Knowledge Network of Toyota: Creation, Diffusion, and Standardization of Knowledge

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Abstract: Knowledge is a source of firm’s competitiveness and is created, diffused, and standardized within a company’s knowledge network. The knowledge network of Toyota Motor Corporation in Japan comprises multiple automotive plants, the Operation Management Consulting Division (OMCD), and the Global Production Center (GPC) as nodes on that network. Knowledge is created on a manufacturing plant floor and diffused between multiple automotive plants through a direct interacting network without standardization. The OMCD diffuses both standardized and unstandardized knowledge. The GPC’s important function is knowledge standardization. In conclusion, Toyota’s domestic knowledge network maintains a balance between the diversification and standardization of knowledge created on the production floor through a mix of nodes at various standardization levels.
Introduction

Many studies have emphasized the idea that knowledge of a firm is a source of competitive advantage (Chini, 2004; Grant, 1996; Kogut & Zander, 1992). To acquire knowledge that can become a source of competitiveness, there is a method of creating knowledge within an organization and gaining knowledge from external sources. Nonaka and Takeuchi (1995) stated that knowledge creation is a dynamic circulation process of tacit knowledge and explicit knowledge through four conversion modes. Cohen and Levinthal (1990) used the concept of absorptive capacity to explain ways in which companies evaluate, interpret, and apply external knowledge. While transferring knowledge to the required location and using it is important, knowledge transfer has cost issues, namely its stickiness (Szulanski, 1996, 2000; von Hippel, 1994). Knowledge network theories have developed to explain the process of gaining, diffusing, and transferring knowledge. Within the field of knowledge network theory, research has focused on the strength or weakness of ties (Hansen, 1999, 2002), network scope (Ernst & Kim, 2002), center of network (Ernst & Kim, 2002; Tsai, 2001), and the directionality of transfer (Chini, 2004; Kim, 2015). However, few detailed studies have explored how knowledge within networks is created, diffused, and standardized.

This study comprehensively analyzes the case of Toyota Motor Corporation (Toyota) to investigate the creation, diffusion, and standardization of knowledge within a corporation. In particular, the analysis is on the function of domestic plants, the Operation
Knowledge network of Toyota

Management Consulting Division (OMCD), and the Global Production Center (GPC) as nodes on Toyota’s domestic knowledge network.

Creation of Knowledge Diversity

Toyota has four domestic vehicle production plants: Motomachi, Takaoka, Tsutsumi, and Tahara. These four plants have slightly different production systems based on conditions such as car model, the ratio of exports, the number of production options, supplier relationships, and plant location constraints.

One characteristic of the Toyota Production System (TPS) is kaizen activities that occur on the production floor. If the results of kaizen activities have positive effect for productivity, it becomes new work standards. These activities are conducted on the production floors of each plant and each operate under different conditions. These activities are reflected in the work standards of each plant, with the production system of each developing over time. This is how diversity of the TPS is initiated.

Kaizen ideas are generated by individual workers or by small groups called QC circles. When a problem is identified on the production floor, a production floor leader confirms the problem as it occurs, investigating the circumstances surrounding the problem in detail and determining the cause. The leader then encourages the worker to generate ideas that will resolve the problem. These ideas are then compiled, and a solution is submitted (Monden, 2006).

When submitting the solution, the production floor leader primarily makes a specific determination regarding various factors involved in work standards. The production floor leader determines the cycle time required to produce each unit of product as well as the order of manufacturing operation job. Production floor leaders in each plant are responsible for creating and revising work standards; this bottom-up organizational culture is characteristic of Toyota. It is
one of the sources of Toyota’s knowledge diversity.

In labor-intensive processes such as final assembly, there are no set of universal engineering principles as can be found in other processes; thus, a chief leader (CL) and group leader (GL) have been influential in developing not only kaizen on a process but also the design of the process (Fujimoto, 1997).

The construction of new plants and refurbishments to existing plants offer major opportunities to implement and test concepts for new assembly systems. The main domestic plants in Toyota were built mainly in the 1960s and 1970s, and plant construction continued overseas in the 1980s. In the 1990s, there was a string of new construction and refurbishment for assembly plants, both domestic and overseas, and new assembly systems were implemented (Fujimoto, 1997).

In this manner, unique production systems were created on the production floors of Toyota in response to unique conditions on each production floor. New system concepts are, at times, implemented when building new plants or refurbishing old plants. Knowledge with a high level of diversification is created within the same TPS.

Knowledge Diffusion by Direct Interaction

Higuma and Suh (2017) discuss knowledge transfer via direct ties between Toyota plants. In Toyota, knowledge is transferred through the direct interaction between hierarchies at each plant. For example, knowledge related to assembly may be diffused if it is determined to be useful for other plants at monthly assembly manager liaison meetings and assembly section manager liaison meetings wherein knowledge is shared. In addition, there is a meeting of general managers of manufacturing divisions wherein executives (vice presidents and those below these positions) participate. Furthermore, there are shop-level subcommittees, manager liaison meetings for
Knowledge network of Toyota

general managers, section manager liaison meetings for section managers, and production floor gatherings wherein line workers from CLs to those at lower levels have direct interactions.

However, knowledge is not standardized at these meetings. Rather, knowledge is transformed and used according to the conditions of each plant. In addition, each plant has its own unique production system and may choose to not adopt good aspects of other plant knowledge. Plants are in constant competition with each other, and thus, there are limits to the diffusion that occurs through these direct interactions.

Knowledge Diffusion by the OMCD

The OMCD is a division that belongs to the Production Management Division. The TPS is not a single system per se but takes on various forms depending on the plant and personnel. The OMCD was created in 1970 with TPS specialists to systemize and diffuse TPS both within and outside Toyota (Dyer & Nobeoka, 2000; Fujimoto, 1997; Higuma & Suh, 2017; Satake, 1998).

Within the OMCD, chief engineers are responsible for certain plants and for diffusing TPS philosophy. A TPS instructor is also appointed for each plant. The OMCD chief engineer and TPS instructor communicate sustainably for TPS management. The chief engineer sponsors voluntary learning team (Jishuken) at each plant. This learning team is a study group of plant members and suppliers, and these study groups jointly discuss solutions for various issues regarding production. Furthermore, chief engineer supports to transfer methodologies and knowledge created in this learning team to other plants.

The OMCD conducts knowledge transfer through two methods. First is by setting standards based on knowledge absorbed from each plant and by diffusing that knowledge. The OMCD
standardizes and diffuses knowledge when there is a great disparity in the knowledge between plants or new knowledge is expected to increase productivity by implementing it.

The second method involves using knowledge gained from domestic plants, overseas plants, and suppliers in problem solving. According to Higuma and Suh (2017), each plant may find it difficult to search external knowledge, and there are issues with objectivity in determining the usefulness of external knowledge. Therefore, the OMCD sometimes acts as an intermediary for knowledge transfer to the plants and supports them by providing useful knowledge.

Chief engineers at the OMCD frequently communicate with their plants: when problems arise, they engage in identifying the problem, proposing solutions, implementing solutions, confirming results, and preventing reoccurrences. The OMCD sometimes transfers knowledge to other plants for problem solving; because they have knowledge of suppliers and various other sites, they provide knowledge that can solve problems occurring in other plants.

Thus, the OMCD serves to not only diffuse knowledge but also standardize it. TPS instructor liaison meetings are also used for standardization and diffusion of production systems developed at each plant.

Knowledge Diffusion by the GPC

The GPC sets the most fundamental skills required in automaking and develops tools to teach these skills with clarity to workers on the production floor. Elemental work refers to individual jobs that comprise standard work, and fundamental skills are skills needed to perform elemental work. There are minor differences in fundamental skills between plants, and the GPC surveys fundamental skills to set the most efficient best practices for production floors.

The GPC creates standard visual manuals used when teaching best
practices for these fundamental skills. Visual manuals explain fundamental skills in the form of videos, computer-based video, animation, and other visuals. Using video and animation, they are able to explain the instinctual aspects. Workers first gain an understanding of these basic skills using the video manuals and subsequently use training facilities for the development of fundamental skills. In other words, in the past, many aspects were tacitly taught in on-the-job training on the shop floor, but fundamental skills have been standardized by GPC’s visual manual.

Trainers are responsible for training at each plant. The GPC has a master trainer who trains these trainers and sends them to each plant.

Two Cases of Knowledge Diffusion

Through two case studies, this section explains knowledge diffusion within Toyota’s knowledge network.

Case 1: The yamazumi table is a tool developed to allocate elemental work for each assembly line worker. It was introduced to each plant through the direct interaction of managers at the assembly section manager liaison meeting. However, because each plant employed different methods, there were varying degrees of table efficiency. Thus, the OMCD recreated the yamazumi table as a standard and from an objective, third-person perspective external to the plant. It then got approval and support from the executive and implemented the table in each plant (Higuma & Suh, 2017).

Case 2: The GPC gathers best practices from each plant to create best practices in visual manuals. Doing so, they notice disparities between plants for even the same work. For example,
the method for holding a paint gun in the painting process may differ by plant. Many such differences appear to be trivial at first, for example, the number of fingers used to hold the spray gun or where the thumb is placed. The GPC analyzes them to find the various merits and demerits and to determine the most efficient best practices with the most merits and the fewest demerits (Suh, 2012).

Table 1 explains this research. With direct interactions, there is no standardization and the GPC has only standardized knowledge diffusion route. The OMCB manages both standardization and non-standardization. In Table 1, case 1 is an example of shifting from diffusion in direct interactions with plants to diffusion through OMCD standardization; case 2 is an example of propagation after GPC standardization.

Table 1. Knowledge diffusion of Toyota

| Standardization Diffusion route | Without Standardization | With Standardization |
|---------------------------------|-------------------------|---------------------|
| Direct interaction              | ①Yamazumi Table         | ②Paint gun          |
| OMCD                            |                         |                     |
| GPC                             |                         |                     |
Knowledge Network of Toyota

The domestic knowledge network of Toyota repeatedly creates diversity of knowledge and standardizes it. The knowledge system of TPS is not uniform even among Toyota’s domestic production sites, with each plant having individuality with regard to detailed operations. Plants directly gain knowledge from each other through liaison meetings although these are not strong ties, as already explained in the case of the yamazumi table. Kono (2016) argued that weak ties promote the acquisition of new, non-redundant knowledge and that it contributes to diversification of knowledge. Furthermore, standardized knowledge is transferred by both the OMCD and the GPC. In other words, Toyota’s domestic knowledge network has nodes for standardization at various levels and balances the contradicting goals of diversification and standardization of knowledge created on production floors (gemba).

Fujimoto (1997) noted how diversification in Toyota’s production system was converged and established. For its certain core values and philosophy, Toyota is exceedingly homogeneous, though on other levels and domains, particularly when the system is changing, many internal discrepancies have been observed. The diversification created within Toyota is converged through a convergence mechanism. Fujimoto (2012) explains this as the evolution of TPS.

Toyota’s domestic knowledge network has been extended overseas. Dyer and Nobeoka (2000) analyzed how Toyota’s learning network was created and evolved in the US. This can be seen as a case of domestic knowledge network expanding overseas. Moreover, studies on Toyota’s global knowledge network (Suh, 2012, 2015, 2016) have clarified that the role of domestic plants, the OMCD, and the GPC in knowledge transfer to overseas is essential.
Conclusion

This paper surveyed the case of Toyota in detail to show a knowledge network that creates, diffuses, and standardizes knowledge that is the source of corporate competitiveness. Within Toyota’s knowledge network, production floors in each plant take the role of knowledge creation. Knowledge created on these production floors is spread throughout the network via three routes: diffusion through direct interaction between plants; diffusion through the OMCD; and diffusion through the GPC. The OMCD and GPC diffuse knowledge through standardization. Knowledge created in Toyota’s plants has the same direction as a part of TPS although they create diversification of knowledge through their differing management environments. The Toyota knowledge network is a source of competitiveness through its balance of knowledge diversification and knowledge standardization.

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Knowledge network of Toyota

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