowledge goal. This study made an in-depth understanding of the content of the project team and found that each project team shall complete two major stages sequentially, and each stage includes four small cycles. The two major stages are: (1) the design stage, which consists of four small cycles including price, design, experiment, and engineering. (2) The production stage, which consists of four small cycles including mass trial production, pre-mass production, mass production, and the end of life cycle. In each small cycle of the project is a knowledge goal set for each key indicator. For example, in a small cycle of the design, the knowledge goal was set for safety specifications (such as, radiation control) to control the number of radiation within a certain range. In the small cycle of experiment, the knowledge goal was set for the system power consumption in power source management of the laptop computer. Currently, the knowledge goal of system standby power consumption has improved from 10 to 20 watts in the past to the current 5 to 8 watts. Furthermore, in the small cycle of engineering, the knowledge goal is set to the average time for producing a laptop in order to facilitate the calculation of the manufacturing efficiency in the actual production. The other analysis unit is R&D Department, which is a permanent unit of the formal establishment and also the respondent unit of this research – the Hardware R&D Center under the Notebook Computers Business Unit. The unit is responsible for the promotion of company-wide balanced scorecards. And this card is used company-wide as the most important and thorough performance evaluation tools in support of the achievement of the annual budget. From
the president down to every employee, all have their respective performance indicators that they should be responsible for as well as the standard values that they should reach. Thus, this study takes the Hardware R&D Center for example and confirmed that all the managers to all the engineers in the balanced scorecard have their own knowledge goal to reach annually. Take patented inventions for example to explain in detail the process of promoting the knowledge goal of patent. Each engineer’s knowledge goal is to complete at least three approved patents per year, so each engineer has their own respective knowledge goal to endeavor and motivation of learning. The achievement of the knowledge goal of the patent is coped with measures of incentives. For the engineer who has made a successful patent, the company will award an appropriate bonus and also mail the results of the patent to the relevant personnel to share the knowledge and praise the inventor, as a form of non-monetary incentive. Further in-depth understanding reveals that the mail will list the names of the patent applicants in order to encourage them. The patent application submitted will be awarded NT$200, and the patent approved will be awarded NT$2,000 or even NT$30,000 as the upper limit.

Secondly, more in-depth tracking of how the two units of analysis obtain the necessary knowledge goals required by their operation thus found three kinds of sources of the knowledge goals: (1) Specified by the customers; (2) Provided by the manufacturers themselves, or developed by Wistron in cooperation with the manufacturers; (3) Set within Wistron. The first one is through contacts with customers to have the chance to obtain the knowledge goal required by Wistron. Take as example the international brand manufacturing customer “B” who provided software technology that required keeping smooth operation of the Driver “details as below—KNOWLEDGE ACQUISITION.”

The knowledge goal established by Wistron is to make each of the tested sample pass through the software function testing of the Driver. Each tested Driver should be properly started and is required to pass through the checkpoint smoothly. Once established, this knowledge goal will serve as the important criteria to determine whether or not the Driver of the tested samples can be used in normal operation in the future.

Knowledge Identification

Wistron has four ways to identify technical knowledge: (1) Through Value Innovation Centre: All design experts with key technology knowledge of laptop computer are concentrated in the A team. The official name of the A team on the organization chart is the “Value Innovation Center” and its function is to be in charge of the development and introduction company-wide innovative products and technology. All design elites are gathered here, and the R&D personnel will hold a fixed lateral meeting every fortnight, so it is not difficult to identify the knowledge of these experts. The experts of the A team are also able to identify the company’s knowledge gaps. (2) Through the database of the R&D Center: In the relevant information of laptop computer technology, employees can search for what they want through the R&D Center research constructed database system. (3) Through the online learning platform: Wistron has written a basic knowledge like Electronics into technical documents, which is the kind of “scientific knowledge” that Leonard-Barton (1998) classified as a type of employee knowledge and skill. The most basic knowledge of the industry, namely, the knowledge that every engineer should understand, is placed on the online learning platforms for all the employees to see, and a fixed learning time is scheduled to facilitate communication between personnel of other departments and engineers. (4) Through the interaction between departments: On the aspect of areas of knowledge, the way for R&D Departments to identify the knowledge required in the future is to rely on the interaction of Sales Department. After an in-depth understanding of the situation of interaction, it was made clear in this study that for Wistron to service customers, its R&D Department must take the initiative to communicate and discuss with the Sales Department on the product line and product map. To cope with the budget system, at the end of every year, the Sales Department is required to plan out a sales budget for the following year, work out the product trends for the following one or two years with the R&D Department, and list in the product line and product map the laptop computer models that should be developed for the product trends. Thus, the interaction with the current intellectual environment will result in the awareness of the knowledge gaps in the following one or two years and seeking measures to fill in advance.

Through the four channels to conduct the knowledge identification and after comparison with the competition industry, it was found that the main difference in R&D activities among manufacturers is in the capability of the system integration. The so-called system integration refers to the process of integrating the eight key technologies when designing new products (i.e. power-saving technology, power management technology, basic input/output software and
hardware technology, wireless integration technology, audiovisual technology, broadband technology, cooling technology, and input/output technology) into the short, small, light and slender laptop computer. It was known from the interview that most of such technology uses tacit knowledge, which is difficult to imitate, so the best way to learn is through direct face-to-face teaching. To illustrate how this capability helps enhance the new product development capabilities, the product O of the small laptop model for customer A was taken as an example, illustrating the three key steps of the operation of the system integration: (1) At “quotation” in the first stage of the life cycle of the new product projects, the project manager will hold a meeting with the Sales Department in order to understand customer’s specific requirements in compatibility, strength, material, and low price on this model laptop. In the strength requirement, for example, as customer A requires the battery life to be up to two hours and resistant to falls, the project manager will conduct identification of knowledge after the meeting, in order to effectively control the personal specialization knowledge and integrate it into the project. As the design elites are concentrated in Team A and the Hardware R&D Center, and the meeting for a fixed horizontal links is available, it is not difficult to get identification experts integrated into the project. At this point, the members who were integrated into the project are all proficient in one part of the eight key technologies. After the establishment of the project, the members will compile the Bill of Material and list in the Bill the abovementioned customer needs (such as the life cycle of two hours and resistance to fall), and will also pay attention to software and hardware compatibility and safety requirements (such as: radiation control and regulations) to comply with the specific requirements of the order. (2) When the project enters the second stage “Design,” experts using the eight techniques will focus on the design in accordance with the specifications, which means the Bill of Materials should bear a battery of 3 Cell (2000mAH). In order to meet the needs of being resistant to falls, the expert in charge of the appearance made the final decision to use a plastic case. This plastic case should also be resistant to falls and high temperatures.

So the eight technologies are inter-linked with one another, and the comprehensive knowledge will be integrated into the very small space. The eight technologies after knowledge integration at this stage will form a whole “product R&D capability” of R&D Department. This knowledge after integration must pass the third stage “experimental” and must go through the three major tests: hardware, software, and function. After the knowledge required for the three tests (such as two hours of life cycle in this example) are all integrated, the organizational capacity is formed; and at this point the organizational capacity has been non-individually formed with any employee. The integration of the eight technologies relies on the basic scientific knowledge (such as electronics, electromagnetism) as a common language for the communication platform, which is consistent with what Grant (1996a) described as the commonality of specialized knowledge. From interviews, it was made aware that they have outstanding performance in the design capacity of body parts and also attach importance to the design speed. For example, in terms of a particular model, it takes at least two months from R&D to mass production, with an average of about three to four months; the latest being six months. This section concludes that there is evidence to support Wistron with many advantages in the system integration, so that product O manufactured at a flexible speed and shipped within two months can meet the specific needs of customer A, and thus enhance product development capabilities. Therefore, the following proposition should be established.

**Proposition 1:** The higher the system integration capability, the higher the product development capabilities.

**Knowledge Acquisition**

Wistron has acquired laptop computer key technologies through five sources: (1) provision by clients; (2) provision by vendors; (3) inquiries from others in the same line of work; (4) participation in new technology seminars or online search; and (5) buying patents, as described below:

In terms of client provision, when asked whether or not the clients could provide the key technologies needed, the clients would usually provide patents of models needed to complete new product projects in order to avoid unnecessary commercial disputes in the future. However, this method has been used less because a meeting is held with the clients once every half a year, thus fewer interactive opportunities. In addition, Wistron’s key clients are mostly leading laptop computer manufacturers, and most of these manufacturers have assigned special personnel stationed in Wistron. Thus, they can contribute to improving the areas of users’ product dissatisfaction with the joint efforts of the Wistron’s R&D personnel. Targeting the areas of dissatisfaction, Wistron has also promoted the six sigma improvement plan, thereby
allowing the various projects to contribute positively to the innovative improvement. The last type of clients provides technologies through joint development. Take Driver software technology for example, how the technologies under this method are obtained from the client end has been described. First, customer B provides software technologies under the premise of module standardization and through joint development. Thus, customer B allows Wistron free access to the source program of the Driver software technologies through the open source method. This method has been adopted by customer B for the purpose of lending Wistron a Driver software technology learning opportunity. In addition, as customer B has long applied for the patent of this software technology, Wistron’s use of these technologies will not lead to an infringement. To the engineers at Wistron, the most important part of the open system is that it is an opportunity for them to gain an insight into customer B’s original design and style of the Driver software technology while the access to customer B’s core design and source codes allows the engineers to learn about the technology and have it written as technical documents to be stored in the database after review by an executive, thus the acquisition of technical knowledge will come to completion. In this paper, three types of client cooperation have been summarized: client provision of patents, client stationed to provide guidance, and joint development technology. Regardless of which of the three types can provide Wistron with the technical knowledge, the executive said that one benefit of such cooperation is that Wistron can lead the industry in terms of technology for up to three to four months, thus increasing the product development capabilities. The following proposition is therefore likely to be true.

**Proposition 2:** The higher the integration capability of clients, the higher the product development capabilities.

Supplier provision may be divided into three methods: (1) through presentations made by suppliers; (2) through strategic alliances; (3) through collaboration. All these three sources allow a supplier to acquire knowledge. To acquire knowledge through the first method, the management authorities first seeks relevant technical knowledge through the various channels before launching the various new model R&D projects. For example, by following the practices of Hardware Vendor I, new technical knowledge needed in OEM is sought from the raw material specifications. In particular, the search begins from the first stage of the project life cycle, which is the “price quote.” Through the bill of material (BOM) of various product models, the component suppliers are first found to acquire the knowledge needed. In order to seek orders, most vendors are willing to showcase their new technologies. For example, the vendors showcased their TFT touch panel, and the engineers learned about this technology and integrated it into the new products to cut down the keyboard costs. In the second method, Wistron sought suppliers through the strategic side. It has been found through interviews that Wistron had actively deployed the joint venture type of strategic alliances with the key component suppliers at the time, through which three advantages were expected to be achieved: have access to stable sources of supply, acquire relevant technical knowledge, and achieve the global logistics objectives. Thus, the top decision-making cadres have been very particular about the integration capacity of the upstream in order to have a competitive edge in terms of quality, price, and delivery time. According to General Manager Mr.S. “Our improvement plan is to find upstream component vendors as targets for the strategic alliance. In the face of a shortage of components in the upstream, Wistron has endeavored for the upstream layout, and well-planned improvement has been underway in recent years (for example, in terms of the optical aspect, we have co-founded WisVision Corporation with the upstream vendors in order to acquire stable backlight module material supply sources.” This alliance method is known as “supplier integration”, through which material knowledge can be acquired. This viewpoint coincides with that of Steensma’s (1996). According to him, “Cooperation or alliance has become important source of knowledge acquisition”, especially when there are only a few OEM/ODM for laptop computers around the world at present. In order for the OEM/ODM to provide more comprehensive services to clients, they have engaged in upstream integration and thus knowledge acquisition through this method is considered an important source. In addition, it was found during the onsite visitation process that chairs were placed by pairs along the Company hallway, and all the seats were taken. The researcher further found after inquiring from the executive that the project engineers and components vendors were exchanging information. This arrangement not only saves space, but also prevents R&D Department data leakage. Thus, this phenomenon confirms the correctness of the description in this paragraph. The third method can be further divided into two types: (1) collaboration design; and (2) collaboration test, the former being conceptualized by Wistron dated previously. Specifically, the design concept is devised six months
before launching a new product, during which time Wistron’s departments, project personnel, and raw material suppliers engage in undertaking different project stages. For example, touch screen (multi-touch screen) vendors have been included in the project design collaboration. Moreover, through the concurrent engineering method, the vendors can simultaneously interact with Wistron. In addition, in the latter collaboration test, Wistron also assists software vendors and parts vendors in performing tests, some examples of which include Software Vendor M’s software testing prior to the launch of Win 7. Similarly, if Hardware Vendor I wish to launch laptop computer ICs, Wistron will also take part in the design and testing. Thus, the third method is also known as “supplier integration.” The achievements of Wistron in terms of supplier integration have been summarized in this paragraph to help enhance the product development capabilities; thus, the following proposition is therefore likely to be true.

Proposition 3: The higher the supplier integration capability, the higher the product development capabilities.

The other three knowledge acquisition methods are: (1) inquiring from others in the industry; (2) participating in new technical presentations or online search; (3) buying patents. Wistron rarely spends money on patents because of the scarcity of channels and difficult acquisition. To summarize, the three methods in this paragraph used derived at little knowledge, so clients and suppliers are still important sources of external knowledge acquisition. After the in-depth tracking of the knowledge acquisition from the Driver above, it was found that the follow-up activities had been used in “knowledge goals” section as the knowledge targets while the “experimental” stage of the product life cycle served as an important basis for testing whether or not the driver inside the laptop computers perform normal turnover. The software testing function performed at this test point ensures normal factory Driver quality, which in turn enhances product development capabilities.

Knowledge Development

Based on the interviews, three directions of knowledge development have been found: the cultivation of staff creativity, the cultivation of the staff’s problem solving, and innovation in problem solving. First, in terms of the cultivation of staff creativity in laptop computer design, Wistron cultivates creativity through education training and knowledge sharing; therefore, the creativity of individuals and Team A are included in the scope. Then, in terms of the cultivation of the staff’s problem solving, Wistron completed it through two aspects. (1) In terms of Standard Operating Procedure (SOP) modifications, SOP basically includes two testing processes, namely mobility and fixity. In terms of mobility, if errors are found in the SOP, the R&D personnel will first confirm the errors and then gather the lecturers to engage in panel discussions targeting the frequently occurring errors or devise the mobile-type of solutions; in terms of fixity, the SOP has a major overhaul at the end of every year. (2) Creating a debugging collection. To devise solutions for the frequently occurring errors, a debugging collection that covers the debugging steps is created and is stored in the database for inquiries needed to facilitate the flow. (3) Innovative problem solving. Innovation not only the abovementioned involves technical innovation, but also problem-solving innovation. At present, the six sigma coupled with multiple projects are carried out simultaneously. For example, the Maintenance and Post-sales Services Department first reports the problem of the slow laptop computer cooling to the R&D Department. The R&D Department shall then launch the six sigma improvement plan, determine the design drawings of others in the industry provided by the Maintenance and Post-sales Services Department, and model the strengths of the others in the industry in terms of the circuit design in order to make changes and finally solve the cooling problem.

In addition, in order to ensure the knowledge development work is in compliance with the Company’s goals, Wistron has adopted the “Company’s overall integration” method. The approach is to set the company-wide annual knowledge goals (such as the number of targeted patents in a full-year) while the technical knowledge goals are included in the 30 projects promoted the same year. Then, the eight small cycles of R&D, manufacture, and maintenance activities are used to connect and implement the Company’s goals. In addition, the technical knowledge goals in the “R&D→manufacture→maintenance” series are connected through the database. From this series, it has been found that the Company’s overall integration begins from the design, passes through manufacturing, and finally is extended to the maintenance. Based on the interviews regarding the specific approach of Wistron’s management authorities, it has been found that the overall knowledge goals are implemented throughout the departments and on
every staff member by order of the Chairman through the balanced scorecard. For example, in terms of patent inventions, the goal of having each engineer complete three (or more) approved patents every year has been achieved. Because of Wistron’s dedicated efforts in the Company’s overall integration, the patent targets have been achieved, which have in turn enhanced the product development capacities. The following proposition is therefore likely to be true.

**Proposition 4: The higher the Company’s overall integration capability, the higher the product development capabilities.**

**Knowledge Sharing/ Distribution**

Wistron shares and distributes knowledge through four methods. (1) Through project and mobile dispatch. When developing new laptop computer models, at the time the new project team was established, the project supervisors assigned tasks to individuals through labor division. The supervisor would adopt the mobile type of technical knowledge distribution depending on the specialization and proficiency of the R&D personnel. For example, staff member A with skilled expertise was assigned tasks outside his area of expertise. (2) Distributing one laptop computer for every person. For employees scattered around the world, Wistron shares and allocates technical knowledge by distributing one laptop computer for every person so as to allow them to have access to the database and internal online learning platform, thereby helping to keep up with the R&D personnel’s areas of expertise and technical knowledge levels. The basic knowledge of electronics on the other hand is learned by personnel from the other departments. As for high-end or complex knowledge sharing, because all the R&D personnel work on the same floor, direct and face to face interaction have been adopted; as for long-distance knowledge sharing, e-mail and video conferencing have been adopted while each person received one laptop computer as a medium for learning. (3) The database and online learning. The R&D personnel at Wistron pass on knowledge through the database and online learning platform while experts capable of independent processing in their respective areas of expertise are mostly senior employees that have rendered service for many years. These employees share knowledge with others by inputting it in the database. Wistron has put professional knowledge into technical documents and has allocated personnel responsibilities in the project organizational framework. One criterion for a technical expert is that he must be capable of processing technical problems in some applications and must demonstrate leadership in order to lead others. (4) The best practices of sharing.

Wistron currently introduces the best industrial and departmental practices through the six sigma and balanced scorecard. Thus, a special assignee is assigned to evaluate each key characteristic, which becomes a benchmark. Clients evaluate the quality, price, and so on and give scores accordingly, while the project members ask around about the client scoring methods and discuss ways to achieve the goals. The ratings shall form the best practices later on. In terms of experience sharing, Wistron has managed to timely update, and the authorization passwords can be used by the relevant personnel in order to acquire the knowledge needed.

The key to completing knowledge sharing lies in the existence of knowledge. Knowledge sharing and distribution environment is considered complete only if the current knowledge stored can be retrieved by those who have potential needs. In this regard, Wistron can quickly copy and pass the new knowledge developed through the database and project manager review to others in need. In addition, as the development department personnel are all working on the same floor, when problems arose after communicating by e-mail or phone, they directly talked about the problems face to face, thus the smooth knowledge sharing. However, as the R&D Department and the Hsinchu Plant held different views on “manufacture integration”, there was poor communication with the Hsinchu Plant in Taiwan due to the distance.

“Manufacture integration” is a practical term used by the R&D Department, which refers to the interaction between the R&D Department and Production Department and the coordination mechanisms that allow the R&D Department to efficiently mass-produce the prototypes in the Production Department. In this mechanism, there are three types of interactions between the two sides; knowledge sharing, joint problem solving, and R&D personnel’s visitation to the factory. In knowledge sharing, the R&D personnel share the prototypes and design knowledge with the factories through circuit diagrams and integration technologies so that the prototypes can pass the three tests (quality assurance, manufacturing efficiency, and engineering test) conducted in the factory with coordinated actual production conditions; joint problem solving refers to the design, process, and quality related problems due to the distance between the two
sides. Thus, based on the understanding of the database and opinion exchanges through e-mail and phone, as well as the integration of the various fields of knowledge, practical problems encountered by the counterpart can be solved. R&D’s visitation to the factory refers to the R&D personnel visiting the factory, which is the best solution strategy when communication by e-mail or phone fails. The Department Head said that there are no communication barriers. In short, the three interactive methods as a whole involve the integration of knowledge for the purpose of achieving the common goals of both sides while the organizational capacity after the integration is known as cross-functional capabilities, as proposed by Grant (1996a). If the capabilities exceed those of the competitors’, competitive advantage can be produced.

Although many studies have shown that the promotion of knowledge sharing and distribution will lead to psychological barriers (regardless of whether or not it is the knowledge sender or receiver), as well as the corporate culture barriers; however, it is not a cause of concern for Wistron because it has long attached importance to the “humanistic management” and “innovation” culture (Chou, 1996). In addition, it has been found from interviews that Wistron adheres to the culture of knowledge heritage, and there is mutual trust among the employees, which are conducive to knowledge sharing and distribution. In addition, Huang (2006) pointed out that to engage in OEM/ODM undertakings, most high-tech companies adopt the project-type approach to take orders and engage in product design. To achieve this end, Wistron is also able to execute accordingly. The project manager assigns the contributions or required knowledge to be learned by the employees in the project based on the knowledge goals and current capabilities of the employees (referring to the employees’ areas of specialization and proficiency). The Department Manager also said that in terms of promotion, “First, battle! Every engineer has the pressure to learn, so forced-learning is faster.” For example, the supervisor assigns an employee with skill A which is not his area of expertise when a new project arrives, which is called “work rotation” in human resource management. In view of knowledge management, it is the distribution of knowledge. The management authorities should ensure every employee is assigned responsibilities in the project organizational framework based on the above arrangements. In addition, the experts that can independently process technical knowledge inside the laptop computer business department can independently process the technical knowledge and place it in the database to share with the colleagues. As for how the Wistron’s employees scattered around the world share the abovementioned knowledge, it has been found in this study through in-depth interviews that each employee is equipped with a laptop computer, and based on their access rights, they can have access to the database and internal e-learning network platform and share with others via e-mail.

In summary of the abovementioned specific practices of knowledge-sharing, coupled with Wistron’s effort to encourage the engineers to engage in technical knowledge innovation, pass on knowledge, give focus to the culture of professional growth, and put to good use the opportunity to enhance employee competency through project learning, particularly the interactions of the three types of “manufacture integration” mentioned above, have all contributed to the success of the mass production. The following proposition is therefore likely to be true

**Proposition 5: The higher the manufacture integration capability, the higher the product development capabilities.**

**Knowledge Utilization**

In terms of knowledge utilization and taking HDMI (High-Definition Multimedia Interface) for instance, Wistron has adopted the four measures in order to make the technical knowledge available to the employees. (1) Placing the HDMI technology in the knowledge base. In Wistron’s knowledge system, the engineers can conveniently access databases of this type that meet their own needs through the exclusive database system of accumulated technologies constructed by the R&D Center. (2) Placing the basic skills on the e-learning platform. (3) Establishing the “lesson learned”. (4) Distributing one laptop computer for every person and common area. This encourages employees to apply the required technical knowledge in daily routines. Moreover, the employees work together (normally through online laptop computer connections) and share a connected common area (such as the R&D personnel working on the same floor), direct and face-to-face communication is facilitated.

The four measures serve as proof that “knowledge should be placed in locations accessible to employees” described by Probst et al. (2002). It has been found in this study that the two coordination methods, namely, the culture and the learning activities, allow the abovementioned four measures to be fully accessible to the employees, thereby enhancing the product development capabilities of the R&D Department. (1) In terms of culture, it has been explained
in the preceding paragraph that the many interviewed participants said that the employees at Wistron have displayed team morale and the willingness to achieve the corporate goals. Take the interview units for instance. In order to make it in time for exhibitions, the accountable engineers were willing to work overtime for consecutive weeks to make sure the samples passed the software and hardware testing, which in turn contributed to the success of the product integration. (2) In terms of learning-activity coordination, Wistron has enhanced the product development capabilities through four types of important learning activities, one of which is putting to good use the on-the-job training opportunity and incorporating the technology into the practical context in order to increase the employees’ technical knowledge use. Thus, in terms of the use of knowledge, the management authorities have made good use of the professional learning opportunity to ensure the project accountable employees battle first before undergoing training or learning. Secondly, fixed topic-discussions are held weekly. In order to support a culture of innovation, fixed topics are scheduled every week to discuss the self-developed new technologies while the relevant details are included in the discussion in order to facilitate idea exchanges among those who share common goals. Thirdly, senior employees should provide guidance to newcomers. If new employees lack knowledge of some sort, the Development Center will regularly send special staff to provide instructions. Fourthly, in terms of external sharing, another opportunity for the employees to use new technologies is to apply the new technologies introduced by the raw material suppliers in their work, particularly the use of the multi-touch screen, 3D animation, and other new technologies in technology integration. Take the latest 3D animation innovation recently introduced by the cadres for instance; the new knowledge has been displayed to customer A through expert instructions and face-to-face communication, thus saw a sound sales performance in Europe.

**Knowledge Retention**

Four foci have been found after the interviews: knowledge transfer, retention, experience heritage, and management and acquisition, which are explained as follows. (1) In terms of the knowledge transfer from senior employees to newcomers, most senior at Wistron have been able to transfer knowledge to their successors. When a set of design data is completed, the engineer will immediately record the data and input it in the database, so the technical knowledge of former employees is constantly updated, and the design data can be stored in the database in text or graphics. In an ongoing project, if the technical knowledge of a former employee is to be transferred to his successor, the successor can understand and take over with the help of the database, and the former employee’s work shift. (2) In terms of the retention of technical knowledge, Wistron is able to provide its employees permanent access and acquisition of new technologies that have been successfully developed. Wistron does exceptionally well in this area because Wistron is a listed company that operates in accordance with the procedures, so the activities in fragments are connected, and the procedures are regularly updated. In this operating system that retains technical knowledge through the procedures rather than manpower, the key point of each procedure comes with a checklist. The knowledge goals in the checklist are use to examine the difference between the actual work results of the key points, the expected work standard values, and the expected work progress to determine whether or not they are consistent with the established specifications. The process contains a full range of knowledge from the price quotation stage of the project lifecycle to the product quality testing before delivery, as well as the loading, customs clearance, and shipping related knowledge. In addition, in terms of the integrity of the process, Wistron maintains the latest and most detailed SOP in every stage of the product life cycle. This study has gained an insight into the abovementioned “regular updates. Regular updating refers to minor modifications made on the SOP in compliance with the client’s provisional instructions (approval from the first-order executive of the undertaker is required); it is a necessary and large-scale measure conducted every October in coordination with the annual budget system. Due to Wistron’s comprehensive measures, clear and appropriate information is retained in every SOP. Moreover, the accuracy of the information used has to be confirmed through knowledge integration of the SOP before shipment, thus the name “product integration.” In short, Wistron relies on well-planned product integration in which the fragmented and scattered knowledge in every product life cycle is integrated into appropriate SOP to become organizational capacity; in addition, sound indicators at the time of the six sigma condition are also included in the process to examine the checklist. Therefore, clear and appropriate knowledge is retained in every process. (3) In terms of the laptop computer experience heritage; the R&D personnel transfer the successful or failed experiences of laptop computer development to others through face-to-face communication and
sharing. If necessary, the employees will amend the SOP to maintain the latest standard operating procedures, and the immediate supervisor will review the technical documents every week, take the initiative to stay updated and research, and record accordingly in order to learn lessons and retain the knowledge. Some experts who are role models of successful experiences as a result of technological breakthroughs in the practices have transferred the secrets to the technological breakthroughs into the checklist while the key points established in the SOP have served as a benchmark and have become an important part of the SOP, all of which have been included in the database in order to retain the memory of the model professional technologies in the organization. The management authorities conduct review every three months or six months to update major successful experiences of laptop computers. (4) In terms of the management and access of the stored technical knowledge, the supervisor conducts a weekly review and transfer important knowledge into the database every weekend based on the R&D Department’s management of the technical knowledge that should be stored and the technical knowledge recorded by an engineer in the daily work journal.

As Wistron develops every new product through project undertakings, and engineers are required to enter the new product knowledge in the daily work journal for weekly review by the project manager before transferring it into the database, every new product project is constantly updated to maintain the database integrity for the employees’ reference. Wistron’s efforts in the product integration have contributed to successful shipments and enhanced product development capabilities. The following proposition is therefore likely to be true.

**Proposition 6:** The higher the product integration capability, the higher the product development capabilities.

**Knowledge Assessment**

In terms of knowledge assessment, Wistron assesses technical knowledge based on the number of successful patent applications or the number of experience heritages. Thus, annual patent goals are set up every year and are covered in the projects. In addition, through regularly conducted monthly reviews, the patent achievement status is monitored. As for the measurement of the product performance, the key performance indicators (KPI) are used.

Although the abovementioned KPI quantification work is difficult to implement in practices, the R&D Departments’ management authorities said that they would try their best to implement it. The four quantification indicators include; (1) in terms of the number of patents, every person has to contribute to at least three patents every year; (2) in terms of the quantification of parts and technical specifications, examples of which include the battery life in number of hours and the heat transfer coefficient; (3) the project progress speed and extent of which are quantified. They may vary depending on the product type; (4) the information contributed, examples of which include the speed of progress of individual projects.

The purpose of knowledge assessment is to assess whether or not the knowledge goals have been achieved in order to establish effective feedbacks. In terms of the assessment of knowledge management results, the assessment indicates if the abovementioned “knowledge goals” have been properly set up and if the knowledge management activities have been successfully implemented. In regards to knowledge assessment, Wistron targets the goal of quantifying knowledge assessment, as well as the qualification of which. For example, the time a project is expected to be completed is the quantitative indicator, but it is suggested that the different product design descriptions be qualitative indicators since the knowledge characteristics of the design knowledge itself are either hidden or narrated.

The empirical results of this case show that the R&D Department of Wistron has displayed full-fledged power because one laptop computer is distributed to every employee; a large database is available for them to retrieve the technical knowledge needed, and the staff quality is sound, thereby successfully supporting the promotion of the balanced scorecard and six sigma.

Finally, on the whole, two conclusions are drawn regarding Wistron’s knowledge assessment: (1) The management authorities have made every effort to quantify the indicators and be mentally prepared for implementing them in spite of the difficulties involved. For example, standard values have been set up for the parts and technical specifications (such as battery life, heat transfer coefficient, etc.). In addition, the management authorities have strived to find feasible ways to achieve the standard values. As for the knowledge goals that cannot be quantified, qualitative text has been used in the detailed description, an example of which is that the information related to the expected project contributions cannot be quantified; (2) In terms of the quantification aspect, the six sigma has been promoted to
fully ensure the execution results in coordination with the standard values of the balanced score card or the best practical indicators of the industry.

RESULT AND DISCUSSION

The abovementioned six integration types, namely, system integration, manufacture integration, product integration, company’s overall integration, supplier integration, and client integration are the individual organizational capabilities used by Wistron for the corresponding steps of the knowledge management process, which have been used to verified the accuracy of the viewpoints of Prahalad (1995) and Yoffie (1996): “Under horizontal industry competition, the vendors in the competition move toward the trend of strengthened upstream and downstream links in order to improve the degree of integration.” In consideration of threats from the strategic alliance between the industry and upstream vendors of key components, Wistron has taken the initiative to seek upstream suppliers to deploy alliance related matters. In this study, the six types of integrations interrelated in terms of knowledge integration and their organizational co-construction capabilities coincide with the “Integrating knowledge to organizational capabilities” proposed by Grant (1996a). Thus, the various types of organizational capabilities of OEM/ODM” in Fig. 2 are explained and discussed as follows:

Figure 2: Organizational capabilities of the Laptop Computer OEM/ODM Integration Types

First, the bottom layer of Fig. 2 shows the individuals’ specialized knowledge and the layers above are constituted by eight technologies known as “system integration”, which include: power-saving technology, power management technology, basic input/output software and hardware technology, wireless integration, audiovisual technology,
broadband technology, cooling technology, and input/output technology. That is, Wistron has first divided the individual capabilities into eight key technologies. After these technologies underwent knowledge integration, the organizational capabilities were then known as “product research and design capabilities.” The capabilities are exclusive only for the R&D Department. Also, as they have the most significant impact on improving the product development capabilities, they are the most difficult to imitated by the competing industry and are the areas that the management authorities give the greatest emphasis to in terms of sharing, distribution, and expanded utilizations. Above system integration is “manufacture integration”, which is the knowledge integration between the R&D Department and Manufacture Development adopted to promote new product projects. In addition, it is knowledge integrated in order within the eight sub-cycles of the project life cycle. The R&D Department is in charge of the former four while the Manufacture Department is in charge of the latter four. Thus, the order of the knowledge integration in the two departments has a sequential relationship. In other words, the “product research and design” constituted by the former four and the “product production and assembly” constituted by the latter four constitute the manufacture integration. Going up the layers, “product integration” is constituted by manufacture integration, coupled with “product shipment.” By this time, the overall product project undertakings are considered completed. Furthermore, if the product integration is viewed from the perspective of the overall knowledge goal achievement, Wistron calls it “corporate overall integration.” Integration of this type is conducted from top to bottom. That is, the Company’s overall annual technical knowledge goals are first devised. In order for the overall goals to be implemented downward, the support of two axes is essential, one of which is the implementation of the knowledge goals through the project organization, and the other is the horizontal departmental communication which is completed through the client service procedures of “R&D-Manufacture-Maintenance.” Therefore, although the two vary in function, both are linked through the database. That is, the knowledge in the database is integrated in order from R&D, manufacture, to maintenance. The knowledge integration features fully completed knowledge integration within the organization, and the knowledge after integration produces interdepartmental organizational capabilities, thereby ensuring the management authorities’ EMS prospects are realized. Going upwards, the knowledge between two organizations, namely, “supplier integration” and “client integration” is incorporated to form the uppermost layer, or the product development capabilities.

In this study, it has been found that by putting to good use the six integration types, knowledge integration can be transformed into the most competitive organizational capabilities, which ultimately enhance the product development capabilities. Hence, after Wistron broke away from its parent company Acer, the turnover exceeded USD16 billion as of 2009 (http://www.wistron.com.tw). The rapid growth in turnover is believed to be associated with the success of the new product development. Furthermore, Wistron has been ranked first in the supplier assessment conducted by customer A, Wistron’s major client. The following proposition is therefore likely to be true

Proposition 7: The more integration types and the more comprehensive the implementation, the better the product development capabilities.

CONCLUSION AND SUGGESTION

Research Conclusion
Above all, this study completely explains how Wistron enhances product development capabilities through knowledge management process and sets forth seven propositions. Probst et al. (2002) is helpful to explain the enhancement of product development capabilities. If management authorities could carry out these eight processes, product department capabilities will be improved significantly. Another critical finding is that Wistron can implement the six types of integration thoroughly. This action leads to the synergy of knowledge integration and furthers product development capabilities.

RESEARCH SUGGESTION

Suggestion for Practices
Among various capabilities in Wistron, the most powerful one is integration capability. Especially Wistron makes
good use of the six types of integration and management tool (i.e. balanced scorecard, six sigma plan, project management) and information technology (i.e. database, network, and laptop computer) so that it can generate satisfactory performance. Competitors can benefit from studying its processes and management. As for others, Wistron has cooperative culture such as customer focus, humanistic management, innovation spirit, team spirit, and learning. According to Lin’s (2007) viewpoint, culture is the most influential factor for knowledge management. Wistron thoroughly carries out knowledge sharing and offers learning opportunity via projects for engineers to foster more expertise capabilities that worth imitation.

SUGGESTTION FOR ACADEMY

The study adopts case study method from knowledge management process perspective to explore product development capabilities of one Taiwan laptop computer leading OEM/ODM firm. The exploratory process of the paper begins from establishing knowledge goals to knowledge assessment. The study sets forth seven propositions that specify the relationship of product development capabilities and knowledge management. Although knowledge or capability-based perspective emphasizes the importance of internal knowledge or capability (Foss, 1997; Teece et al., 1997), but the literature about the process of enhancing product development capabilities of OEM/ODM firm was rare (Helfat, 2000). Above all, none literature has deeply explored and explained how the R&D Department of high-tech information OEM/ODM firms enhances product development capabilities with the model of Probst et al. (2002) via case study method. The study is beneficial to the enhancement of product development capabilities. Meanwhile, it verifies the effectiveness of the model of Probst et al. (2002).

The following suggestions are presented for further research: (1) Researcher could develop appropriate measures to quantify propositions in this paper. (2) Researcher can further explore interactions among these eight steps. (3) Researcher could conduct the moderating effect of these eight processes incurred by the characteristics of knowledge (e.g. tacit degree). (4) Researcher could explore whether or not different knowledge sources (i.e. internal or external) incur different knowledge management process. (5) Researcher could conduct multi-case analysis and comparisons.

REFERENCES


Wistron Website: http://www.wistron.com.tw