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Followers of *Harvard Study*: A Review of Product Development Research 1990s-2000s

Kenichi KUWASHIMA[a)]

Abstract: A diversification of research approaches became apparent in the field of product development management in the 1990s, based on a monumental study by Clark and Fujimoto (1991) (the so-called "*Harvard Study*"). The following five new research approaches then came into play. The "product-industry based approach," sought to clarify effective product development management by focusing on the characteristics of products and industry. The "multi-project approach" analyzed multiple projects over single projects. The "dynamic approach" focused on the dynamic aspects of product development from the long-term perspective. The "problem-solving approach" regarded product development as a problem-solving process. The "organizational capability approach" sought to elucidate organizational capabilities that contribute to high performance in product development.

Keywords: literature review, product development, problem solving, organizational capability

[a)] Graduate School of Economics, University of Tokyo, kuwa@e.u-tokyo.ac.jp
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1. Introduction

A diversification of research approaches became apparent in the field of product development management in the 1990s, based on a monumental empirical research on the automotive industry by Clark and Fujimoto (1991), the so-called "*Harvard Study*".

Since the 1960s, when the field of product development research established, it has been redirecting its focus of research approach in approximately every decade. The "grand approach" of the 1960s gave way to the "focus approach" of the late 1970s, which ushered in the "process approach" of the late 1980s (Kuwashima, 2012). In the 1990s, the "process approach," established by Clark and Fujimoto (1991), laid the foundation for the following five new research approaches,[1] which attempted to overcome the limitations of Clark and Fujimoto (1991) and develop the process approach.[2]

(1) Product-industry based approach
(2) Multi-project approach
(3) Dynamic approach
(4) Problem-solving approach
(5) Organizational capability approach

In fact, Clark and Fujimoto (1991) address the following three limitations (distinguishing characteristics).

a) Single product (industry) analysis

[1] Although not all new product development research is based on Clark and Fujimoto (1991), a large number of articles cite this article in several major journals, such as *Academy of Management Journal*, *Administrative Science Quarterly*, *Journal of Product Innovation Management*, *R&D Management*, *Research Policy*, and *Strategic Management Journal*.

[2] The author categorized the five approaches for simplicity; however, not all such research can be distinctly categorized. For example, some research in the product-industry based approach can also be accommodated within the problem-solving model framework and cited while analyzing organizational capability.

b) Single project unit of analysis

c) Static cross-section analysis

Research approaches (1)–(3), mentioned above, appeared as attempts to overcome the limitations a)–c).[3]

Problem-solving approach adopts a "problem-solving" perspective as a framework for analyzing product development management. Throughout the history of product development research, it was common to regard product development as a problem-solving process; however, after Clark and Fujimoto (1991) a "problem-solving model" has explicitly been used as a framework for analysis.

Organizational capability approach appeared in proximity to strategic management, seeking to clarify the organizational capabilities and resources that would contribute to high product development performance. Much of the existing strategic management research on organizational capabilities and resource-based view (RBV) was conceptual; gaining insight from Clark and Fujimoto's (1991) precise measurement of organizational capabilities and performances, many researchers regarded product development as suitable a field for testing their theoretical hypotheses.

Focusing on the five approaches, this paper reviews product development management research from the 1990s to the 2000s.

[3] Clark and Fujimoto (1991) was an attempt to overcome the limitations of Imai, Takeuchi, and Nonaka (1985), a pioneering study on the "process approach." Doyle (1985) criticized Imai et al. (1985) as having (1) very few samples (five samples) and (2) vague measurements of performance (subjective measurement). In contrast, Clark and Fujimoto (1991) conducted a quantitative analysis of 29 projects (to overcome criticism (1)), measuring performance precisely in terms of quality, cost, and delivery time (QCD) (to overcome criticism (2)).

2. Product-Industry Based Approach

The first research approach based on Clark and Fujimoto (1991), appearing in the 1990s, was the "product-industry based approach." This approach aimed at discovering effective product development patterns and considered the characteristics of products and industry. The main concern of this approach is clarifying whether effective product development patterns, such as overlapping problem solving or the heavy-weight product manager (HWPM), identified by Clark and Fujimoto (1991) in the automotive industry, can be applied to other products or industries (e.g., Eisenhardt & Tabrizi, 1995; Fujimoto & Yasumoto, 2000; Iansiti, 1998; Kuwashima, 2003; Kuwashima, Takahashi, & Tamada, 2005; Pisano, 1997; Tomita, 2009; Wi, 2008; Yasumoto & Shiu, 2007; Yoshimoto, 2009).

For example, Iansiti (1998) analyzed the state of effective product development in the mainframe computer industry. The results showed that development patterns such as internal integration and overlapping problem solving are unrelated to product development performance. Instead, what contributes to the performance in the industry is "technology integration," that is, how effectively the upstream product development process (advanced development) integrates with the downstream (product development) process.

Eisenhardt and Tabrizi (1995), attempting to solve the same issue, analyzed the effect of two contrasting product development strategies ("experiential strategy" and "compression strategy") on development lead time in the computer industry, which in comparison has a more rapidly changing market and technology than the automotive industry. The results agreed with those of Clark and Fujimoto (1991) in that variables, such as strong leaders and cross-functional teams (including "experiential strategy"), contributed to a shorter lead time. However, in terms of overlap in development phases and supplier participation, the results differed from those of Clark and Fujimoto

(1991). Eisenhardt and Tabrizi (1995) explain that these differences are caused by the characteristic unpredictability of and rapid changes in the computer industry, which is unlike the relatively stable automotive industry.

In the 2000s, researchers began to perform cross-sectional analyses across different industries on basis of existing empirical research in various industries as outlined above. For example, Fujimoto and Yasumoto (2000) propose a contingency framework for cross-industry analyses on the basis of case studies of product development in the mobile phone, color television, pharmaceuticals, plastic, beer, cosmetics, game software, and apparel industries.

3. Multi-Project Approach

The second approach was the "multi-project approach," which shed light on effective management of multiple projects, rather than a single project. Clark and Fujimoto (1991) validated effective development patterns for single projects. However, many studies question how multiple product development projects (bundle of projects) are effectively managed, which is an important issue for many companies (e.g., Aoshima, 2002; Halman, Hofer, & Vuuren, 2003; Nobeoka & Cusumano, 1997; Sundgren, 1999; Tatikonda, 1999).

For example, Nobeoka and Cusumano (1997) analyzed the relationship between four multi-project strategies ("New Design," "Rapid Design Transfer," "Sequential Design Transfer," and "Design Modification") and product development performance (development lead time and development costs) in the Japanese and American automotive industries. The results showed that while there was no obvious difference between the four strategies in terms of lead time, the development costs of projects that adopted "Rapid Design Transfer" to introduce core technology from other current projects

were significantly lower than those of projects that adopted the other strategies.

Aoshima (2002) analyzed the knowledge transfer and retention mechanisms of product development between generations of projects in the Japanese automotive industry. The results showed that while knowledge transfer and retention through databases or computers was effective for simpler components based products, human or organizational transfer and retention mechanisms were more effective on development projects for highly complex products, such as automobiles.

These studies gradually brought to light the effective management of "multiple projects," something Clark and Fujimoto (1991) had not clarified. However, research on the multi-project approach has a shorter and less bountiful history than research on single projects.

4. Dynamic Approach

The "dynamic approach" focuses on the dynamic aspects of product development, such as continuous product development or product evolution, adopting a more long-term perspective (e.g., Brown & Eisenhardt, 1997; Helfat & Raubitschek, 2000; Kusunoki, 1995; Meyer, Tertzakian, & Utterback, 1997; Uzumeri & Sanderson, 1995).

Kusunoki (1995) proposes a "trajectory driven" model for effective, continuous product development in a changing competitive environment, drawing from a case study in the Japanese facsimile industry. In trajectory driven product development, the design of dynamic patterns called "product trajectory" takes precedence over individual product development; each product is developed according to the trajectory. This results in "continuity" in product development as well as adaptation to technology and market competition, serving a dynamic differentiation from other companies.

Attempting to solve the same issue as Kusunoki (1995), Brown and Eisenhardt (1997) conduct an analysis of case studies on the rapidly changing computer industry. The analysis compared three high-performing companies that were well adapted to the changing environment, and three low-performing companies. There were three major differences between the high- and low-performance companies. High-performance companies 1) have both "limited structure," such as project manager responsibilities and project priorities, and "flexibility and chaos" in the form of extensive communication and a degree of freedom to make quick judgments; 2) rely on a wide variety of low-cost analyses about the future, including experimental products and strategic alliances; 3) link the present and future through systematic project transition processes.

An increase in the limited numbers of research on the dynamic approach, similar to that of the multi-project approach, can be expected in the future.

5. Problem-Solving Approach

The fourth approach is the "problem-solving approach," which discovers effective problem-solving patterns in product development. The approach uses Clark and Fujimoto's (1991) framework of treating product development as a problem-solving process (e.g., Barnett & Clark, 1998; Krishnan, Eppinger, & Whitney, 1997; Ku, 2004; Sheremata, 2002; Terwiesch & Loch, 1999; Thomke, 1998; Thomke & Fujimoto, 2000).

Although product development can be analyzed from many different perspectives, treating product development as a problem-solving process is one of the oldest perspectives in this field of research (e.g., Myers and Marquis, 1969). However, only after Clark and Fujimoto's study (Clark & Fujimoto, 1991), a "problem-solving model" has explicitly been used as a framework for

empirical research.

For example, Thomke (1998) analyzed the product development process using a four-step problem-solving model of "design → build → test → analysis" and examined the impact of adopting high technology on the timing of test mode switching. Thomke (1998) compared cases of using and not using "rapid prototyping," a new technology for rapidly building prototypes at low cost, in the semiconductor-industry. The study showed that the optimum switch point shifted to an earlier stage in the former cases (adopting the technology), than in the latter cases (not adopting the technology).

Barnett and Clark (1998) attempted to clarify problem-solving activities in the process industry, focusing on identifying distinguishing problem-solving patterns in the process industry compared with the assembly industry. Barnett and Clark (1998) used case studies of six companies from four industries—plastics, superalloy, pesticide, and applied chemistry industries. The study shows that a major distinguishing characteristic of problem-solving in the process industry is that there is no clear distinction between product development and process development, as there is in the assembly industry; rather, process development is embedded in product development. This process differs from the "stage-based model," observed in product development in the assembly industry. This distinction is very important in comparative analyses of effective product development management in the product and process industries.

More recently, Thomke and Fujimoto (2000) proposed the concept of "front-loading problem-solving" as an effective means of reducing product development lead time, on the basis of an analysis of the automotive industry. The term "front-loading" refers to a technique of predominantly investing problem-solving efforts and resources into the early stages of product development. By predominantly investing problem-solving efforts into the early stages of product development

through "short-cycle problem-solving tools," such as computer simulations, enables a smaller number of "highly accurate yet time-consuming simulations," such as test builds, in the later stages of product development; thereby helping reduce the product development lead time. Toyota actually introduced front-loading in the 1990s and achieved major reductions in development time.

6. Organizational Capability Approach

The last research approach, appearing in the 1990s, was the "organizational capability approach," which sought to identify the organizational capabilities and resources contributing to product development performance on the basis of RBV and capability theory in the field of strategic management (e.g., Cockburn, Henderson, & Stern, 2000; Helfat, 1997; Henderson & Cockburn, 1994; Kusunoki, Nonaka, & Nagata, 1998; Yeoh & Roth, 1999). Although many studies in the field of strategic management, since the late 1980s, have focused on organizational capabilities as a source of competitive advantages (e.g., Barney, 1991; Teece, Pisano, & Shuen, 1997), most of these studies were conceptual and very few empirical. Product development was a suitable field for empirical studies on organizational capabilities and RBV.

Henderson and Cockburn (1994), one of the first studies to use this research approach, hypothesized that "component competence" and "architectural competence" were sources of competitive advantage, and analyzed the impact of the two organizational capabilities on product development performance (number of patents obtained). The results of a statistical analysis of data from a research project, based on ten pharmaceutical companies in Europe and the USA, showed a statistically significant relationship between performance indicators and variables representing architectural competence, such as "resource allocation for research and development being determined

by use committees rather than relying on a single dictator." From these results, Henderson and Cockburn (1994) assert that architectural competence, which are organizational capabilities related to the integration of information and knowledge, are a major source of competitive advantage.

Kusunoki et al. (1998) used a similar framework in an empirical study on Japanese companies. This study focused on Japanese companies in particular because an analysis of organizational capabilities in the field of product development management could explain the competitive advantage of Japanese companies, which could not be explained by existing strategic management theory. Despite referring to Henderson and Cockburn (1994), Kusunoki et al. (1998) applied an analysis with an original framework comprising "local capabilities," "architecture capabilities," and "process capabilities" to assert that process capabilities are the most important organizational capabilities in Japanese companies.

Research has continued into the 2000s, with many empirical studies using this approach from the standpoints of product development management and strategic management.

7. Conclusion

This paper reviews product development research from the 1990s to the 2000s. The field of product development research, established in the 1960s, has been redirecting its focus of research approach in approximately every decade. Five new research approaches appeared in the 1990s as various attempts to apply or improve Clark and Fujimoto (1991) (the so-called "*Harvard Study*"), one of the most influential studies in the field. In general, academic research aims to overcome the limitations in previous research and move forward by "standing on the shoulders of giants." Research in the field of new product development is a truly classic example of this.

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