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An Examination of Knowledge Asset Dynamics for Competitive Advantage in a Manufacturing R&D Department

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Abstract

The dynamics characteristic has been considered one of the crucial characteristics of the knowledge assets of a firm. However, many studies to date merely focus on stressing the existence of this characteristic, and very little attention has been given to why this characteristic exists or to find an appropriate way for describing it. The major obstruction, in our opinion, may be the lack of underlying perspectives. Clearly, describing knowledge asset dynamics should be based on some kinds of specific perspectives. Adopting different perspectives will lead to quite different descriptions. This article adopts two perspectives, durability and profitability, to describe knowledge asset dynamics. The profitability perspective refers to how knowledge assets impact the profits of a firm, and the durability perspective concerns how long can the profitability be sustained. The aim of this article is centered on developing a model in terms of durability and profitability to describe the dynamics of the knowledge assets of a firm. A model with three propositions to describe knowledge asset dynamics is proposed. In addition, a case study on the dynamics of major knowledge assets in the R&D department of a manufacturer was then conducted to verify the proposed propositions.

Keywords: Knowledge asset dynamics, durability, profitability, knowledge management

1. Introduction

Knowledge assets have many characteristics, but the two most associated with a firm's sustainable competitive advantage (SCA) are their tacit and dynamic characteristics (Nonaka and Toyama, 2002; Teece, 2000). The tacit characteristic refers to the knowledge assets that are different to write down, to formalize (Nonaka, 1991). The dynamic characteristic refers to the knowledge assets that are constantly renewed, enhanced, and nurtured (Nonaka et al., 2000; Nonaka and Toyama, 2002). There are plenty of articles discussing the relationships between tacit characteristic and firm's competitive advantage (Coff, 2003; McEvily and Chakravarthy, 2002; Nonaka and Toyama, 2002; Teece, 2000). On the other hand, many studies to date focus on stressing the existing of the dynamics characteristic, whereas, there is still the rare case that studies the dynamic characteristic in depth.

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Knowledge asset dynamics mainly stems from the interactions between firm knowledge assets and is enabled by organizational learning mechanism. In addition to interacting with other knowledge within the organizational boundaries, knowledge assets also interact with external knowledge sources (Moustaghfir, 2009; Schiuma, 2009). Therefore, knowledge asset dynamics, in a sense, recommend that firms should adapt their knowledge to reflect the competitive conditions. Though prior studies have explicitly asserted knowledge assets own the dynamic characteristic, there is still lack of effective methods that can help firms understand, explain, or even harness this characteristic. Because there are numerous factors involved in knowledge asset dynamics, it is nearly impossible to understand such dynamics from a holistic view. One feasible solution to remedy this problem, in our opinion, is to find a model based on some appropriate perspectives and then to help firms understanding knowledge assets dynamics in depth. Li et al. (2010) produced a taxonomy that provides two perspectives to investigate the knowledge assets of a firm: how much a knowledge asset impacts the firm's profit (i.e., profitability) and how long this kind of profit can be sustained (i.e., durability). Because the durability and profitability of knowledge assets are likely to change constantly, we could trace these changes and regard these loci as knowledge asset dynamics. Even though both the perspectives are incapable of describing all possibilities of knowledge asset dynamics, they can at least help a firm by viewing the dynamics in the light of competitive advantage.

This study is concerned with developing a model with three propositions based on the taxonomy in Li et al. (2010) to help explain the dynamics of knowledge assets. Through these three propositions, firms could understand that knowledge asset dynamics primarily stem from the changes of durability and profitability. Firms could also understand the impact on their competitive advantage of such changes.

2. Categorizing knowledge assets in terms of durability and profitability

In academic and business, the origins of a firm's SCA have been the issue that is considered most worthy to study over time. Without a doubt, the prevailing theory is Barney's VRIN model (1991) which argues that if the resources of an organization possess the characteristics of value, rareness, inimitability and non-substitutability, then they can bring the organization SCA. Recently, many studies have argued that knowledge assets are the primary sources of a firm's SCA because knowledge assets have tacit, complex, specified and dynamic characteristics. These explicit characteristics make them difficult to transfer within a firm and even more difficult for rival firms to imitate (McEvily and Chakravarthy, 2002; Coff, 2003).

According to Barney (2006), a firm has a competitive advantage when it is capable of creating more economic value than rival firms. Thus, a firm can be regarded as having SCA if it can sustain such economic value for a long time. For a firm, how to obtain SCA implies how it earns more profit than its competitors and how to sustain such an advantage. Thereby, Li et al. (2010) argue that assessing knowledge assets in terms of durability and profitability seems to be a feasible approach to verify the relationships between a firm's knowledge assets and its SCA. They propose a knowledge assets taxonomy that uses "durability" and "profitability" as two dimensions to categorize firm knowledge assets into four types: core knowledge assets, dynamic knowledge assets, supportive knowledge assets and low-value knowledge assets; see Figure 1. Core knowledge assets refer to those knowledge assets that can bring a firm significant long-term profit; dynamic knowledge assets consist of those knowledge assets that can only help a firm gain significant profits in the short-term; supportive knowledge assets refer to knowledge assets that have less impact on profitability and may not change frequently; and low-value knowledge assets consist of knowledge assets

that have less impact on durability as well as profitability. In addition, the low-value type has two completely opposite subtypes, which we can label the "falling" and "rising" type. Falling type refers to those knowledge assets that might have been core, dynamic or supportive knowledge assets in the past, but now they have eroded and will probably be eliminated in the near future. Rising type includes knowledge assets which have potential to grow in the future, but have no significant impact on a firm yet.

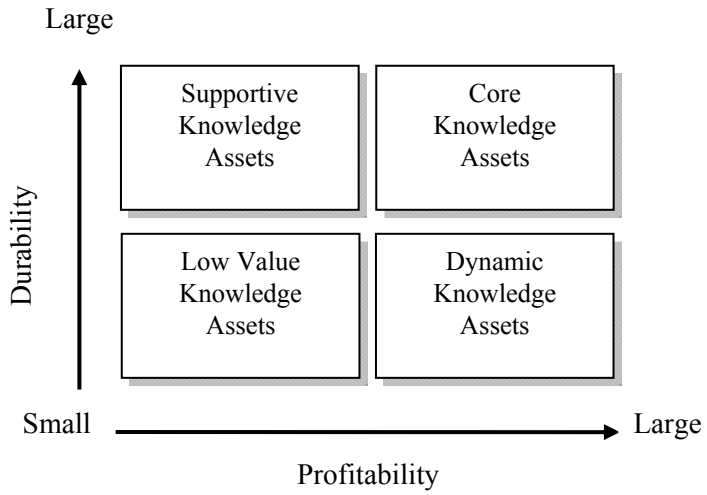
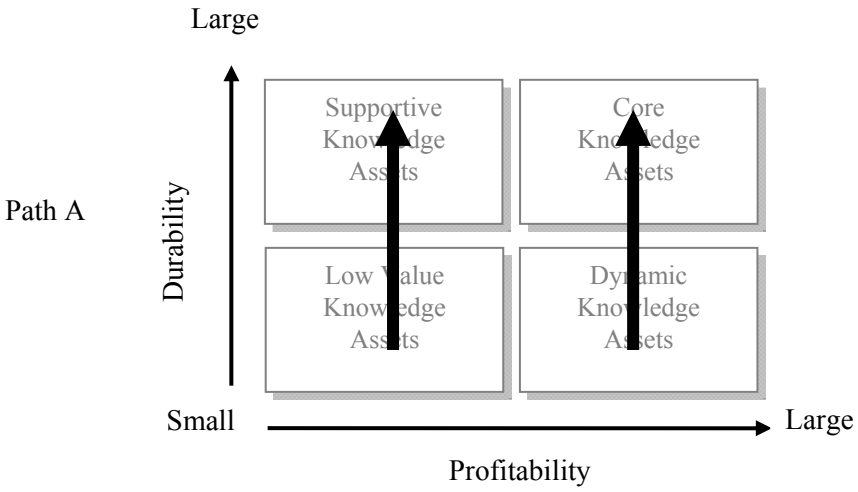


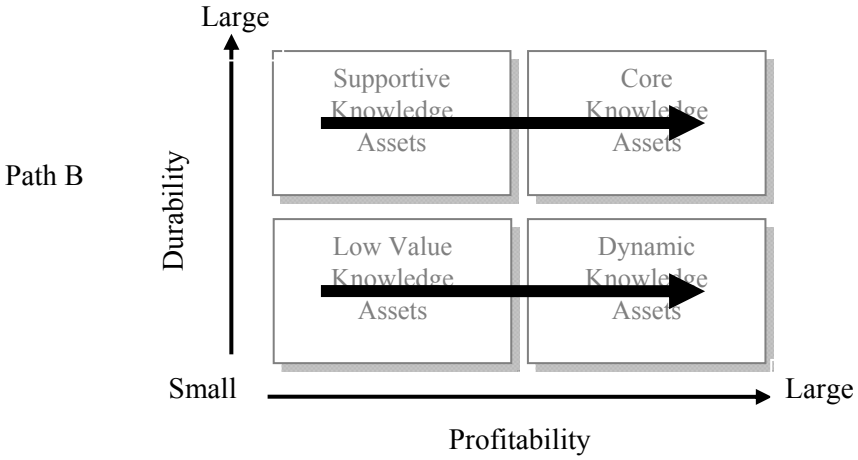
Figure 1. Knowledge assets taxonomy

3. Descriptions for knowledge asset dynamics

In Li et al.'s taxonomy (2010), knowledge assets in a firm can be classified as one of the four types by measuring their durability and profitability at the outset. However, as the setting changes, the durability and profitability of a knowledge asset may change. That knowledge asset, then, will move either within one type or between two types in the taxonomy. In the long run, a firm's knowledge assets are likely to change their types, primarily because knowledge assets change their durability and profitability according to the competitive conditions. In other words, knowledge assets often play different roles in different competitive contexts.

In general, introducing a new knowledge asset refers to a new member is located in the taxonomy, i.e., a new pair of durability and profitability is assessed. In addition, amending an existing knowledge asset would cause the durability and profitability of such knowledge asset to be reassessed, the belonging knowledge type then may change. Though in the real world there are innumerable type changing paths in this taxonomy, three primary paths namely path A, path B and path C are highlighted parsimoniously (See Figure 2). Three propositions correspond to such three paths for explaining the dynamics is developed and some evidences from the literature are given.





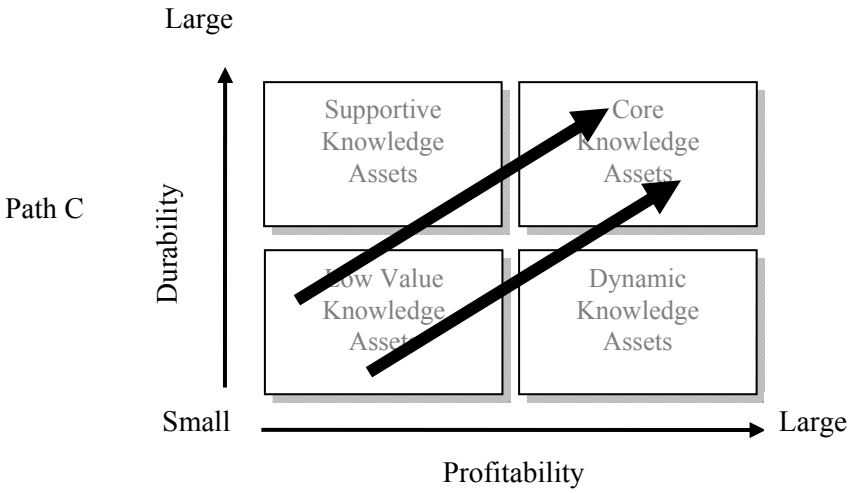


Figure 2. Primary knowledge type changing paths

3.1 Path A

Path A means that the durability of a knowledge asset shows significant change, whereas the profitability shows less change. Therefore, a knowledge asset may transform between low-value type and supportive type or between dynamic type and core type. For example, well trained operational employees are likely to build human resource advantages through improved performance in manufacturing, distributing, servicing, and quality control (Boxall, 1998). Especially in a turbulent context, employees who can harness technology are more competitive (Hitt, 2000). However, human resources are freely mobile in the labor market. Therefore, developing an appropriate incentive plan, such as profit sharing, is an effective way to cope with the problem of losing well trained employees (Fernández et al., 2000) which can sustain human resource advantages.

As for IT infrastructure, though it cannot carry an advantage for firms because of standardization and the trend of openness (Bhatt and Grover, 2005), applying IT can create a flexible culture and then contribute to obtaining the firm's competitive advantage (Powell and Dent-Micallef, 1997). Additionally, IT can play an important role in the success of business process reengineering, but only when the organization changes the mindset regarding the role of the IT function (Attaran, 2004).

Therefore, some kinds of knowledge assets such as well-trained skills of operators, IT infrastructure, and effective incentive policy cannot have significant impacts on a firm's profit, whereas they can sustain concurrent performance effectively. In terms of the taxonomy in Li et al. (2010):

Proposition 1: Enhancing some knowledge assets, for example, skills of operators, IT infrastructure and incentive policy, cannot help increase the impacts on firm's profit but help sustain the present profit performance. Thus this may cause a type changing from low-value to supportive or from dynamic to core.

3.2 Path B

Path B means that the profitability of a knowledge asset shows significant change, whereas the durability shows less change. Therefore, a knowledge asset may be transformed between low-value type and dynamic type or between supportive type and core type. For example, product and process innovation can bring profit for firms, and in order to retain this result firms often adopt effective mechanisms to protect them from copying by rivals (Harabi, 1995; Levin et al., 1987; Teece, 1986). In contrast to the above traditional innovations, the high performance of IT innovative processes stem, in part, from close interfirm collaboration (Patrakosol and Olson, 2007). Wal-Mart's cross-docking successfully lowers the level of inventory and the cost of activities, and Wal-Mart in consequence gains low cost advantage (Hammer, 2004). Pisano (2006) argues that agile product development can help firms gain profit even without the protection regime.

Over time, Microsoft has dominated the market of operating systems in the PC industry. The irresistible trend of open source has produced Linux and whittled away the benefits for operating system firms. Even in such negative contexts, firms that change their product offering to develop downstream products such as middle ware, application software, hardware and services can still obtain high profit. Additionally, firms with foresight, like 7-Eleven, have an increasing trend to engage in knowledge sourcing. Sourcing knowledge makes firms openly choose suitable short term sourcing contracts instead of being restricted by long term contracts. Broad market opportunities exist under a dynamic environment, so rapidly remodelling sourcing arrangements in response to market conditions is a way to continuously create competitive advantage (Gottfredson et al., 2005). In order to cope with the turbulent context a firm should develop more flexible practices. Even if, in general,

leveraging IT can appropriately enhance the degree of flexibility of business processes (Moitra and Ganesh, 2005), the point still needs to be noted that if IT cannot adapt to the changing setting it instead restricts a firm's flexibility (Golden and Powell, 2000).

Therefore, some kinds of knowledge assets that lead to technological innovation, agile product development, and dynamic relationships with partners can have significant impacts on firm's profit, whereas, they can not definitely sustain concurrent advantage. In terms of Li et al.'s taxonomy (2010):

Proposition 2: Improving certain knowledge assets like technological innovation practices, agile product development practices and dynamic relationships with partners can help increase the impacts on firm's profit, whereas can not help sustain such performance. Consequently, it may lead to a type changing from low-value to dynamic or from supportive to core.

3.3 Path C

Path C can be considered as a synthesis of path A and path B, meaning that both durability and profitability of a knowledge asset show significant change. Therefore, knowledge assets may be transformed between low-value type and core type. For example, knowledge assets that lead to continuous innovation and fast development are likely to help firms sustain their competitive advantage. In the financial service industry, innovations are likely to be imitated, and the innovator is often surpassed by rivals due to the assimilation of experience. To conquer this problem, the next version has to be ready while the first version is available in the market (López and Roberts, 2002). In addition, while embodying the knowledge into new products or services, some tacit elements will be reintroduced and will cause firms to sustain their competitive advantage (Saviotti, 1998). The value of tacit knowledge partly depends on the individuals. The trust that exists among them greatly influences the result of knowledge sharing (De Long and Fahey, 2000; Dyerson and Mueller, 1999). Firms that want to sustain their competitive advantage have to encourage employees to share their knowledge with colleagues (Gupta and Govindarajan, 2000).

Highly specializing the knowledge or embedding the knowledge into processes or routines can contribute to the retention of knowledge in a firm, and then, even if employees leave the company, the knowledge carried away only causes a slight threat to the company. In addition, because culture possesses the tacit and inimitable characteristics, it has been understood as the source of competitive advantage (Barney, 1986; Powell, 1995).

Often, creating intimate and long term relationships with partners and a fine reputation can help a firm sustain competitive advantage. However, to do so, a stable and predictable culture is necessary. On the other hand, a firm that over-pursues financial results may not have the patience to establish and obtain a long term relationship with partners because of their extreme efforts for performance (Beugelsdijk et al., 2006).

Sometimes, even without any protection mechanism, tacit organization-specific and cumulative aspects of knowledge, like the sheer complexity of products, are likely to bring firms opportunities to benefit (Dosi et al., 2006). Regarding this, the production system in Toyota is a typical example (Adler et al., 1999). In a turbulent context, an arduous problem is whether individuals in an organization are ready and willing to change rapidly. Structural inertia means that the changing speed of an organization cannot catch up with the changing speed of the environment. Consequently, it will give rivals opportunities to enter, and finally the organization will suffer from competitive disadvantage (Gilbert, 2005; Hannan and Freeman, 1984).

Therefore, some kinds of knowledge assets such as complex and tacit knowledge assets that lead to continuous product development, superior processes and routines, culture, or

structure inertia can have significant impacts on durability as well as profitability. In terms of the taxonomy in Li et al. (2010):

Proposition 3: Enhancing a number of knowledge assets such as continuous product development processes and superior culture can help increase as well as sustain the impacts on firm's profit. Therefore, it may result in a type changing from low-value to core.

4. Knowledge assets in an R&D department

By collecting and analyzing the literature in relation to the topic of what knowledge in R&D function can cause firm's innovations, a set of knowledge assets are identified as follows:

1) Customer relationships. For a firm, customers are undoubtedly always the most important external partners. Keeping intimate relationships with them can help a firm not only understand and deliver their needs but also obtain more orders. Accordingly, a firm possessing superior customer relationship is capable of creating positional advantage and subsequent improved performance (Coltman, 2007). IBM has undertaken a four-year initiative to reengineer its Customer Relationship Management (CRM) process. This project will eventually improve the performance of both customers and IBM's human experts by providing knowledge access and availability, acquiring and assembling knowledge, and disseminating knowledge to those who need to apply it (Massey et al., 2001).
2) Partner relationships. Strategic alliances are another kind of external relationship. They are also an important source of resources and learning and thereby competitive advantage (Ireland et al., 2002). Few firms possess all of the resources needed in the current dynamic context. Thus, firms look for the necessary resources by alliances. Therefore, seeking complementary resources is one of the principal objectives of strategic alliance (Harrison et al., 2001). The decision of choosing a collaborative partner is relevant to the uncertainty of environmental condition. According to Hoetker (2005), when in low uncertainty, the decision of selecting a supplier is made primarily on the bases of differences in technological capabilities. As the uncertainty increases, firms intend to select internal suppliers. Collaborations between firms may benefit participants. According to Kumar (1996), when manufactures and retailers can trust each other, both of them can obtain more profit, and the customers will be served better as well. Additionally, adopting open search strategies that involve the use of wide range of external actors and sources can help firms achieve and sustain innovation (Laursen and Salter, 2006).
3) Experienced R&D staff. Human resource is firmly one of the most critical strategic resources (Bartlett and Ghoshal, 2002; Luthans and Youssef, 2004). To a firm, rare and valuable employees are by far the very source of competitive advantage (Barney and Wright, 1998). Therefore, in an R&D department, skilled and experienced staff are likely to establish competitive advantage for a firm (Huang et al., 2005; Lopez-Cabrales et al., 2006).
4) Human resource practices. Though developing human resource practices in an R&D department can help improve human quality, the influences are quite different for different firms. For example, in contrast with firms where operating procedures depend on the discretion of the R&D staff, those that depend on technological processes to constrain the contributions of core R&D staff are likely to rely extensively on the human resource practices designed to enhance employee skills and motivation (Lepak et al., 2007). In addition to competitive advantage, R&D practices are highly relevant to foster a culture. A human resource practice that emphasizes extensive training, performance-based reward,

and team development is necessary to create an organizational culture that is conducive to product innovation (Lau and Ngo, 2004). Because many diverse competences are embedded in human resources, firms engaged in developing their distinctive expertise are likely to obtain competitive advantage (Cardy and Selvarajan, 2006).

5) Knowing about technologies. Appropriately leveraging IT can enhance the degree of flexibility of a business process (Moitra and Ganesh, 2005). However, if IT cannot adapt to a changing context, it eventually restricts the firm's flexibility (Golden and Powell, 2000). IT infrastructures cannot carry a firm significant profit because of standardization and the trend to openness (Bhatt and Grover, 2005). They only can facilitate the simplification and innovation of business processes (Broadbent et al., 1999). In addition, knowing about technologies has positively impacts on marketing capabilities and firm's competitiveness (Mei and Nie, 2008).
6) Culture and values. Culture provides employees in a firm a sharing of values and a consistent direction (Goffee and Jones, 1996; Horng, 2006). In addition to human resources and financial support, innovations in a firm still need an appropriate culture as a base (Baer and Frese, 2003; Claver et al., 1998; Frohman, 1998; Jassawalla and Sashittal, 2002; Yang and Farn, 2010). In general, innovative culture is established via the connections between one person and other employees, between employees and external partners, and between employees and the firm's goals (Zien and Buckler, 1997). Accordingly, values can be firmly considered as the building block of an organization. However, there is a paradoxical phenomenon in a firm: the interplay between flexibility and control values. The values of flexibility in a firm can aid problem solving, but the values of control can inversely be an explicit obstacle to its innovation (Khazanchi et al., 2007; Zammuto and O'Connor, 1992). However, managers sometimes are likely to select averting flexibility for fear of losing control (Mills and Ungson, 2003). While firms in different industries are rather distinct in many aspects, compared with less innovative companies, innovative companies still share a set of characteristics, qualities and behaviors (Zien and Buckler, 1997). Among the influencing factors, awareness is the essential underpinning (Price, 2007). Highly innovative cultures are more likely to emerge when leaders focus on simultaneous rather than serial change and regard it as part of what they do daily (Jassawalla and Sashittal, 2002). While culture was considered as a kind of infrastructure of an organization in previous studies, recent studies have found that for managers who are facing a readily changing context and unlikely to predict the future directions concurrent focus on the culture of competitiveness and knowledge development is critical to ensuring success (Hult et al., 2007).
7) Organizational practices. Speaking to project management, an R&D team should not adopt a unique way to manage projects with variant characteristics (Talukder et al., 2008). Radical innovation projects can be non-routine, they require more external sources of information, and the team members should communicate with outside the team. However, incremental innovation projects are routine, they require more internal sources of information, and they only need a single gatekeeper to be responsible for external communication (Cardinal, 2001). Additionally, cross-team successes primarily rely on objectives-setting, leadership and collaboration (Li et al, 2008; McDonough, 2000). However, Khazanchi et al. (2007) suggest that effectiveness of innovations does not result from the employees' complete autonomy, but rather a balance must be kept between control and flexibility.
8) Means for securing innovations. Levin et al. (1987) argue that firms are generally inclined to protect their process innovations through secrecy rather than patent. On the other hand, for product innovations, most firms use patents as a mean to protect them. Using a large number of R&D experts in Switzerland as a base to carry out a survey, Harabi (1995)

argues that, for process innovations, lead-time is considered as the most effect means of appropriability. For product innovations, prominent sales and service efforts are regarded as the most effective means. In addition, for both product and process innovations, patents are viewed as the least effective means of appropriability. As a mean of appropriability, patents are only effect in a few industries, including drugs, chemicals, and in some cases in the machinery and electronics industries.

Table 1 summarizes this set of important knowledge assets in an R&D department.

Table 1. Key knowledge assets in an R&D department

Key Knowledge assets	Literature
Customer relationships	Coltman (2007); Massey (2001).
Partner relationships	Harrison et al. (2001); Hoetker (2005); Ireland et al. (2002); Laursen and Salter (2006).
Experienced RD staff	Barney and Wright (1998); Bartlett and Ghoshal (2002); Lopez-Cabrales et al. (2006); Luthans and Youssef (2004)
HR practices	Lepak et al. (2007); Lau and Ngo (2004).
Knowing about technologies	Bhatt and Grover (2005); Broadbent et al. (1999); Golden and Powell (2000); Mei and Nie (2008); Moitra and Ganesh (2005).
Culture and values	Khazanchi et al. (2007); Jassawalla and Sashittal (2002); Hult et al. (2007); Mills and Ungson (2003); Price (2007); Zammuto and O'Connor (1992).
Organizational practices	Cardinal (2001); McDonough (2000); Khazanchi et al. (2007); Talukder et al. (2008).
Means for securing innovations	Harabi (1995); Levin et al. (1987).

5. Research method

This study focuses on understanding the dynamics of knowledge assets based on a taxonomy proposed by Li et al. (2010). Thus, we need to look for a knowledge intensive business unit which we hope would lead to fruitful discussions. According to Yin (1994), the case study technique is an all-encompassing method which can be designed to incorporate specific approaches to data collection and to data analysis. Therefore, this study adopts case study as a research method.

In Taiwan, the automobile parts and accessories manufacturing industry has a longer than thirty-year history and is still flourishing at present. Firms in this industry were forced to evolve from ordinary manufacturers due to the combinations of complicated materials, advanced techniques and designs. Tong-Yang is a well-known leading company in this industry. Therefore, we selected the R&D department of Tong-Yang as a case to conduct our study. We anticipated that its experiences could provide us with fruitful evidence.

In order to focus our discussion on the critical R&D knowledge assets, this study surveys the literature in relation to firm R&D knowledge and then obtains a list of knowledge assets (Table 1). The interviews were based on this essential set of knowledge assets. During the course of the interview some assets were not featured and other knowledge assets not on the list but identified by interviewees were included. The director of this department and his two subordinate managers were interviewed independently, and each interview was held for about three hours. For the sake of convenience, this study adopts the retrospective approach. Though the longitudinal approach can help collect more detailed and accurate information, in our opinion, the retrospective approach could be effective enough to collect evidence about the dynamics of R&D knowledge assets. Below, the case study is discussed in detail.

6. Case study

Tong-Yang was established in 1967 in Taiwan as a manufacturer for automotive collision parts and accessories. For the domestic market, Tong-Yang is the main supplier for a number of local automobile assembly plants like Ford, Nissan, Honda, Mazda, etc. For the international export market, it provides after-market automotive parts to over 170 countries. At present, Tong-Yang has nearly 1200 employees and an annual turnover of 300 million USD. In recent years, the R&D budget has amounted to approximately 3% of annual turnover, which substantially exceeds the average rate in its industry. Except for 25 professionals in the R&D department, there are more than 300 people dispersed in manufacturing departments and engaged in improving the manufacturing processes. Therefore, as the director of R&D department said: "In a sense, almost a quarter of the employees in this company deal with affairs related to R&D".

The automobile industry has been rooted in Taiwan for nearly 50 years. Due to the long-running development in this industry, Tong-Yang possesses intimate relationships with its customers presently, which indicates that Tong-Yang often can receive more orders than their competitors even while the industry lapses into a depression. For the product development and manufacturing processes, Tong-Yang has created a bundle of unique skills to fulfill customer needs and therefore has earned a fine reputation in the industry. This reputation also helps Tong-Yang to obtain orders with higher benefit. In addition, mostly in the short term, Tong-Yang has for years collaborated with various Japanese firms, and thereby it often acquires more advanced skills or complementary skills that are scarce relative to competitors in Taiwan. Though Tong-Yang continuously endeavors to search for promising opportunities to acquire new knowledge from Japanese firms, it would resolutely cease the collaborative relations if bilateral firms deem that such collaborations do not create more value for both of them anymore. The director of the R&D department notes that such dynamic relationships with partners can make the company introduce new advancing technologies and thereby gain high profit. In addition, there is a notable collaboration model between Tong-Yang and its competitors in this industry. For some kinds of products, if two mutual competition firms receive the orders with the same product specification from the automobile assembly plant, they will cooperate to develop only one set of dies for that product due to the cost issue. For sharing, one company can use the dies set on the first three days in a week, and the other enjoys the dies set on the following three days. One manager put it: "The dies-sharing model eventually benefits Tong-Yang and its competitors. Without this model, firms in this industry are sometimes difficult to make even a little profit because the dies cost too much".

In the past, Tong-Yang had a high turnover of R&D staff. However, Tong-Yang has made much effort to introduce a well-designed incentive pay plan and to create a close partnership among R&D staff. As a result, a superior culture has been cultivated successfully, and the turnover in the R&D department has dramatically decreased and stayed at a very low level. Presently, almost all the R&D staffs are very experienced, which allows the R&D department to achieve an outstanding performance.

In addition, recently, for the sake of knowledge sharing, Tong-Yang conducted job rotation at the operator level and engineer level. The operators and engineers are arranged to rotate their work in a one- or two-year period to learn additional skills and widen their skill bases. It also conducted an apprenticeship at the manager level. Every manager is required to be an apprentice of another manager or a higher position director. The apprentices have to spend a full four days per month accompanying their masters and assisting their masters' daily affairs, and the apprentices therefore may have opportunities to perceive and learn some valuable experiences from their masters. The R&D director noted: "Until now, job rotation and apprenticeship can actually broaden the knowledge base of every participant, but whether

both of them are helpful for the performance has yet to be ascertained".

R&D staff are always busy with designing new equipment because most new products need to use exclusive equipment during the manufacturing processes. Through an accumulation of experiences over many years, the R&D staff have owned abundant knowledge in designing sophisticated equipment. Often, such equipment can help simplify the manufacturing processes and increase the benefit. However, due to the short lifecycle nature of the products, the equipment is only in service for a short run.

Recently, Tong-Yang considerably invested in importing manufacturing facilities. Some of them are costly and even unique in the industry in Taiwan. As a result, for some kinds of products that are very complicated to produce but profitable, Tong-Yang often becomes the only supplier in the market. One of the managers explained: "Precise ongoing investments in such facilities make us possess special manufacturing knowledge, and ultimately bring us generous returns. I believe that our advantage can still last for five years at least".

In the past ten years, Tong-Yang has endeavored to strengthen the values of "enthusiasm", "integrity", and "innovation". All employees were encouraged to broaden their knowledge base. Tong-Yang can be regarded as an innovative company in this conservative industry. One of managers described it so: "Company's culture makes us being willing to contribute our new ideas, because no one would be blamed or even punished for failures. Employees have gained ground in broadening their knowledge in recent year. And I firmly believe that this is one of the most important factors for us to be the leading company in this industry".

Additionally, Tong-Yang struggles to conduct a Quality Control Circle (QCC) to collect valuable ideas dispersed in their employees' minds. Ideas from the QCC are gradually increasing, and most of them can help reduce cost, streamline processes or promote product quality. However, until now, it has been a rare case that has great impact on profit.

Tong-Yang has introduced project management techniques for some time, and now the R&D staff hold the knowledge to harness the projects. Generally, R&D staff should participate in several projects concurrently; accordingly, it is hard for a manager to check and control the staff's performance by centralization. Thus, during the project lifecycle, managers often intensively discuss with project team members to establish challenging but reasonable objectives in the beginning stages. In the follow-up stages, team members enjoy nearly complete autonomy. The resultant, project can keep a balance between control and flexibility and can always achieve its objectives. The director put it thus: "knowledge about project management practices is the main cause that the focal company is the industrial leader".

As an OEM, the product shapes are mostly designed by customers. The focal company, therefore, pays much attention to the innovations in manufacturing processes. One impressive example concerns the blades of a fan, which was assembled manually and was a costly and time-intensive procedure for a long time. However, in order to fulfill the requirements from a severe customer, R&D staff eventually succeeded in developing a set of exclusive equipment that can assemble the blades automatically, and then the performance acquired an increase of nearly 400%. The director stated: "*Over time, R&D teams have to face the severe requirements from customers, which ultimately result in the accumulation of abundant know-how of fast development*".

7. Discussion

The distinctive collaboration model with competitors is a rare case in other industries. For the sake of lowering costs, they often develop only one set of dies and share it for some kinds of products; but even so, often, the profit still not significant. Therefore, the working model can only benefit the durability and has less effect on profit. In other words, such kind of relationship with competitors moves upward in the taxonomy (see Figure 3).

Additionally, Tong-Yang struggles to conduct a Quality Control Circle (QCC) to collect valuable ideas dispersed in their employees' minds. This number of ideas from the QCC is dramatically increasing, and many areas such as the production cost, manufacturing process and product quality can actually gain ground. However, until now, there has not been a case that has had great impact on profit. Clearly, in Tong-Yang, knowledge from the QCC can only help with the durability. Therefore, it moves upward in the taxonomy (see Figure 3).

Job rotation and the apprenticeship are thoroughly conducted at the operator and engineer level and at the manager level. Though, as expected, plenty of valuable experiences can be shared and retained at various levels of the organization, they still lack adequate evidence to verify a significant impact on profit. Therefore, experiences shared from job rotation and apprenticeship only increase durability and so move upward in the taxonomy (see Figure 3). The knowledge assets depicted above present their dynamics compliant with path A. Thus, proposition one is supported.

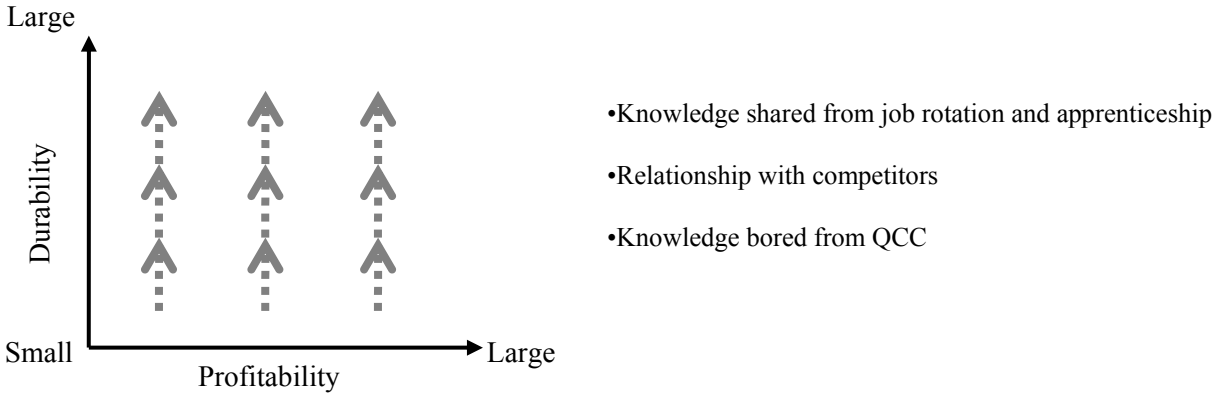


Figure 3. Knowledge assets move upward

Collaborations with various Japanese firms may aid in nurturing the knowledge base of Tong-Yang. Though such knowledge may bring Tong-Yang great profit, there is still no guarantee that the profit can be sustained long because most of the relationships are short term and may cease abruptly. Such collaborative relationships, as knowledge assets, move to the right hand side in the taxonomy (see Figure 4). In addition, as described previously, know-how to design effective equipment can bring the firm SCA, whereas the knowledge embedded in self-designed equipment often brings short-term profit due to the short lifecycle nature of products. Therefore, such knowledge will move to the right-hand side in the taxonomy (see Figure 4). Knowledge assets depicted above present their dynamics compliant with path B. Thus, proposition two is supported.

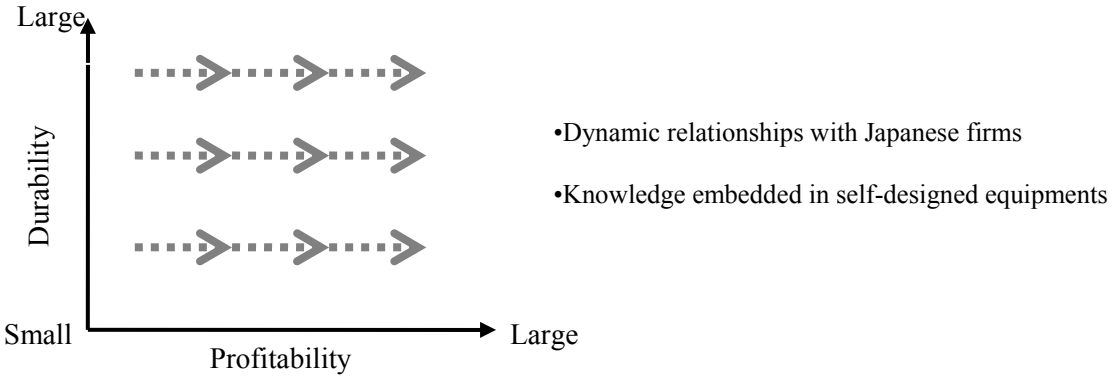


Figure 4. Knowledge assets move to the right hand side

The recent effort that Tong-Yang has made in the R&D department, including introducing an effective incentive pay plan, creating closer relationships among R&D staff, and carrying out project management, have nurtured a group of R&D veterans who own the complicated, tacit, and synthesized knowledge. Such knowledge made the R&D staff make their company a leading performer in the industry. Because such knowledge cannot be duplicated by the competitors easily, they move up the right hand side in the taxonomy (see Figure 5).

Know-how to design effective equipment increases the manufacturing performance in effectiveness and efficiency. Therefore, such kinds of know-how significantly benefit both durability and profitability, and as a knowledge asset, it moves up the right-hand side (see Figure 5). Additionally, over time, the company has been very willing to invest in costly facilities. Some of such facilities are even unique in the industry in Taiwan. R&D staff thus learned know-how for using these facilities to design and produce special products. The focal company can obtain exclusive orders to produce these special products, and it seems that, at least in the near future, there is no substitute on the market. Certainly, these kinds of orders can bring the firm significant profits, and these profits can be sustained. Again, know-how to design special products as a knowledge asset moves up the right-hand side in the taxonomy (see Figure 5).

The abilities to provide customers unique needs have caused Tong-Yang to nurture close relationships with many automobile companies. Such relationships can not only be sustained long-term but also contribute to profit. Therefore, such knowledge assets move up the right-hand side in the taxonomy (see Figure 5).

Tong-Yang successfully cultivates its superior culture by continuously strengthening its values of “enthusiasm”, “integrity”, and “innovation”. Today’s Tong-Yang has a great group of employees who are willing to share their innovative ideas. The open and innovative culture is believed to be the solid base of numerous activities such as QCC, experience sharing, equipment designing, relationships building and so on. When compared with competitors, this kind of culture is rare, valuable and inimitable. Consequently, the culture becomes the source of SCA. As a knowledge asset, culture will move up the right-hand side in the taxonomy (see Figure 5).

Through having conducted the project management for many years, R&D staff learned volume of know-how about it. The most critical knowledge, in our opinion, knows how to keep a project in a good balance between control and flexibility. Project management practices in the focal department allow the team members to utilize their resources autonomously on the premise of achieving the project objectives. Up to now, it has explicitly resulted in an excellent performance; thus, the R&D director stresses that knowledge about project management practices is one of the main reasons that Tong-Yang is the industrial leader. Consequently, this knowledge asset moves up the right-hand side accordingly (see Figure 5).

Several kinds of knowledge assets such as culture, know-how to design equipment, know-how embedded in unique facilities, and close relations between and within companies are synthesized to construct Tong-Yang's distinctive knowledge of fast development, which helps the focal company fulfilling customers' varied requirements efficiently and thus obtain great benefit. Additionally, know-how about fast development is complicated and not easy to be imitated. Therefore, this knowledge becomes the base of SCA and moves up the right-hand side in the taxonomy (see Figure 5). The knowledge assets depicted above present their dynamics compliant with path C. Thus, proposition three is supported.

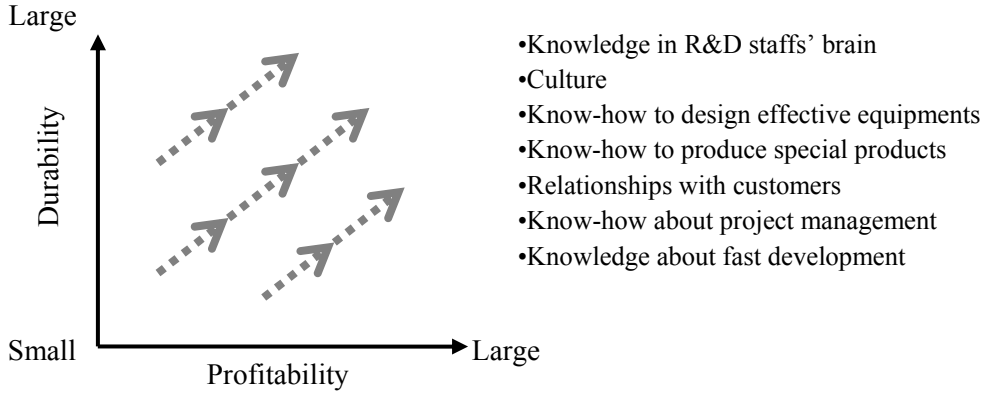


Figure 5. Knowledge assets move up the right hand side

8. Implications for managers

The three propositions offered by this article have empirical implications for managers as follows:

Firstly, the results of this study help managers understand knowledge asset dynamics as well as the relations between such dynamics and competitive conditions. For example, relationships with customers are able to help a firm obtain a margin greater than can be obtained by rivals, and so they may be classified as a core knowledge asset. However, if they eventually cause the firm to be subject to some kind of contract and so lose other opportunities in the market, they may be classified as a supportive or even low-value knowledge asset. Therefore, the dynamics reveal that this knowledge asset cannot bring great profit for the firm anymore, and managers should be concerned about this problem.

Secondly, except for knowledge asset dynamics, this study implies that if managers can develop some means to harness the changes of durability and profitability of knowledge assets, they can then harness knowledge asset dynamics (i.e., type changing). Therefore, this taxonomy not only records the dynamics of knowledge assets but also provides effective ways (change of durability and profitability) to harness the type changing of knowledge assets. For example, if Tong-Yang is planning to introduce a new coating skill, the R&D department can first consider the ways the coating skill can promote a gain in profit and whether, in effect, the type changing will occur from rising low-value type to dynamic type. Furthermore, if significant profits can be maintained by some effort, then such skill will change its type from dynamic type to core type. Certainly, if the department can investigate a process to gain durability as well as profitability simultaneously, then this asset will move from a rising low-value to a core type directly.

Thirdly, this study also gives managers an implication that managers should draw up appropriate dynamics for knowledge assets according to the contingencies. For example, when introducing new knowledge in a firm in the high-tech electronic industry, because of its short

lifecycle nature, managers should draw up its type-changing path from low-value type to dynamic type. In other word, managers ought to do more to increase this knowledge's contributions to the firm's profit within the short-term. If managers make an inappropriate decision to make this know-how change from low-value type to core type, ultimately it will not only be difficult to achieve the firm's goal but also may lose the opportunity to obtain short-term profit.

9. Conclusion

The existence of knowledge asset dynamics has been discussed explicitly in extant studies. However, to date, there has been a lack of a definite means to understand, explain, and even harness such characteristics. The primary goal of this study is to develop a model to help firms understand their knowledge asset dynamics. Because there are many causes that lead to knowledge asset dynamics, in order to understand such dynamics, some focal perspectives must be selected, and we regard them as crucial. As noted above, investigating the dynamic characteristic of knowledge assets from only a few focal perspectives would risk losing some important information. Nevertheless, as long as the selected perspectives can bring anticipated contributions, the model can be regarded as valuable.

This study proposes a model with perspectives of durability and profitability to help firms understand knowledge asset dynamics. Though the two perspectives are only two of all potential ones, combining the two can reflect the relationships between the dynamics and the firm's competitive advantage. To explicitly describe the dynamic characteristic, this study develops three propositions. Proposition one refers to the dynamics relative to the durability of a knowledge asset that has significant change, whereas the profitability has less change. Proposition two refers to the profitability of a knowledge asset that has significant change, whereas the durability has less change. Proposition three can be regarded as a synthesis of proposition one and two, meaning that both durability and profitability of a knowledge asset have significant change. This study verifies these propositions with a case study discussing how R&D knowledge assets change their types in Tong-Yang, and the proposed propositions were strongly supported. Thus, we believe that the developed model with three propositions has practical contributions to investigate knowledge asset dynamics in terms of durability and profitability.

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