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Dynamic capabilities through continuous improvement infrastructure

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ABSTRACT

We examine the content of continuous improvement strategies and identify infrastructure decision areas that are important for continuous improvement initiatives. We present a framework of infrastructure based on the idea that continuous improvement can serve as a dynamic capability when it includes a comprehensive organizational context. Further, we study continuous improvement initiatives in five companies to investigate the practices used by them in each of the decision areas of our framework. This research adds to the conceptual understanding of continuous improvement and results in grounded propositions about critical areas of infrastructure for continuous improvement.

1. Introduction

Continuous improvement initiatives such as lean production and Six Sigma have proliferated among manufacturing and service organizations worldwide (Voss, 2005). Due to an increasing pace and complexity of business environments, organizations no longer compete on processes but the ability to continually improve processes (Teece, 2007). At the same time numerous organizations that have deployed continuous improvement initiatives have not been successful in getting what they set out to achieve. Results of a 2007 survey of US manufacturers showed that while 70% of plants had deployed lean manufacturing techniques, 74% of these were disappointed with the progress they were making with lean (Pay, 2008). An earlier study found that only 11% of companies considered their continuous improvement initiatives to be successful (Mendelbaum, 2006). Although operations management executives realize the importance of continually improving processes, they have found that managing continuous improvement is a challenging task (Kiernan, 1996; Pullin, 2005). The challenge lies in creating an infrastructure to coordinate continuous improvement projects (Choo et al., 2007; Wruck and Jensen, 1998). This paper seeks to identify the elements of such infrastructure. We present a framework of continuous improvement infrastructure derived from the dynamic capabilities perspective and its underlying theory of organizational learning (Zollo and Winter, 2002). Further, we offer preliminary empirical evidence in support of our framework based on case studies of continuous improvement initiatives in five companies. Thus, we propose a grounded theory framework by combining logical arguments from existing literature with cross-case empirical insights from companies that have deployed continuous improvement initiatives.

Continuous improvement is defined as a systematic effort to seek out and apply new ways of doing work i.e. actively and repeatedly making process improvements. We define processes as designed sequences of tasks aimed

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at creating value-adding transformations of inputs – material and information – to achieve intended outputs (Upton, 1996). For example, raw materials such as wood and iron fixtures go through several operational processes to manufacture a chair; information about the customer and aggregate risk-related data are processed to produce an automobile insurance policy. Process improvements are defined as enhancements in operational processes; e.g. improving a chair manufacturing process so that less raw material is consumed, or reducing the cycle time from proposal to delivery of an insurance policy.

Our premise is that continuous improvement can be a dynamic capability when it includes a comprehensive organizational context. Dynamic capability is defined as "a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness." (Zollo and Winter, 2002, p. 340). The implementation of dynamic capabilities involves repeated cycles of organizational learning (Cyert and March, 1963; Mahoney, 1995; Schön, 1975). Similarly, process improvement involves organizational learning to make changes in operating routines. As described earlier, the ability to consistently improve current processes and learn new ones is termed continuous improvement capability (Ittner and Larcker, 1997).

Organizations aim to achieve continuous improvement capability through the deployment of continuous improvement initiatives such as lean management and Six Sigma (Voss, 2005). A continuous improvement initiative implies bundles of practices, such as prescribed sequences of steps for carrying out projects, and sets of tools and techniques commonly used to execute these projects (Handel and Gittleman, 2004; Pil and MacDuffie, 1996). Continuous improvement thus fits into Helfat et al.'s (2007, p. 5) notion of dynamic capability as patterned activity, in contrast to "a one-time idiosyncratic change to the resource base of an organization." When appropriately implemented, continuous improvement initiatives help to integrate operations processes and enhance the organization's ability to make cohesive and quick process changes to improve performance. In this way, continuous improvement initiatives can serve as dynamic capabilities for the organization (Fig. 1 presents a schematic representing the parallels drawn between continuous improvement and dynamic capabilities). For continuous improvement to create and support dynamically changing operational capabilities it is critical that it include a coherent infrastructure (Eisenhardt and Martin, 2000; Garvin, 1993b).

Thus, our proposed framework of infrastructure elements is based on the idea that continuous improvement is meant to be a dynamic capability. Following the development of this theoretical framework, we study continuous improvement initiatives in five companies and gain insight into the practices for each of the elements of their continuous improvement infrastructure. The theoretical importance of the elements that constitute our framework and the preliminary empirical support for the validity of this framework provided by the case studies leads to the proposition that continuous improvement deployments that do not institute practices in each of the areas of continuous improvement infrastructure will be less effective.

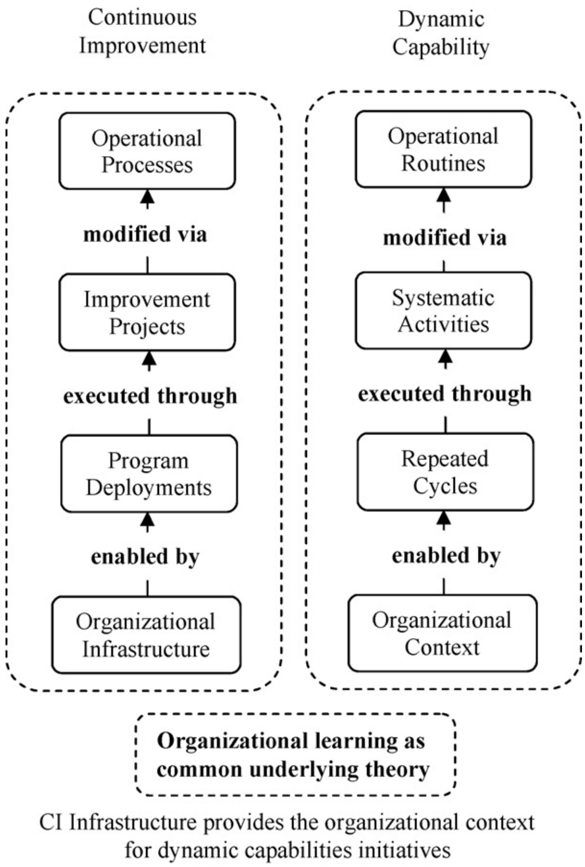

Fig. 1. Continuous improvement as dynamic capability.

The remainder of the paper is organized as follows. In Section 2 we relate the organizational context for dynamic capabilities to continuous improvement infrastructure. While this section broadly describes the underlying theory on which our framework is based, conceptual development of each of the elements of the framework is done in Section 4. Section 3 describes our method for developing the framework and for applying it to empirically study its application through five case studies of continuous improvement deployments. In Section 4 we develop a framework of infrastructure decision areas for continuous improvement. As we present each of the elements of this framework and discuss their theoretical origins we also present our observations from the case studies. Section 5 consists of an analysis of our framework. We highlight the limitations of the proposed framework revealed by inconsistencies with some of our empirical observations and discuss the complexities of certain infrastructure decisions for companies. This analysis leads to 10 research questions that we believe are important for further theoretical development in the area of continuous improvement. Section 6 identifies key recommendations for practice, points out some limitations of our empirical study and concludes the paper.

2. Theory

2.1. Continuous improvement and its infrastructure

Continuous improvement (CI) is an ongoing activity aimed at raising the level of organization-wide performance through focused incremental changes in processes (Bessant and Caffyn, 1997; Wu and Chen, 2006). A CI initiative provides a planned and organized system for the continual discovery and implementation of such process changes. CI initiatives consist of two broad areas of action required for sustained improvements, namely the execution and the coordination of process improvement projects. While CI infrastructure should support both execution and coordination of projects, several organizations deploy CI initiatives simply by executing ad-hoc projects using tools and techniques popular at the time. In doing so, these organizations ignore the more difficult to imitate project coordination and supporting activities of CI initiatives such as those for systematically selecting and reviewing projects, preserving lessons learned from projects, and training and motivating employees for participation in CI. A number of researchers have observed that CI deployments that lack adequate coordination and support lose traction and become ineffective after realizing initial gains (Choo et al., 2007; Wruck and Jensen, 1998).

Existing studies have acknowledged the importance of project coordination issues for CI initiatives (see, e.g., Alexander et al., 2006; Flynn and Sakakibara, 1995; Powell, 1995; Samson and Terziovski, 1999; Yeung et al., 2006). Infrastructure practices can fulfill the important role of coordination and support of projects and create a culture for continuous improvement to help sustain a CI initiative beyond its immediate gains. However, existing studies tell us little about the constituent elements of such an infrastructure. In seeking these elements for CI infrastructure we rely on the theoretical relationship between organizational learning and dynamic capability (Zollo and Winter, 2002). In order for a CI initiative to serve as a dynamic capability, CI infrastructure should provide an organizational context that enables organizations to coordinate and sustain their organizational learning efforts toward systematically improving processes (see Fig. 2).

2.2. Organizational context for dynamic capabilities

CI infrastructure can add a dynamic dimension to CI initiatives by institutionalizing organizational learning, manifested in the form of process improvements (Linderman et al., 2004; Molina et al., 2007). It can serve as the right context for dynamic capability by facilitating the involvement of middle and lower levels of management in strategy deployment and creating a culture for organizational learning (Neilson et al., 2008). Thus, we begin by examining the role of organizational context for dynamic capabilities.

Traditional management methods typically involving top-down strategic planning with systems in place to dictate and control actions of middle and front-line managers in order to ensure adherence to plans are poorly suited to developing dynamic capabilities (Montgomery, 2008; Tyler and Blader, 2005). These systems assign responsibility for the formulation and implementation of organizational strategy to top management exclusively. Such management methods mesh poorly with organizational learning and the development of dynamic capabilities, for at least three reasons (Pfeffer, 2005; Tourish, 2005). First, because information needs to pass through several layers, it takes longer for upper management decisions to reach operational front-lines, and this delay affects the speed and accuracy of the communication (Beer et al., 2005). Second, organizational levels are affected by multiple environmental factors, making it difficult for upper management to keep track of the factors affecting each level (Elenkov, 1997). Finally, a conventional top-down structure inhibits bottom-up communication about environmental changes and thus impedes organizational learning (Wright and Snell, 1998).

To overcome these weaknesses of traditional strategy formulation and implementation methods, organizations must choose to use organic, "purpose-process-people" types of management frameworks (Bartlett and Ghoshal, 1994). Such frameworks treat *people* as knowledge resources and encourage their participation in the discovery of better ways to execute *processes* in order to accomplish broader organizational *purposes*. By allowing and even facilitating proactive changes at the middle and front-line levels while maintaining strategic congruence, such management approaches provide an effective context for organizational learning and the development of dynamic capabilities (Teece et al., 1997). We turn to organizational learning theory in order to identify the dimensions of CI infrastructure.

2.3. Organizational learning theory

Organizational learning is a principal source of dynamic capabilities (Helfat et al., 2007). As defined by Fiol and

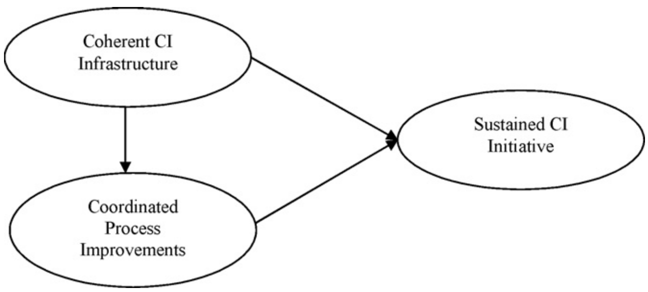

Fig. 2. Coordination and execution of projects for sustained continuous improvement.

Lyles (1985, p. 803), organizational learning involves "improving actions through better knowledge and understanding." Organizations employ routine methods of carrying out processes, which include selecting among alternate action paths in response to changes in operating conditions. These routine operating processes are changed from time to time to improve performance—for instance, to increase production efficiency or improve customer responsiveness (Zahra et al., 2006). The ability to make changes to routine operating processes through organizational learning is a dynamic capability. (Examples of other dynamic capabilities include alliance-forming and acquisition-making capabilities; please see Augier and Teece, 2006; Helfat et al., 2007.)

Performance-enhancing changes in routine operating processes can be discovered and implemented through projects executed using CI protocols and practices. The two nested activities noted above – the routine selection among alternate paths in a process, and the adaptation or updating of routine ways of operating the process – are referred to as single-loop and double-loop learning (Argyris and Schön, 1978). CI initiatives can play a major role in double-loop learning, resulting in the creation of knowledge about processes and process changes (Linderman et al., 2004). Thus, organizational learning is an appropriate theoretical lens through which to examine the elements of CI infrastructure that can serve as organizational context for dynamic capabilities. We extend existing applications of organizational learning theory in the areas of new product development and new technology adoption to the topic of CI (please see Section 4). Our principal thesis is that infrastructure for continuous improvement should provide appropriate organizational context for achieving the dynamic capability of continuous improvement. In the absence of such an infrastructure, the continuous improvement initiative will not take the form of a dynamic capability.

3. Methods

Our aim in conducting this research is to contribute to a theory of continuous improvement. Toward this purpose, we developed a framework of CI infrastructure and conducted a preliminary empirical investigation to observe the practices used by companies as they relate to this framework. We derived critical elements of CI infrastructure described in detail in Section 4 based on the dynamic capabilities perspective and organizational learning theory. Using existing research on dynamic capabilities and organizational learning as applied to the topics of new product development and new technology adoption, we adapted the concepts and relationships previously established, to the phenomenon of CI. Following this theoretical development of our CI infrastructure framework we sought empirical evidence about the relevance of this framework. Thus, we collected data on practices instituted in each of the framework's decision areas by companies that have exhibited success in using CI initiatives, and made comparisons across the companies via a systematic cross-case analysis. In all, this exploratory research method embodies the grounded theory building approach of Yin (2002) and Eisenhardt (1989).

These practices are described along with the development of the framework in Section 4. Because our research is exploratory, we relied on qualitative methods to collect and compile this empirical evidence. Case studies, based on in-depth interviews with CI executives and scrutiny of internal company documents, enabled us to identify practices instituted by companies in the areas of our framework and provided preliminary evidence supporting the importance of these areas. We chose the company as our level of analysis because the infrastructure practices for CI initiatives are both determined and executed at that level.

3.1. Sampling

It would have been ideal for us to study a random selection of companies given the theory development nature of our research (Cook and Campbell, 1979). However, in the interest of theory building we also wanted our sample to be such that we could reliably address questions of CI infrastructure by having access to upper management time and internal company documents (Eisenhardt, 1989). Thus, the companies in our sample were selected based on their CI deployments. Our sample was derived from a list of member and associated companies of a Center for research in operations management at a major US University. We started by going down the list of 29 companies provided to us and seeking out companies in which top management had demonstrated commitment to continuous improvement defined as a minimum of 5 years of deployment of CI initiatives. To identify such companies from the list, we conducted Internet searches to check for information on their CI deployments and sought input from Center administrators about their knowledge of CI initiatives in these companies. In this manner, we narrowed down the initial list of 29 companies to 17 companies that had deployed continuous improvement initiatives with some degree of success. Then, we contacted executives in these selected companies by e-mail and telephone to request their company's participation in our research project.

As we contacted these executives and obtained agreements and refusals to participate, we consciously attempted to put together a theoretical sample consisting of companies engaged in different businesses – mainly manufacturing, services and a hybrid of the two – in order to make our framework more widely applicable. Companies that turned down our requests cited shortage of time and data sensitivity issues as reasons for their unwillingness to participate. Ultimately, our search resulted in five such companies that agreed to participate. This sample size fell within the suggested norm of between 4 and 10 cases for such research (Eisenhardt, 1989) and moreover, would be adequate for us to study CI infrastructure in companies across different business types. As all five companies agreed to participate in our study on condition of anonymity we have used pseudonyms to refer to them and disguised company descriptions to prevent detection. As a result of the selection method followed, our sample

Table 1
Profile of companies participating in case studies.

	HEAL	SERV	CHEM	MEDI	TECH
Industry	Healthcare	Industrial services	Chemicals	Medical equipment	High-tech industrial solutions
Headquarters location	Illinois	Ohio	Tennessee	Minnesota	Illinois
Employees	50,000	30,000	12,000	31,000	4000
Annual revenues (billions)	$20	$3	$7	$10	$1

Information reflects December 2005 data.

was characterized by a regional bias as four of the five companies in our sample are headquartered in the Midwestern US. Given the exploratory nature of this study and our stated purpose of studying infrastructures for CI initiatives, we intentionally limited our attention to companies in which we could get extended amounts of time with respondents involved in CI deployments.

3.2. Sample

The five companies in our sample – henceforth referred to as CHEM, HEAL, MEDI, SERV and TECH – are companies that continue to be successful to date in their respective businesses. Top management – chief executive officers and vice presidents – of these companies have gone on record, and the popular business press has also written reports, attributing the financial successes of these companies to their CI initiatives. Specifically, MEDI Company credited benefits of $62 million to CI projects in 2004–2005 and was expecting an additional $14 million from ongoing projects. TECH Company recognized their CI initiative as being responsible for a 30% improvement in on-time deliveries and a 50% reduction in inventories in the 5 years until 2005. SERV Company acknowledged the importance of its CI initiative in its 2005 Annual Report attributing reduction of back orders by 75% and increase in customer satisfaction by 40% to process improvement efforts. CHEM Company was previously a winner of the Malcolm Baldrige National Quality Award and HEAL Company had repeatedly won accolades for its environmental performance, which it credits to the company's focus on CI. Thus, these companies have served as exemplars in terms of continually improving their processes and successfully relating such process improvements to improved competitiveness.

For our study we sought respondents from upper management executives in charge of CI initiatives as we believe that they are in a position to know about their infrastructure practices for CI. However, in two of the companies – SERV and CHEM – that agreed to participate in our study we were unable to obtain adequate time for interviews with upper management. Therefore, we took the next best option of interviewing respondents at the project leader level. This mismatch in our respondent pool leaves room for different perspectives about CI infrastructure that can be problematic for analyzing empirical data (Rungtusanatham et al., 2008). However, in the interest of gaining as much empirical information as possible we did not drop these companies from our sample. Moreover, as our mode of data collection was the in-depth, open-ended interview combined with follow-up, we believe that we were able to prompt mid-management respondents to collect and provide organizational-level information of which they were otherwise unaware.The five companies in our sample were publicly traded with annual revenues ranging from $1 billion to over $20 billion. In Table 1 we provide brief profiles of these companies. Although their CI initiatives at the time of our study were mainly focused on lean management and Six Sigma, all five companies had previously deployed other CI initiatives, such as total quality management (TQM), Crosby's (1980) principles, short interval scheduling (Smith, 1968), and the Baldrige award criteria (NIST, 2008). All respondents suggested that their companies' experiences with past CI initiatives were reflected in their deployment of current CI approaches.

3.3. Interviews

Our case studies mainly comprised in-depth interviews in each of the five participating companies, conducted by the primary author. The main purpose of these interviews was to gather information on CI infrastructure practices instituted by the companies. Interview questions were compiled with this purpose and based on existing literature on CI initiatives. A list of the questions used, along with references to previous research that prompted their inclusion, is provided in Appendix A. The format for the interviews was free-flowing discussion and, although the investigator covered each question in the list, the questions were not covered in any particular order. In addition, respondents were encouraged to discuss their CI initiatives in general. Respondents consisted of one upper management CI executive each from two companies—HEAL and TECH, two such executives from MEDI, and one and five project leader level respondents respectively from CHEM and SERV, for a total of 10 respondents. Each of these interviews lasted over 3 h, and the responses were digitally recorded and transcribed. Respondents also provided internal company documentation related to infrastructure practices, including strategic plans, training protocols, and examples of project reports. Based on the interviews and company documentation the primary author compiled information on how the companies' practices related to our CI infrastructure framework. The empirical evidence and its compilation into the framework were then reviewed and refined by the research team consisting of the co-authors.

After incorporating company practices in each area of the framework based on the data collected and discussions among the research team, the primary author conducted follow-up interviews with each of the company participants. Before these interviews, the information compiled from the first round of interviews was presented to the respondents. The follow-up interviews yielded information on practices deployed that respondents might have

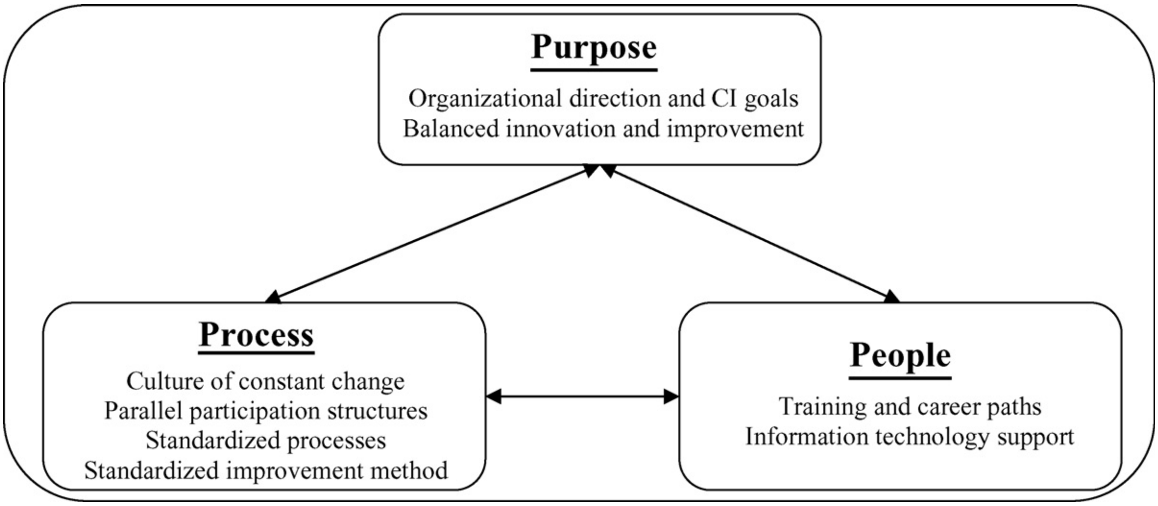

Fig. 3. CI infrastructure framework.

overlooked in the first round. These interviews lasted at least 30 min each.

Results from both rounds of interviews and analyses – practices in each of the areas of infrastructure along with comments about the importance of each of the areas – are reported in Section 4 following explanation of the underlying theory supporting the inclusion of the elements of the framework. Thus, following Emden et al. (2006), Gerwin (1993), and Madhavan and Grover (1998), we used a combination of literature synthesis and managerial input to develop our framework and provide preliminary evidence of its relevance.

4. Elements of CI infrastructure

In this section we rely on organizational learning theory, the dynamic capabilities perspective and the principal objectives of CI to identify elements of CI infrastructure. Our aim is to identify the crucial decision areas – aspects that must not be ignored – for the development of an effective organizational infrastructure for CI. We focus on what Sakakibara et al. (1997) called "common infrastructure practices" in the context of just-in-time (JIT) and total quality management (TQM) programs, and what Cua et al. (2001) labeled "human- and strategic-oriented common practices" in their assessment of TQM, JIT and total preventive maintenance (TPM) programs. These earlier studies assessed the patterns of organizations' infrastructure decisions related to particular CI programs. We take a different view and present a more general framework of decision areas for infrastructure development that is applicable to all CI programs.

We adopt Bartlett and Ghoshal's three categories of decisions for dynamic strategy deployment (Bartlett and Ghoshal, 1994, 1995; Ghoshal and Bartlett, 1994) as an overall framework for the categorization of CI decision areas. Bartlett and Ghoshal studied organizations that performed exceptionally well in dynamic, volatile, and highly competitive environments—the kind of environments in which CI deploying organizations operate. They found that the success of these organizations could be attributed to decisions made by management in three broad categories that they labeled *purpose*, *process*, and *people*. Appropriate decisions in these categories facilitated the dynamic creation of front-line capabilities that provided successful and coherent responses to environmental pressures. Similarly, CI initiatives generally aim to provide employees the motivation and skills to make process changes in order to improve the competitiveness of the organization.

Management decisions in these three broad categories – *purpose*, *process*, and *people* – are the essence of CI infrastructure and affect the sustainability of the initiative (see Fig. 3). First, infrastructure decisions in the purpose category cover the formulation and communication of organizational and project goals for CI. Second, the achievement of CI purpose requires organizational support for implementation of the CI initiative, mainly in the form of the adoption of uniform methods for the discovery and execution of improvements. These decision areas are grouped under the *process* category. Finally, adequate training and motivation of employees are required to promote CI and to enable participation. Infrastructure decision areas related to this objective come under the *people* category.

In Table 2 we list our proposed decision areas within the three-category CI infrastructure framework along with key sources of theoretical support for each decision area. We discuss the framework and its conceptual development in more detail below. As we make the case for each area in our framework we also present, based on our case studies, evidence of practices instituted by companies in these areas. Table 3 summarizes the main empirical insights from our case studies.

4.1. Purpose

In order to achieve dynamic capabilities through operations, it is critical for organizations to translate their overall strategic direction into operational goals while allowing for flexibility to respond to changes in their operational environment. CI initiatives warrant the for-

Table 2
CI infrastructure decision areas—intent, underlying concepts and literature support.

Infrastructure decision area	Intent	Underlying concept and literature support
Purpose	Determine multilevel goals while maintaining unified strategic outlook	
Organizational direction and CI goals	Facilitate mid- and lower-level managers' participation in strategy formulation and implementation	Interlinked levels: Forrester (2000a), Jelinek (1979), Linderman et al. (2003) and Nonaka (1988)
	Assure project goal congruence with strategic objectives; set and validate goals and results	Integrated strategy formulation: Hart (1992), Beer et al. (2005) and Lyles (1981)
	Maintain focus on CI initiative	Team-based learning: Imai (1986) and Evans (2004)
Balanced innovation and improvement	Incorporate stability and change objectives and process-improvement and new-process-design projects	Ambidexterity: Crossan and Berdrow (2003), Gibson and Birkinshaw (2004), Jansen et al. (2006), Sitkin et al. (1994) and Spear and Bowen (1999)
Process	Institute practices and structures gearing implementations toward *purpose*	
Constant-change culture	Encourage proactive scanning for opportunities and threats	Nested environmental scanning: Cohen et al. (1972), Crossan and Berdrow (2003) and Elenkov (1997)
	Prepare employees for constant change and reorientations	Double-loop learning: Argyris and Schön (1978), Barrett (1995) and Sitkin et al. (1994)
Parallel participation structures	Superimpose lateral structures for cross-functional cooperation	Organization structure for dynamic environments: Delbridge and Barton (2002), Joyce et al. (1997), Kogut and Zander (1992) and Mohrman et al. (2002)
	Avoid suboptimization of organizational performance for functional goals	Systems thinking: Ackoff (1994) and Senge (1990)
Standardized processes	Enable measurement and comparison for improvement projects	Scientific management: Adler and Cole (1993), MacDuffie (1997), Spear and Bowen (1999) and Taylor and Wright (2006)
Standardized improvement method	Provide common scientific method for improvement and facilitate participation	Scientific experimentation: Forrester (2000b), Garvin (1993a) and Spear and Bowen (1999)
People	Invest in resources toward achieving *purpose*	
Training and career paths	Enable participation in CI projects	Participative climate: Bowen and Lawler (1992) and Gowen et al. (2006)
	Update body of knowledge and provide training when appropriate	Knowledge management: Hatch and Dyer (2004); Wright and Snell (1998)
	Clarify reporting structures and paths for personal development	Administrative practices: Dyer and Ericksen (2005)
Information technology support	Support process-measurement needs and provide repository of project reports	Information processing: Bendoly and Swink (2007), Davenport (2006) and Garvin (1993a)

mulation of multilevel organizational goals, including overall organizational vision, departmental objectives, process objectives, and project goals. The role of top management in CI initiatives is to provide a vision that guides the formulation of goals at the middle and lower managerial levels (Nonaka, 1988). The biases of managers and employees at different levels and in different departments may affect their interpretations of organizational vision, in turn affecting the formulation of goals for their domain (Carter, 1971; Cohen et al., 1972). Infrastructure decisions categorized under *purpose* are aimed at aligning multiple sub-goals and avoiding any incongruence that may result from organization-level or functional biases. The need for management to support decentralized goal-determination while maintaining an overall strategic vision is reflected in the *purpose*-related decision areas described below.

4.1.1. Organizational direction and CI goals

4.1.1.1. Conceptual development. In CI deployments, front-line employees and middle management not only are responsible for making process improvements, but also are expected to suggest broader changes in organizational strategies at the next-highest level (Hart, 1992; Imai, 1986). CI infrastructure must therefore include mechanisms that link vertical organizational levels, facilitating participation of middle- and lower-level managers in the formulation of strategic goals (Forrester, 2000a; Jelinek, 1979). Such linkages may also generate debate and discussion (Lyles, 1981; Nonaka, 1988) in regard to the direction of the CI initiative while ensuring employees' commitment through their involvement (Evans, 2004). Thus, a set of mechanisms that encourages employee initiative in goal-setting through interactions with upper management is an important part of CI infrastructure.

Another requisite for the success of a CI initiative is the emergence of ideas for process improvement projects that have achievable and relevant objectives matched with and following from overall CI goals (Beer et al., 2005). Toward this end, it is important that the CI infrastructure incorporate mechanisms for the selection and prioritization of projects and for tracking the effectiveness of projects (Linderman et al., 2003). Project goals must be

Table 3
CI infrastructure practices—empirical observations.

Infrastructure decision area	Empirical observations	Companies[a]
Purpose		
Organizational direction and CI goals	Multilevel steering committees with interlinked membership for cascading organizational goals	A, B, C, D, E
	Project selection focused on matching areas of opportunity that the business cares about with improvement frameworks	A, B, C
	Projects required to have strategic implications 'Y's' relating intended process improvements to organizational goals	A, B, C, D, E
	Governance systems to ensure legitimacy of targets and assess extent of achievement	B, D, E
	CI initiatives blessed by top management	B, C, E
	Internal job postings referring to CI initiatives as metric for program relevance	D
	Awards for participation and leadership roles in CI	A, D
Balanced innovation and improvement	Different project protocols such as Design for Six Sigma, Six Sigma, Lean Projects, and Kaizen Bursts	A, B, C, D, E
	Mistake-proofing features built into processes as part of improvements to ensure long-term and uniform process control	D
Process		
Constant-change culture	Steering committees encouraging multilevel scanning of external environment	A, B, C, D, E
	External benchmarking through interactions with similar businesses	D
	Internal benchmarking through project-tracking databases	D
	Voice of the customer, a common feature of process improvement projects	A, B, C, D, E
	Iterations of current and future state value stream maps encouraging sustained emphasis on change	E
	CI champions created to act as change agents and to spread CI culture	D, E
	Leadership, team involvement, and change management tools included in CI training	A, B, C, D, E
Parallel participation structures	Offline teams headed by team leaders functioning as internal CI methodology experts	A, B, C, D, E
	Use of projects to target specific process improvement goals	A, B, C, D, E
	Built-in adjustments for functional goals to tackle conflicts encountered in projects	E
	Special emphasis placed on data to incorporate tradeoffs of functional goals in the interest of organizational performance	C
	Supplier involvement in process improvement projects that span organizational boundaries	B, D
Standardized processes	Standardization of work practices accomplished and gradually dispersing as a result of process improvement projects	A, B, C, D, E
	Mistake-proofing mechanisms to design out problems	D
Standardized improvement method	Specified sets of steps to search and implement process improvements	A, B, C, D, E
	"Tollgate reviews" at transitional steps between project stages to ensure compliance	C, D, E
People		
Training and career paths	Systematic initiatives for different levels of training in CI methodology	A, B, C, D, E
	Selection of highly motivated employees as trainees	A, B, C, D, E
	Internal expensing of training to maintain importance of CI methodology training	D
	Front-line employees trained to work on improved processes by process improvement project leaders as part of project	C
	Specific roles assigned to people with different levels of training in CI methodologies	A, B, C, D, E
	Well defined paths for professional development of full-time CI members	D, E
	Well-defined grades and salary levels in human resource systems for CI participants	D, E
Information technology support	Project-tracking software to make real-time progress information available to team members and management	A, B, C, D, E
	Information technology experts frequently included in process improvement teams	B

[a] Companies: HEAL (A), SERV (B), CHEM (C), MEDI (D) and TECH (E).

consistent with organizational goals, and project teams must be held accountable for attainment of those goals. An effective CI infrastructure includes mechanisms to ensure such fidelity and accountability to established goals.

4.1.1.2. Empirical observations. Each of the five companies we studied has some form of administrative mechanism consisting of multilevel steering committees with interlinked membership – in which representatives from one level serve as members in the next higher and lower levels – to coordinate the direction of its CI initiative. These interlinked committees periodically determine key organizational and CI initiatives and translate them into key performance indicators for projects. In addition to the strategic congruence of goals across vertical levels, these companies also pay attention to matching the solution mechanism to the problem at hand. "*There's a side of the coin that says, make sure you pick a good [strategic] project, and there's the other side that says pick the one that the business cares about.*" This quote from a HEAL CI executive illustrates the importance of matching improvement projects with strategic company goals as well as the appropriate methodology (such as variance reduction through Six Sigma, or waste-reduction through lean implementation).

Each of the companies also has in place governance procedures under which financial controllers are responsible for signing off on realized or forecasted benefits of projects. However, we observed that the companies do not strictly adhere to their project goals. An executive from MEDI remarked, "*It is not a hard must-make goal*. . .*Most times they end up surpassing the goal, but [if they do not] they are not held to it.*" Such laxities in the assessment of goal achievement may indicate the prevalence of "satisficing"—that is, aiming for minimal improvement instead of striving for optimal performance (Simon, 1947). On the other hand, such subjectivity may also serve to maintain a culture of risk-taking and creativity that some researchers have argued gets stifled under the restrictive requirements of specific project goals (Benner and Tushman, 2002). Balancing the competing elements of efficiency and innovation is the objective of the second element of CI infrastructure under the *purpose* category.

4.1.2. Balanced innovation and improvement

4.1.2.1. Conceptual development. Although the essence of dynamic capabilities is change, for sustainable continuous improvement such change must punctuate periods in which disciplined and standardized methods are used for operational processes. Thus, two kinds of ambidexterity are necessary for an organization to sustain its CI initiative (Gibson and Birkinshaw, 2004). First, organizations must keep up their ability to create new operational capabilities while implementing existing processes in a uniform, standardized manner. This goal can be achieved by incorporating control features within process design while at the same time providing opportunities and motivation for employees to experiment and learn (Sitkin et al., 1994; Spear and Bowen, 1999). Second, there needs to be a balance between projects that are intended to improve existing process capabilities and those that seek to design new processes (Jansen et al., 2006; March, 1991; Tatikonda and Rosenthal, 2000a,b). The importance of this aspect of CI initiatives has also come to light in recent reports on 3M and Home Depot (Hindo, 2007) that criticized the focus of these companies on disciplined process improvement at the cost of innovation.

CI infrastructure can be instrumental in ensuring uniform implementation of operational processes through checks and balances and mistake-proofing features within process designs. At the same time, opportunities and incentives for suggesting changes and for participating in process improvement projects can ensure that the learning aspects of the CI initiative are kept alive. In addition, an appropriate CI infrastructure can help maintain an orientation toward both process improvements and new process design through a balanced portfolio of projects (George et al., 2005).

4.1.2.2. Empirical observations. Companies in our sample emphasize the use of mistake-proofing mechanisms – built-in error-prevention devices in operational processes – in order to ensure standardized work practices. In addition, project portfolios in each of the five sampled companies include learning-focused objectives, such as supplier-payment rationalization and customer satisfaction improvement. Thus, the first category of ambidexterity – control and learning-focused front-line initiatives – is clearly reflected in our sample: companies focus on variation control and error reduction, as well as on the discovery of process improvements.

With regard to the second type of ambidexterity – the balance of process improvements and new process design – our sample companies recognize a need for different improvement frameworks for the two distinct categories of problems. The CI initiatives in these companies mainly focus on lean management and Six Sigma, within which there are classifications such as Kaizen events for one-time workplace improvements, Just-Do-It for "quick hit" projects, Green Belt projects for less complicated error reduction problems, and Black Belt projects for more complicated variability reduction projects. None of the five companies has a framework in place to address the design of new processes. However, company executives see the Design for Six Sigma (DFSS) framework as an area of future development in their CI initiatives. Each of the companies sees the implementation of a new process design framework as a step to be taken when their company crosses a certain (future) threshold in process improvements.

4.2. Process

Decision areas in the *process* category of CI infrastructure are geared toward the achievement of CI goals that come from infrastructure decisions in the *purpose* category. These process decision areas follow from Bartlett and Ghoshal's (1994) observation that in order for participative management to be effective, the physiology of an organization must be supportive of its psychology. Thus, decision areas in the *process* category are geared toward the participation of employees in the implementation of change toward continuous improvement. The knowledge-based theory of the firm (Grant, 1996; Nonaka, 1994) and organizational learning theory (Argyris and Schön, 1978; Cyert and March, 1963) have much to say about organizational factors that create behaviors conducive to continuous improvement. Based on these theories, we consider the CI initiative a dynamic capability through infrastructure decisions in the *process* category.

4.2.1. Culture of constant change

4.2.1.1. Conceptual development. CI participants should look beyond reactionary process corrections when errors are detected. Effective process improvements under CI initiatives include scrutiny of the underlying causal variables and scanning of the environment, which result in changes to processes so that errors do not recur. This pattern of in-depth causal investigation and subsequent corrective action reflects double-loop learning (Argyris and Schön, 1978). The effectiveness of CI depends on engaging employees in such double-loop learning, which involves challenging the existing ways of executing processes and improving them. It is imperative for organizations deploying CI initiatives to avoid the ''sclerosis [that] prevents companies from adjusting to new market realities...'' (Bartlett and Ghoshal, 1995, p. 94). Thus, for the success of CI, it is important to create and sustain a culture of ongoing change (Barrett, 1995; Verona and Ravasi, 2003) that includes both encouraging employees to suggest changes and preparing them to expect regular changes (Sitkin et al., 1994; Upton, 1996). Toward this end, CI infrastructure must be designed to remove any fears in employees' minds that may prevent them from suggesting changes and to encourage employees to share their knowledge with others in the organization (Deming, 1993; Tucker and Edmondson, 2003). Such an infrastructure enhances an organization's capacity to purposefully create, extend, and/or modify its operational capabilities, thus equipping it with dynamic capabilities (Helfat et al., 2007).

To achieve a culture focused on change, it is also important to engage employees in the continual scanning of the environment for opportunities and threats that warrant change in existing processes. Scanning improves an organization's capacity to react to or even preempt environmental changes that pose risks or provide opportunities (Crossan and Berdrow, 2003; Eisenhardt and Martin, 2000). Organizations interact with their environments at multiple levels—at the level of the organization, business unit, department, and process (Elenkov, 1997). For example, at the organizational level, there are regulators and major competitors to manage, while the department and process levels interact with suppliers and customers. Scanning at multiple levels is facilitated through CI infrastructure mechanisms that enable the cascading of organizational goals into divisional and other subunit goals; such mechanisms comprise the *purpose* category of CI infrastructure described earlier. Clearly understood goals provide employees with the appropriate contexts for interpreting the effects of the environment, but the absence of such goals results in inefficient and unproductive scanning behaviors (Cohen et al., 1972).

4.2.1.2. Empirical observations. While the interlinked planning structures described earlier support multilevel environmental scanning, companies in our sample use additional mechanisms for such scanning and also to create a culture of constant change. MEDI benchmarks with peer companies and encourages managers to interact periodically with their counterparts in these companies. SERV uses visual dashboards of metrics for daily management of processes and to encourage change and improvement. TECH uses value stream mapping (Rother and Shook, 1999) to communicate to employees the need for the constant transformation of processes by incorporating changes in the requirements of customers, employees, and the business.

Our case studies did not reveal evidence of other salient initiatives to capture process improvement ideas from front-line employees. Suggestion boxes and reward programs, which are discussed in the employee involvement and quality management literature, are not prevalent in the five companies we studied. However, each of the companies regularly holds workshops for middle management to generate ideas for process improvement projects. Thus, although they do not explicitly use bottom-up idea generation practices, these companies systematically attempt to capture ideas from middle management.

On the topic of assessing employee acceptance of the CI initiative and its constant-change culture, a TECH company executive remarked, ''*If we sold that business off today, and we kept the management team...would they continue on the operational excellence course they are on, or would they immediately dump it?*'' Overall, while the five companies recognize the importance of engaging employees in CI, their efforts are focused more on the middle-management level and less on the front-lines, where processes are executed. While these companies appear to see training in the CI methodology as an avenue to generate excitement among front-line employees for the initiative, they also indicate that they believe that training middle management in leadership techniques supports the same objective.

4.2.2. Parallel participation structures

4.2.2.1. Conceptual development. Dynamic capabilities require the ability to make quick changes while attaining organization-wide performance objectives. Lateral and parallel participation structures consisting of cross-functional teams can provide organizations with the ability to make changes more quickly than is possible with hierarchical structures (Joyce et al., 1997). A team-based infrastructure for executing projects can also facilitate the integration of new knowledge into operating routines (Kogut and Zander, 1992).

At the same time, a primarily project-dominated focus can result in narrow process-specific changes that may compromise organization-wide performance. Such myopia can result from two possible sources: the inability of teams to see beyond the process that is the focus of their project, or a reward system that inadvertently discourages the alignment of objectives (Ackoff, 1994). These two underlying issues can be combated by a rational project-selection procedure that assesses goals with a systems view, combined with an appropriate reward mechanism (Senge, 1990). Therefore it is important that CI infrastructure include mechanisms to ensure that the selected CI projects add value for the organization rather than simply targeting improvement for improvement's sake (Bateman, 2005; Mohrman et al., 2002).

A systems view can also be facilitated by focusing on the customers' point of view at every step of the CI initiative (Delbridge and Barton, 2002; McGrath et al., 1992). Continually asking the question, ''What adds value for the internal process customer and the external customer?''

can help guard against pointless change in operational processes. Thus, infrastructure mechanisms that are designed to maintain customer focus and to involve external customers and suppliers in projects play an important role in making the CI initiative a dynamic capability.

4.2.2.2. Empirical observations. The five companies in our sample use off-line teams comprising cross-functional personnel and customer and supplier representatives if and when required. (Off-line teams contain at least one member who exclusively participates in improvement projects and does not have any other line or functional responsibilities.) Project team leaders serve as independent internal facilitators, in the sense that they are encouraged and trained to keep any functional biases aside and focus on project goals in relation to organizational goals. When faced with conflicting cross-functional viewpoints, project leaders make use of data and pilot applications to provide objective evidence and resolve arguments.

A TECH company executive remarked that by providing a forum for sharing different viewpoints, cross-functional teams encourage systems thinking—viewing problems as part of the overall organizational system. Further, while MEDI has partially implemented the systems concept by including suppliers in projects, SERV has implemented it on the customer side of the system. These companies use off-line, goal-directed project teams as a mechanism to ensure cross-functional participation and systems thinking.

4.2.3. Standardized processes

4.2.3.1. Conceptual development. To sustain benefits from a CI initiative, it is important that process changes discovered through CI projects become routinized and that such operational routines be standardized throughout the organization (Spear and Bowen, 1999). Standardized processes are important for providing valid baselines for further improvements. Standardization also facilitates root-cause analyses and the sharing of lessons learned across replications of common processes (Taylor and Wright, 2006). In addition, standardized processes provide relevant and common experiences to employees that are the basis of process improvement (Adler and Cole, 1993; MacDuffie, 1997). Thus, infrastructure practices that support the standardization of operational processes are considered to be of paramount importance for sustaining a CI initiative.

4.2.3.2. Empirical observations. Three of the companies in our sample claim to have standard operating procedures (SOPs) in place that are followed strictly and thus serve as a baseline for any improvement or change. Executives from the other two companies, SERV and MEDI, pointed out that some of their process improvement projects were aimed at standardizing current ways of doing work. A top CI executive at MEDI remarked that, in his view, a project is deemed successful only when it results in a standardized process design that includes features to design out any potential for variance in the way that the process is routinely completed.

4.2.4. Standardized improvement method

4.2.4.1. Conceptual development. Systematic organizational learning through CI initiatives requires a common scientific method – a standard set of steps – for process improvement projects (Garvin, 1993a; Forrester, 2000b; Spear and Bowen, 1999). A standardized improvement method promotes common understanding of the basis on which changes are made (Bateman, 2005). Such a common understanding also ensures that the knowledge created by implementing the method is not limited to a particular individual or project-team but can be utilized organization-wide and over time.

4.2.4.2. Empirical observations. Companies in our sample use heuristics consisting of steps for completing projects. Prominent among these heuristics are the "define-measure-analyze-improve-control" (DMAIC) set of stages popularized under the Six Sigma program label, and Kaizen projects and 5-S events popularized under lean management programs. The DMAIC set of stages is commonly used as an umbrella framework under which different types of projects – for instance, waste reduction using lean management principles, or variance reduction using the statistical tools of Six Sigma – are conducted. The completion of every stage in the standard method for a project is treated as a milestone (or tollgate, in Six Sigma parlance). These milestones are then used as opportunities to review interim findings. Before the advent of Six Sigma and DMAIC, each of the companies used some version of Shewhart's (1980) plan-do-check-act (PDCA) cycle as the basis for a standardized CI method. The companies in our sample recognize the importance of following standardized improvement methods in the creation of dynamic capabilities, and as a result they diligently follow a standard heuristic for completing their CI projects.

4.3. People

The learning capabilities of individual employees have an impact on organizational dynamic capabilities: they determine an organization's ability to make changes to its operational processes in response to environmental demands (Ghoshal and Bartlett, 1994; Kraatz and Zajac, 2001). Thus, practices that facilitate organizational learning through individual learning constitute the *people* category of CI infrastructure decisions. Appropriate decisions within the *people* category support employee actions that help achieve the *purposes* of the CI initiative, via employees' participation in practices within the *process* category of infrastructure.

4.3.1. Training and career paths

4.3.1.1. Conceptual development. Specialized roles for employees with the authority and responsibility to act as change agents are important both for organizational learning and for the development of dynamic capabilities

(Dyer and Ericksen, 2005; Wright and Snell, 1998). For CI, employees require training and apprenticeship in the use of the scientific method for structured problem solving and for leading process improvement teams (Hatch and Dyer, 2004). Further, human resource practices such as defined designations, roles, and career paths provide the motivation and opportunity for employees to participate in CI initiatives (Gowen et al., 2006).

Explicit incentives provided through career development paths for CI executives motivate them to participate in a CI initiative for the longer term. In turn, such unambiguous roles and career paths also help reduce employees' fear of participating in CI initiatives: participants in CI projects feel safe about speaking up about improvement ideas, especially when they are part of a team created for the specific purpose of improving a process. In addition, the formalization of the CI initiative by the creation of CI-focused job positions indicates to employees that the CI initiative is more than just an ad hoc improvement to a few "broken" processes.

4.3.1.2. Empirical observations. Each of the five companies in our sample provides formal in-house training for employees to participate in and lead process improvement projects. Different levels of training enable employees to qualify at different levels of expertise in CI methodologies, preparing them for projects with levels of complexity matched to their qualifications. The highest level of expertise qualifies employees to train other prospective CI initiative participants in the standardized methodologies and tools and techniques. Furthermore, these highest-level experts keep track of the latest developments in tools and techniques used for CI; thus, in addition to training, they also focus on improving the CI initiative.

All five companies have in place designated project leaders whose full-time responsibility for a determined period of time is to lead CI projects. During this assignment, which usually lasts 2–3 years, these leaders do not have any other functional responsibilities. At the end of this period, these leaders are commonly offered a promotion within their original function. Thus, the notion of assigning full-time CI experts to lead projects – sometimes tagged "Senseis" under lean management or "Black Belts" under Six Sigma programs – is prevalent among our sample of companies.

4.3.2. Information technology support

4.3.2.1. Conceptual development. In order for an organization to build dynamic capabilities, it must systematically record and track the results of its repeated cycles of knowledge creation (Bendoly and Swink, 2007; Davidson et al., 1999; Stock and Tatikonda, 2000, 2008). The effective deployment of a CI initiative that includes standardized processes and improvement-seeking techniques thus demands continual assessment, which in turn requires the gathering and dispersion of information in an efficient and timely fashion. In addition, repositories of project reports maintained in databases can be useful for historical reviews of project successes and failures (Garvin, 1993a). Thus, decisions regarding information systems for data collection, online process controls, and the maintenance of databases are all critical components of CI infrastructure. Managing information so that it is available laterally across the enterprise and to senior management in a timely manner can turn an organization into an "analytic competitor" and enhance the effectiveness of its process improvement efforts (Davenport, 2006).

4.3.2.2. Empirical observations. The importance of information systems for CI initiatives is not lost on the five companies in our sample. Among these companies, information-systems support for the conducting of projects and circulation of interim project reports is prevalent, as is support for on-line process controls and mistake proofing. All five companies maintain their existing repositories of project reports using sophisticated database systems with search capabilities, which have been designed and installed at considerable expense. The intention of such repositories is for employees and project leaders to learn from their experiences in previously completed projects and avoid the proverbial reinvention of the wheel. However, executives in all five companies expressed disappointment with the extent to which these reports were being utilized. A MEDI executive observed:

> "*There's no way you can poka-yoke [mistake proof] the process. . .it is a human push process; you just hope that the belt [project leader] has the wherewithal to go in and search for other projects. Quite honestly, one of the best ways to do this is to rigorously schedule project reviews.*"

SERV plans to offer incentives for project leaders to update the databases once their projects are completed, as this aspect of project closure is frequently neglected. An executive from CHEM commented that even when projects address similar process improvement questions, project leaders are reluctant to rely on previous reports, focusing instead on the projects' differences and exceptions. Thus, the companies in our sample find it challenging to motivate project leaders to take advantage of the available technology.

5. Analysis of the framework and emergent questions

Our principle proposition is that the decision areas that constitute our framework play a critical role in the shaping of any CI initiative. Without making deliberate and systematic decisions in each area of the framework, an organization cannot sustain its CI initiative. However, our case studies indicate that companies in our sample do not consistently assign equal or sufficient importance to all the areas included in our framework. Our empirical investigation also points to certain difficulties faced by companies when they try to institute elements of infrastructure that they do recognize as important.

The following paragraphs draw attention to such gaps between our proposed normative framework and the observed CI practices in each of the eight content areas of the framework. These gaps are organized by the three broad decision area categories of purpose, process and people. We also reflect on the paradoxical nature of certain

CI infrastructure decisions resulting from the need to balance conflicting objectives that make these decisions complex and difficult. These gaps, concerns and observations all merit further study, and are stated as 10 research questions (noted "RQ") below.

5.1. Purpose

5.1.1. Organizational direction and CI goals

All five companies in our sample endeavor to coordinate CI goals with broader business strategy objectives, and consider it important to set concrete goals for process improvement projects. Thus, our observations in these companies appear to match our proposed framework in the CI infrastructure area of goal setting. However, there is a mismatch between our empirical observations and proposed framework stemming from the laxity of these companies in adhering to project goals, particularly goals related to process performance (as opposed to goals related to project cost and duration). Our case studies reveal that process performance targets in these companies are occasionally adjusted after projects are underway or even when they are close to completion. Lengthening project durations, and the need for project leaders to move on to the next project to achieve their individual target number of projects, is often given as a reason for adjusting process performance targets downward.

While it is important to consider certain tradeoffs such as that between project duration and achievement of process performance targets, relaxation of performance targets in these companies appears to be ad hoc, and does not reveal any attention to contingencies that justify different levels of rigidity for project goals. Questions remain whether these companies weaken their CI initiatives by such adjustments of process performance targets, or whether CI infrastructure needs to incorporate mechanisms that systematically allow for such adjustments. Research is required to answer these questions and to identify conditions under which recalibration of project targets might be advisable, separating them from conditions in which strict accountability for project targets is the better course.

> RQ_1: Are there conditions under which different levels of strictness in evaluating CI project performance relative to pre-specified targets are warranted?

5.1.2. Balanced innovation and improvement

Our empirical findings suggest that innovation in new process design lags efforts to improve existing processes. Companies in our sample indicate that while presently their focus is exclusively on improving existing processes, they plan to shift focus and deploy initiatives for in-house process redesign after reaching a certain level of company-wide performance in improved processes. This notion of sequential rather than parallel attention to improvement and redesign of processes is in conflict with our argument for balancing these two objectives through CI infrastructure. Research is needed to investigate which infrastructure practices might be incorporated in order to assure that both incremental and revolutionary efforts are accommodated in a CI initiative.

> RQ_2: Which infrastructure practices can help companies to deploy initiatives for improvement and redesign of processes in parallel rather than in sequence?

Further, although our framework stresses the need for balancing innovation and improvement, questions remain about the extent to which a commitment to CI hinders innovation (Hindo, 2007). Investigations are warranted into which of these divergent views – advocating combination versus separation of process improvement and process innovation – is practical and beneficial.

> RQ_3: Is there an inherent tradeoff between continual improvement of processes and radical process innovations?

5.2. Process

5.2.1. Culture of constant change

A hallmark principle of most CI initiatives is that the best process improvement ideas reside in front-line associates. Infrastructure practices for generating and harnessing these ideas help create a culture of constant change that is important for sustaining any CI initiative. Thus, it is surprising to find the occasional mismatch between our theoretical framework and empirical observations, as indicated by the absence of infrastructure mechanisms for generating and capturing improvement ideas from front-line employees.

We questioned respondents in our case study interviews about this gap between theory and practice. They pointed out that project team leaders extract process improvement ideas from front-line employees in team meetings or other problem solving sessions and effectively act as channels between front-line employees and management for the communication of such ideas. This, according to our respondents, obviates the need for supplementary practices such as suggestion boxes and reward programs for individuals that are used beyond the realm of team projects to capture front-line ideas. Further research is needed to understand if and how project leaders can indeed capture the tacit knowledge and creativity possessed at the front-lines and effectively fulfill the CI infrastructure function of bottom-up generation of process improvement ideas.

Alternately, it is possible that reliance on highly trained and credentialed project leaders creates a rift between team leaders and front-line employees. This rift undermines efforts to engage front-line employees in suggesting process improvement ideas. This perspective implies that there exists an inherent trade-off between creating experts in CI methods to lead projects and a culture that encourages proactive change originating from front-line employees. Inquiry into the existence of such a tradeoff would be beneficial for better understanding design of CI infrastructure.

Questions emerging from the two perspectives presented here are (1) whether the team leadership of expert project leaders fosters the discovery of process improvement ideas from the front-lines or (2) whether the perceived elitism of expert project leaders impinges on discovering improvement ideas from front-line employees.

RQ_{4A}: Can CI methods experts act as conduits for bottom-up flow of improvement ideas, thus obviating the need for additional infrastructure mechanisms to capture improvement ideas directly from front-line employees?

RQ_{4B}: Does the infrastructure practice of creating CI methods experts imply disregarding bottom-up generation of process improvement ideas?

5.2.2. Parallel participation structures

From our empirical analysis it is clear that companies in our sample subscribe to the need for parallel and lateral participation structures that are advocated in our framework. These companies use cross-functional project teams for ensuring that process improvements are viewed holistically. However, the relatively short-lived nature of their project teams raises some interesting questions about the inherent challenges of such teams and about ways to tackle these challenges within the framework of CI infrastructure.

Under the team structure used by these companies, a team is put together at the start of a project under the leadership of a CI methods expert and disbanded after the completion of that project. Such a team structure does not foster long-term relationships among employees, and thus cross-functional communication may be limited to the time spent working as part of the project team. Theory suggests that it would be challenging for team leaders to bring out and integrate individual knowledge of diverse team members that do not work in proximity or otherwise interact over long periods (Young and Parker, 1999).

Further research is warranted to find ways of using such temporary teams while effectively integrating the knowledge of individual team members. For instance, one way might be to train project leaders in the use of practices designed specifically to compensate for the intermittent and infrequent interactions of team members in capturing their knowledge. This perspective of project leaders seeking out and harnessing individual knowledge points to a deficiency in our existing proposed framework and emphasizes the need of including such training in addition to CI methods training as part of CI infrastructure.

RQ_5: What methods can project leaders employ to compensate for the lack of long term interaction among individual team members in garnering their knowledge for the benefit of the project?

5.2.3. Standardized processes

Companies in our sample clearly support the idea of standardized work, and are thorough about developing standard operating procedures for their processes. Thus, our empirical observations in this area are consistent with our proposed framework. However, in pursuing standardized work, these companies do not seem to recognize the need to iterate between periods of stability and change for every process.

As MacDuffie (1997, p. 501) pointed out, "...when process standardization is understood as the beginning (and not the end) of further improvement efforts, the normal inertial tendencies of organizations with respect to adaptive learning can be partially overcome." This caveat about focus on standardized work implies that CI infrastructure should not only seek to put in place standardized processes but also aim to create alternating periods of stability and change in processes. Thus, our proposition of standardized work as an area of infrastructure must be tempered with the need for incorporating ways to systematically introduce periodic change (improvement) in such standardized work.

RQ_6: How can CI infrastructure effectively incorporate systematic change to punctuate process stability created via standardized processes?

5.2.4. Standardized improvement method

Companies in our sample use the define-measure-analyze-improve-control or DMAIC heuristic consisting of standardized steps for conducting process improvement projects. At the same time, the DMAIC method is only the most recent in a series of standardized improvement methods adopted by these companies for CI. Respondents assert that lessons learned by them from their companies' prior experiences of using different improvement methods before DMAIC have been absorbed into their deployment of DMAIC.

Although there is consistency between the proposed CI infrastructure framework and empirical observations in terms of the importance given to standardized improvement methods, the phenomenon of evolving CI initiatives and underlying standardized improvement methods that we observed in our sample companies presents interesting research topics. Inquiry into this phenomenon would provide insights into challenges of adopting new CI initiatives, and perhaps help identify efficient and effective ways for companies to move from one version of improvement method to another.

RQ_7: Given the type of incumbent CI initiatives, are there different evolutionary paths that companies can adopt in moving toward newer CI initiatives?

5.3. People

5.3.1. Training and career paths

Our sample companies make CI leadership a development role that requires specific training in CI methods, and leads to progression through the management ranks. Designated project leaders work as full-time project leaders for a period of 2–3 years, and during this period, do not have any other functional responsibilities. As noted earlier, this is consistent with prescribed good human resource practices and also makes sense in terms of creating agents of change within the organization. The similarity with which companies in our sample deal with the training and career paths of experts raises the question of the advisability of alternative methods for developing and promoting change agent CI leaders. Such a method, followed by Toyota, entails training all middle managers as permanent CI leaders (Spear, 2004).

RQ_8: Would it be better to use a more organic approach to CI under which, instead of specialist CI method experts, all middle managers continually serve as CI leaders?

Under the existing system followed in our sample companies, CI leaders, having completed their tenure as full-time project leaders, are redeployed to functional areas of the company. After such redeployment, these leaders no longer have express, formal responsibility for projects. Still, they are expected to bring their CI knowledge and experience to bear in influencing their colleagues and subordinates to adopt root-cause analysis as a way of thinking and use CI techniques for discovery and implementation of process improvements. Executives we interviewed considered such diffusion of CI initiatives as critical to justify their companies' investments in CI leaders' training. However, there was common concern among these executives about finding ways to keep CI leaders engaged in diffusing their knowledge.

RQ_9: After CI leaders have completed their full time tenure leading improvement projects, how can their interest in dispersing their CI knowledge be sustained?

5.3.2. Information technology support

Our case studies show that all five companies have made significant technology investments for capturing the outcomes of process improvement projects with the intention of creating company-wide repositories of knowledge. However, respondents from these companies are also disappointed and frustrated with their organizations' abilities to utilize such technologies for sharing project learning across their companies. They observe that several project leaders seem resistant to the idea of exchanging knowledge with their peers. These project leaders are not disciplined about entering information into and accessing information from project report databases.

Thus, the infrastructure area of information technology support in our proposed framework requires a stipulation. Specifically, it is critical to supplement the installation of information technology with mechanisms that encourage maintenance and utilization of the technology for sharing new knowledge created from projects. Further research is warranted to identify methods for assuring that knowledge created from projects transcends project team and target process boundaries.

RQ_{10}: How can companies encourage CI project leaders to share knowledge gained from their projects with the rest of the company and to seek out knowledge from previous projects when faced with new process improvement questions?

Above we raised conceptual and practical questions about issues with which companies deploying CI initiatives grapple as they put together their infrastructures for continually improving processes. These questions are left unanswered after applying the experience of sample organizations to the framework developed from theory. Nevertheless, our analysis points to the fact that decisions in each of the areas of our framework have a bearing on the effectiveness and sustainability of CI initiatives. In related ongoing research we are working toward developing measures that can be used to assess the level of importance assigned by organizations to each of the CI infrastructure areas.

6. Conclusions

This research makes two broad conceptual contributions to the study of continuous improvement. First, it provides clear definitions for process improvement and continuous improvement initiatives that will be helpful for further studies in the area of CI. Second, the research reveals how organizational learning theory informs a theory of continuous improvement, and enables us to view continuous improvement as a potential dynamic capability.

For managers, our research provides two broad lessons. First, it points out the fallacy of implementing CI simply by training people in new process improvement methods without putting in place mechanisms for managing and maintaining CI initiatives. Second, our analysis emphasizes the interdependencies among the elements of CI infrastructure, implying that attempts to manage CI through selected aspects of its infrastructure may be ineffective. Most importantly, our research juxtaposes academic and practitioner viewpoints of continuous improvement, and presents questions that can best be explored by combining both perspectives.

In analyzing our proposed framework we have revealed some of its limitations in the form of questions raised when it is applied to empirical settings. These questions emerge from two sources: (1) the absence, in some of our sample companies, of certain CI infrastructure characteristics that were expected in our proposed framework, and (2) the challenges which companies in our sample were grappling with as they tried to implement practices in some areas of the framework.

In addition, our analysis should be viewed and applied in the context of four limitations of our empirical study. First, a sample of CI deployments in only five companies was used to assess the applicability and relevance of the decision areas in our framework. Moreover, the sample was selected based on approachability and subjective judgments of success in CI. Thus, although the companies in our sample represented five industries, CI deployments in other industries may warrant additional elements of infrastructure that are missing in our framework. Second, our empirical observations must be interpreted with the caveat that we used two different levels of informants—top level CI executives and project leaders. We did obtain thorough information using in-depth interviews with systematic follow-ups.

Third, our study, for scope purposes, investigated infrastructure practices. Our study did not include any structural elements of CI such as decisions regarding capacity of CI (e.g., the number of employees trained in CI methods) and the extent of vertical integration (e.g., parallel line and CI responsibilities, or exclusive CI responsibilities, for CI participants) that may affect the implementation of CI. Although research is needed in both structure and infrastructure areas of CI, we limited the scope to infrastructure decision areas for the sake of manageability. These limitations related to sampling and missing variables may be overcome with additional research in the area for which our study provides a foundation. Fourth, future research should empirically assess longitudinal firm performance under conditions of differential emphasis on the eight CI infrastructure practices and particular combinations of them.

Overall, the proposed framework delineates the characteristics of an organizational system that would be conducive to sustained organizational learning—an ideal infrastructure for continuous improvement that can provide organizations the agility and consistency necessary to continually update operational processes. Having a system in place that incorporates coherent CI infrastructure decisions within the eight areas categorized by *purpose*, *process*, and *people* would enable managements to steer their organizations in a unified strategic direction, creating new operational capabilities as and when required (i.e., dynamically).

Regardless of the type of CI initiative that an organization chooses, consistent patterns of decisions in these areas can provide the organizational wherewithal for succeeding in the long term against changes in the environment—the dynamic capabilities crucial for the creation and maintenance of competitive advantage. Within the eight decision areas many combinations are available—companies can decide on how to combine choices to fit their needs. What is important is that a CI infrastructure be purposefully constructed to support vital CI efforts.

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Appendix A

Questions for semi-structured interviews with continuous improvement executives.

Questions	CI literature references
Who took the initiative to adopt the current continuous improvement program, when, and why?	3, 6
Was there a previous continuous improvement initiative?	3, 4
Where do continuous improvement project ideas come from?	1, 6
As part of projects, do teams study other divisions or organizations?	5
How are projects selected and coordinated?	1, 3
Is there a separate program in place for designing new processes?	2
Please describe the administration structure for projects	7, 11
Who selects team members for project teams?	1, 10
To what extent are project teams cross-functional?	1, 8, 10
How are project results assessed?	1, 11
Are process customers and suppliers included in teams?	2, 4, 5
How strictly are standard operating procedures followed?	4
Are data on processes collected regularly, e.g., cycle time of an order, time to respond to customer query, or tracking of customer satisfaction data?	1, 4
Is there a framework that is strictly followed in project executions?	7
How is project documentation maintained?	7
Are there different levels of project leader training?	4
How are candidates selected to undergo training?	3, 4
What are the responsibilities of project leaders?	3
What are the career paths for project leaders?	4
What role does information technology play at the routine process level, project level and organizational level?	1
How are goals for projects decided?	11
Is there a project tracker used to track project execution?	1, 9
Are reports from completed projects stored in a database and accessible to others?	1, 9
What is the general perception about the continuous improvement program among employees?	1, 9, 11

(1) Davidson et al. (1999); (2) George et al. (2005); (3) Juran (1992); (4) Lareau (2003); (5) McGrath et al. (1992); (6) Nonaka (1988); (7) O'Connor (1994); (8) Rummler and Brache (1995); (9) Senge (1990); (10) Upton (1996); (11) Witcher and Butterworth (2001).

References

Ackoff, R.L., 1994. Systems thinking and thinking systems. System Dynamics Review 10 (2/3), 175–188.
Adler, P.S., Cole, R.E., 1993. Designed for learning: a tale of two auto plants. Sloan Management Review 34 (3), 85–94.
Alexander, J.A., Weiner, B.J., Shortell, S.M., Baker, L.C., Becker, M.P., 2006. The role of organizational infrastructure in implementation of hospitals' quality improvement. Hospital Topics 84 (1), 11–20.
Argyris, C., Schön, D., 1978. Organizational Learning: A Theory of Action Perspective. Addison Wesley, Reading, MA.
Augier, M., Teece, D.J., 2006. Understanding complex organization: the role of know-how, internal structure, and human behavior in the evolution of capabilities. Industrial and Corporate Change: Sidney G. Winter Special Section, Part II 15 (2), 395–416.
Barrett, F.J., 1995. Creating appreciative learning cultures. Organizational Dynamics 24 (2), 36–49.
Bartlett, C.A., Ghoshal, S., 1994. Changing the role of top management: beyond strategy to purpose. Harvard Business Review 72 (6), 79–88.
Bartlett, C.A., Ghoshal, S., 1995. Changing the role of top management: beyond systems to people. Harvard Business Review 73 (3), 132–142.
Bateman, N., 2005. Sustainability: the elusive element of process improvement. International Journal of Operations & Production Management 25 (3), 261–276.
Beer, M., Voelpel, S.C., Leibold, M., Tekie, E.B., 2005. Strategic management as organizational learning: developing fit and alignment through a disciplined process. Long Range Planning 38 (5), 445–465.
Bendoly, E., Swink, M., 2007. Moderating effects of information access on project management behavior, performance and perceptions. Journal of Operations Management 25 (3), 604–622.
Benner, M.J., Tushman, M., 2002. Process management and technological innovation: a longitudinal study of the photography and paint industries. Administrative Science Quarterly 47, 676–706.
Bessant, J., Caffyn, S., 1997. High-involvement innovation through continuous improvement. International Journal of Technology Management 14 (1), 7–28.
Bowen, D.E., Lawler III, E.E., 1992. Total quality-oriented human resources management. Organizational Dynamics 20 (4), 29–41.

Carter, E.E., 1971. The behavioral theory of the firm and top-level corporate decisions. Administrative Science Quarterly 16 (4), 413–429.
Choo, A.S., Linderman, K.W., Schroeder, R.G., 2007. Method and context perspectives on learning and knowledge creation in quality management. Journal of Operations Management 25 (4), 918–931.
Cohen, M.D., March, J.G., Olsen, J.P., 1972. A garbage can model of organizational choice. Administrative Science Quarterly 17 (1), 1–25.
Cook, T.D., Campbell, D.T., 1979. Quasi-Experimentation: Design & Analysis Issues for Field Settings. Houghton Mifflin, Boston, MA.
Crosby, P.B., 1980. Quality is Free: The Art of Making Quality Certain. New American Library, New York, NY.
Crossan, M.M., Berdrow, I., 2003. Organizational learning and strategic renewal. Strategic Management Journal 24, 1087–1105.
Cua, K.O., McKone, K.E., Schroeder, R.G., 2001. Relationships between implementation of TQM, JIT, and TPM and manufacturing performance. Journal of Operations Management 19 (6), 675–694.
Cyert, R.M., March, J.G., 1963. A Behavioral Theory of the Firm. Prentice-Hall, Englewood Cliffs, NJ.
Davenport, T.H., 2006. Competing on analytics. Harvard Business Review 84 (1), 98–107.
Davidson, J.M., Clamen, A., Karol, R.A., 1999. Learning from the best new product developers. Research Technology Management 42 (4), 12–18.
Delbridge, R., Barton, H., 2002. Organizing for continuous improvement: structures and roles in automotive components plants. International Journal of Operations & Production Management 22 (5), 680–692.
Deming, W.E., 1993. The New Economics for Industry, Government, Education. Massachusetts Institute of Technology, Center for Advanced Engineering Study, Cambridge, MA.
Dyer, L., Ericksen, J., 2005. In pursuit of marketplace agility: applying precepts of self-organizing systems to optimize human resource scalability. Human Resource Management 44 (2), 183–188.
Eisenhardt, K.M., 1989. Building theories from case studies. Academy of Management Review 14 (4), 532–550.
Eisenhardt, K.M., Martin, J.A., 2000. Dynamic capabilities: what are they? Strategic Management Journal 21 (October–November Special Issue), 1105–1121.
Elenkov, D.S., 1997. Strategic uncertainty and environmental scanning: the case for institutional influences on scanning behavior. Strategic Management Journal 18 (4), 287–302.
Emden, Z., Calantone, R.J., Droge, C., 2006. Collaborating for new product development: selecting the partner with maximum potential to create value. Journal of Product Innovation Management 23 (4), 330–341.
Evans, J.R., 2004. An exploratory study of performance measurement systems and relationships with performance results. Journal of Operations Management 22 (3), 219–232.
Fiol, C.M., Lyles, M.A., 1985. Organizational learning. Academy of Management Review 10 (4), 803–813.
Flynn, B.B., Sakakibara, S., 1995. Relationship between JIT and TQM: practices and performance. Academy of Management Journal 38 (5), 1325–1360.
Forrester, R., 2000a. Empowerment: rejuvenating a potent idea. Academy of Management Executive 14 (3), 67–80.
Forrester, R., 2000b. Capturing learning and applying knowledge: an investigation of the use of innovation teams in Japanese and American automotive firms. Journal of Business Research 47 (1), 35–45.
Garvin, D.A., 1993a. Building a learning organization. Harvard Business Review 71 (4), 78–92.
Garvin, D.A., 1993b. Manufacturing strategic planning. California Management Review 35 (4), 85–106.
George, M.L., Works, J., Watson-Hemphill, K., 2005. Fast Innovation: Achieving Superior Differentiation, Speed to Market and Increased Profitability. McGraw-Hill, New York, NY.
Gerwin, D., 1993. Integrating manufacturing into the strategic phases of new product development. California Management Review 35 (4), 123–136.
Ghoshal, S., Bartlett, C.A., 1994. Linking organizational context and managerial action: the dimensions of quality of management. Strategic Management Journal 15 (5), 91–112.
Gibson, C.B., Birkinshaw, J., 2004. The antecedents, consequences, and mediating role of organizational ambidexterity. Academy of Management Journal 47, 209–226.
Gowen, C.R., Mcfadden, K.L., Hoobler, J.M., Tallon, W.J., 2006. Exploring the efficacy of healthcare quality practices, employee commitment, and employee control. Journal of Operations Management 24 (6), 765–778.
Grant, R.M., 1996. Prospering in dynamically competitive environments: organizational capability as knowledge integration. Organization Science 7 (4), 375–387.
Handel, M.J., Gittleman, M., 2004. Is there a wage payoff to innovative work practices? Industrial Relations 43 (1), 67–97.
Hart, S., 1992. An integrative framework for strategy-making processes. Academy of Management Review 17, 327–351.
Hatch, N.W., Dyer, J.H., 2004. Human capital and learning as a source of sustainable competitive advantage. Strategic Management Journal 25 (12), 1155–1178.
Helfat, C.E., Finkelstein, S., Mitchell, W., Peteraf, M.A., Singh, H., Teece, D.J., Winter, S.G., 2007. Dynamic Capabilities: Understanding Strategic Change in Organizations. Blackwell Publishing, Malden, MA.
Hindo, B., 2007. Six Sigma: So yesterday? Business Week, 6/11/2007, Issue 4038.
Imai, M., 1986. Kaizen: The Key to Japan's Competitive Success. McGraw-Hill/Irwin, New York.
Ittner, C.D., Larcker, D.F., 1997. The performance effects of process management techniques. Management Science 43 (4), 522–534.
Jansen, J.J.P., Van Den Bosch, F.A.J., Volberda, H.W., 2006. Exploratory innovation, exploitative innovation, and performance: effects of organizational antecedents and environmental moderators. Management Science 52 (11), 1661–1674.
Jelinek, M., 1979. Institutionalizing Innovation: A Study of Organizational Learning Systems. Praeger, New York, NY.
Joyce, W.F., McGee, V.E., Slocum Jr., J.W., 1997. Designing lateral organizations: an analysis of the benefits, costs, and enablers of nonhierarchical organizational forms. Decision Sciences 28 (1), 1–25.
Juran, J.M., 1992. Juran on Quality by Design: The New Steps for Planning Quality into Goods and Services. Free Press, New York, NY.
Kiernan, M.J., 1996. Get innovative or get dead. Business Quarterly 61 (1), 51–58.
Kogut, B., Zander, U., 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. Organization Science 3 (3), 383–397.
Kraatz, M.S., Zajac, E.J., 2001. How organizational resources affect strategic change and performance in turbulent environments: theory and evidence. Organization Science 12 (5), 632–657.
Lareau, W., 2003. Office kaizen: Transforming Office Operations into a Strategic Competitive Advantage. ASQ Quality Press, Milwaukee, WI.
Linderman, K., Schroeder, R.G., Zaheer, S., Choo, A.S., 2003. Six Sigma: a goal-theoretic perspective. Journal of Operations Management 21 (2), 193–204.
Linderman, K., Schroeder, R.G., Zaheer, S., Liedtke, C., Choo, A.S., 2004. Integrating quality management practices with knowledge creation processes. Journal of Operations Management 22 (6), 589–607.
Lyles, M.A., 1981. Formulating strategic problems: empirical analysis and model development. Strategic Management Journal 2 (1), 61–75.
MacDuffie, J.P., 1997. The road to 'root cause': shop-floor problem-solving at three auto assembly plants. Management Science 43 (4), 479–503.
Madhavan, R., Grover, R., 1998. From embedded knowledge to embodied knowledge: new product development and knowledge management. Journal of Marketing 62, 1–12.
Mahoney, J.T., 1995. The management of resources and the resource of management. Journal of Business Research 33 (2), 91–101.
March, J.G., 1991. Exploration and exploitation in organizational learning. Organization Science 2 (1), 71–87.
McGrath, M.E., Anthony, M.T., Shapiro, A.R., 1992. Product Development Success through Product and Cycle Time Excellence. Butterworth-Heinemann, Newton, MA.
Mendelbaum, G., 2006. Keep your eye on the ball. APICS Magazine, January 2006.
Mohrman, S.A., Finegold, D., Klein, J.A., 2002. Designing the knowledge enterprise: beyond programs and tools. Organizational Dynamics 31 (2), 134–150.
Molina, L.M., Llorens-Montes, J., Ruiz-Moreno, A., 2007. Relationship between quality management practices and knowledge transfer. Journal of Operations Management 25 (3), 682–701.
Montgomery, C.A., 2008. Putting leadership back into strategy. Harvard Business Review 86 (5), 54–60.
National Institute of Standards and Technology (NIST), 2008. Malcolm Baldrige National Quality Award 2006 Criteria for Performance Excellence. Gaithersburg, MD.
Neilson, G.L., Martin, K.L., Powers, E., 2008. The secrets to successful strategy execution. Harvard Business Review 86 (6), 60–70.
Nonaka, I., 1988. Toward middle-up-down management: accelerating information creation. Sloan Management Review 29 (3), 9–18.
Nonaka, I., 1994. A dynamic theory of organizational knowledge creation. Organization Science 5 (1), 14–37.
O'Connor, P., 1994. Implementing a stage-gate process: a multi-company perspective. Journal of Product Innovation Management 11 (3), 183–200.
Pay, R., 2008. Everybody's jumping on the lean bandwagon, but many are being taken for a ride. Industry Week; March 05, 2008.

Pfeffer, J., 2005. Producing sustainable competitive advantage through the effective management of people. Academy of Management Executive 19 (4), 95–106.

Pil, F.K., MacDuffie, J.P., 1996. The adoption of high-involvement work practices. Industrial Relations 35 (3), 423–455.

Powell, T.C., 1995. Total quality management as competitive advantage: a review and empirical study. Strategic Management Journal 16 (1), 15–37.

Pullin, J., 2005. Room for improvement. Professional Engineering 18 (15), 38–138.

Rother, M., Shook, J., 1999. Learning to See. Lean Enterprise Institute, Cambridge, MA.

Rummler, G.A., Brache, A.P., 1995. Improving Performance: How to Manage the White Space on the Organization Chart. Jossey-Bass, Hoboken, NJ.

Rungtusanatham, N., Ng, C.H., Zhao, X., Lee, T.S., 2008. Pooling data across transparently different groups of key informants: measurement equivalence and survey research. Decision Sciences 39 (1), 115–145.

Sakakibara, S., Flynn, B.B., Schroeder, R.C., Morris, W.T., 1997. The impact of Just-In-Time manufacturing and its infrastructure on manufacturing performance. Management Science 43 (9), 1246–1257.

Samson, D., Terziovski, M., 1999. The relationship between total quality management practices and operational performance. Journal of Operations Management 17 (4), 393–409.

Schön, D.A., 1975. Deutero-learning in organizations: learning for increased effectiveness. Organizational Dynamics 4 (1), 2–16.

Senge, P.M., 1990. The Fifth Discipline: The Art and Practice of the Learning Organization. Doubleday, New York, NY.

Shewhart, W.A., 1980. Economic Control of Quality of Manufactured Product. 50th Anniversary Commemorative Issue. American Society for Quality, Milwaukee, WI.

Simon, H., 1947. Administrative Behavior. Macmillan, New York, NY.

Sitkin, S.B., Sutcliffe, K.M., Schroeder, R.G., 1994. Distinguishing control from learning in total quality management: a contingency perspective. Academy of Management Review 19 (3), 537–564.

Smith, M.R., 1968. Short Interval Scheduling: A Systematic Approach to Cost Reduction. McGraw Hill, New York, NY.

Spear, S.J., 2004. Learning to Lead at Toyota. Harvard Business Review 82 (5), 78–86.

Spear, S.J., Bowen, H.K., 1999. Decoding the DNA of the Toyota production system. Harvard Business Review 77 (5), 96–106.

Stock, G.N., Tatikonda, M.V., 2000. A typology of project-level technology transfer processes. Journal of Operations Management 18 (6), 719–737.

Stock, G.N., Tatikonda, M.V., 2008. The joint influence of technology uncertainty and interorganizational interaction on external technology integration success. Journal of Operations Management 26 (1), 65–80.

Tatikonda, M.V., Rosenthal, S.R., 2000a. Successful execution of product development projects. Journal of Operations Management 18 (4), 401–425.

Tatikonda, M.V., Rosenthal, S.R., 2000b. Technology novelty, project complexity and product development project execution. IEEE Transactions on Engineering Management 47 (1), 74–87.

Taylor, W.A., Wright, G.H., 2006. The contribution of measurement and information infrastructure to TQM success. Omega 34 (4), 372–384.

Teece, D.J., 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. Strategic Management Journal 28 (11), 1319–1350.

Teece, D.J., Pisano, G., Shuen, A., 1997. Dynamic capabilities and strategic management. Strategic Management Journal 18 (7), 509–533.

Tourish, D., 2005. Critical upward communication: ten commandments for improving strategy and decision making. Long Range Planning 38 (5), 485–503.

Tucker, A.L., Edmondson, A.C., 2003. Why hospitals don't learn from failures: organizational and psychological dynamics that inhibit system change. California Management Review 45 (2), 55–72.

Tyler, T.R., Blader, S.L., 2005. Can businesses effectively regulate employee conduct? The antecedants of rule following in work settings. Academy of Management Journal 48 (6), 1143–1158.

Upton, D., 1996. Mechanisms for building and sustaining operations improvement. European Management Journal 14 (3), 215–228.

Verona, G., Ravasi, D., 2003. Unbundling dynamic capabilities: an exploratory study of continuous product innovation. Industrial & Corporate Change 12 (3), 577–606.

Voss, C.A., 2005. Paradigms of manufacturing strategy revisited. International Journal of Operations & Production Management 25 (12), 1223–1227.

Witcher, B.J., Butterworth, R., 2001. Hoshin Kanri: policy management in Japanese-owned UK subsidiaries. Journal of Management Studies 38 (5), 651–674.

Wright, P.M., Snell, S.A., 1998. Toward a unifying framework for exploring fit and flexibility in strategic human resource management. Academy of Management Review 23 (4), 756–772.

Wruck, K.H., Jensen, M.C., 1998. The two key principles behind effective TQM program. European Financial Management 4 (3), 401–423.

Wu, C.W., Chen, C.L., 2006. An integrated structural model toward successful continuous improvement activity. Technovation 26 (5/6), 697–707.

Yeung, A.C.L., Cheng, T.C.E., Lai, K., 2006. An operational and institutional perspective on Total Quality Management. Production and Operations Management 15 (1), 156–170.

Yin, R.K., 2002. Case Study Research: Design and Methods. Sage Publications.

Young, S.A., Parker, C.P., 1999. Predicting collective climates: assessing the role of shared work values, needs, employee interaction and workgroup membership. Journal of Organizational Behavior 20 (7), 1199–1218.

Zahra, S.A., Sapienza, H.J., Davidsson, P., 2006. Entrepreneurship and dynamic capabilities: a review, model and research agenda. Journal of Management Studies 43 (4), 917–955.

Zollo, M., Winter, S.G., 2002. Deliberate learning and the evolution of dynamic capabilities. Organization Science 13 (3), 339–351.