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Organisational Knowledge Integration

Towards a Conceptual Framework

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Abstract This study analyses organisational knowledge integration processes from a multi-level and systemic perspective, with particular reference to the case of Fujitsu. A conceptual framework for knowledge integration is suggested focusing 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 research highlights that knowledge integration occurring in the innovation process is a result of knowledge exposure, its distribution and embodiment and finally its transfer, which leads to innovation capability and competitive advantage in firm.

1 Introduction

In this study, knowledge integration (KI) is all the activities by which an organization identifies and utilizes external and internal knowledge. 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 (Cavusgil et al. 2003). 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 (NPD). This process of external transfer of knowledge or internal capability development and learning which will result to knowledge integration and new product development within organization is the focal subject of this study. The conceptual research question is: How is knowledge integrated, sourced and recombined from internal and external sources for innovation and new product development?

To analyse the above question from a conceptual perspective, this paper firstly examines theoretical background of KI and it then provides some evidence of KI in Japanese firms with particular reference to the case of Fujitsu. Finally a conceptual framework will be suggested which may provide a better understanding of knowledge integration within an organisation.

2 The Theoretical Background

Knowledge integration in firms has received considerable attention in recent research (see, for example, Mohannak 2011; Brusoni et al. 2009; Zirpoli and 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 1996a; Kogut and Zander 1992). From the perspective of the knowledge-based theory of the firm, the main problem lies in assuring the most effective integration of individuals' specialized knowledge at the lowest attainable cost (Grant 1996a). A central claim of the knowledge based theory of the firm is that organizational capabilities depend not only on specialized knowledge held by individuals but also on an organization's ability to integrate that specialized knowledge (Galunic and Rodan 1998; Garud and Nayyar 1994; Grant 1996a; 1996b; Huang and Newell 2003; Kogut and Zander 1992; 1996; Okhuyzen and Eisenhardt 2002; Purvis et al. 2001). The knowledge-based theory thus extends existing theory on organizational differentiation and integration to include the differentiation and integration of knowledge.

Stemming from the need for differentiation and integration, the theory of knowledge integration emphasizes the economic value of specialization and the effectiveness of integration. In other words, competitiveness depends on the diversity and strategic value of specialized knowledge, as well as an organization's capacity to integrate the knowledge in an effective manner. Grant (1996a) describes the integration of individuals' specialized knowledge to create value as a key capability.

Following knowledge-based theory of firm, Alavi and Tiwana (2002) has defined KI as synthesis of individuals' specialized knowledge into situation-specific systemic knowledge. This definition is based on the fact that the specialization of organization members turns organizations into distributed knowledge systems in which the range of knowledge that is required for production or innovation is dispersed over organization members (Tsoukas 1996). Therefore, organization members have to integrate dispersed bits of specialized knowledge held by individuals, i.e., to apply this dispersed knowledge in a coordinated way (Becker 2001; Grant 1996a). In this sense, knowledge integration is essentially a matter of organization, and the ability to create and exploit useful combinations is the *raison d'être* of firms (Kogut and Zander 1992; Grant 1996a).

Another definition is given by Huang and Newell (2003:167), which is defined as: "an ongoing collective process of constructing, articulating and redefining shared beliefs through the social interaction of organizational members". In fact, the emphasis on the need for communication and shared knowledge which is to be found in much product development literature is reflected in this definition. This is to say that new product development team members must be able to communicate in a manner that is meaningful. Moreover, they must be able to create new knowledge. In this way, the outcome of knowledge integration consists of "both the shared knowledge of individuals and the combined knowledge that emerges from their interaction" (Okhuysen and Eisenhardt 2002:371).

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 knowledge integration. Indeed, facilitating the combination of knowledge elements relies on the ability to create shared agreements across different expertise (Nonaka 1994). Therefore, for the purpose of this paper knowledge integration is defined as all activities by which an organization identifies and utilizes internal and external knowledge including creating, transferring, sharing and maintaining information and knowledge.

Knowledge integration, therefore, is a fundamental process by which firms gain the benefits of internal and external knowledge, create competitive advantage and develop capability. However, characteristics of new technologies and learning processes are such that organization members have to specialize in order to ac-

quire a high level of expertise. Given the large amount of relevant knowledge that are available in many fields and the limitations of human information processing, individuals have to share and integrate their knowledge. While efforts aimed at knowledge sharing can constitute important mechanisms for knowledge integration, other organizational mechanisms such as codification of knowledge through procedures, instructions, and code books (Grant 1996a), knowledge platforms (Purvis et al. 2001), communication networks, knowledge integrators, communities of practice, teams (Grandori 2001), rules, directives, routines, group problem solving, decision making (Grant 1996a), tacit experience accumulation, articulation and codification (Zollo and Winter 2002) all facilitate knowledge integration.

As Gittell (2002) emphasized organizational routines in particular cause predictable patterns of collective behavior, and hence are appropriate integration mechanisms in stable environments (Gittell 2002). Routines also support complex, simultaneous and varied sequences of interactions among agents (Becker 2004; Grant 1996a). Grandori (2001) suggests that the tacit and unobservable nature of judgment and action generates epistemic complexity. Such complexities can be captured in tacit organizational routines which in turn allow for task partitioning and for specialization among organizational members (Prencipe and Tell 2001).

In contrast to these internalizing features of learning through experience accumulation and routines, literature also has emphasized the need for firms to acquire knowledge from external sources. External knowledge, generally, can be traded in labor or intellectual property markets. It tends to be rather technical and explicit, which makes it relatively easy to acquire, be it through internal training or simply by 'hiring' a specialist in the market. External knowledge does not lead to differentiation, although it may be essential for any given firm because a certain level of this type of knowledge is indispensable for competitive survival. In contrast, internal knowledge is idiosyncratic and typically related to a particular firm and refers to and is embedded in its particular organizational context. It acts as a sort of organizational glue that holds the organization together, giving it cohesiveness and sense of unity. It is therefore more valuable inside the organization than in the market, and is less subjected to imitation. Hence it constitutes a critical source of sustainable competitive advantage.

It is, therefore, through the 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. Project teams, for example, generate knowledge internally and often seek knowledge from external sources. Team members must combine their complementary, yet separately held knowledge into a new knowledge set. In order for a project team to be productive, they must have a deep knowledge of their own disciplines and an appreciation for the relevance and importance of their teammates' knowledge. All this external and internal knowledge must be integrated into team responses (Anand, Clark and Zellmer-Bruhn 2003). New product development and innovation requires the use of a multitude of skills and expertise, as well as the accumulated knowledge of the organization in order to maximize the performance of the new product. The inte-

gration of all this accumulated knowledge into the business processes used by these skilled and experienced employees has great potential to improve the new products themselves. It has been suggested that it is the degree of integration of dispersed and distributed knowledge that helps explain differences in the product development performance of different firms and that it is the effectiveness of a firm's knowledge integration that distinguishes it from its competitors (Carlile 2002).

As Grant (1996a) mentioned the integration of knowledge may be viewed as a hierarchy which is not one of authority and control, as in the traditional concept of an administrative hierarchy, but is a hierarchy of integration. In this view, organizational knowledge is treated at different levels of integration, which can be seen as an elaboration of knowledge distinctions that simply focus on different levels of analysis (Hedlund 1994; Kogut and Zander 1992). At the base of the hierarchy is the specialized knowledge held by individual organizational members which deal with specialized tasks, while at the very top lies cross-functional and new product development capability. The purpose of the multi-level integration process is to create innovation that is firm-specific. However, the crucial extension of this hierarchy is the explicit recognition of the need for specialized knowledge at the different levels. Firms may also need to combine various specialized knowledge from different disciplines such as electronics, biology, computer science, etc. This specialized knowledge might be held by individuals within the firm or can be acquired through external sources.

In this paper, the internal and external dimension of the knowledge integration is emphasized, which matches the concept of hierarchy of integration (Grant 1996a) especially considering the nature of differentiated specialized knowledge. As discussed it should be noted that in relation to different knowledge integration processes defined here – namely creation, sharing/transfer and use, knowledge integration may occur at different levels of interaction – individual, group, organizational, inter-organizational. The focus of this paper is to explore how firms respond to knowledge integration needs. In particular how firms exploit potential synergies among various internal and external knowledge sources and create competitive advantage. Knowledge exists in firms and networks, but how firms execute KI processes and whether knowledge integration performed by individuals, teams, or by firms – or whether KI is something that happens at the network level? The proposition here is that KI addresses technical, strategic and operational challenges at the various levels. To illustrate this point next section will look at KI in Fujitsu.

3 KI in Fujitsu: Towards a Human Centric Networked Society

In order to analyze the process of knowledge integration at Fujitsu Corporation, this study combined on-site interviews with analysis of company internal docu-

ments 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. Findings suggest that, 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 especially through application of cloud computing.

Furthermore, in Fujitsu new knowledge, whether from *inside* or *outside*, 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, technology fusion and integration in Fujitsu, 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.

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 field 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 and 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 volumes of sensor and web data and proactively deliver necessary services whenever 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 from 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.

In summary, it seems that Fujitsu will continue to innovate by placing importance on technology and continuing to create 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 Towards a Conceptual Framework for KI

Based on the above discussions, a framework for 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. As emphasized before, integration capability plays an important role in acquiring and exploiting the knowledge from internal and external sources. The paper argues 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 as emphasized in a R&D firm extent of the individual specialized knowledge, team-building capability, social networks, and internal/external organizational climate affect capability, which in turn will affect the creation of new products and services. Before discussing the conceptual framework, it is worth reviewing some of the current relevant frameworks.

Kodama (2005), for example, have proposed a framework in this relation. He bases his framework on the notion of strategic communities (SC) and maintains that these strategic communities are horizontally and vertically integrated within Japanese firms. These horizontally and vertically integrated SC networks, Kodama (2005) argues, promotes the external and internal integration of knowledge among corporations including external customers and internal-layers of management, so that the corporation can provide products and services that match market needs. He referred to this networking as external and internal integration capability. In this model heterogeneous knowledge from inside and outside the firm, which arising from dynamic changes to vertical and horizontal corporate boundaries, delivers two new insights regarding ‘new knowledge creation’: (i) the vertical value chain model distinctive to Japanese firms realizing new products, services and business models, and (ii) the co-evolution model realizing new win-win business models. Kodama investigates this integration at macro-level within Japanese firms; however he does not elaborate on the role of the individuals, teams or knowledge management systems within the knowledge integration process.

On the other hand Andreu and Sieber (2005) argue that different firms need different knowledge integration systems. They have identified different knowledge integration systems needed at the corporate level, which is determined by the type of knowledge the firm wishes to integrate. Using three classifications of knowledge (explicit vs. tacit, collective vs. individual, external and internal) these

authors emphasize that different combinations, impacts overall feasibility ('integration trajectories') of knowledge integration among organizations or business units

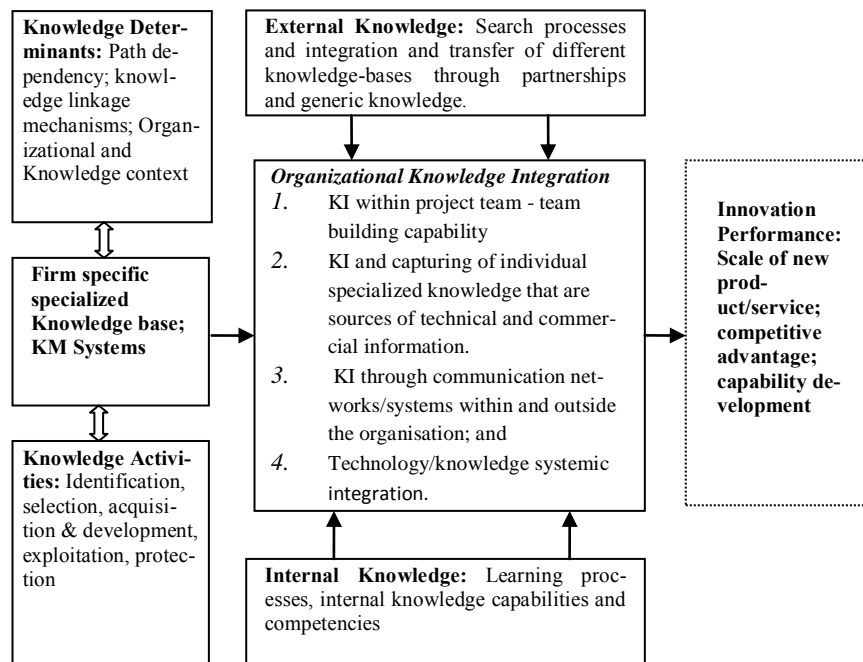
This study builds on the previous literature and takes the knowledge integration capability as the key capability in a dynamic environment and as a starting point of departure (see among others Grover and Davenport 2001; Probst, Raub, and Romhardt 2000; Lu, Wang and Mao 2007). This study suggest the 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, it is emphasized 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.

The conceptualization of 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. Therefore, this study considers a knowledge integration system that can 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.

Therefore, organizational mechanisms for effective knowledge integration should address 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 Fig. 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.

Fig. 1 The relationship between knowledge activity and knowledge integration



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 (for instance, technology selection decisions are made during business strategy and new product development). 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 and 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 1996a). 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).

As indicated in the Fig. 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 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 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 internal and external environment.

5 Concluding Remarks

As this study demonstrated, knowledge integration takes place in different levels, namely individual level, team level and systemic level. The research highlights that knowledge integration occurring in the innovation process is a result of knowledge exposure, its distribution and embodiment and finally its transfer, which leads to innovation capability and competitive advantage in firm. Knowledge management provides platforms, tools and processes to ensure integration of an organization's knowledge base. Through knowledge management structures and systems such as taxonomies, data mining, expert systems, etc., knowledge management can ensure the integration of the knowledge base. This enables staff members to have an integrated view of what knowledge is available, where it can be accessed, and also what the gaps in the knowledge base are. This is extremely important in the innovation process to ensure that knowledge as resource is utilised to its maximum to ensure that knowledge is not recreated in the innovation process.

Furthermore, this paper suggested a conceptual framework emphasising specifically 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.

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