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An Emerging Economy Perspective

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ABSTRACT

The role of dynamic capabilities in emerging economies has been an under-researched area. Based on our research, we believe that the nature of dynamic capabilities is fundamentally different in these economies. We investigate the dynamic capabilities evidenced in the quality processes of software operations in a large multi-business Indian firm. We pay special attention to three patterns – evolutionary trajectory, nature of learning and benefits of business group affiliation. After due analysis, we find that dynamic capabilities are characterized by a different set of factors in an emerging economy – internal markets, liability of origin and ownership structure.

Key words:
Dynamic capabilities, Emerging economies, Quality processes

Dynamic Capabilities: An Emerging Economy Perspective

INTRODUCTION

The rapid and exponential growth of emerging economies has been the headline news for sometime now. It is recognized that outsourcing and offshoring have contributed to this frenetic growth in no small measure. The Indian software services industry, whose exports tripled in five years, is a case in point (Ramachandran & Garg, 2006). It is apparent that cost savings are at the heart of such trends. However, this advantage is available to all players in that economy; more importantly, the advantage is not sustainable as the operations could shift to other emerging low-cost economies. In such a scenario, what explains the continued success of some firms is an interesting, yet, unanswered question. The role of cost and wage arbitrage can explain only the initial success of a firm in an emerging economy. The firm needs to continuously add value, for it to remain competitive and successful in the long run. The reasons for continued success of some firms in the offshoring space, despite vast changes in the environment, are not well understood and it still remains an under researched area. We believe that the answer lies in the dynamic capabilities of these firms. The view that dynamic capabilities help firms constantly reinvent themselves in the context of changing business realities has been a fruitful avenue in strategy research (Eisenhardt & Martin, 2000; Helfat & Peteraf, 2003; Rindova & Taylor, 2002; Teece & Pisano, 1994; Teece, Pisano, & Shuen, 1997; Winter, 2003; Zollo & Winter, 2002).

Dynamic capabilities may be broadly defined as the firm capabilities that aid the development, assimilation, exploitation, recombination and reconfiguration of its competences to address the changes in business landscape appropriately. A variety of empirical studies have informed us immensely about the nature of dynamic capabilities. These studies have employed a multitude of research methods, ranging from questionnaire surveys (Griffith & Harvey, 2001) to investigation of secondary data (Helfat, 1997) and inductive case studies (Galunic & Eisenhardt, 2001; Lazonick & Prencipe, 2005; Rindova & Kotha, 2001; Tripsas, 1997; Verona & Ravasi, 2003). They have given us a good insight into the creation of organization-wide dynamic capabilities. Given that dynamic capabilities are firm idiosyncratic, this should well be the case; however, there is scope for further diversity in terms of research settings. First, very few studies have looked at the evolutionary trajectory of dynamic capabilities – this could be because of the fact that dynamic capabilities take years to build, and possibly, decades (Teece & Pisano, 1994), placing practical difficulties on the research process. Second, while it is nevertheless useful to study organizations in their entirety, our understanding would be further enriched by looking at an appropriate functional area as it is not necessary for a firm to have dynamic capabilities in all its functions (Helfat & Peteraf, 2003). Third, most of the studies have been from advanced economies; it would be an apt research setting to look at firms in emerging economies as well to understand the nature of dynamic capabilities in such economies.

In this study, we look at the evolution of dynamic capabilities in a specific function inside an Indian firm. As observed earlier, we can enhance our learning by

focusing on dynamic capabilities within a functional area. To put the application of dynamic capabilities in perspective, we complement it by looking at the developments in the wider organization and external environment, where required. Such an approach would help in conceptual clarity. From a practical viewpoint as well, it would be much easier to capture the evolution of a specific process richly, rather than that of the entire organization, given the constraints of space. An unintended but not unwelcome benefit of such an approach is that it would make it easier for practitioners to understand the fashioning of dynamic capabilities.

The research setting was Wipro, a $2 billion multi-business firm with diverse interests such as information technology, lighting and consumer care products. Apart from being a part of market indices in India such as the Bombay Stock Exchange's Sensex and the National Stock Exchange's Nifty, it has been listed on the New York Stock Exchange since 2000 and is a part of its Technology-Media-Telecom index. Wipro Ltd. is headed by Azim H. Premji, who controls over three-fourths of equity of the firm. Wipro, a 60 year-old company was dealing in hydrogenated vegetable oils to start with, when Premji, the son of the company's founder, took over operations in 1967 and embarked on establishing Wipro in diverse businesses such as IT, hydraulics (subsidiary) and medical systems (joint venture with GE). His focus was on non-commodity businesses, where attention to quality would be a good proposition as a differentiator. To reinforce this message, he later on launched a company-wide initiative titled "Mission Quality" to sensitize the managers to the importance of quality and energize the divisions to the changing realities of business.

Today, Wipro is organized into three major lines of business – Global IT services and products, India & Asia-Pacific IT services and products, and consumer care & lighting. The global IT services and products business is popularly known as Wipro Technologies (WT hereafter). WT is a major part of Wipro; in the 2005-06 financial year, it contributed 75% of the revenues and 88% of the profits of Wipro. WT consists of four businesses – Enterprise IT, Technical infrastructure, R & D and Business Process Outsourcing. Software development, testing and other software-related activities are central to the businesses of WT. It has been among the top three software exporters from India all through the last decade. Given our objective of understanding what accounts for success on a continuous basis, we chose WT as the research setting. We investigate the evolution of quality processes within its software activities over the years and their impact on its performance. We specifically look at the evolutionary trajectory of its quality practices, the nature of its learning through its three quality phases and the influence of other divisions and top management in its quality journey.

We begin our account with a description of the grounded theory methodology adopted. We then present the narrative of WT's quality journey sequentially in three parts, each dealing with a different phase of quality process improvements. In each of these parts, the narrative has been structured around three themes for easier discernment of patterns. We go on to present our findings with a discussion on the nature of dynamic capabilities in an emerging economy. We conclude by delineating extensions to the existing literature and indicate future avenues of study.

METHODS

Case study methodology was deemed fit for the study, given the embedded nature of dynamic capabilities (Eisenhardt & Martin, 2000), and the need to understand antecedents and consequences of such capabilities by way of routines and processes. A large part of our collective understanding in dynamic capabilities has been informed by rigorous cases, with a substantial number of them being in-depth studies of a single setting, such as an industry (Rindova & Kotha, 2001; Tripsas, 1997), a firm (Galunic & Eisenhardt, 2001; Lawson & Samson, 2001; Petroni, 1998) or a process (Lazonick & Prencipe, 2005; Verona & Ravasi, 2003). We adopted a line of inductive inquiry as the objective here was to understand a hitherto under-explored phenomenon. This approach helps in grounding the emergent theory in the case data (Glaser & Strauss, 1967).

While this article is the result of a larger study investigating the transformation of Indian businesses in the new millennium, the focus is restricted to understanding the role of dynamic capabilities in the quality journey of WT. We look at the various quality initiatives embarked upon by WT. Thus, while the quality department has been the unit of analysis, each quality initiative has been viewed as an event with its own narrative.

Data sources and Analysis

Data sources. As the objective of the study was to generate a description that was rich and to obtain data which could be viewed through an assortment of conceptual lenses, we followed the recommendation of Glaser and Strauss (1967) in tapping a variety of sources, both primary and secondary. This was all the more important as we were investigating a single case. The primary data sources included intensive semi-structured interviews with the Chief Quality Officer (CQO) - this was the main data source; it was aided by discussions with a variety of employees, ranging from the project managers, who are in charge of project execution and deliverables to the programmers who actually write the code. Secondary data sources consisted of media stories, white papers by industry bodies (such as the SEI – Software Engineering Institute, Carnegie Mellon University and NASSCOM – National Association of Software and Services Companies, India), case studies from international business schools, financial analyst reports, media statements and interviews by the top management, books in the business press and company annual reports. Reports from industry bodies are deemed to be unbiased and precise; information from company sources on these delineated themes adds to the richness of the data. Using multiple sources of data aided in triangulation of the data and thus increased our confidence in the validity of the inferences.

Analysis. We used widely recommended approaches for data analysis (Glaser & Strauss, 1967; Miles & Huberman, 1994; Strauss & Corbin, 1990; Yin, 1994). Interviews were transcribed within 24 hours. As mentioned earlier, the study was part of a broader study looking at the transformation of Indian businesses and as such, when the transcripts were prepared initially, neither of the authors had researched the area of dynamic capabilities extensively. Thus, at the stage of initial analysis of the transcripts, the authors were mostly impervious to the theoretical underpinnings of the dynamic capabilities

literature. This turned out to be a blessing in disguise as the analysis was not constrained by a fixed framework of ideas. The information in transcripts was augmented with data from secondary sources and an individual and independent narrative was generated for each of the quality initiatives undertaken by the company. After verifying for correctness and completeness, these narratives were compared with one another to identify *inter alia*, similar patterns, elements of continuity and instances of learning. An iterative process of reconstruction of the narratives was carried out to obtain a rich description of the processes at work, thus helping in the design of a thematic representation of the dynamic capabilities involved.

RESULTS

How do firms fashion dynamic capabilities? At WT, we found three distinct phases as it went about building better quality practices. In the first phase, it had, by and large, adopted industry standards such as ISO 9000 from International Organization for Standardization (ISO) and Capability Maturity Model (CMM) from the SEI. In the second phase, it had become adept in the utilization of a slew of standards along with the Six Sigma set of methodologies which was hitherto applied to service businesses sparsely. In the third phase, it embarked on previously untested and unheard of application of lean manufacturing techniques in the software development process, in conjunction with some potentially game-changing practices. While adoption of industry standards and widely known techniques may not indicate an instance of dynamic capabilities, especially at first glance, the pathways followed and the routines adopted by WT gave it an edge in each of the three phases. Narratives corresponding to the three phases are presented sequentially with emphasis on three recurrent themes in each phase: evolutionary trajectory, influence of other constituents in the firm and the nature of learning.

First phase: Making the promise

In 1978, when IBM chose to leave the Indian market in the light of restrictive governmental regulations, several local players entered the market to service the existing mainframe computers – Wipro was one of them. Over time, it entered allied businesses such as manufacture of computer hardware and development of package software.

The Indian government started a limited phase of liberalization in 1985. Alive to the technical talent of the Indian workforce as well as the huge wage differential, several MNCs explored opportunities to tap into this base. Texas Instruments started operations in India in 1985, thus becoming the first multinational company to start a software development centre in India. Motorola was another company to tread that route. However, other MNCs such as Nortel and GE engaged Indian firms (including Wipro) hitherto involved in activities such as writing package software, compilers and the like to work for them. The MNCs understood that the Indian firms did not have experience in writing industrial software and hence invested considerable management bandwidth in improving the vendor skill base. To start with, the work that was outsourced was admittedly structured, routinized and not perceived to be challenging. However, the cost

savings were sizeable and this inevitably attracted other multinationals to explore outsourcing of software maintenance and development to India.

Evolutionary trajectory. A key difference in these new clients was that they wanted to maintain an arm's length relation with the Indian suppliers, being unable to invest time and effort in managing the relationship. By 1992, this translated into the need for a promise by the supplier that he could take care of the delivery and the quality by adhering to a due process. However, each client had its own process. It became increasingly difficult to cater to the variety of demands and hence, the search for a standard, international process began.

WT adopted ISO 9000 methods in 1992 and obtained the certification in 1995. ISO is an international standard-setting body comprising representatives of standards boards of several countries. ISO 9000 was a major system of standards promoted by ISO. Originally developed from the British Standards Institution's BS 5750, this system certifies the application of consistent business practices. The certification and the attendant adherence to the process helped WT in several ways. Apart from enabling quality, it helped in reducing the variety of processes and simplified the job of negotiating with clients. It had a salutary signaling value as well.

While ISO 9000 was originally devised for manufacturing operations, it had found application in other sectors as well, since it contained generic practices. Still, it gave enough flexibility to an organization to devise specific processes adhering to the broad tenets. However, this flexibility also meant that it became everything for everybody and thus, its application to the software service industry could not address industry-specific issues. Also, given its British origins, it was considered to be a Europe-centric standard, while the market for the Indian firms was primarily the USA, which did not give much weightage to the certification. It thus became important to have an acceptable certification specific to the software industry, and fast.

The mandate of the SEI (Software Engineering Institute), started by the Carnegie Mellon University under the commission of the US Department of Defense was to improve the software development processes with a bid to rein in the costs and improve the quality. By 1993, SEI released the stable version (v1.1) of its assessment process, known as CMM. CMM is designed as a layered system with five levels, level 5 being the most evolved. The Indian subsidiary of Motorola became the first commercial organization in the world to be assessed at level 5, in 1994.

While ISO 9000 was a guarantee of processes being followed, CMM may be viewed as an arbiter of these processes leading to quality. Also, while ISO 9000 was generic, CMM was specific to the software industry, dealing with pertinent issues such as design validation and configuration management. After attaining ISO 9000, WT embraced CMM certification and attained level 3 in 1997. Realizing that there were several companies assessed at level 3, while very few were assessed at level 5, WT decided to go for it at the earliest and achieved it in December 1998, just over a year after getting assessed at level 3. With this, it became the *first software services company* in the

world to be assessed at level 5. Firms that started work on CMM before WT were surprised that it could beat them to it. It changed the positioning in the customer's mind.

Benefit of business group affiliation. The very first time that Wipro undertook a standard quality process was in its adoption of ISO 9000 in 1991. Soon thereafter, the stable version of CMM had released; Yet, WT chose to stick with ISO 9000 due to the improvements that other divisions experienced. For example, the implementation of ISO 9000 in Wipro's computer manufacturing factories helped in saving 30% space, seven truckloads of space and helped reduce headcount from 200 to 110 people during 1991-94.

Nature of learning: Learning by doing. However, WT also additionally looked at other standards that could be more specific for its purpose. The top management adopted from other approaches liberally. They looked at the IEEE (Institute of Electrical and Electronics Engineers) standard for software - while it was not tuned to the business realities and perceived to be cumbersome and incomplete, it had good specifics on writing a design document. So, even when they adopted ISO 9000, they incorporated design document elements from IEEE standard.

However, not everything was smooth sailing. Some customers had strong, evolved practices in certain areas and wanted their processes to be adhered to. WT looked at such practices and integrated them into its own practice as ISO 9000 was more a generic process. For example, a client had a good defect-tracking system as it was involved in supply of non-stop trading machines to stock exchanges. Another client, involved in the development of a general purpose operating system, had a sophisticated release process as it used to release several versions in a short duration of time. However, none of them covered the whole gamut – they were happy that WT used their processes where they were strong and ISO 9000 in other processes. The quality practice of WT resembled an expanded umbrella covering ISO 9000 and best practices of clients.

Around the same time that it was going for these certifications, the division grew in terms of headcount, from 460 people in 1992 when it embarked on ISO 9000 certification to 1600 people in 1995 by the time it obtained ISO 9000 certification. Similarly, the headcount reached 3000 by the time it got assessed for CMM certifications. A realization struck the top management that the division was able to scale effortlessly due to the adoption of these processes and the standardization they engendered along with the regime of discipline they brought forth.

Summary: First phase. In this phase, the adoption of standards by WT helped it in achieving its objective of *assuring* the client. However, standards, at best, are in the nature of best practices. Assimilation of these would imply significant commonalities across firms (Eisenhardt & Martin, 2000) – a dynamic capability, albeit arguably of a lower order (Winter, 2003). Still, what differentiates the experience of WT was that it treated the best practices of its clients in various components as an opportunity rather than as a constraint, integrating them seamlessly.

Being a part of a multi-business entity appears to have helped WT in having a faster pace in adoption of quality processes, especially ISO 9000. Teece & Pisano (1994) argue that a conglomerate does not aid dynamic capabilities as it does not add to efficiency; they also argue that competences would unravel if a subunit separated from the parent. While Wipro may appear to be a conglomerate, the relation between the divisions was more in the nature of sub-units of a composite firm and this was the principal reason for the success of WT in adopting ISO 9000.

In real life, the sample size of similar situations is limited for any firm. An approach to overcome this situation is by experiencing more aspects of experience (March, Sproull, & Tamuz, 1991). We believe that WT demonstrates this in ample measure by viewing ISO 9000 and CMM not just as devices that help in building quality. It also views them as signaling devices to let the market know about its competence – evidenced by the pace at which it attained CMM level 5 certification to become the first software services company in the world to do so. It also views standards as devices that help in the reduction of process complexity by integrating client best practices within the fabric of standards. Most importantly, it also views standards as scaling devices, which help in effortlessly adding headcount.

Second Phase: Breaking the compromise

While WT was first off the block in signaling the quality of its practices through adoption of international process standards, it had, at best, a transient advantage. Process standards are meant to be propagated as best practices and a key role of industry bodies such as NASSCOM was to ensure that these were diffused effectively. While this made the Indian software industry more competitive, it left little to differentiate between individual firms. For example, there were hardly a dozen ISO 9000 certifications across all Indian firms in 1990; by the end of the decade, the number touched two thousand (Khandwalla, 2002). Similarly, while WT was one of the first organizations to achieve CMM level 5 in the world, today, 75% of all the companies assessed at level 5 are located in India.

Also, CMM level 5 mandated continuous improvement, but was silent about the methods to employ for achieving the same. WT started looking for a process that could help it on its path to continuous improvement as well as differentiate it from the multitude of other firms.

Benefit of business group affiliation. While WT was adopting CMM, Premji observed the productivity improvements in GE, attributed widely to its Six Sigma initiative. Six Sigma is a statistical process designed to find the causes of errors. Apart from the application of the concept of Six Sigma, the technique embodies several analytical methods. Six Sigma received an impetus for application in business with an eponymous university started by Motorola. GE followed Motorola's lead and applied the techniques in service businesses as well.

In 1996, the top management of Wipro decided to embark on Wipro-wide Six Sigma program. However, WT decided against embracing Six Sigma as it wanted to attain the CMM certification first. Six Sigma was perceived to be a natural choice for fostering enterprise-wide quality in Wipro. Still, the initiative, though launched with massive exuberance, did not take off for the first couple of years as the type of problems picked up were too complex for a single firm to solve. Soon, the expectations from the initiative became more realistic and this, coupled with the availability of successful case studies of Six Sigma implementation elsewhere, gave a renewed focus to the effort at Wipro, leading to better results.

Meanwhile, WT had achieved its CMM level 5 certification and zeroed in on Six Sigma as the potential way to embark on continuous improvement. The challenge, however, was that WT was unclear as to how it could be applied to a software development operation per se and the idea of the initiative drew reactions that ranged from incredulity to apathy, at least initially. Clued-up by the experience of Wipro with Six Sigma in the previous years, WT eschewed a big-bang approach and proceeded cautiously.

Evolutionary trajectory. In 2000, it embarked on the Six Sigma initiative and limited its application to defect prevention at the project level. An important innovation it launched was its own Six Sigma methodology called "Developing Six Sigma Software". Using this methodology, a better fit is achieved between voice of the customer, i.e. customer requirements and voice of the engineer, i.e. technical requirements, by exercising control through use of statistical techniques, known as voice of the process. Only after successful implementation at the project level for over a year, was the program broad-based to cover other problems in WT and to deal with higher levels of abstraction.

Earlier initiatives of WT such as ISO 9000 and CMM level 5 certification bestowed a competitive, albeit temporary advantage, as other firms also managed to obtain these certifications over time. However, in the application of Six Sigma methodologies, other firms seemed to lag behind. The CQO of WT opined that its track record in abstracting Six Sigma is good since it employs the technique well at the design stage; it is also effective in determining appropriate number of test cases and the like through methods such as Taguchi's orthogonal arrays. He believed that these were the two factors that helped WT to remain competitive with respect to other firms.

Such an outlook on competitiveness meant that it was not enough if the processes were world-class; the people manning such processes also needed to make the cut. The SEI had launched a standard specific to the people working in the software industry called the PCMM (People Capability Maturity Model) and this was also structured into 5 levels. In 2001, Wipro became the first organization in the world to achieve the PCMM level 5 certification. Meanwhile, as the software industry grew, complexity increased and hence, SEI had come up with other associated capability maturity models such as the ones dealing with systems engineering and product development. Despite their utility, firms found it problematic to use them as they were not integrated. SEI worked on an alternate model integrating all these models within it and designated it as the CMMI. Yet

again, in 2002, Wipro became the first organization in the world to be assessed at CMMI level 5.

In the aftermath of 9/11, when the key concern for businesses world over was the question of business continuity, WT realized the need for contextually relevant processes. It adopted BS7799, a standard specifically addressed to the needs of information security and network security. TL9000 (standard for telecom industry) and COPC (standard for business process operations) were other context-specific standards it adhered to.

It may appear that WT was into excessive adoption of standards from all over the world, rather than developing its own set of practices or standards. The belief in WT was that it was better to use a standard than re-invent the wheel, especially since a renowned body has already done the research as to *what* needs to be done. The advantage accrued to those firms who figured *how* it can be done, and fast. WT believed, and not without reason, that it possessed this advantage in ample measure.

Nature of learning: Learning by integrating. While WT was adopting several standards to improve the quality of its offerings, it was also important to ensure that the employees were clear as to when to use what. The thinking in WT was that these processes supplement one another rather than supplanting. Hence, it became important to integrate these processes and best practices in a seamless fashion. As the headcount in the division grew, it also made sense to move from physical manuals to web-based manuals.

An initiative was started in June 2000 with specially constituted task teams for the purpose. After an organization-wide contest to name the new system, it was titled veloci-Q, with the tagline "fast track to quality." Task teams integrated the best of available practices into the system. Six Sigma concepts were also integrated into the system, apart from making it CMMI compliant. The web-based quality system of veloci-Q found recognition outside the firm as well. Software Engineering Process Group (SEPG), the entity behind the creation and maintenance of veloci-Q was awarded the Software Process Achievement (SPA) award in 2003. This award was jointly established by the SEI and the IEEE Computer Society in 1994 to recognize excellence in the software processes of an organization. The award criteria are stringent and fewer than ten organizations have achieved the award. The award citation had this to say about veloci-Q:

> Much of the support for access to, application of, and improvement to the assets is provided by a well-designed and well-maintained Web site deployed through the organization's intranet. This Web site supports widespread sharing of "best practices" as well as "lessons learned" throughout the organization.

The web-based quality system is supplemented with other systems such as a web-based project management tool, a repository of historic project information and an enterprise-wide knowledge management system. Thus, veloci-Q, in combination with other systems, helped in integrating versatile processes and best practices. The same seamlessness of flow in work was carried over to the customer as well, with the

establishment of "Cocoon", an extranet site where the customer could review the status and performance of a project, which allows for quicker analysis and reporting.

While the web-based systems helped the actual integration of diverse processes into a composite whole, it was also important to capture the essence of the unified effect of these seemingly disparate processes in a symbolic manner. WT used the figure of a triangle with the three corners corresponding to the process, continuous improvement and people dimensions, each representing a key component of the overall organizational capability. While standards like ISO 9000 and CMM5 took care of processes and Six Sigma helped in continuous improvement, PCMM took care of the people component.

Summary: Second phase. We see that the emphasis in this phase has been on integrating processes through assimilation, not just on selecting them. Veloci-Q and Cocoon for example, illustrate the use of digital networks to reduce barriers of time and distance. In our view, moving from physical manuals to web-based system effortlessly, displays architectural innovation of the first order. This innovation helped them not only to address issues of scale, distance and time, but also aided them in updating quality systems without loss of time. The distinctive processes of knowledge articulation and codification coupled with ways of coordinating and combining such as the veloci-Q makes the capability dynamic (Teece et al., 1997; Zollo & Winter, 2002), and the advantage, more enduring.

Literature suggests that successful Six Sigma design depends on the dynamic capabilities of the firm (Gowen & Tallon, 2005). WT was helped indirectly by viewing the earlier experience of the other constituents of the firm in Six Sigma methodology from close quarters. So, it is the membership of Wipro group that helped WT, not just its own process framework. It was also the case in the earlier phase, in the implementation of ISO 9000. Historical antecedents such as choices at founding & development stage and the resulting path dependency do play a crucial role in subsequent evolution of capabilities (Helfat & Peteraf, 2003).

Third phase: Redefining the premise

The initial premise that led to the success of Indian software firms was to make the client competitive through cost reduction. With time, complexity in the marketplace increased and the cost advantage enjoyed by the Indian firms became accessible to MNCs such as IBM, which were scaling up fast in India. While the quality practice of WT helped in standardization of work that reduced costs further, it also became imperative to address issues such as speed to market with the steady movement of Indian firms towards more value-added offerings.

Due to the certification processes topped with continuous improvements, WT bettered its performance every year on the three things that matter the most for the customer – cost, quality and time. These translated into metrics related to improved productivity, reduced number of defects and on-time delivery, as shown in Table 1.

Insert Table 1 about here

At the end of each year, WT would identify the statistically significant average effort for that year and make it the baseline for bids in the coming year. For example, if the estimate for a particular type of project is 3000 person months and the average time taken to complete such a project in the current year is 2500 person months, it would bid for such projects in the next year with a figure of 2500 person months only. Thus, each year, it achieved more competitiveness.

Due to this relentless pursuit of productivity improvements, it was considered imperative to investigate the adoption of new processes to achieve higher productivity and better quality. This was essential to retain the competitive edge. Even as it excelled, WT realized that in the mastery of a particular process, the learning curve tapered after three years either because they had extracted the benefits fully or because the division needed a "dose of adrenalin" in the form of a new process. WT started to actively work on three year cycles to seed new quality processes.

Benefit of business group affiliation. While other divisions did not have as much an influence as in the previous phases, metaphors associated with manufacturing helped WT understand its courses of action. The sheer scale and size of projects undertaken by WT afforded even further scope for standardization such as more specific standards based on the project type and the industry-domain focused verticals like Finance and Telecom. The CQO observed that, in the first stage, he substituted the customer's experience with a set of rules (ISO 9000, CMM, veloci-Q). He remarked that he is now substituting the domain experts' (project manager in a vertical) expertise with another set of rules.

Evolutionary trajectory. Most importantly, he had to plan for the next wave of productivity, by opting for a new process that accentuated the competitive edge of WT. He and his team looked at alternate frameworks such as TRIZ, a creative problem solving mechanism from Russia. Following its Six Sigma experience, WT rejected TRIZ as non-scalable, since its success depended on the abstraction capability of the problem solver. WT realized from its Six Sigma initiative that success came mostly from the initiatives of specially trained people designated as master black belts and black belts – hardly 200 people in a business that was already 20,000 people strong and still growing.

The team finally zeroed down on lean manufacturing principles. Lean manufacturing refers to a set of principles and practices designed to eliminate waste and increase productivity. The principles and practices were devised and perfected by Toyota initially and hence the system is also known as the Toyota Production System or more popularly as the Toyota way.

WT applied lean techniques in software by testing software code daily instead of testing it at the end of a module as was done previously. Testing the code daily meant that

some mistakes were caught early and repetitive mistakes were easily avoided. This was akin to the Toyota worker catching the defect on assembly line and stopping the work.

Adopting lean techniques helped in increasing pace by reducing the cycle time, apart from sustaining the cost advantage. For instance, WT applied lean techniques with its European telecom clients in designing next generation switches where speed to market was critical. This translated into an early mover advantage for its clients, thus maximizing their revenue. Hitherto, WT's quality processes were mostly anchored in making the customer competitive by reducing the total cost to the customer; application of lean principles meant that it made the customer further competitive by increasing the revenue of the customer – a paradigm shift.

Unlike in the case of Six Sigma, where the availability of Motorola University helped service industries, no forum was available to disseminate application of lean techniques in service industries. Again, available experts on lean technologies lacked expertise in the software industry. Also, application of lean principles calls for broad consensus, which implies slower pace in adoption. Given the fact that application of Six Sigma itself in the software industry was patchy, it is apparent that the application of lean techniques to the industry would be much more arduous and slow. Prior experience in Six Sigma helped WT in the implementation of lean principles. WT viewed these as complementary, where Six Sigma helped in unearthing the causes of defects while lean techniques helped in solving these defects.

The quality team adopted an incremental approach in adoption of lean. For instance, it decided to adopt only two of the 14 tenets of lean to start with; it began with the ones that looked easy to execute with potential for maximum returns, i.e., the low-lying fruit. Apart from reducing waste and enabling speed to market, lean techniques also offered scope for further standardization in WT's processes, which could help them, if need be, to create factories which can be run from anywhere in the world. This was important in case newer low-cost locations appeared on the horizon. On the other hand, WT also realized that such levels of standardization would imply trade-off with creativity to some extent; to counter this, they run an innovation school where bright ideas for products or services with the potential to generate exponential growth are funded through internal venture capital.

Nature of learning: Learning before doing. Selection of new process initiatives such as lean technique was carried out by weighing various pros and cons in comparison to other alternatives, and with respect to factors such as organization-wide fungibility and scalability. This means that learning has to take place before the decision on a process can be made. It also would necessitate an appropriate structure and qualified personnel for the evaluation of the task. Quality department played the role of that arbiter. The quality function percolated down to the project level in the sense that each project also had a quality representative, whose job was to ensure the implementation of quality assurance procedures and practices in that project. This role supplemented the role of the project manager, who had the responsibility of overall project execution.

At a more centralized level, the Quality function in WT had 225 people in 2006 (Hamm, 2007: 205), constituted into different groups, each with a specific mandate. SEPG, which had the responsibility for maintenance of quality systems and coordination of process improvement activities, apart from investigating new models of productivity and quality is probably the most important group. The 2003 SPA award committee commended the SEPG for its skills in the award citation. Among other groups, the Process Quality Assurance Team ensured the implementation of processes defined in the quality system, thus complementing the efforts of SEPG. The Tools group ensured that quality system processes were automated while Mission Quality Group drove Six Sigma initiatives in the organization.

Yet another group was the Quality Consulting Group that had a slightly different focus, in that it helped clients to implement quality systems in their own organizations. In FY 2006, the quality consulting practice had 100 engagements and generated $ 11 mn. in revenues. It is conceivable that learnings from the consulting practice fed back into WT's own future quality processes, another instance of learning-before-doing. For more interested clients, WT customizes its own quality software Veloci-Q to the client's needs in what may be termed as the distillation of a decade of hard-won lessons into a 6-month tutorial for the client (Hamm, 2007: 230-232). Thus, after enabling the client competitiveness through cost reduction and speed to market, WT is now enabling its client to become competitive in a third way - through adoption of better practices.

Summary: Third phase. We do not find much evidence of influence of other divisions in this phase. We see it as an indicator of the growing strengths of WT in looking beyond the organization for its next lever of advantage. A noticeable facet of this phase is that a concerted approach was adopted to fashion the next quality process, which also brings the importance of the quality department to fore in this stage. The type and quality of managerial resources has an important bearing on firm performance (Castanias & Helfat, 2001). Dynamic capabilities involve full-time specialized personnel committed to particular roles (Winter, 2003) – the mandate of the quality department, its orientation and place in the organization hierarchy is a pointer.

Eisenhardt and Martin (2000) argue that dynamic capabilities are simple in high-velocity markets; in this case, for example, "follow only 2 tenets of lean to start with" is a simple though not an unstructured capability. In a broader sense, having appropriate quality standards is itself a simple but structured dynamic capability. These authors also suggest that time is of essence and dynamic capabilities are unstable in high velocity markets – it is interesting to see WT take it to the logical extreme of a planned 3 year cycle. And finally, they suggest that the order of implementation of dynamic capabilities is consequential – "sequenced steps" – the case of WT suggests that the picture would not have been the same if their adopted sequence (ISO 9000 followed by CMM level 5, Six Sigma and lean techniques sequentially) was any different.

DISCUSSION

This paper focuses on the continuous morphing of the quality practices in the software businesses of WT and explores the dynamic capabilities involved. The journey of WT from process taker to process setter and order taker to quality consultant entailed several dynamic capabilities. This journey happened in conjunction with high growth – in terms of revenues, number of employees and markets served.

It would be difficult to fathom the impact of dynamic capabilities unless it is linked to performance measures. Defined in such terms of functional relationship makes the study falsifiable (Eisenhardt & Martin, 2000) and rigorous. The performance measures vis-à-vis the quality practices depicted in table 1 are an ample measure of this. This attention to quality was noticed by industry analysts as well. A September 2004 report from Forrester Research observes:

> Wipro delivers an additional 10 to 15% increase in application maintenance productivity by applying its quality methodology and by consolidating redundant program applications.

Form, structure and orientation: Some observations

We see different dynamic capabilities in operation in the WT case, which evolved with time and helped the firm to move on to the next trajectory of growth. The important dynamic capabilities we evidenced are depicted in table 2. While some of these derive from the case study in a straight forward manner, we detail those that we believe may need to be explained.

Insert Table 2 about here

When WT embarked on its initial quality standards, the focus was on creating a group of activities that could be standardized across the division and be common across projects, the generic "core." Later, as practices evolved and as quality standards became more discriminating, WT could realize that it was possible to have efficiency without sacrificing flexibility. Standardization, while still stressed upon, was now at the level of a domain or a project type, thus generating into a specific core. This progression from a generic core to specific cores indicates an increasing expertise. This movement closely resembles that of the manufacturing industry from a standardized mode to a mass-customized mode. WT's ability in mirroring this progression in a service business exemplifies the nature of its dynamic capabilities.

From the above description, it becomes clear that, initially, the top management planned the implementation of the project and the actual practice was left to the project manager. However, with increasing expertise, they have been able to standardize to the level of substituting the domain experts' (project manager in a vertical) expertise with another set of rules – leading to the practice being mandated by top management. The

CQO also mentioned in passing that there has been some resistance to lean techniques from the project managers because they are now required to plan the project execution in a granular way. Thus, it is apparent that with the increasing maturity of quality processes, there has been some reversal of sorts in the roles played by top management and project manager. Previously, planning was the domain of the former and practice was left to the latter. Now, planning (albeit at the project level) is delegated to the project management but the practice itself is mandated by the top management. In management lexicon, this implies that WT has moved from a regime of high centralization and low formalization to that of low centralization and high formalization. This was an appropriate response given that the scale of operations grew by a factor of hundred within a decade, from around 400 employees to over 40,000 employees; the quality of manpower also matured to be considered on par with the best in the world.

Additionally, during the same period, environmental complexity went up with MNCs scaling up operations in India. The situation changed from that of low environment complexity and limited availability of trained local resources to one of high environment complexity and increased availability of local resources. The response of an organization for the first scenario should be high centralization/ low formalization and for the second scenario, it should be low centralization/ high formalization (Ghoshal & Nohria, 1989). However, it is difficult for an organization to transform itself to a diametrically polar mode of organizing within a short period of one decade. The success of WT in riding this transformation and turning it into an advantage, is, yet another dynamic capability, and in our view, the most important.

It follows from the above that dynamic capabilities of WT impacted mode of organizing. Conversely, would the organization form of WT have a bearing on dynamic capabilities, and what should be the ideal form to engender them? Several studies talk of decentralization/ organic forms supporting flexibility & dynamic capabilities (cf. Rindova & Kotha, 2001). We advance a contrasting argument as to why we believe that it is not necessary to have organic forms throughout the organization.

It is understood that it is the interaction between technological and organizational processes that determines innovation (Petroni, 1998). However, the nature of such interactions is not yet understood fully. An organization has two cores, technical and administrative (Daft, 1978). In the software business of WT, the software coding operations are clearly the technical core while the management of such operations by industry verticals and staff functions like the quality department would constitute the administrative core. Literature suggests that organic contexts facilitate initiation of innovations while mechanistic contexts facilitate adoption of innovations (Zmud, 1982). This duality of contexts can be better addressed by having appropriate overlays (Pierce & Delbecq, 1977; Zmud, 1982). We neither see the need nor find evidence for an organic form in day-to-day operations of WT; processes are a must to run such a huge organization in a disciplined manner. Creativity may not have a role to play in such a dispensation. However, for continued growth, initiation of process innovations is a must and the administrative core acts as an organic overlay to the prevailing, larger mechanistic context. Else, it becomes tough to satisfy the seemingly orthogonal factors of

scaling up and customer responsiveness. The quality department in WT can be considered as an organic overlay of a mechanistic form. This obviously raises questions on stifling of creativity in the mechanistic structures; to address this, firms should provide outlets in the manner done by WT through initiatives such as the innovation school.

We believe that a dual-core model with appropriate overlays would be the ideal organizational form in any place; however, in the case of developing nations, the need for separation of the forms is more acute due to the stark difference in the education profile, aptitude and managerial capabilities of the members of the two cores. In one sense, the difference in this context between developing and developed nations is more of degree rather than distinction.

Having said that, we now turn to lay out the case as to what factors make the nature of dynamic capabilities fundamentally different in an emerging economy.

The nature of dynamic capabilities in emerging economies

Our findings suggest that the nature of dynamic capabilities is fundamentally different in an emerging economy. We characterize some key differences by the following features, elaborated below: (1) Internal markets provide highly valuable tacit knowledge, albeit on an infrequent basis; (2) Context of location is more important than the context of business environment and dynamic capabilities are more important than resource positions; and (3) Prevalence of owner managers has different implications in terms of orientation.

The fabric of internal markets. Multi-business firms dealing in unrelated businesses are a reality in emerging economies even in this day and age. They may appear to be, and in most cases, probably are, historical accidents under conditions of limited business opportunities and restrictive regulatory requirements. However, not withstanding that fact, they may still add a lot of value even in the changed business scenario. We aver that they enable internal best practices transfer. In the case of WT, we see that it was aided either directly or indirectly by the experience of the wider organization in the adoption of ISO 9000 and Six Sigma. Also, even in the case of CMM level 5, it helped to have ISO 9000 framework already in place – a factor that probably allowed it to reach CMM level 5 certification in a year's time. While the notion of internal markets (Khanna & Palepu, 1997) is not new, such markets being the enablers of dynamic capabilities has been an unresearched area. In the case of Wipro, the constituent parts are reasonably diverse with negligible day-to-day interactions; Interaction happens once in a while, is strategic in orientation and vision-setting in nature. We advance a view that interactions within the group membership are bound to be more effective towards formation of dynamic capabilities when they are of the nature of experience-sharing and vicarious experiencing. A multi-business firm is a great place to experience more of business realities in comparison with a single-business firm that would have a smaller sample of experiences to draw from. It requires lot of imagination and perspective to draw from a limited sample (March et al., 1991) and hence a single business firm would fare much poorer. Internal markets may not take off in two scenarios – one, when the

boundaries between the firms are blurred, thus impacting lines of authority and responsibility; and two, when there is no interaction between the constituent businesses, with the firm acting in effect as a holding company. In all other scenarios, internal markets should aid dynamic capability building by acting as sounding boards and in sharing experiences.

Overcoming and moving beyond the liability of origin. In a globalized world, at least in principle, nothing matters except the value proposition of the product. However, in practice, the consumer would need an assurance, implicit or explicit, that the product would deliver. Even at the best of times, a "liability of foreignness" (Zaheer, 1995) raises costs of business. Liability of foreignness relates to the fact that international business becomes difficult due to unfamiliarity with the environment and factors of time & distance. This notion does not succinctly capture the idea that the costs would be much higher for a developing nation. In case of products from a developing nation, generic apprehensions abound with respect to the quality of the product. Thus, a firm from a developing nation contends not only with "liability of foreignness" but also with "liability of origin" (Bartlett & Ghoshal, 2000; Ramachandran & Mukherji, 2006).

To start with, wage arbitrage was the sole driver of business – the opportunity was available to all the firms in the market and hence, the advantage was country-specific at best. However, as firms tried to deepen their engagement with the client, it became important to lay the liability of origin concerns to rest. The need to assure the client was higher in the software services industry as the firms operate in the b2b space where stickiness and involvement are higher. Adhering to internationally accepted standards is an effective way of alleviating the concerns of the client in this market. Hence, we see that a slew of software companies – WT included – from India went for CMM certifications. However, assimilating standards and process innovations depends on several factors such as the scale of operations (Fichman & Kemerer, 1997). Only a few firms are able to achieve this advantage, one we term as scale-specific advantage. Again, the advantage here does not appear to be firm-specific. However, WT shows that it is possible even in such a scenario to build a competitive advantage, arguably transient, by being the first to the market with a slew of standards and certifications. Exercising this logic of opportunity (Eisenhardt & Martin, 2000) would not be adequate in the long run. WT went on to repeatedly build its routines in a proactive manner, thus displaying a clear logic of leverage (Eisenhardt & Martin, 2000) – Six Sigma and lean are yet to be replicated with success in other software firms. Hence, by this stage, WT has moved from country-specific and scale-specific advantage to difficult-to-imitate firm-specific advantage.

The experience of WT suggests the broad contours of a theory for overcoming the issue of liability of origin. The dynamic capabilities literature typically talks of the need for such capabilities in the light of environmental complexity. However, in emerging economies with high growth potential, the environment is munificent, to start with, due to the possible arbitrage and underdeveloped competition. Despite this, it becomes imperative for the industry to fight negative perceptions in order to offer solutions to more challenging problems. To start with, the endeavor of the firms is to signal the

viability and the reliability of the location. To this end, they work in tandem, through industry bodies (such as NASSCOM in the context of Indian software industry) and the like in fighting negative perceptions of the country and in allaying fears of clients (Ramachandran & Garg, 2006). Competition is limited at this juncture; so as internal competence. Dynamic capabilities would be more in the nature of logic of opportunity. Later, it becomes necessary to move beyond industry standards as the country of origin liability displays signs of becoming a country of origin advantage (Ramachandran & Mukherji, 2006). The competitive context would intensify due to better exposure to markets; firm competences would develop due to cumulative experience and institutional forces would become enablers and disseminators. The scenario would be ripe for the logic of leverage now, to build on the existing internal competencies of the firm and to undertake a unique competitive trajectory. Firms would still support and build the industry-wide institutions as they derive their legitimacy from these and we believe that the nature of dynamic capabilities in an emerging economy would involve judicial balancing of the internal context, institutional context and competitive context.

We find that the utility of the dynamic capabilities view is greater than the classic RBV view of VRIN resources in an emerging economy. This is easy to fathom, given the fact that the firms from developing nations have poor resource configurations to start with. Nor are they endowed appropriately to pick strong resources off the shelf from the marketplace. Miller (2003) makes an interesting argument that it is not necessary *a priori* that the resources are valuable. Even if the firm has rare, inimitable and non-substitutable resources that may not be valuable, it is possible to build value into this fabric and the advantage of such an action is that it cannot be imitated easily. In the case of firms from developing countries, however, given the resource scarcity, limited managerial talent and mimetic behavior, it is difficult for firms to have asymmetric resource positions. The quest to fight the liability of origin issues means that they need to adopt standards, which, while valuable, are not RIN resources by any stretch of imagination. The trajectory of firms seems to be to adopt *a priori* valuable resources and then, build on them to make them RIN as well (Matthews, 2002). Our own view is that what gives these firms the advantage is the constellations they build through recombination of these resources – a dynamic capability. While RBV would advocate maintaining a stranglehold on resource positions, we suspect that these firms disregard such advice, instead, relying on continuous morphing of their capabilities. We offer the case of WT's quality consulting practice – where WT gives away to its clients, its hard earned knowledge essence of its own quality system – as a pointer. Hence, while resource-picking and capability building (Makadok, 2001) may both confer competitive advantage, we are forced to believe that dynamic capabilities view has more applicability than RBV in explaining the success of firms from emerging economies.

Shareholding patterns and role of management. Dynamic capabilities, by their nature, reside in the routines of the firm, and as such, cannot be captured by balance sheet items. However, antecedents such as owner's equity may explain the presence of certain historic capabilities in the firm (Helfat & Peteraf, 2003; Teece & Pisano, 1994). In the case of Wipro, Premji holding a majority of the share capital, seems to explain certain capabilities such as routines to embed quality, as he championed a companywide

"Mission: Quality" and had been insistent on entering only high-technology businesses where quality could play a role. As Adner and Helfat (2003) rightly observe, "An answer to the question of 'what makes firms different' requires an answer to the question of 'what makes managers different.'" Premji had been an owner-manager and had closely overseen the development of managerial talent in the company; the importance of managerial agency has been stressed as a contributory factor of evolutionary path dependence (Hathaway, 2001). Also, the members of the current top management team of the company have been employees of Wipro for a long time, with most of them having worked for over 20 years with the firm in various responsibilities, the CQO being a case in point. We believe that this has also contributed to the dynamic capabilities of the firm; support from literature has been mixed, indicating evidence of dynamic capabilities (Lazonick & Prencipe, 2005; Rindova & Kotha, 2001) as well as core rigidities (Tripsas & Gavetti, 2000).

Managers have often been accused of being short-sighted and focusing more on quarterly earnings pressures to keep shareholders happy. However, dynamic capabilities are time-intensive and the management needs to have a long term orientation to fashion them. We believe that a notion of "patient capital" (Lazonick & Prencipe, 2005) has helped WT in steadfastly building its dynamic capabilities in the quality arena continuously over a period of time. The weak presence of venture capital and angel investor community in emerging economies accentuates the need for patient capital. Premji's shareholding provided the same. Also, it is possible that his being involved in the management of the firm negated potential agency problems.

Given the preponderance of owner-managers in emerging economies such as India, we expect that dynamic capabilities, or the lack of such capabilities, would be largely dependent on the outlook and orientation of the owner-managers.

CONCLUSIONS

We show that the context of emerging economies is different from that of the developed world, and hence, the nature of dynamic capabilities is also fundamentally different. We establish that the operative paradigm in emerging economies has been the dynamic capabilities approach rather than the RBV. While no two developing countries may be similar with respect to factor endowments, paths of development, socio-political background and regulatory environment, we believe that the three features we identified are reasonably common across developing countries. First, all these countries face the liability of origin issue as they try to execute more challenging and value-added work. Second, the institutional environment is underdeveloped and capital markets are weak in these nations (Khanna & Palepu, 1997), placing a demand on the financial and the managerial abilities of the entrepreneurs – thus setting the stage for dominance of owner-managers and development of internal markets.

The theoretical contributions of this paper are two-fold – advancing internationalization research and extending empirical support to the dynamic capabilities view. Hitherto, the explanations for success of firms from emerging economies in

international trade have mostly revolved around cost-based advantage. We have advanced an alternate explanation based on dynamic capabilities, albeit built on initial cost arbitrage. A common refrain of late has been that dynamic capabilities view is an ex-post facto explanation and does not hold much utility for practice (Lawson & Samson, 2001; McGuiness & Morgan, 2000). From the WT case, it is apparent that in the first phase, quality processes were adhered to with the sole objective of assuring the customer. However, by the middle of the second phase, the managers could fully realize the benefits of their actions and hence, plan in a concerted manner for the third phase. While practitioners may not use terminology espoused in the dynamic capabilities literature, we observe that they nevertheless apply that logic, especially with passage of time and accumulation of learning. A recent paper (Zahra, Sapienza, & Davidsson, 2006) suggests that dynamic capabilities should enable new strategic direction – we find ample confirmation in the WT case, where the quality processes not only enabled cost reductions but also reduced time to market, leading WT to increasingly impact revenues of the client, thus redefining the competitive premise. Toyota could implement the lean system easily as it had a largely compliant network of suppliers with whom it shared a network relationship; the difficulties that WT may have had to face in getting client approval for its quality processes, given that the buyer power was higher, are not difficult to imagine. We believe that WT is an extreme case, operating in a buyer-dominant business, hailing from a developing country, and working in an exponentially growing economy. Thus, the conclusions of this study are broadly generalizable (Yin, 1994).

A point of contention in the dynamic capabilities literature is that inconsistencies abound in the usage of the term and that the meaning of the phrase is ambiguous (Zahra et al., 2006). While Teece et al. (1997) define them as firm-specific idiosyncratic path dependencies, Eisenhardt & Martin (2000) define them as similar processes across firms. This led to the interesting question if dynamic capabilities are firm-specific or universal, and organization pushed or market pulled (Rindova & Taylor, 2002). In our research, we find that WT used industry standards initially but later went on to adopt distinctive processes of its own. We propose a two-stage process model where we argue that, in the first stage, dynamic capabilities are largely similar processes across firms, dictated by market pull and thus, universal. In the second stage, firms build on their internal competencies and the dynamic capabilities acquire a firm-specific hue, built due to factors related to organization push. The first stage would be more pronounced in emerging economies due to the need to overcome the liability of origin.

We believe that this work firmly establishes an agenda for future research to be carried out. This article is of utility to practitioners as well, since we link the implementation of dynamic capabilities with explicit performance measures. Today, researchers and practitioners increasingly ponder the ways in which firms in emerging economies try to move from best practices to next practices. This study was a step in addressing that need.

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TABLE 1

The impact of quality processes on performance metrics

(adapted from Subramanyam, Deb, Krishnaswamy, & Ghosh, 2004)

Year\ Metric	Schedule adherence	Field error rate	Phase containment	Process used
1998-1999	65%	0.60	76%	ISO 9000
1999-2000	80%	0.40	81%	CMM level 5
2000-2001	83%	0.37	79%	CMM level 5
2001-2002	91%	0.15	87%	Six Sigma

Key for performance measures:
Schedule adherence: % of projects delivered on time
Field error rate: No. of defects/ 1000 lines of code
Phase containment: % of defects captured in reviews

TABLE 2

The implementation of Quality practices: Dynamic capabilities

ISO 9000	*CMM5*	*Six Sigma*	*Lean*
Practices	(Internalizing; Increasing abstraction)		Philosophy
Others' standards	(Increasing confidence)		Own standards
Generic (core)	(Increasing expertise)		Specific core(s)
Top mgmt plng. / Project mgr's practice			Top mgmt practices/ Project mgr's plng.
High centralization/ Low formalization			*Low centralization/ High formalization*
Low environmental complexity/ Low local resources			High environmental complexity/ High local resources
Trial & error/ Learning-by-doing			Learning-before-doing