Knowledge Integration Within Japanese Firms: The Fujitsu Way

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ABSTRACT:

The paper analyses knowledge integration processes at Fujitsu from a multi-level and systemic perspective. The focus is on team-building capability, capturing and utilising individual tacit knowledge, and communication networks for integrating dispersed specialist knowledge required in the development of new products and services. The analysis shows how knowledge integration is performed by Fujitsu at different layers of the company.

Keywords: *Knowledge integration, Case study, Fujitsu, Knowledge management systems, Team building*

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1. Introduction

Knowledge integration (KI) in firms has received considerable attention in recent research (see, for example, Brusoni et al, 2009; Zirpoli & Camuffo, 2009; Becker, 2003). In particular the research has highlighted the pivotal role of knowledge integration in creating and sustaining firms' innovative and competitive advantage (Kraaijenbrink, et al, 2007; Grant, 1996; Kogut & Zander, 1992). The research findings suggest that innovations occur when existing or new knowledge is integrated within organization which will result in a new product or service (Grant, 1996). Also findings of the importance of factors across industries suggest that integration of knowledge within the companies is the most important driver for innovation (OECD, 2004). Since knowledge is continuously changing and depreciating, organizations cannot possess all the required knowledge themselves. This implies that the effective transfer of external knowledge or internal creation of new knowledge is significant success factor for innovation and new product development. This process of external transfer of knowledge or internal capability development and learning which will result to *knowledge integration* and new product or service development within organization is the focal subject of this study.

This paper explores knowledge integration (KI) processes and practices in the case of Fujitsu. Our concern is how this Japanese firm responds to knowledge integration needs of the firm which is consisting of several business units or divisions. In particular how the firm takes advantage and exploits potential synergies among various internal and external knowledge sources and creates competitive advantage. Knowledge exists in firms and networks, but how is the execution of KI processes in Japanese firms: is knowledge integration performed by individuals, teams, or by firms, or is KI something that happens at the network level? What is the role of technology and knowledge management systems in knowledge integration? As emphasized by Brusoni et al (2009)

"we are still puzzled by the loci of execution of KI processes". The proposition here is that KI addresses technical, strategic and operational challenges at the various levels. To illustrate this point next section will develop a conceptual framework for analyzing KI.

2. A Conceptual Framework For Analysing Knowledge Integration

In this section, a framework for analyzing knowledge integration in R&D organizations will be proposed. The framework will assist in conceptual understanding of the issues related to integrating knowledge from internal and external sources in R&D firms. We argue that knowledge integration can be characterized as having a multi-layered structure with an external (i.e., outside the firm) or internal (i.e., within the firm) orientation. Furthermore we emphasize that in a R&D firm extent of the individual specialized knowledge, team–building capability, communication networks, and internal/external organizational climate affect capability, which in turn will affect the creation of new products and services.

This study builds on the previous literature and takes the knowledge integration capability as the key capability in a dynamic environment and as a starting point of departure (see among others Grover & Davenport, 2001; Probst, et al, 2000; Lu et al, 2007). We suggest the process of integrating knowledge in R&D firms comprised of various activities that are involved in the identification, selection, acquisition, development, exploitation and protection of technologies. These activities are needed to maintain a stream of products and services to the market. In fact, R&D firms deal with all aspects of integrating technological issues into business decision making and new product development process. Furthermore, we emphasize that knowledge integration is a multifunctional field, requiring inputs from both commercial and technical functions in the firm. Therefore effective knowledge integration requires establishing appropriate knowledge flows between core business processes and between commercial and technological requirements in the firm.

Our conceptualization of the knowledge integration capabilities assumes that there are both "macro" and "micro" organizational mechanisms designed to address the problem of knowledge integration in new product or process development. We also assume that a knowledge integration system should be described by internal or external orientation. Internally-oriented knowledge systems rely primarily on private knowledge sources (both personal contacts and documents) inside the firm. In contrast, an externally-oriented knowledge system relies on company's collaborative agreements (such as consortia, alliances or partnerships) as well as employees external private networks with people at other companies or when R&D staff in internal knowledge systems access external knowledge and information.

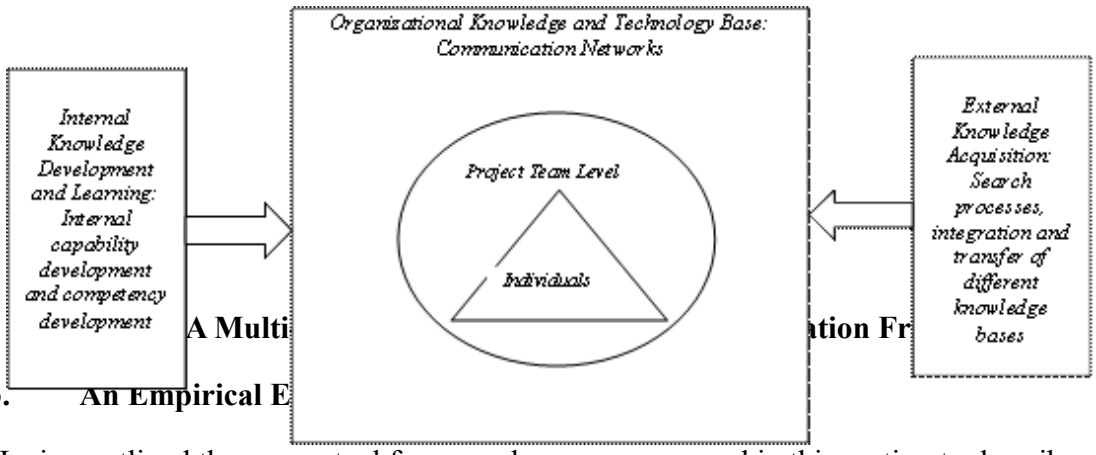
Hence managing the integration of knowledge do not operate in isolation, and are generally not managed as separate 'core' business processes. The various activities that constitute the knowledge integration processes tend to be distributed within business processes. In fact, formal interventions and routines that focus on the improvement of the group process are also a potential way to achieve superior knowledge integration (Eisenhardt & Okhuysen, 2002). In R&D firms specialized knowledge are more widespread and ideas should be used with enthusiasm, thus organization must be able to integrate them through mechanisms such as direction and organizational routines (Grant,

1996). Additionally firms that can harness outside ideas to advance their own businesses while leveraging their internal ideas outside their current operations will likely thrive in this new era of open innovation (Chesbrough, 2003).

Therefore, organizational mechanisms for effective and systemic knowledge integration should address at least four components: 1) team-building capability; 2) integration of individual specialized knowledge that are sources of technical and commercial information; 3) knowledge integration through communication networks within and outside the organization; and 4) technology/knowledge system integration. As Figure 1 illustrates, the technology systems overlap in producing the organizational capabilities in which technical staff solve problems and create new technology. Firms rely on the interaction between their organizational mechanisms and their employees' activities involving problem solving and experimentation, facilitated by their ability to import and integrate knowledge. As explained the components of the knowledge integration model can be described as internal or external according to their orientation to firm-based rules or external markets, respectively, in determining how work is organized, skills are learned, and the new technology is integrated within the new product or processes. For example, companies creating new products in an industry with short product generations find themselves relentlessly combining new internal knowledge with external knowledge to keep pace with the industry.

As indicated in the Figure 1, the technology and knowledge base of the firm, represents the technological knowledge, competencies and capabilities that support the development and delivery of competitive products and services, and may include other organizational infrastructures such as knowledge management (KM) systems. Knowledge integration activities including identification, selection, acquisition, development, exploitation and protection, operate on the technology and knowledge base, which combine to support the generation and exploitation of the firm's technology base.

This framework provides an example of how the issue of knowledge integration may be formulated into a holistic and systemic perspective by including some internal and external factors in the process of new product or process development. Emphases have been put on the context within which knowledge integration occurs within units (e.g., an individual, a group, or an organization), and the relationships between units, and properties of the knowledge itself. The overall aim of the framework is to support understanding of how technological and commercial knowledge combine to support strategy, innovation and operational processes in the firm, in the context of both the



3. An Empirical E

Having outlined the conceptual framework, we now proceed in this section to describe the adopted methodology including data collection and the actual results of Fujitsu case study.

3.1. Research Methodology

In order to analyze the process of knowledge integration at Fujitsu Corporation, this paper adopted a qualitative research approach and the study was designed to be explorative. Guided by general interest in knowledge integration processes this study looked at Fujitsu case to explore how the company employs external and internal networks in integration of their knowledge systems into their new product or system development process. This case study method was used as an empirical basis because of its advantages in improving contextual sense (Miles, 1979), deeper understanding (Geertz, 1973), and theory development (Van Maanen, 1979).

The research methodology combined on-site interviews and analysis of company internal documents such as annual reports, web pages and internal publications. The interviews were conducted in 2010 in Japan. Senior managers at the Fujitsu headquarters and middle managers who were directly involved in the new product or system development project were interviewed, with each interview having lasted for about 1 to 2 hours. In total seven interviews were conducted and informants were chosen on the basis of the closeness of their expertise and knowledge to the topic under investigation.

In the course of the qualitative interviews, semi-structured and open-ended questions in accordance with the theory of knowledge integration and new product development within firms were employed. The interview partner could nevertheless answer openly and lead the interview mostly. All interviews were conducted in English, recorded and authentically transcribed. Questions were asked about the following topics: 1) KI in Fujitsu and the way Fujitsu performs KI in new product or system development projects; and 2) the methods, techniques, and tools that Fujitsu uses during KI. Also questions were asked about the problems that company face during KI. We were particularly interested in how Fujitsu address the four components of integration discussed in our conceptual framework namely: 1) team building capability; 2) integration of individual specialized knowledge; 3) integration through communication networks; and 4) technology system integration.

In what follows, we will first provide general information about the company and then the findings from the case study will be analyzed. Knowledge integration literature and the conceptual framework presented above have been used as a backbone for the analysis of the Fujitsu case study.

3.2. Case Evidence

3.2.1. Company Information: The "Fujitsu Way"

Fujitsu is a leading provider of information and communication technology (ICT) based business solutions for the global marketplace and is the world's third-largest IT services provider and No.1 in Japan. Fujitsu operates through about 540 group companies in 70 countries around the world and employs more than 170,000 people. Headquartered in Tokyo, Fujitsu's consolidated revenue was 4.6 trillion yen (US$50 billion) for the fiscal year ended March 31, 2010 (see, Fujitsu, 2010a)

Fujitsu delivers total solutions in the field of ICT and combines a worldwide system and services experts with computing and communications products and advanced microelectronics to deliver added value services to customers. Along with multifaceted services provision, Fujitsu is also active in the development, manufacture, sales and maintenance of the cutting-edge, innovative products and electronic devices that make these services possible. So far, Fujitsu innovations have garnered over 34,000 patents (Fujitsu, 2010b).

The "Fujitsu Way" embodies the philosophy of the Fujitsu Group and the values and the principles that the Group follows in their daily activities. On April 1, 2008, Fujitsu announced a new Fujitsu Way. All Fujitsu Group employees have a shared commitment to the Fujitsu Way, which promotes a common direction for Group employees. The new Fujitsu Way aims to facilitate management innovation and promotes a unified direction as the Group expands in global business activities. The Fujitsu Way consists of four core elements—the Corporate Vision, Corporate Values, Principles, and Code of Conduct. The Corporate Vision embodies the reason for the Group's existence, as well as the social role that it should fulfill. Corporate Values encompasses a set of values important for realizing the Corporate Vision. Finally, the Principles and Code of Conduct articulate rules of behavior to which every Fujitsu Group employee should actively adhere in accordance with the Corporate Values. The Group has also formulated a Business Policy that outlines the medium-term direction of Fujitsu's businesses as defined by the Fujitsu Way. This policy serves as the basis for all Group business activities (Fujitsu, 2010c).

In recent years, Fujitsu has expanded globally by taking advantage of the unique capabilities of each of its local operations around the world. With the recent expansion of open standards and cloud computing, Fujitsu expanded its business by promoting a unified global approach. There are two initiatives that are essential for Fujitsu to become the Japanese global ICT company: 1) the creation of an organizational structure that enables Fujitsu to deliver uniform, optimal services to customers in every region of the globe (transnational model); and 2) the creation of global solutions. Therefore, Fujitsu will strive to strengthen its brand globally as it transforms into a truly global company (Fujitsu, 2010b).

Since 2005, the research and development management also has been strengthened to create a stronger awareness of the output from global cooperation. In this relation Fujitsu's overseas laboratories have taken on the challenge of R&D by setting their own research strategies and topics. By taking advantage of the local environments, these laboratories play an important role in supporting the cutting edge research and development in Fujitsu. Currently, in addition to Fujitsu R&D Laboratories in Japan, Fujitsu operates research and development activities in three overseas research facilities: Fujitsu Laboratories of America (established in 1995), Fujitsu Research and Development Center – China (established 1998), and Fujitsu Laboratories of Europe (established in 2001 in London). These facilities conduct research in close cooperation with local universities and research organizations, including work on technology related to the characteristics of each local region (Matsumoto et al, 2010).

As outlined in Fujitsu's Business Policy, through sophisticated ICT utilization, the Fujitsu Group aims to realize a more prosperous and secure society (Fujitsu, 2010a). To this end, Fujitsu is determined to resolve a range of problems facing not only business, but society itself. Fujitsu hopes this effort will bring innovation to a host of fields, from healthcare, agriculture, and education, to energy and transportation. In this relation, Fujitsu is working towards a "Human Centric Networked Society," where everyone has access to sophisticated services that are supported by a complex but invisible infrastructure. This approach of holistic technology and knowledge integration will be elaborated more in below.

3.2.2. Knowledge Integration In Fujitsu

As discussed in the conceptual section, organisational mechanisms should address; team-building capability in NPD process; integration of individual specialized knowledge that are sources of technical and commercial information; knowledge integration through communication networks; and technology and knowledge system integration. As argued earlier these aspects of knowledge integration are critical in understating how KI is performed by individuals, teams, or by firms at different layers of the company. In what follows Fujitsu's practice in each of these issues will be highlighted.

3.2.3. Team Building Capability

From the interviews it became clear that KI was not organized as a separate or formalized process at Fujitsu, but that the company perform it as part of the new product development (NPD) process (or any other business process such as system or service development) without explicitly developing a strategy for it. Fujitsu's NPD demonstrated the need for knowledge integration of heterogeneous technology elements including server development, image compression, voice compression, semiconductor design, semiconductor software, communications interface, computer, software, and human interface technologies (Kodama, 2005). To fulfill this need, not only Fujitsu absorbed technology from other firms through collaboration with external partners, it also relied on in-house NPD teams in order to mobilize heterogeneous elements of technological knowledge distributed within the firm. In this section, therefore, we focus on task-oriented teams as a primary means of knowledge integration.

The complexity of the NPD process in Fujitsu is reflected in the complexity of the related knowledge flows, which are both crucial for advancing the process but at the same time difficult to manage. More specifically, part of the knowledge needed for developing a new product already exists within the organizations involved, while fresh knowledge is created as the process unfolds, problems are analyzed, and the product is developed, refined and ultimately launched on the market. The existing knowledge stored or embedded in the minds of people, in archives, in existing products and in procedures and equipment, needs to be recognized, retrieved and made available to engineers and other project participants. The newly created knowledge developed by practical problem solving needs to be analyzed, shared and integrated with previous knowledge, to ensure a spiral of continuous expansion and development/refinement of knowledge for future use in the NPD process. As emphasized in literature and demonstrated by Fujitsu the transfer and sharing of knowledge are critical components for enabling this integration of newly created and previously existing knowledge, and thus for efficient NPD process.

Product and system development in Fujitsu is the dynamic and continuous process of adaptation to changes in the environment. The key elements of this effort are self-organizing development teams, facing challenges collectively, and a commitment to continuous learning. At Fujitsu project teams are assigned to pursue both specific new product concept as well as broad strategic product development goal. These self-managing teams are perhaps most important mechanism for knowledge integration. As emphasized by the interviewees teams provide a viable mechanism for the integration of knowledge for complex and non-routine organizational tasks, especially when task uncertainty, novelty, and complexity preclude the use of existing routines or directives.

Through a team structure, diverse knowledge and expertise of individuals at various locations are assembled, integrated, and applied to the task at hand. Rich communication, collaboration, and creative solution characterize knowledge integration in teams at Fujitsu. Fujitsu rely on reconfiguration of distributed organizational knowledge using team structures that facilitates innovation. By encompassing diverse sources of specialized knowledge, teams enhance Fujitsu’s ability to innovate.

A new product development team at Fujitsu, may consist of fixed members within a division, for example server development group, or may consist of a cross-functional team with several members with diverse backgrounds, which usually is hand picked by management and is given a free hand to create something new. Reasons for introducing new products mainly include matching to changing customer demand, solving a problem and innovating. To become self-organizing, a group needs to be completely autonomous; it must come up with its own challenging goals and then try to keep elevating those goals. Sharing of information is encouraged. Decision making relies on up-to-date information from the marketplace and technical communities within or outside the organization. Sharing of responsibilities is accepted by all group members. This allows teams to assume major responsibilities and to solve problems spontaneously as they arise rather than asking the engineers for a new blueprint and the staff for new work procedures. The work is more varied, flexible, and challenging and may make levels of supervision

The success of the new product programs is related to the level of R&D and marketing integration as well (sharing of information, working together on specific new product development tasks, organizational structure, attitudes). In Fujitsu as in many other Japanese companies, methods of organizing new product activity are influenced by corporate culture, which accomplishes the necessary factors. In the successful projects, inter-functional cooperation is based on shared commitment and is reinforced through participative decision making, job rotation, and the use of reward systems. When R&D-marketing relationships are harmonious, new product projects tend to have greater success. By their very nature, Japanese companies such as Fujitsu produce this harmonious interaction.

At Fujitsu, employee participation in new product development, product modification, and service solution is high, as is expected in a participative decision-making. R&D and marketing are involved early in the process. Management tends to be decentralized, although top-down strategic decision-making for R&D resource allocation is emphasized, and tend to have a greater emphasis on role clarity. New product development is one of the most knowledge intensive processes in business and is itself constantly creating new knowledge. Technology and knowledge are transferred to other divisions or subsequent projects and become institutionalized over time. Personnel are rotated as well. Successful, highly visible projects will be studied and copied by others in the company. Because of the Japanese emphasis on lifelong learning and the job rotation which exists in most every large Japanese corporation, the organizational transfer of learning to other individuals or to entire other groups can be accomplished easily, quickly, and cooperatively. As in Fujitsu, NPD relies heavily on collaboration within fixed- or cross-functional teams, the question of how such knowledge, which to a large extent is tacit, should best be captured, managed and disseminated is crucial. This will be further elaborated in the following section.

3.2.4. Capturing And Utilising Tacit Knowledge

As emphasized in the literature a prerequisite for effective knowledge integration is knowing who has the required knowledge and expertise, where the knowledge and expertise are located, and where they are needed (Grant, 1996). Furthermore, as mentioned before effective teamwork (in both virtual and face-to-face settings) requires an emergent process of rich exchanges and joint problem-solving to integrate and apply knowledge and expertise to the task at hand in a coordinated manner. Thus integration of individual knowledge and knowledge sharing has become an important corporate strategy for capturing technical and commercial experience. A number of ethnographic workplace studies show that the intelligence employed in everyday work practice is crucial to accomplish work (see, for example, Kishimoto et al, 2010). However, it is difficult to share such intangible, invisible, and situated knowledge of workers as organizational knowledge. At Fujitsu, in addition to common codification and KM systems, organizational learning method and personalization method that extracts organizational knowledge from individual workers' experiences have been put into practice (Kouji et al, 2010). This method enables the conversion of tacit knowledge to explicit knowledge. It also enables the transfer of the knowledge generated by individual workers' experiences to members who have not experienced the event.

The experimental method of capturing individual knowledge is based on virtual experiences that promote experiential learning by using history charts and activity logs. History charts visualize success/failure cases in step-by-step actions with evidenced materials. Fujitsu applies this method in three separate phases: 1. analyzing and visualizing individual experiences, 2. conceptualizing organizational knowledge, and 3. facilitating virtual experiences. Phase 1 corresponds to reflective observation. Some events and episodes are extracted based on the individual workers' experiences. Phase 2 corresponds to abstract conceptualization. Lessons learned are extracted from the events and episodes. Phase 3 corresponds to active experimentation and concrete experiences. Fujitsu's laboratories have applied this method to knowledge sharing problems during new system development process (Kouji et al, 2010). .

For example, the above method has been used during requirements engineering (RE) process in information system (IS) developments and the effectiveness of the method was evaluated. Requirements engineering (RE) is a process that system engineers clarify system specification through interactions with customers. The quality of the RE process highly depends on the engineers' skills and poor understanding of customer requirements for IS development triggers project failures and produce a number of reworks. Based on the actual results and according to the interviewed managers it appears that this method, which is currently at the experimental stage, is an effective method and will be put into practice more in future product or system development projects. This method in particular proved to be efficient in transferring individual tacit knowledge to other members which normally are difficult to be captured by any KM systems.

Therefore, capturing tacit knowledge in Fujitsu is about ensuring that expertise, information and ideas are visible, it can be shared and applied to deliver benefit to their customers. Fujitsu also has developed a set of guidelines to ensure that everyone comprehends the importance of the knowledge management and sharing. For example according to these guidelines everyone is responsible for knowledge management and all employees are expected to use, contribute to, and protect the company's intellectual assets. Employees are also expected to pro-actively learn from and re-use the company's knowledge assets, and are encouraged to participate in Communities, Special Interest Groups and similar knowledge sharing networks. Knowledge and corporate history that are preserved in Fujitsu's knowledge systems constitutes an important Fujitsu resource. This resource is managed as a corporate asset, rather than as the property of individual teams or units. Knowledge is managed to ensure the security of customer data, customer contracts and Fujitsu intellectual property. All knowledge assets developed in Fujitsu is freely available to all Fujitsu employees, subject to confidentiality restrictions. Fujitsu will only share its knowledge assets with their customers and partners, provided there is an appropriate commercial or contractual arrangement in place (Fujitsu, 2010d).

Fujitsu, also recognizes that utilizing tacit knowledge captured in previous projects is quite important in new product development projects. However, instead of using only manuals or formal scripted deliverables, it also recognized that it is more effective and also faster to make use of deliverables of similar projects during development in order to understand the background of the actions taken and why they are necessary. Hence, to draw on previous experiences and to capture important knowledge from similar and previous projects, Fujitsu relies on its in-house communication network and KM

systems where project members get-together in network not only using concise jargon to share important information on a current project but also to obtain critical information from previous projects. In this regard, Fujitsu has applied knowledge management concepts that create a shared workplace to new product or system development projects in a network environment. This will be further elaborated in below.

3.2.5. Communication Networks: The Role Of KM Systems

As mentioned Fujitsu is promoting efficient on-site activities to improve communication and information sharing among management activities during a new product or system development project. Fujitsu has been promoting in-house use of communication networks and knowledge management concepts, such as SolutionNET, since 1997 and have developed several SolutionNET tools for their in-house use (Hosono, 2006). By applying these tools Fujitsu promoted the use of knowledge management systems throughout their entire systems engineering organization. In this relation, in order to accumulate and integrate various types of expertise and know-how generated in the systems engineering field and accelerate on-site problem-solving, Fujitsu has developed and introduced ProjectWEB, its in-house knowledge management tool. In ProjectWEB, members not only can share the information but also are able to visualize the project development system at each phase of the project. ProjectWEB, which is a knowledge management concept, is one of the main tools that play the most important role within communication networks of Fujitsu (Murakami, 2010). In this section Fujitsu's approach in using ProjectWEB is explained.

As emphasized by interviewed managers, in a new product or system development project, it is important that not only the project manager but also all the members share the progress and status of the scope, delivery date, quality, and cost of the project so members can work according to the schedule. To improve communication between people, Fujitsu established a common workplace in which every project member can communicate directly with each other on a daily basis on a network. Since its introduction in 1998, ProjectWEB has played an essential role in Fujitsu's systems engineering work (Hosono, 2006). ProjectWEB is based on the concept of providing a work site on a network allowing activities across different locations at all times. Because it is a Web-based application, it allows real-time sharing of information between different business locations by having clients connect to a network. By practicing day-to-day systems engineering activities on ProjectWEB, important knowledge can be obtained regarding discussions in the process of how conclusions can be reached and problems to be solved, which according to managers, was difficult to do in the past. ProjectWEB designed to provide an effective environment that allows automatic accumulation and use of knowledge in day-to-day workflows rather than organizing information.

ProjectWEB is the core tool for implementing workplace sharing and includes a project management support function as well. This function supports project management and engineering activities based on Fujitsu's Solution-oriented system Development Engineering Methodology (SDEM). Functions provided by ProjectWEB have been effective as a mechanism for speeding up communication and implementing real-time management in addition to practicing KM (Murakami, 2010). ProjectWEB includes various communication features such as bulleting board systems (BBSs), forums, and

schedulers, but the core features are the ToDoList (To Do List) and the Library. Unlike a common personal to-do-list, the ToDoList function of ProjectWEB is positioned as a shared E-mail function on the Web (Murakami, 2010). It allows sophisticated sharing of information among multiple people on the Web, a process that tended to be cumbersome vie E-mail. The Library is a place where the interim results of daily activities (tacit knowledge) are stored. It enables members to mutually review documents so troubles can be avoided at an early stage. This function also provides file sharing with high operability, and mainly is used for purposes such as sharing files between project members.

The project management support function (known as PMPACH/C), roughly consists of two groups: a progress management function and a quality management function. The progress management function is equipped with a work breakdown structure (WBS) function for capturing the progress of a project (Murakami, 2010). The quality management function is provided with features that allow user to manage information to be shared with customers. The project management function is also linked with the communication function, while being independent, and provides users with a means of efficiently sharing information.

Hence, by applying knowledge management concepts to systems engineering activities, ProjectWEB is designed to foster the practice of real-time management by visualization and knowledge integration. Daily communication between project managers and project members is an important activity in many large or medium-scale projects. In ProjectWEB, this communication is supported through communication-based project management in which daily reports from members can be captured and used to create information for status management and quality management and to share these reports among each member. For example, in a NPD project involving multiple contractors, all reports related to quality management are issued within the system, and by analyzing the cause classification and taking measures within each development phase, critical problems after project completion are prevented. In short-term projects, the ProjectWEB is being used for communication among members, where the members mutually check the deliverables stored on the system every day. As a result, there is no rework in the project.

According to Fujitsu, increasing number of business units have been using ProjectWEB. Fujitsu reported that at the end of March 2009, almost 3000 ProjectWEB installations were running as services (Murakami, 2010). More than one project environment can also be built in each ProjectWEB and the number of projects using it amounts to nearly 8000. Fujitsu also aimed to position ProjectWEB as a business infrastructure for all Fujitsu engineers to be used also outside the company. Since 2001, Fujitsu has been providing an environment for sharing ProjectWEB, which was built in an Internet environment, with customers and business partners. To that end, efforts for ensuring secure operation of ProjectWEB are essential and as a result Fujitsu provided major security measures in latest versions.

ProjectWEB has become firmly established and widely used as Fujitsu’s systems engineering work style. It also demonstrates its ability to be used not only in projects, but also in various other business arenas. Fujitsu, therefore, has been continuously working to enhance functions and security with the aim of having it used by external

parties as well. For instance, ProjectWEB can be used in NPD projects that involve contractors and global users. Because the system can be used over the Internet, Fujitsu's activities have become more visible, which according to the customers, has increased their sense of trust in Fujitsu. As mentioned by managers, ProjectWEB has been continuously evolving to overcome challenges in project activities and particularly to strengthen its linkages with other systems so that real-time management is further evolved by visualizing quality, progress, costs and risks. Therefore, Fujitsu intend to use ProjectWEB as a communication system that can be reliably used internally and externally through further strengthening security and improving functions.

3.2.6. Technology Integration: Toward A Human Centric Networked Society

As mentioned before, KI in Fujitsu is not limited at individual, team or organisational levels. More importantly, at technological level, Fujitsu is moving toward a Human Centric computing environment, where ICT could provide tailored and precise services wherever and whenever people needed those services (Yoshikawa and Sasaki, 2010). In this way, Fujitsu through its slogan "Shaping Tomorrow with You" is shifting the paradigm from system centric to human centric solutions. Fujitsu realised that through evolution of social activities that are supported by technological innovation in information and communication technologies there are numerous real-life fields in which the application of ICT can be further leveraged.

In this regard, attempts are being made to achieve innovation in field operations and collaborate with service providers by sharing data in addition to the shared use of service components. For example, Fujitsu has been working on field solutions that allow a detailed understanding of field situations by introducing wireless and sensing technologies to the fields where IT technologies have not traditionally been in place, such as agriculture and healthcare, for collecting, analysing and sharing field data, namely real-time filed management, and proposed optimization of management resources, improvement of eco-friendliness and sensor solutions (Takahashi et al, 2010). To achieve this, Fujitsu is conducting R&D in integrating new technologies in areas such as Cloud computing, network technology and Smartphone evolution Abe & Shibata, 2009). Fujitsu's strength lies on its command over all of these relevant technologies and Fujitsu believes integration of these technologies will provide significant technological revolution with varied social and human centric applications.

Fujitsu intends to take advantage of the major social changes, increased business opportunities, and other such substantial changes that can be brought about by sensing the various kinds of information and acquiring knowledge from the environment that surrounds individuals. This information then can be provided to the Cloud environment via a network and converting the immense amount of collected knowledge into new value (Yoshikawa and Sasaki, 2010). As a result it would be possible feeding it back to the individual and to the business environment that surrounds individuals. The question is what technology and infrastructure is needed to achieve this? Fujitsu believes it is important to place people at the centre while taking a strategic and scenario-based approach to R&D by focusing on changing events and then developing technologies and products.

For this purpose, Fujitsu has adopted a series of strategic and technological decisions to integrate the world of ICT and the real world. The aim is to be able to analyse massive volume of sensor and web data and proactively deliver necessary services where and when are needed (Lida, 2010). In this way, Fujitsu is striving towards a world where people, society and IT systems are in harmony with each other. For example, technologies can be developed to detect human movements through acceleration sensors embedded in mobile phones. By analysing human movements then it would be possible to provide health support or sports diagnostic services. Another example of human centric application would be, for instance, visualization of power consumption and environmental sensing in order to optimise the power usage based on comprehension of behavioural patterns. Fujitsu is currently working on several such applications with emphasis on integrating technologies (such as sensors, mobile devices, human interfaces, mining, ergonomics, etc.) that would merge the real world with the world of ICT and leverage knowledge and innovation (see Lida, 2010).

Fujitsu's R&D strategy in this relation currently focusing on three themes: 1) large-boned themes, which consist of core research projects on important themes for the future technology of Fujitsu Group with medium- to long-term development; 2) business strategic themes, which focuses on strategic business projects with commitment form internal business segments for commercialisation with short- to medium-term technology development; and 3) seeds-oriented themes, with emphasis on new research areas for growth of future emerging technology seeds, which basically these projects are for long-term technology development (Murano, 2010). According to Yoshikawa and Sasaki (2010), to enable a human centric networked society Fujitsu's laboratories have adopted several important policy initiatives including:

- Roadmap-based R&D activities related to business while looking forward ten years into the future.
- Open innovation activities utilising cooperation between industry and academia.
- Business incubation activities aimed at opening new markets.
- Strategic public relations activities for mass media, investors, and analysts, and
- Cultivation of personnel.

Each of the above is explained here briefly. In order Fujitsu to optimise its R&D contributions in emerging technology areas, R&D in their laboratories must proceed under the guidance of a roadmap that serves as the key to technology management and with information sharing that extends from the supervisor level to upper management. As mentioned, Fujitsu also aims at devising new technologies that create value for customers. For this propose Fujitsu Laboratories is actively using outside technology to take advantage of open innovation era that involve stronger cooperation with other companies that possess special areas of expertise and with universities as well. Fujitsu Laboratories is also conducting new R&D activities and business incubation activities that are coordinated with the technology roadmap by means of a phased portfolio. For risky projects that are not understood clearly by the business sector, Fujitsu set strategies for converting technology into business individually, according to the situation of each

project. Fujitsu also is strategically raising public awareness of its results through presentations at scientific conferences, press releases, web publishing, participation at exhibitions, and so on. Finally Fujitsu's policy toward personnel cultivation is very diverse. Fujitsu realises that personnel in the R&D sector are a vital managerial resource, and securing, training, and raising their abilities is one the most important goals for laboratory management. Fujitsu Laboratories is currently introducing a business model approach to R&D, aiming at the 21st century laboratory that are implementing continuous personnel development form the time employees join until they leave (Yoshikawa and Sasaki, 2010).

In summary, it seems that Fujitsu will continue to grow by placing importance on technology and continuing to cerate new value. Through systemic technology and knowledge integration it will continue contributing to building a human-centric networked society in which a new social infrastructure brings people into harmony with computers and enable ICT to leverage knowledge and expertise. For this purpose, Fujitsu needs to integrate knowledge by forming networked team within the firm, while also absorbing the knowledge of external partners via integration with other firms. This internal and external knowledge integration for the Fujitsu case forms the base of the 'knowledge integration,' which integrates knowledge at various layers of the company.

4. Discussion: Knowledge Integration In Japanese Firms

The objective of this paper has been to look at the execution of KI processes in Japanese firms. In particular the paper explored the case of Fujitsu. The research question was: is knowledge integration performed by individuals, teams, or by firms, or is KI something that happens at the network level? Also the paper looked at the role of technology and knowledge management systems in knowledge integration. As demonstrated by the case of Fujitsu, knowledge creation and integration occurs at various layers including individuals, teams, organizations, technology and networks. This multi-layered model is frequently observed in cases of large-scale new product development and major projects. Furthermore, knowledge integration takes place through networks inside and outside of the firms. This is in line with previous research which highlights that Japanese firms acquire knowledge and integrate it within the company from outside of the firm as well as inside of the firm. Basically the Japanese firms rely both on the knowledge *inside* the company networks and knowledge *outside* the company that created by suppliers, customers, dealers, local communities, competitors, universities, government and other stakeholders.

In relation to external knowledge, as argued by Kodama (2005), Japanese firms exploit vertical integration strategy to assess other firms' knowledge and business models, with a view to absorbing ideas and expertise, and with their 'connect and development' strategy to enhance the independence of product, service, and business models (Kodama, 2005).

However, as is argued in the case of Fujitsu, besides external networks and collaborations, internal networks also feature strongly in Japanese knowledge creation and transfer. In terms of the internal networks, Nonaka and Takeuchi (1995) point out Japanese companies success depends on having small knowledge creating units that is working autonomously, so that the chances for "unexpected opportunities" (Nonaka &

Takeuchi, 1995) and employee motivation increases within the team. Takeuchi and Nonaka's six “jigsaw puzzle” characterizes these teams in terms of self-organization, subtle control, multi-learning, transfer of learning, built-in instability, and overlapping development phases. These characteristics of the self-organized teams seem to be applicable to the case of Fujitsu. In Fujitsu, as discussed, teams seem to establish their own targets and keep elevating them throughout the team's activities, an approach termed self-transcendence.

In fact, these self-organizing teams play a central role in the Japanese approach to knowledge creation and integration. As the case Fujitsu has shown new product development processes possess natural features that make it easy to routinely form fixed or temporary cross-divisional teams, oriented to achieving new targets and solving problems. The teams that overcome organizational and knowledge boundaries among practitioners can then trigger creativity and new knowledge inspiration. However, as emphasized by Huang and Newell (2003) it is crucial to recognize that cross functional knowledge integration within the context of a project team is not limited to a focus on the dynamics occurring within the team boundary. It is equally vital to understand the dynamics of knowledge integration beyond the team boundary, in particular in relation to knowledge integration within or outside the firm and with all stakeholder groups. In this view, knowledge creation, sharing and transfer constitute an important component of systemic knowledge integration.

In Fujitsu new knowledge, whether from *inside* or *outsides,* fuels innovative breakthroughs and sharing of knowledge is not purely a matter of multifunctional teams. The extensive R&D activity makes it possible to use invented technologies in new or unexpected industries and further build up the competitive edge. For example, as discussed technology fusion and integration in Fujitsu, which aims at creating a “human centric networked society”, builds from knowledge from different industries and technologies with a multi-technology basis instead of reliance on a single technology. In this regard, building integrated knowledge capital platforms from accumulated experience and expertise works advantageously in responding to technological change and resolving new issues which require speed and creativity. Knowledge management systems in Fujitsu, such as ProjectWEB, or capturing individual tacit knowledge based on virtual experiences in fact supports building integrated knowledge capital platforms from accumulated experiences.

In summary, this study has shown that in high-tech firms such as Fujitsu, the interdependence among various departments, and multi-layered organizational structures facilitate knowledge creation and integration. This is in line with the literature that acknowledges knowledge processes (knowledge creation, sharing, and use) are influenced by organizational structure, governance and coordination mechanisms. As demonstrated, Fujitsu has certain governance mechanisms in place to facilitate this knowledge process.

5. Concluding Remarks

This case study of Fujitsu demonstrated how R&D firms may arrange their knowledge integration requirements within new product or system development process. The paper focused specifically on team-building capability, capturing and utilising individual tacit

knowledge, and communication networks for integrating dispersed specialist knowledge. Knowledge integration, as discussed, is a fundamental process by which firms gain the benefits of internal and external knowledge, create competitive advantage and develop capability. It is through internal development or external acquisition that an organization is able to get both the range and the quality of expertise, which is required for complex production and innovation processes.

As this paper argued, knowledge integration in Fujitsu is not limited at individual, team or organisational levels. More importantly, at systemic and technological level, Fujitsu is developing a human centric computing environment, where ICT will provide tailored services wherever and whenever people needed those services. Therefore, as a specific empirical case, Fujitsu demonstrated the need for knowledge integration of heterogeneous technology elements including human interface technologies.

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