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Information Technology as a Facilitator of Enhancing Dynamic Capability through Knowledge Management

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ABSTRACT

Dynamic capability is an emergent field of firms encountering turbulent administrative environment. Eisenhardt and Martin (2000) point out that firms with dynamic capability are not guaranteed to enhancing organizational performance, but without dynamic capability it is impossible for firms to enhance organizational performance. Another research stream in current management thoughts is related to knowledge management that has been confirmed to be a major source of competitive advantage. Research question of this research is whether or not knowledge management contributes to the enhancement of dynamic capability, and thus to the enhancement of competitive advantage of a firm. Following previous research interest of knowledge management on the application of information technology (IT), this research incorporates knowledge management facilitated by IT to examine the effect on enhancement of dynamic capability. Based on a survey of top 1000 Taiwanese firms, the current empirical research tests relevant hypotheses with regression models. Empirical findings include management of both endogenous and exogenous knowledge through IT applications significantly affects the enhancement of dynamic capability. Results shed light to current strategic management issues.

(Keyword: Knowledge Management, Dynamic Capability, and Information Technology)

INTRODUCTION

Drucker (1993) predicts that traditional factors (capital, land, and labor) play less critical roles as they used to do. Knowledge capital substitutes these traditional factors as the most important factor for future economy and society. Moreover, he postulates that knowledge is not just *a* source of competitive advantage, but also the *only* source of competitive advantage. Responding to Drucker's prophecy, knowledge management emerges as the hottest subject in both academic and professional world. In 1996, there are at least six major conferences on the subjects; three new journals focusing on knowledge were published; and many major firms in the USA and Europe add positions such as chief knowledge officer, organizational learning officer, and even a few vice presidents for intellectual capital (Prusak, 1998: ix). Maturity and takeoff of information technology (IT) development facilitates applications (groupwares, on-line database, intranet..etc.) in knowledge management and strategic management, thus generates competitive advantage and profits for effective firms (Quinn et al., 1997).

Another major stream of business administration appealing to academics and professionals relates to the concern of managing in a dynamic and discontinuous environment. What calls for attention to meet this challenge in recent years is the dynamic capability school (Teece and Pisano, 1994; Teece et al., 1997). The dynamic capability perspective toward strategic management extends the resource-based view in stochastic environments. Dynamic capability refers to responding capability of an organization in a fast-changing environment. Helfat (1997) notes that exploitation of knowledge assets of a firm enhances its dynamic capability and creates its business

value. Furthermore, Eisenhardt and Martin (2000) postulate that integrative learning mechanisms of a firm's endogenous knowledge affect its dynamic capability that is required in enhancing competitive advantage.

Co-evolution of knowledge management and dynamic capability for breeding a firm's competitive advantage is thus the subject of this research while IT is an indispensable element in current practice of knowledge management. How does a firm's dynamic capability be affected by knowledge management controlled by types of IT is empirically examined in this research. Although knowledge management covers not only the application of IT but also organizational culture for exchanging and sharing knowledge among members of a firm, this research focuses primarily on knowledge management infrastructure facilitated by IT. Nonetheless, the focus of this research does not imply ignorance of organizational factors is appropriate for an effective knowledge management.

LITERATURE REVIEW

The goal of knowledge management is to maximize organizational knowledge value through continuously create, accumulate and share organizational knowledge (Wiig, 1997). Knowledge management involves knowledge relevant activities in an organization including knowledge creation, knowledge storage and retrieval, knowledge diffusion and sharing, and knowledge utilization to optimize the value of organizational knowledge asset. Pan and Scarbrough (1999) postulate that knowledge management is a critical measure of acquiring competitive advantage in

knowledge economy. The activity of a firm's knowledge management should be designed according to its experience to improve or sustain its performance. To achieve knowledge management objectives, IT should be incorporated to a firm's daily operation in order that its members can access, store, retrieve, and make use of organizational knowledge without barriers (Duffy, 2000b). Subsequent paragraphs are dedicated in two primary domain of literature in interest: dynamic capability and IT application in knowledge management. Literature is reviewed followed by corresponding hypotheses.

1. Dynamic capability

Teece and Pisano (1994) and Teece et al. (1997) note that dynamic capability is of strategic importance for firms operating in a fast-changing environment. Dynamic capability refers to the responding capability of a firm while it encounters environmental uncertainties by emphasizing both "dynamic" and "capability". "Dynamic" refers to the concurrency of organizational renewal with environmental change. When the timing of market entry and technological change demand highly responsive decisions, and when future competition and market are difficult to forecast, firms need special innovative responsiveness. "Capability" emphasizes adoption, integration, and reconfiguration of endogenous and exogenous organizational skills, resources and functions to meet changes. Helfat (1997) notes that dynamic capability refers to the decisive capability enabling firms to develop new products or new processes to respond market changes. Strategic outputs of firms' operation in knowledge economy are primarily information and knowledge. If well managed, knowledge management enriches intelligent assets and intangible assets of a firm and

thus improves decision quality in subsequent operations. Through knowledge flow and sharing within a firm, the ones who are in demand can easily acquire specific knowledge. Knowledge embedded in organization through IT to reduce complexity and uncertainty so as to improve the effectiveness of new product development, managerial capability, and competitive position of a firm (Bonora and Revang, 1991).

In order to breed dynamic capability, Teece et al. (1997) notes that firm-specific dynamic capability relates to process, position and path of the firm. Organizational capabilities are embedded in processes, while the substance and opportunities of processes are affected by previous positions and paths evolved. Therefore, current capabilities and routines are conditioned by previous routines, resources and capabilities. The phenomenon echoes path dependence (Nelson and Winter, 1982) and provides a solid foundation for incorporating knowledge management into dynamic capability setting for acquiring competitive advantage. Furthermore, deployment of personal knowledge and experience is a source of organizational competitiveness (Teece, 1998).

Bierly and Chakrabarti (1996) consider strategic flexibility as a proxy of dynamic capability because that both deal with speedy responsiveness to fast-changing environment. Changes in environment demand changes of strategy and turbulent environmental changes demand turbulent strategic responsiveness. They convince that firms equipped with capability of faster adjustment, i.e. dynamic capability, than rivals outcompete rivals. However, swift strategic realignment to market demand is difficult to achieve as it appears to be. Eisenhardt and Martin (2000) extend resource-based view and consider dynamic capability as routines to learn routines. Deploying

processes of business resources reflected in dynamic capability as a source of competitiveness require intensive learning mechanism along processes of strategic planning and implementation.

2. Information Technology Application in Knowledge Management

IT application researches concern primarily three categories of issues: comprehensiveness of IT construction within a firm, knowledge construction and maintenance, and facilitation of knowledge creation, searching and diffusion. Firstly, concerning comprehensiveness of IT construction, different objectives of IT construction lead to employment of different tools to meet the diversity of objectives (Meso and Smith, 2000; Offsey, 1997). Davenport and Prusak (1998) find from case study on successful knowledge management that popular tools include employee competence database, on-line searching system, expert network, case-based experience database, etc... Gates (1999) postulates that effective IT infrastructure encompasses communication infrastructure, groupware, email, documentation management, data warehousing, workflow software, decision support system, etc... Lynn et al. (2000) note that IT is required to meet documentation management for project relevant information, storage and searching of project information, and procedure of project information renewal. Groupware contributes to knowledge sharing and management to improve organizational effectiveness (Papows, 1998).

Secondly, concerning knowledge construction and maintenance, Bonora and Revang (1991) find that IT has to achieve at least two objectives: reduction of uncertainties of knowledge loss derived from employee 's variation of positions, and reduction of dependence on specific personnel. Finally, concerning facilitation of knowledge creation, searching and diffusion, IT increases transmitting

and receiving speed of organizational information and knowledge (Meso and Smith, 2000; Offsey, 1997). Beside transmission and reception of information and knowledge, IT also facilitates storage and sharing capacity of organizational knowledge (Davenport et al, 1998; Demarest, 1997; Duffy, 2000a, 2000b; Hasen et al, 1999; Nonaka et al, 1996; Meso and Smith, 2000). High IT application capability leads to reduction of IT application costs, thus high IT application capability tends to be a source of competitive advantage (Bharadwaj, 2000). Knowledge management function facilitated by IT include create new knowledge, storage current knowledge, diffuse knowledge, and utilize knowledge. All objectives are guiding resource deployment to a better value-added transformation of knowledge asset. According to Helfat (1997), better management of knowledge results in enhancing dynamic capability and we put for H1 as:

H1a: Information technology applications in management of endogenous knowledge positively affect the enhancement of dynamic capability.

H1b: Information technology applications in management of endogenous knowledge positively affect the enhancement of dynamic capability controlled by different types of IT applications.

No matter a firm adopts “systematic knowledge management strategy” or “personal knowledge management strategy”; IT is responsible of acquiring and accumulating core knowledge for organizations (Hasen et al., 1999). Therefore, knowledge management emphasizes the importance of integrating organizational core knowledge, both tacit and explicit, with IT. Zack (1999) notes that knowledge management ought to take competitive strategy into consideration while construct

IT applications. Incorporating exogenous knowledge into a firm's knowledge management system is inevitably a critical dimension for dynamic capability that is aimed at effectively responding to environmental change. Knowledge management must incorporate corporate strategy and competitive advantage that include integration of endogenous functions with supply chain functions as systemic knowledge advantage (Davenport et al., 1998). Bennett and Gabriel (1999) study knowledge management in marketing departments of British firms and conclude several effective knowledge management attributes: congruence of IT with corporate strategy, facilitation of processing marketing knowledge by IT, facilitation of processing supply chain knowledge by IT, facilitation of acquiring marketing knowledge by IT, and facilitation of acquiring supply chain knowledge by IT. Based on previous research, H2 is put forth as

H2a: Information technology applications in management of exogenous knowledge positively affect the enhancement of dynamic capability.

H2b: Information technology applications in management of exogenous knowledge positively affect the enhancement of dynamic capability controlled by different types of IT applications.

METHODOLOGY

This research collects data through mailing questionnaire. Taking Taiwanese firms as the sampling framework drawn from the Top 1000 Firms in Taiwan published by Commonwealth Ltd., sampling firms belong to manufacturing sector (700 firms), service industry (300 firms), and finance industry (100 firms). One hundred and forty two among 1100 sampled firms respond,

accounting for a response rate of 12.72%. Forty-eight of respondents fall into finance and service sectors, and the rest, manufacturing. This research applies 7-point Likert scale to measure relevant research constructs. Cronbach's alpha of twelve measurements concerning IT application is .9386 and alpha of ten dynamic capability measurements, .9551, demonstrating a high reliability of research measurements.

---Table 1 inserted here---

Factor analysis is applied to reduce 12 measurements knowledge management. Varimax rotation with principal component extracts two factors of knowledge management, namely management of endogenous knowledge (KMin) and management of exogenous knowledge (KMex) (see Table 2). The first factor, management of endogenous knowledge, encompasses reducing uncertainties of knowledge loss, reducing dependence on specific personnel, IT being comprehensively utilized by members in organization, IT being comprehensively constructed in organization, top management being capable of applying IT, members in organization applying IT to search and use current organizational knowledge, members in organization applying IT to create new knowledge. The second factor, management of exogenous knowledge, encompasses facilitating acquisition of supply chain knowledge, facilitating acquisition of marketing knowledge, facilitating processing of supply chain knowledge, facilitating processing of marketing knowledge, and congruence of IT infrastructure with corporate strategy.

---Table 2 inserted here---

Factor analysis is also applied to extract factor of dynamic capability by varimax rotation with

principal component. Ten measurements of dynamic capability are reduced into one factor accounting for nearly 70% of cumulative variance (see Table 3). One factor, namely dynamic capability, is extracted from all measurements concerning dynamic capability, encompassing enhancing learning effectiveness of new knowledge, enhancing decision quality, enhancing capability of communication and coordination, enhancing responsiveness, enhance integration in new product development, enhancing accumulation of knowledge, enhancing capability of resource deployment, enhancing customer relationship, enhancing trust with vendors, and enhancing unimitability of strategic asset.

---Table 3 inserted here---

Linear regression is then applied to test research hypotheses. Dynamic capability is analyzed with management of endogenous knowledge (KMin) and management of exogenous knowledge (KMex), being controlled by typology of IT application (app) (see Table 4). As previously indicated, this research examine seventeen types of IT application: employee competence database (Model 1), groupware for discussion (Model 2), expert network (Model 3), case-based experience database (Model 4), e-mail (Model 5), documentation management (Model 6), on-line knowledge searching (Model 7), data warehousing (Model 8), on-line learning (Model 9), workflow (Model 10), decision support system (Model 11), enterprise portal site (Model 12), teleconferencing (Model 13), exogenous professional database (Model 14), enterprise resource planning (Model 15), supply chain management (Model 16), and customer relationship management (Model 17).

---Table 4 inserted here---

RESEARCH FINDINGS AND DISCUSSION

All models demonstrate significant influence of management of endogenous knowledge and management of exogenous knowledge factors on dynamic capability enhancement (see table 4). Empirical results support perspective of Teece et al. (1997) that path and process of knowledge accumulation through knowledge management determine a firm's current position. On the other hand, continuous tracking positions of a firm provide observation of its developing path as well as the process embodying position changing. Findings of this research also concord the evolutionary perspective (Nelson and Winter, 1982) that path dependence nature of knowledge management is probably the central issue of tracking a firm's knowledge asset. By neutralizing volatility of personal knowledge by transmitting, preserving, and embedding personal knowledge into organizational knowledge, knowledge management significantly reduces strategic astonishment and prepares firms of better knowledge management a better responsiveness toward environmental turbulence. Furthermore, routines to learn routines, noted by Eisenhardt and Martin (2000) as dynamic capability, are most appropriately manifested by knowledge management in accumulating profound organizational reasoning and practices. Both hypotheses H1a and H2a find strong statistical support from empirical results.

Several contingent variables (IT applications) are proven to significantly affect the explaining power of independent variables (management of endogenous knowledge and management of exogenous knowledge) on the dependent variable (dynamic capability). Among these contingent IT applications, the most noteworthy is enterprise resource planning (ERP) because it is found

positively contingent both management of endogenous knowledge and management of exogenous knowledge ($t=2.444$, $p<.05$, and $t=1.777$, $p<.1$ respectively). Investment in ERP represents the endeavor of integrating entire business resources, including backwardly supplier and forwardly customer relationships, thus integrating supply chain and customer relationship investments. Therefore, ERP plays a critically linking role in corporate knowledge management investment and strongly affect management of both endogenous and exogenous knowledge.

Beside ERP, four IT applications are found significantly contingent on knowledge management's influence of dynamic capability. First, e-mail is found negatively contingent on the explaining power of management of endogenous knowledge on dynamic capability ($t=-1.882$, $p<.1$). E-mail is the most popular tools of information system and the basis of most groupwares (see Table 1); however, effectiveness of email is obviously questionable in terms of knowledge management. Thus, managers should be aware the difference between expectation and reality in terms of enhancing knowledge transmission and storage through email system.

Second, documentation management is found negatively contingent on the explaining power of management of exogenous knowledge on dynamic capability ($t=-1.701$, $p<.1$). Documentation sharing and synchronization with external entities generally involve tremendous effort in communication and coordination wherein inherent costs of maintaining accuracy and timeliness are high. Documentation management across firms sometimes leads to interlock effect and responsiveness deterioration that undermine dynamic capability.

Third, on-line knowledge searching is found negatively contingent on the explaining power of

management of endogenous knowledge on dynamic capability ($t=-2.658, p<.01$). Powerful on-line searching capability often increase the overemphasis of knowledge availability that potentially reduce the criticality of employee's absurd responsiveness to changing conditions given to a specific decision point. Thus on-line search dimension of knowledge management may lead to impediments for organizational renewal and potentially organizational inertia.

Finally, data warehousing is found positively contingent on the explaining power of management of exogenous knowledge on dynamic capability ($t=1.729, p<.1$). Implementation of knowledge management depends largely on powerful databases. More attention should be paid to the storage and retrieval of knowledge accessed from exogenous clients. Safety, accessibility, and communicability of entire system are critical to managing exogenous knowledge. Summarizing these statistical results, H1b and H2b are supported by aforementioned IT applications.

CONCLUSION

Empirical results of this research show that management of both endogenous knowledge and exogenous knowledge significantly affect the enhancement of dynamic capability. Thus, we can draw conclusion based on this empirical research that firms ought to pay attention to knowledge management in order to enhance dynamic capability to outcompete rivalry in a turbulent environment. Development of Internet and database technology facilitates more advanced IT application in modern business administration. New frontiers of business world are expanded and new business models are launched continuously to serve customers better. As trends of

globalization, shorter life cycles, and stronger IT functions remain, firms are operating in an increasingly fierce competitive arena. Dynamic capability literature demonstrates that dynamic capability is an indispensable ingredient of successful strategic management in the coming global competition (Luo, 2000). Eisenhardt and Martin (2000) argue that firms equipped with dynamic capability do not guarantee performance enhancement, but dynamic capability is requisite for firms intending to enhance performance. Among other dynamic capability factors, IT factors of knowledge management are empirically proven in this research to be critically important in enhancing dynamic capability. Some IT applications are also found significantly contingent influences of the IT dimension of knowledge management on the enhancement of dynamic capability.

The contribution of this research is to bring two current research streams, knowledge management and dynamic capability, together to empirically examine their relevance. Research findings concord previous researches and provide strong managerial implications for the function of knowledge management in cultivating and developing dynamic capability to meet challenges derived from ever- and fast- changing business environment. Limitations of applying research findings include the low response rate (only 13%), and potential of generalizability derived from the sampling method (Taiwanese top 1000 firms). Relative differences exist among IT application levels also need to be aware of parallel comparisons of implementing different information systems.

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Table 1 Descriptive Statistics of IT Application

Typology of IT Applications	Not-Constructed	Constructed
(1) Employee competence database	103 (72.5%)	39 (27.5%)
(2) Groupware for discussion	110 (77.5%)	32 (22.5%)
(3) Expert network	126 (88.7%)	16 (11.3%)
(4) Case-based experience database	100 (70.4%)	42 (29.6%)
(5) e-Mail	49 (34.5%)	93 (65.5%)
(6) Documentation management	60 (42.3%)	82 (57.7%)
(7) On-line knowledge searching	77 (54.2%)	65 (45.8%)
(8) Data warehousing	87 (61.3%)	55 (38.7%)
(9) On-line learning	101 (71.1%)	41 (28.9%)
(10) Workflow	97 (68.3%)	45 (31.7%)
(11) Decision support system	97 (68.3%)	45 (31.7%)
(12) Enterprise portal site	65 (45.8%)	77 (54.2%)
(13) Teleconferencing	109 (76.8)	33 (23.2%)
(14) Exogenous professional database	122 (85.9%)	20 (14.1%)
(15) Enterprise resource planning	85 (59.9%)	57 (40.1%)
(16) Supply chain management	115 (81%)	27 (19%)
(17) Customer relationship management	104 (73.2%)	38 (26.8%)

Note: Percentages accounted are presented in parenthesis underneath corresponding observations.

Table 2 Factor Analysis of the Application of IT in Knowledge Management

Measurement of knowledge management	Factor	
	Endogenous KM (KMin)	Exogenous KM (KMex)
IT reduces uncertainties of knowledge loss	.808	.808
IT reduces dependence on specific personnel	.800	.345
IT is comprehensively utilized by members in organization	.795	.292
IT is comprehensively constructed in organization	.768	.337
Top management is capable of applying IT	.688	.444
Members in organization apply IT to search and use current organizational knowledge	.652	.530
Members in organization apply IT to create new knowledge	.623	.465
IT facilitates acquisition of supply chain knowledge	.313	.850
IT facilitates acquisition of marketing knowledge	.375	.789
IT facilitates processing of supply chain knowledge	.319	.781
IT facilitates processing of marketing knowledge	.205	.755
IT infrastructure is congruent with corporate strategy	.414	.587
Eigenvalue	7.199	1.069
Variance	36.303%	32.598%
Cumulative Variance		68.901%

Table 3 Factor Analysis of Dynamic Capability

Measurement of Dynamic Capability	Factor
Enhance learning effectiveness of new knowledge	.884
Enhance decision quality	.870
Enhance capability of communication and coordination	.863
Enhance responsiveness	.855
Enhance integration in new product development	.846
Enhance accumulation of knowledge	.827
Enhance capability of resource deployment	.827
Enhance customer relationship	.813
Enhance trust with vendors	.808
Enhance unimitability of strategic asset	.739
Eigenvalue	6.959
Cumulative Variance	69.592%

Table 4 Linear Regression Models

	Constant	KMin	KMex	KMin*app	KMex*app	F	R ²
Model 1	-.333	.438 (5.444***)	.401 (5.291***)	.041 (.509)	.062 (.822)	23.247***	.404
Model 2	-.308	.438 (5.949***)	.418 (5.581***)	.044 (.579)	.063 (.836)	23.245***	.404
Model 3	-.247	.448 (6.345***)	.404 (5.769***)	.013 (.180)	.079 (1.068)	23.461***	.407
Model 4	.127	.496 (6.427***)	.420 (5.082***)	.020 (.237)	-.065 (-.837)	23.197***	.404
Model 5	.307	.634 (5.696***)	.551 (4.933***)	-.209 (-1.882*)	-.143 (-1.279)	25.007***	.422
Model 6	.412	.589 (5.954***)	.413 (4.082***)	.019 (.185)	-.168 (-1.701*)	24.106***	.413
Model 7	.477	.602 (7.243***)	.461 (5.466***)	-.221 (-2.658***)	-.016 (-.188)	25.851***	.430
Model 8	-.637	.357 (4.188***)	.366 (4.462***)	.082 (.989)	.148 (1.729*)	24.625***	.418
Model 9	-.039	.455 (5.686***)	.433 (5.763***)	.012 (.155)	.001 (.009)	22.889***	.401
Model 10	-.087	.494 (6.143***)	.374 (4.483***)	.088 (1.014)	-.031 (-.367)	23.468***	.407
Model 11	-.041	.436 (5.381***)	.456 (5.859***)	.046 (.565)	-.045 (-.573)	23.154***	.403
Model 12	-.117	.438 (4.341***)	.378 (3.882***)	.074 (.758)	.031 (.307)	23.157***	.403
Model 13	-.178	.440 (6.072***)	.421 (5.928***)	.052 (.715)	.029 (.412)	23.163***	.403
Model 14	.048	.472 (6.840***)	.419 (5.954***)	.049 (.679)	-.046 (-.659)	23.194***	.404
Model 15	-.237	.350 (4.495***)	.325 (3.802***)	.190 (2.444**)	.152 (1.777*)	26.757***	.439
Model 16	.064	.469 (6.564***)	.440 (6.053***)	-.016 (-.222)	-.016 (-.218)	22.924***	.401
Model 17	-.242	.495 (6.073***)	.420 (5.040***)	.031 (.304)	.076 (.919)	23.267***	.405

Note: 1. *t*-value with significance level are presented in parenthesis underneath coefficient.

2. * $p < .1$, ** $p < .05$, *** $p < .01$