Continuous improvement approach: state-of-art review and future implications

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Abstract

Purpose – The purpose of this paper is to review the literature and provide an overview of the history, evolution and existing research on continuous improvement (CI). It reviews a large number of research papers in this field and presents the overview of various CI implementation practices demonstrated by manufacturing organizations globally.

Design/methodology/approach – The paper systematically categorizes the published literature, analyzes and reviews it methodically.

Findings – The paper reveals the important concepts, case studies and surveys in concerned with CI methodology. The contributions of CI programmes towards improving manufacturing performance of the organizations and CI values that underlies continuous improvement have also been highlighted.

Practical implications – The literature on classification of CI has so far been very limited. The paper reviews a large number of papers in this field and presents the overview of various CI practices demonstrated by manufacturing organizations globally. Further the future implications have also been discussed for the smooth and effective implementation of CI practices in manufacturing organizations.

Originality/value – The paper contains a comprehensive listing of publications on the field in question and their classification. It will be useful to researchers, professionals and others concerned with this subject to understand the significance of CI methodology.

Keywords Continuous improvement, Operations and production management, Manufacturing operations, Management techniques

Paper type Literature review

1. Introduction

KAIZEN is a Japanese word that has become common in many western companies; the word indicates a process of continuous incremental improvement of the standard way of work (Chen *et al.*, 2000). It is translated in the west as ongoing, continuous improvement (CI) (Malik *et al.*, 2007). It is a compound word involving two concepts: KAI (change) and ZEN (for the better) (Palmer, 2001). Most of the manufacturing organizations are currently encountering a necessity to respond to rapidly changing customer needs, desires and tastes.

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To compete in this continuously changing environment, these companies must seek out new methods allowing them to remain competitive and flexible simultaneously, enabling their companies to respond rapidly to new demands (Black, 1991). With increased global competition, attention has been shifted from increasing efficiency by means of economies of scale and internal specialization to meeting market conditions in terms of flexibility, delivery performance and quality (Yamashina, 1995). The changes in the current business environment are characterized by intense competition on the supply side and heightened volatility in customer requirements on the demand side. These changes have left their unmistakable marks on the different facets of the manufacturing organizations (Gomes *et al.*, 2006). To meet the challenges posed by the contemporary competitive environment, the manufacturing organizations must infuse quality and performance improvement initiatives in all aspects of their operations to improve their competitiveness (Pintelon and Gelders, 1992). In order for these companies to remain competitive, retain their market share in this global economy, and satisfy both external and internal economy, and satisfy both external and internal customers, CI of manufacturing system processes has become necessary (Shingo, 1988). Competition and continuously increasing standards of customer satisfaction have proven to be endless driver of organizational performance improvements. The CI approach constantly seeks to identify and implement ongoing enhancements in a firm's products, services and processes (Reid, 2006).

The nature of production technologies has changed tremendously because of the implementation of total quality management (TQM), just-in-time (JIT) manufacturing and CI. However, benefits from these programs have often been limited because of unreliable or inflexible equipment (Tajiri and Gotoh, 1992). Historically, management has devoted much of its effort in improving manufacturing productivity by probing, measuring, reporting and analyzing manufacturing costs. Similar efforts in regard to CI function productivity are long overdue.

The manufacturing industry has experienced an unprecedented degree of change in the last three decades, involving drastic changes in management approaches, product and process technologies, customer expectations, supplier attitudes as well as competitive behavior. In today's highly dynamic and rapidly changing environment, the global competition among organizations has lead to higher demands on the manufacturing organizations. The global marketplace has witnessed an increased pressure from customers and competitors in manufacturing sector (Ahuja and Khamba, 2008). As a result, these manufacturing organizations need to adopt some modern manufacturing techniques like CI, total productive maintenance and TQM, etc. to improve the performance of current manufacturing system processes. CI is a widely practiced by manufacturing firms to improve quality, reduce lead times, reduce price, reduced lead times, reduce price and improve delivery reliability. It is one of the core strategies for manufacturing excellence and is considered vital in today's competitive environment (Dean and Robinson, 1991). The concept of CI has received much attention as a key to Japan's competitive success. A considerable number of studies, which have focused on Japanese management techniques like CI have illustrated the importance of KAIZEN. Furthermore, studies of KAIZEN activities in different countries suggest that the concept of KAIZEN has become routinely accepted throughout the world (Aoki, 2008). Over the past decades, CI has been studied from many perspectives. In this paper, objective is to present the history, evolution and the research conducted in this field. Through exhaustive review of literature, a brief description of existing research on CI has been provided in

order to gain an understanding of how the use of CI has had an impact on organizations. Different practices of CI needed to achieve an ongoing cycle of incremental improvements, the benefits incurred after implementation of CI approach have been identified and the future implications are also suggested. This article presents a review of the literature, demonstrates the different values underlying the CI concept and attempts to identify the important and useful contributions in this field. The literature is divided in three different sections including conceptual review, case studies and empirical research in this field.

2. History and evolution of CI

The roots of modern improvement programs can be traced back to initiatives undertaken in several companies in the 1800s, where management encouraged employee-driven improvement, and incentive programs were set in place to reward employees that brought about positive changes in the organization (Schroeder and Robinson, 1991). In 1894, National Cash Register's program included the reward scheme, employee development opportunities, and improving labor-management relationship. During the late 1800s and early 1900s, much attention was given to scientific management; this involved developing methods to help managers analyze and solve production problems using scientific methods based on tightly controlled time trails to achieve proper piece rates and labor standards. The US government then set up the "training within industry" service during the Second World War to enhance the industrial output on a national scale. This included job method training, a program designed to educate supervisors on the importance and technique of CI method. This program was later introduced in Japan by management experts like Deming, Juran and Gilbreth, and by the US forces present there after the end of the Second World War. Eventually, the Japanese developed their own ideas, and quality control, which was used initially in the manufacturing process, had evolved into a much broader term, growing into a management tool for ongoing improvement involving everyone in an organization (Robinson, 1990). In 1950s when management and government acknowledge that there is a problem in the current confrontational management system and a pending labor shortage. Japan has sought to resolve this problem through cooperation with the workforce. The groundwork was established in the labor contracts championed by the government and is taken up by most major companies, which has introduced lifetime employment and guidelines for gain sharing distribution of benefits for the company development. This contract remains the background for all KAIZEN activities providing the necessary security to ensure confidence in the workforce (Brunet, 2000). Because of its simple nature, the overwhelming and much described success stories of Japan, and the minimal costs involved in the implementation and maintenance, CI was warmly welcomed in Europe. In 1995, a survey conducted by European Continuous Improvement Network indicated that CI was becoming more and more widespread across Europe (Boer *et al.*, 2000). First, it was introduced and applied by Imai (1986) to improve efficiency, productivity and competitiveness at Japanese Toyota Carmaker Company in response to increasing competition and the pressure of globalization. Since then, KAIZEN has become a part of the Japanese manufacturing system and has contributed enormously to the manufacturing success (Ashmore, 2001).

3. KAIZEN and innovation

There are two types of focus on process that are opposing: one of them is the gradual improvement and the other is Innovation; the Japanese enterprises favor the gradual

improvement and the western enterprises favor on the large jumps with invention. In spite of KAIZEN not demanding great investment for its implementation, it demands continuous efforts and commitment. In ideal conditions, KAIZEN can be compared to a ramp, since the progress is gradual, and the innovation to a step. Improvement can be broken down into KAIZEN and innovation. KAIZEN signifies small improvements as a result of ongoing efforts. Innovation involves a drastic improvement as a result of a large investment of resources in new technology or equipment. In the context of KAIZEN, management has two major functions: maintenance and improvement. Maintenance refers to activities directed towards maintaining current technologies, managerial and operating standards and upholding such standards through training and discipline. Under its maintenance function, management performs its assigned tasks so that everybody can follow standard operating procedure. Improvement, meanwhile, refers to activities directed towards elevating current standards (Imai, 1997). Table I presents the comparison of KAIZEN and innovation as pointed by Karkoszka and Szewieczek (2007).

In spite of KAIZEN not demanding great investment for its implementation, it demands continuous efforts and commitment. In ideal conditions, KAIZEN can be compared to a ramp, since the progress is gradual, and the innovation to a step. There are two types of focus on progress that are opposing; one is the gradual improvement called KAIZEN and other is large steps commonly known as innovation (Shingo, 1985). KAIZEN may facilitate innovation, but the innovation refers to incremental innovation or small-scale innovation conducted by blue-collar workers and not to disruptive

Innovation	KAIZEN
Ability to adaptation	Creativity
Orientation towards person having no specialized qualifications	Orientation towards the specialists
Attaching great value to the details	Attaching great value to the general matters
Rejection and rework	Maintenance and Improvement
Free-for-all information, generalized	Information directed to the chosen persons
Interdepartmental orientation	Orientation to the individual section
Technological advances, new inventions and new theories	Know-how and conventional updating
Basing on the existing technologies	Searching for the new technology
Strong feedback	Limited feedback
Team work	Individualism
Participation of every worker	Participation of several chosen “leaders”
Intermittent and not incremental	Continuous and incremental
Small investment needed	Big investment needed
Processing estimation criterion	Results in the aspect of profit as the estimation criterion
Orientation towards human	Orientation towards techniques
Strong individuality, individual ideas and efforts	Collective team efforts, system focus
Long-time effect	Short-time effect
Adaptation to the slow growth rate economy	Adaptation to the fast growth rate economy
Technology	Persons
Demand large investment, however, less effort to maintain	Demand less investment, however, greater effort to maintain

Source: Adapted from Karkoszka and Szewieczek (2007)

Table I.
Comparison of KAIZEN and innovation

innovation such as value innovation (Setijono, 2010). The focus on innovation pushes managers to go beyond continuous incremental improvements of existing products, service and processes to new ways of doing things (Kim and Mauborgne, 1999). KAIZEN generates process-oriented thinking since processes must be improved before improved results can be obtained. KAIZEN signifies small improvements made in the status quo as a result of ongoing efforts. It does not necessarily call for a large investment in capital or a radical redesign of processes to implement the strategy. However, the KAIZEN strategy does call for continuous efforts and commitment from all level of management. Thus, KAIZEN calls for a substantial management commitment of time and effort. Investment in KAIZEN means investing in people. On other hand, innovation involves step-change improvements in the status quo as a result of large investment in new technology or radical change in process design using business process re-engineering (BPR) concept (Terziovski, 2001). Innovation, which is implemented by abrupt changes, and KAIZEN, which is a gradual process, are alternative means of introducing improvement. KAIZEN means small improvements made as a result of continuing effort. Innovation involves a drastic improvement made as a result of large improvements in new equipment or technology (Wittenberg, 1994).

4. Why is CI important?

Approaches to quality have evolved significantly since the beginning of this century. Four major quality eras have been identified (Bounds *et al.*, 1994):

(1) inspection;
(2) statistical quality control;
(3) quality assurance; and
(4) strategic quality management.

Each quality era built on the previous era. During the first three eras quality was viewed as a problem to be solved and the focus was on the internal operations of the organization. In the 1980s, quality was seen for the first time as a competitive opportunity, a strategic weapon that could be used against competitors. Thus, in the fourth quality era the focus was on the customer and the organization was more proactive in anticipating and responding to both customer and market needs. Continued top management commitment and involvement in quality was seen a paramount to ensure that quality was fully integrated into business strategy and plans and that it was adequately deployed throughout the organization. The strategic quality management approach, however, is still inadequate to meet today's rapidly changing business environment, characterized by uncertainty and unpredictability. To meet these challenges, a fifth quality era – competitive CI – has been identified (Kaye and Dyason, 1995). Here, the primary concern is with the organization being flexible, responsive and able to adapt quickly to changes needed in strategy in the light of feedback from customers and from benchmarking against competitors. For an organization to achieve flexibility, responsiveness and the ability to adapt quickly to changes within its environment, the implementation of a sound strategy for CI is essential.

5. Conceptual review

Imai (1986) proposed that there exist at least three types of KAIZEN: management-group- and individual-oriented KAIZEN. Management-oriented KAIZEN is considered

to be the most important one as it focuses on the company strategy and involves everyone in the company. Group-oriented KAIZEN is best represented by quality circles, which require employees to form a team or a circle with the goal of finding and solving problems faced during their day-to-day work without any interference from management. Individual-oriented KAIZEN is derived from the concept of bottom-up design, in which the worker makes a recommendation to the problem faced. This has been very successful in the Japanese industry since it is the worker who is on the shop floor and typically knows the best solution to an existing problem. Certain industries even have incentive programs where, depending on the problem and the solution provided, the worker is rewarded, thus encouraging the workers to concentrate on problem areas and find the best solution.

Watson (1986) described that KAIZEN strategy depends mainly on human efforts to improve results, and this requires process improvement. A process-oriented approach, referred to as the plan, do, check and act (PDCA) cycle is used for process improvement. The origin of PDCA cycle or Deming cycle can be traced back to the eminent statistics expert Shewart in the 1920s. Shewart introduced the concept of plan, do, see. The late TQM guru Deming modified the Shewart cycle as: plan, do, study and act. The Deming cycle is continuous quality improvement (CQI) model consisting out of a logical sequence of these four repetitive steps for CI and learning: plan, do, check and act. The PDCA cycle is also known as Deming cycle, the Deming wheel of CI spiral. In plan phase, objective is to plan for change, to analyze and predict the results. In do phase, the plan is executed by taking small steps in controlled circumstances. In study/check phase the results are studied. Finally in act phase, organization takes action to improve the process. These concepts form the basis of virtuous cycle of improvement:

- Plan – study current situation and develop changes for improvement.
- Do – pilot measures on a trial basis.
- Check – examine effect of changes to see if the desired result is achieved.
- Action – standardize on a permanent basis.

The main purpose of this cycle is to iron out abnormalities in the resulting work process and bring it back to harmony before moving to a new improving cycle. In other words, the standardizing cycle maintain current work processes, while the improving cycle improves them. The two cycles – PDCA and stadardize-do-check-act (SDCA) cycle revolve regularly to spread a culture of CI as a standard practice within an organization as shown in Figure 1.

Suzaki (1987) explained that CI is a philosophy widely practiced in manufacturing and quality circles. Also known as, "KAIZEN" it is the philosophy of achieving major enhancements in a process through incremental improvements. As the name implies, it relies on the idea that there is no end to making a process better. Each incremental improvement consists one of the infinitely many phases of development. Originally used for enhancing manufacturing processes, the philosophy has gained considerable popularity recently, and has been extended to all aspects of business including the software industry.

Wickens (1990) described the contribution of teamwork to make through the concept of KAIZEN. The key role and authority of each supervisor as a leader of his work team has been described taking an example of Nissan Motor Plant in UK.

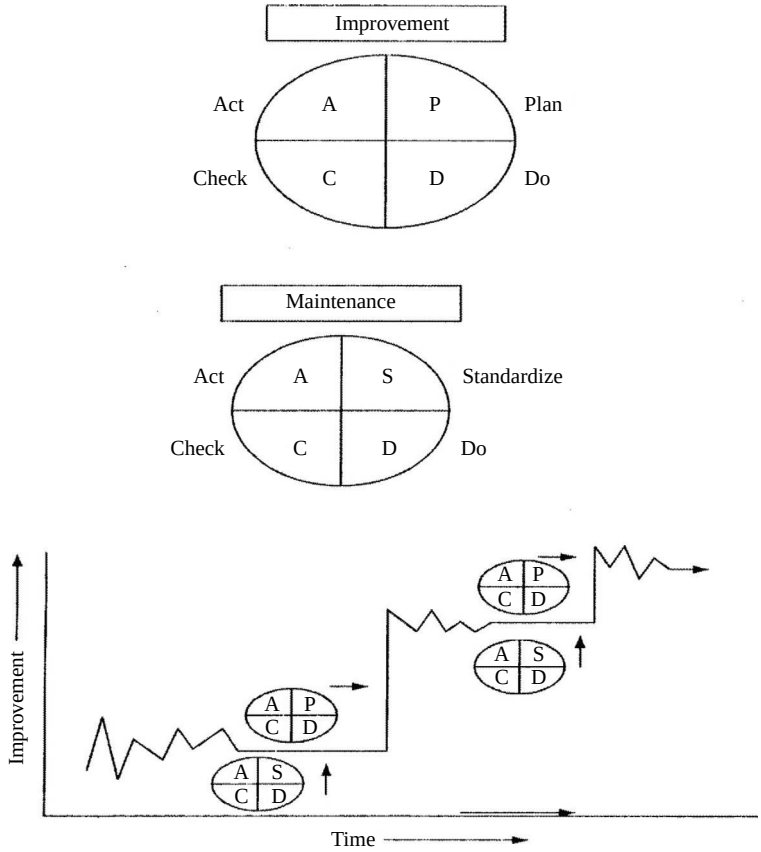

Figure 1.
PDCA and SDCA cycle

Emphasis is placed on teamwork, flexibility and quality. Team working and commitment do not come from involving the representatives of employees, but from the direct contact and communication between the individual and his boss.

Teian (1992) described that KAIZEN is more than just a means of improvement because it represent the daily struggles occurring in the workplace and the manner in which these struggles are overcome. KAIZEN can be applied to any area in need of improvement.

Hammer *et al.* (1993) explained that KAIZEN generates process-oriented thinking since processes must be improved before improved results are obtained. Improvement can be broken down between CI and innovation. KAIZEN signifies small improvements that have been made in the status quo as a result of ongoing efforts. On the other hand Innovation involves a step-change improvement in the status quo as a result of a large investment in new technology and equipment or a radical change in process design using the BPR concept.

Bessant and Caffyn (1994) defined the CI concept as "an organization-wide process of focused and sustained incremental innovation". Many tools and techniques are developed to support these processes of incremental innovation. The difficulty

is the consistent application of CI philosophy and the CI tools and techniques. As an organization-wide process, CI requires the efforts of all employees on every level.

Deming (1995) highlighted that organizations are evolved at a greater rate than at any time in recorded history. Since organizations are dynamic entities and since they reside in an ever-changing environment, most are in a constant state of flux. This highly competitive, constant changing, environment offers significant managerial opportunities as well as challenges. To effectively address this situation, many managers have embraced the management philosophy of KAIZEN.

Deniels (1995) explained that the way to achieve fundamental improvement on the shop floor is by enabling operators to establish their own measures, aligns to the business strategies and uses these to drive their KAIZEN activities. The author explains that operators are the experts and once they realize that they are the ones who are going to solve their problems, and then all they need is some direction. He also discusses the role of performance measurement in fashioning the world class manufacturing company.

Yeo *et al.* (1995) described the viewpoints of various traditional quality management gurus on the concept of "Zero defects" and "Do it better each time", that these strategies are the important ways to improve quality continuously. "Zero defects" represents CI over quality by detection of defects. A "DIBET" strategy is associated with constant, conscious and committed efforts to reduce process variation. They conclude that CI is the most important way to manage business through these strategies.

Berger (1997) presented five types of CI based on the organizational designs including:

(1) Quality control circles: a group of people in the staff who meet regularly to discuss problems and issues related to quality so that they may examine them and come up with solutions.

(2) Wide-focus CI: a blend of organic CI and expert task force CI (described below). It is used for temporary operations and for CI in self-managed work groups by combining CI process teams.

(3) Organic CI: multifunctional work groups are integrated with improvement activities. Organic CI is different from other CI models since the improvement activities are not left to the experts for design and planning and the decision-making is not left to the authorities outside the group.

(4) Expert task force CI: this form of CI is based on the reliance on temporary expert task force consisting of professional from quality, engineering and maintenance and therefore the span of improvement tasks requires considerable time and investment.

(5) Individual CI: improvements are set off by individuals and generally organized in the form of a suggestion system. Individuals come up with ideas and the implementation of the ideas is left to the specialists.

Newitt (1996) had given a new insight onto old thinking. The author has suggested the key factors to determine the business process management requirements. The author also has brought insight that KAIZEN philosophy in the business process management will liberate the thinking of both management and employees at all levels and provides the climate in which creativity and value addition can flourish.

Womack and Jones (1996) referred to KAIZEN as lean thinking and lay out a systematic approach to helping organizations systematically reduce waste, or muda. They describe muda as any human activity that absorbs resources but creates or adds no value to the process. Most employees could identify several different types of muda in their workplace, but unfortunately the waste that they identify is only the tip of the iceberg. The authors continue by stating that until these employees have been taught the essentials of lean thinking, they are unable to perceive a few types of the waste actually present in their environment. The authors provide an example involving preparing a newsletter for mailing. Most of us would tackle the problem after the printing has been completed by folding all copies of the newsletter placing stamps on the envelopes, then inserting the folded newsletter into an envelop and finally, sealing all of the envelopes. When examining this process, it is not readily apparent to the observer that the newsletter is picked up four times. We compartmentalize and attempt to group tasks without looking at the flow. It would reduce muda if newsletter has been folded, inserted into the envelope, stamped as stacked. When explained, this opens up a new world of operation to those studying manufacturing processes. The KAIZEN process carries many other benefits as well.

Ghalayini *et al.* (1997) described that KAIZEN is characterized by operatives on the shop floor identifying problems and proposing solutions – the epitome of spontaneous, bottom-up change. Small-scale tuning of a system, by its very nature, is likely to be low cost, generated from an intimate knowledge of a small part of the system. Progress is likely to be largely outside the control of management who are not the sponsors of change but only play, at most, a supporting role. Even though the aggregate effects may be significant, there is an obvious danger that process may be erratic and fragmented.

Williamson (1997) highlighted the target and KAIZEN costing concept, one of the manufacturing techniques, which has been developed in Japan. Target costing is a process of ensuring that products are designed such that the company can sell them cheaply and still make a fair profit. KAIZEN costing continuous to focus on the value and profitability into the manufacturing phase, both of new and existing products. KAIZEN costing activities should be a part of a process of business improvement continuously, with improvements in quality, product functionality and service jointly. KAIZEN activities and targets may vary depending on the type of cost. Combining target costing and KAIZEN costing provides a basis of the total life cost management, managing cost throughout the product life cycle.

Cheser (1998) explained that KAIZEN is based on making small changes on a regular basis – reducing waste and continuously improving productivity, safety and effectiveness. While KAIZEN has historically been applied in manufacturing settings, it is now becoming common to find it applied to service business processes as well.

Melnyk *et al.* (1998) described seven characteristics that distinguish KAIZEN events from other process improvement approaches. First, a KAIZEN event is a self-contained short-term intervention (typically three to five days), with a clearly defined, finite life (Cuscela, 1998). Second, the scope of a KAIZEN event is focused on part of a specific value stream (Laraia *et al.*, 1999). Third, KAIZEN events focus on improving existing processes, rather than implementing solutions that require investment in new technology (Sheridan, 1997). Fourth, KAIZEN events are team-based, comprised of employees from the targeted work area and support functions including, for example, engineering, purchasing and production control. KAIZEN events make use of employee knowledge to develop better solutions, and are hypothesized to increase ownership

(McNichols *et al.*, 1999). Fifth, KAIZEN events are action-oriented. KAIZEN teams are often given the authority to implement solutions as they are developed, without additional direct approval from management (Minton, 1998). Sixth, most KAIZEN event goals are measurable. Common metrics include productivity, work-in-process (WIP), floor space, throughput, lead-time, setup time, part travel time, percent on-time delivery, defect rate, throughput and product design measures such as price, product line diversity, etc. (Kosandal and Farris, 2004). Seventh, KAIZEN events are designed to create a cycle of CI. By using KAIZEN events at multiple points in time, cycles of performance improvement within a given process are created.

Kim and Mauborgne (1999) called incremental improvement "imitation" and not "innovation". According to these authors, companies should focus on a proactive strategy, which focuses on the creation of new customers as well as sustaining existing customers. They refer this strategy as "value innovation strategy" where the emphasis is on value and customers and to a lesser extent on the competition. The focus on value innovation pushes managers to go beyond continuous incremental improvements of existing products, service and processes to new ways of doing things.

Tennant and Roberts (2001) described that there are four types of activity associated with KAIZEN as given below and as shown in Figure 2:

(1) "ZD" refers to the actions associated with the adoption of a "Zero defects" mindset in the organization, in which employees spontaneously and autonomously improve things.

(2) "Suggestions" refers to the operation of suggestion schemes, which may require considerable organization to process, evaluate and potentially act upon employee suggestions, but for which the topics of the suggestions are determined by the particular inspiration of the employees.

(3) "Policy deployment" refers to the process by which top management targets and agendas are promoted throughout the organization, which need not in itself require the organization of resulting activities.

(4) "SGAs" refers to small group activities which form the core of overt KAIZEN activity.

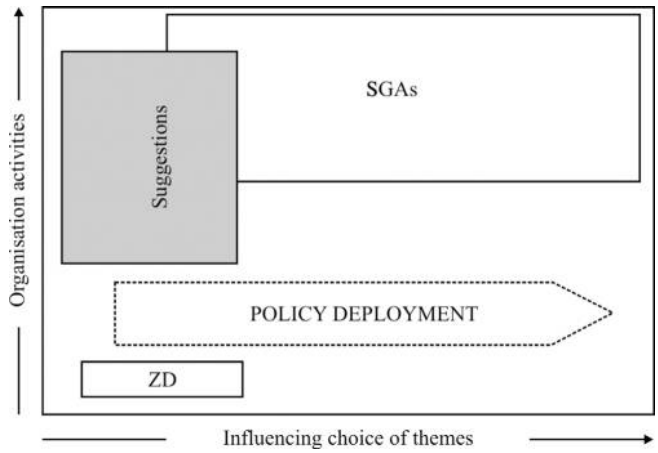

Figure 2.
Activities associated with CI approach

Williams (2001) highlighted that CI techniques are the recognized way of making significant reduction to production costs. Quality function deployment (QFD) is a well-known technique for translating customer requirements for a product into functional specification. Data suggests that the best opportunity for significant reduction in the overall cost of manufacturing a product is at the design stage of the new product development program.

Doolen *et al.* (2003) described the variables that are used to measure the impact of KAIZEN activities on human resource. These variables include attitude toward KAIZEN events, skills gained from event participation, understanding the need for KAIZEN, impact of these event on employee, impact of these events on the work area and the overall impression of the relative successfulness of these events.

Chen and Wu (2004) explained that CI can be generated and sustained through the promotion of good improvement model and management support. In fact, it is not so easy in reality. The improvement case may fail without carefully examining the problem in the activity.

Hyland *et al.* (2004) highlighted the major potential benefits of CI. These benefits are: increased business performance (in terms of reduced waste, setup time, breakdowns and lead time) and increased "people performance" in the form of improved development, empowerment, participation and quality of work life of employees; all of which address contemporary societal needs.

Abdolshah and Jahan (2006) described about how to use CI tools in the different life periods of the organization. Organizations are facing the problem that which CI tool should be used during various stages and different life periods of organization. Methodologies of applying both quantitative and qualitative tools in the different life periods of an organization have been discussed.

Karkoszka and Honorowicz (2009) described that KAIZEN idea should have positive influence on areas outside department of employee, surpass the level of ordinary scope of duties of employee, be characterized by high level of practicality, what means that employee has devoted a lot personal time and energy to achieve effective implementation and obtain the results exceeding desired ones; correct functioning of KAIZEN system should be confirmed by statistics of implementation. The paper is being constituted by the procedure of the carried out estimation of KAIZEN ideas taking into account practicality and efficiency of the idea, direct influence of it on safety, quality, cost and time as well as creativity and personal involvement of employee, which can be used as an improvement tool in every organization estimating every improving activity.

Salah *et al.* (2010) presented the existing models that describe how Six Sigma and lean fit together. Finally, a new detailed description for integrating Six Sigma and lean is developed to provide an improved approach for CI. The purpose of this paper is to explain how lean compares to the Six Sigma and outline the benefits for integrating them. Six Sigma and lean are related and share common grounds in terms of striving to achieve customer satisfaction. Their integration is concluded to be possible and beneficial.

6. Case studies related to CI approach

Jayaraman *et al.* (1995) demonstrated the application of the CI in simulation model development. This study presents several techniques that can be used to build accurate and efficient model of systems that include one or more transfer machines and long conveyors. The system under study shows a fair amount of complexity, so a five staged

model has been developed to obtain a balance between model accuracy and execution performance. The simulation analysis helps to predict optimal combinations of operation times, material handling speeds, buffer sizes, preventive maintenance, breakdown schedules and a considerable cost savings has been obtained.

Radharamanan *et al.* (1996) applied KAIZEN technique in a small sized custom-made furniture Industry. The various problems that have been identified through brainstorming process includes absence of appropriate methodology to assure quality, less compatibility of the individual protection equipment, old machines, disorganized workplace, inadequate and insufficient number of measuring instruments, lack of training, insufficient illumination at certain places and poor quality of raw material. Suggestions are also given to solve these problems. The main aim is to develop the product with higher quality, lower cost and higher productivity in meeting the customer requirements.

Chaudhari (1997) described the key factors of the CI system at Morris Electronics Limited, an Indo-Japanese joint venture firm that has contributed to dramatic improvement in the productivity and sustained competitiveness. The paper examines corporate values in terms of sets with values held by individuals within organization. A general methodology is proposed that allows corporate values to be mapped into both attitude and management style required to implement and support organizational change. The author also highlights the evolution of the collaboration between Morris and Hitachi metals and its impact on the development of the higher-level competencies.

Erlandson *et al.* (1998) applied KAIZEN tool, i.e. poka-yoke on fuel-fitter assembly. The fixture that has been introduced shows considerable variation in the assembly process. The old fixture is replaced by the more promising of the two fixtures that have been designed, built and tested. Results show the increase in the production rate of about 80 percent and the error rate drops from above 50 percent to about 1 percent. More significantly, a large number of individuals who could not perform the assembly task with the old fixture are now being able to competently perform the task with the new fixture.

Adams *et al.* (1999) explained that simulation is the powerful tool to support CI process improvement. Two case studies including a commercial manufacturer and aerospace manufacturer have been performed where simulation is used to support the CI steps. In summary, the following conclusions are made:

- Process simulation can be used to support steps in the CI process.
- To be most effective, simulation model should be developed.
- For new situations, basic, simple model of the process are a good way to start.
- Interpreting the results with management can be beneficial.

Bond (1999) studied the KAIZEN and re-engineering programs in a leading international company manufacturing surgical products. Research data is collected from a program of semi-structured interviews with appropriate staff at all levels ranging from senior management to machine operators. Research has been confined to in-depth studies:

- The “mini company” and the role of CI.
- New “quantum project” of process innovation and step change.

Key performance factors that are identified include quality, delivery reliability, customer satisfaction, cost, safety and morale. Result shows that performance measures

are used in four distinct stages and each stage has its distinctive characteristics, which should be taken into account while applying KAIZEN and re-engineering techniques.

Savolainen (1999) conducted two case studies including a medium sized metal industry and other larger group in the construction and concrete industry. The main aim of the studies is to increase the understanding of the processes and dynamics of CI implementation. Focus is placed on how these companies are renewed through the embedding of quality related management ideology. The paper has discussed the processes and dynamics of CI implementation conceptually and empirically. Results show that the dynamics of CI implementation process is cyclic in nature, which progresses at different speeds and with varying intensity.

Burns (2000) described the importance of two techniques namely overall equipment effectiveness (OEE) and setup reduction, taking an example of Weston EU Company. No appropriate measures of the process and equipment usage are available. Initially, six pilot areas have been identified, out of these three turned out to be successful. OEE is actually used to drive CI in the development of a company. Setup reduction has been applied to reduce change over times, to meet the customer demand for greater product mix and to overcome the difficulties in machine loading. Both techniques are described in terms of how they help the company to drive improvement in the core of the business-70 capital equipment CNC machines.

Chen *et al.* (2000) applied KAIZEN approach on a small manufacturing designing system. The focus of this project is the virtual manufacture of meat tenderizer. The product is currently too expensive to produce. In order to address this system design problem, a design engineer, a manufacturing engineer, a quality engineer and two machining operators are invited to be the team members in this KAIZEN project. After identifying the problem, a brainstorming process has been used to explore the team goals by receiving the information on current process of the product. Cellular manufacturing system is introduced to reduce production costs. KAIZEN brings CI, it reduces 25 percent of the unit cost, reduces floor space requirement by 15 percent and it also develops a better communication network throughout the organization.

Lee (2000) conducted a case study at Nichols Foods manufacturing food products. There was a lack of standard operating procedures, forces and structure. The study describes how the company values have improved the work environment for the employees and motivated them to achieve excellence. The paper describes that how the KAIZEN program has been implemented in this company using 5S technique and team training. The result shows decrease in quality rejections, reduction in change over times and increase in manufacturing efficiencies.

Lee *et al.* (2000) described that inclusion of the KAIZEN approach in industrial technology is beneficial. This case study provides a description of the steps used to implement lean thinking in a typical mid-western company developing a dynamic tri-resin fiberglass rod, which has hundred times more tensile strength than that of steel. After implementing lean thinking, reduction in space used in the building, material handling costs and also lower scrap rates can be expected. Exercises that are described in this paper can be used within existing system in all manufacturing-focused programs to assure that graduates are sufficiently familiar with this important thrust.

Ashmore (2001) discovered that KAIZEN is a hardheaded weapon in hard-pressed manufacturing industries. KAIZEN technique has been applied at Toyota Company in response to increasing competition and costs. It has found that after implementation of

this technique has increased its sales by multiple of not less than 69 percent and its profit by 54 times in an economic year. The author has also discussed the role of 5S, eliminating muda and JIT in making CI. Palmer (2001) focused his study on the "Inventory management KAIZEN" that has been conducted at "BAE SYSTEM" to remove the muda (waste) from the receiving and storing process. KAIZEN event encompasses about five months, one week from actual analysis of the process and the remainder working to implement the changes that are identified. Results show that the process time is reduced from 610 to 290 hours. Ultimately the KAIZEN event results in saving well over million dollars per year.

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Ahmed *et al.* (2005) conducted a study in a casting based manufacturing plant, which is currently implementing KAIZEN towards achieving higher productivity. The study has focused into the performance indicators (PIs) currently being measured by the company. Careful investigations and observations have been taken to show the effectiveness and efficiency of the implementation of the KAIZEN system in an innovative manner. After analyzing the collected data, sufficient information has been generated on various aspects of performance evaluation. However, due to lack of financial data, monetary-based PIs could not be carried out in this study.

Granja *et al.* (2005) studied the target and KAIZEN costing concept in the construction based company. The aim is to develop the framework taking together these two matching approaches, which provides a basis for a total cost management system. The authors explain that the continuing series of KAIZEN activities are needed to achieve product performance and reduce the cost. Combining target and KAIZEN costing is a powerful approach for Construction Company by assuring value for the customer at a low but profitable price.

Dehghan *et al.* (2006) described the case study of KAIZEN project that is performed by National Productivity Improvement Program (NPIP), at Chaharmahalbakhtiari Agriculture Organization. Two KAIZEN methodologies namely 5S and process improvement are used for this CI project. The status of the process before and after KAIZEN is shown by using flow charts, block diagrams and spaghetti charts, etc. Shortening of work processes, decrease in financial expenses results in increasing the satisfaction level of both domestic and foreign customers. Results show the decrease in 11 percent stations, decrease in 11.7 percent moving around, 16 percent time has been saved, 34.2 percent length decreases and 53 per cent transportation cost has been saved.

Kikuchi *et al.* (2007) aimed at applying OEE method to cost reduction by using KAIZEN technique in a semiconductor industry. The consumption of gases and chemicals (GAC) for a specific process was very high. Two different methods of overall consumable effectiveness (OCE) technique are adopted to reduce the consumption of GAC for 12 items. Result indicates a cost reduction of 7 percent annually for GAC usage. This experience has raised the engineer's awareness that the KAIZEN process can be applied to other areas also.

Chandrasekaran *et al.* (2008) applied KAIZEN technique to solve the "part mismatch problem" problems in automobile assembly production line. Step by step KAIZEN procedure has been followed to solve the problem by data collection, root cause analysis, selection of the best solution method, corrective action and documentation. The various benefits that have been observed after implementing KAIZEN include elimination of major functional problem, reduction in quality rejections, elimination of rework processes and a considerable cost savings has been obtained.

7. Empirical research/surveys

Gibb and Davies (1990) identified and highlighted the critical success factor for CI and innovative strategy in Australian small to medium enterprises (SMEs), the importance of market orientation and effective strategic formulation in successful SMEs. The critical success factors that have been highlighted in the survey include promoting a corporate culture, creating an effective structure, analyzing competitors, developing cooperations and partnerships, and developing flexibility and speed of response.

Soderquist (1996) investigated CI and innovation practices in French SMEs. In this survey, they examine the drivers for change and the short and long-term goals, the sources of innovation and the nature of innovation management in French SMEs. Respondents are asked to consider a recent and successful innovation in product and then to indicate just how important a number of items are used as a source of particular innovation. The top nine sources of innovation that have been found include introduction of the new product, CI of work processes, radical change (e.g. through BPR), increased focus in marketing/sales efforts, reduction in indirect staff numbers, improvement on staff competence, improved quality of product and services, improving the quality of management, efforts to improve supplier performance. The survey identifies two groups of SMEs. The first group has reported satisfaction with their organization's performance in product innovation and has also reported that their organizations have a strategic approach to innovation. The second group comprises SMEs, which are satisfied with current actions for improving short-term performances. Further analysis shows that the second group is more likely to report a stronger emphasis on performance management approach.

Irane and Sharp (1997) suggested on the basis of a survey conducted in a small-scale manufacture, that CI strategy should be engrained as a belief into the employees' heart. The ideal situation of CI strategy is its integration with the corporate culture.

Bessant (2000) presented a survey that has been conducted by CI research advantage (CIRCA) at UK firms. Survey suggests that 65 percent of companies consider CI to be strategic importance, around 50 percent have instituted some form of systematic program to apply these concepts, 19 percent claims to have a wide spread and sustained process of CI in operation, and of those firms using CI. 89 percent claims that it has impact on productivity, quality, delivery performance or combination of these.

Hongming *et al.* (2000) carried out a survey in Chinese companies that not all companies that have carried out CI activities achieve desired results. It has significant impact on companies in which CI implementation requires adequate input on company capital human resource and organizational activities. It is a challenge for companies in the organizational structure business principle and operations methods.

Mackle (2000) presented a survey conducted by KAIZEN institute that has been designing and implementing various CI programs in most of companies in UK.

Institution has conducted a survey with all of their UK clients. Outcomes of the survey show that organizations have not successfully implemented these improvement programs. The opportunities for improvement are also identified in this survey.

Terziovski (2001) presented the result of a mail survey used to investigate the relationship between CI and innovation practices and SME performance in 115 Australian manufacturing industries. A total of 19 questions have been included in the questionnaire. 57 independent variables and 12 dependent variables are analyzed using multi regression analysis. The author concludes that a CI and innovation management strategy and system are significant predictors of SME performance.

Gonsalves (2002) performed a survey about the effect of ERP and CI on the performance in 500 manufacturing companies. He concludes that CI implementation has positive influence on BPR execution. Integrated CI and BPR have positive effects on the company's performance.

Malik and YeZhuang (2006) performed a survey in 105 Spanish and 50 Pakistani companies to analyze the outcome of CI practices carried out in these industries. Questionnaire is circulated to different industries. 12 CI tools have been investigated. Result shows that Spanish industries utilize these tools more than Pakistani industries. Spanish industries are comparatively more experienced and advanced from Pakistani industries.

Tseng *et al.* (2006) investigated the effects of CI and cleaner production on the operational performance. A total of 223 responses have been obtained after the distribution of questionnaire. Sample for study has been collected via a survey of Taiwan electronic manufacturing firms. The direct and indirect influences of independent variables on dependent variables are tested by structural equation modeling (SEM) technique. The result shows that the CI might not be able to directly improve the operational performance. However, CI plays a significant role in cleaner production implementation.

Yan-jiang *et al.* (2006) conducted a survey by using data of the global continuous innovation network to analyze the influencing factors of CI. This survey designs 18 questions to describe the reasons why companies are implementing CI activities, 13 questions to describe the company's external environment and 11 questions to describe the situation of CI activities in functional departments of the companies. Result shows that the internal motivation factors are responsible for popularization of CI activities and have varying degree of influence on these activities.

Malik *et al.* (2007) conducted a survey by comparative analysis between two Asian developing countries, China and Pakistan, by investigating how they are deploying CI practices. The questionnaire consists of 18 selected blocks of questions related to organization and its operation of CI, supporting tools used in improvement activities, effects of improvement activities and company background and its characteristics. Result shows that industries in both of the countries are deploying CI methodologies, but with different proportions.

Singh and Singh (2010) investigated the level of difficulties in implementing CI strategies in SMEs of Punjab. 32 CI strategies have been investigated for their level of difficulties in implementation. Results indicated that manufacturing organization of Punjab are facing most difficulties in implementing strategies of TQM and are facing least difficulties in implementing total productive maintenance strategies.

8. CI values underlying CI

CI values play an important role in implementing CI methodology. The importance of CI is widely recognized, little research has been conducted in this area. CI related values are usually addressed within the context of TQM. These values include humbleness (Gupta, 1996; Gibson, 1995), openness (Steyn, 1999; Roberts, 1992), respect for people (Seiling, 1999), responsibility and integrity (Goetsch and Davis, 2000), empathy and responsiveness (Bogue, 1997), trust (Axline, 1991) and cooperation (Oakland, 1997). Customer satisfaction is the objective of all CI initiatives. Deming considers customer to be the most important part of the production line. Customer should be recognized as reasons behind the existence of the organization. They are the origin and the purpose of product improvement. Product improvement that does not meet customers' needs and expectations will be a total waste for the organization. Customer satisfaction should therefore be the objective and drive of CI (Dean and Bowen, 1994). To infuse the all values, top management should appreciate their importance to the CI process and hence to the competitiveness of the organization. Top managers should also be committed to the infusion of these values through being the first ones to enact them; for the organizational culture is a reflection of the personality of its leader effective leadership should be engaged in modeling, teaching and coaching in order to infuse desired values. It is not enough to secure the commitment of top management, provide structural support, and shift the focus of the control system to achieve behavioral change. An explicit behavioral change program with specific improvement targets and a clear reward system is usually needed for such an endeavor (Kilman's, 1989) (Figure 3).

9. Future implications

After successful institutionalization of CI programs in the organizations, concerted efforts must be made to ensure sustained CI deployment in the manufacturing organizations, as manufacturing improvements are only possible through persistent deployment of world class CI initiatives. The goal of the organization at this stage, after successful deployment of CI, has to continue the CI Program into the incremental process improvement phase, using a CQI approach. It is extremely important for an organization to consistently move forward after attaining CI excellence award for sustaining the levels attained and to reach higher levels of achievements. The changes introduced into the organization by CI activities must be anchored thereby becoming an established part of everybody's daily routine. CI has to be regarded as a "change process", rather than a "project" otherwise the competencies gained

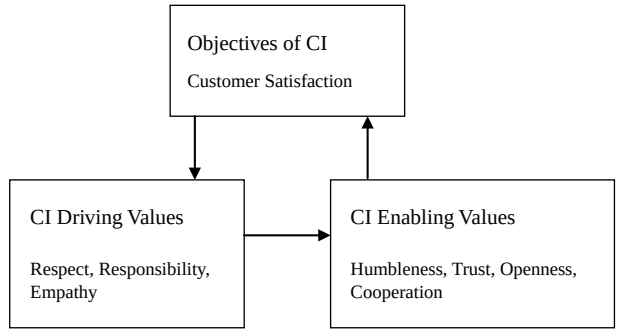

Figure 3.
CI values

by the organization might fade away after the project is completed. Once the crucial achievements through strategically implemented and institutionalized CI programs have been realized, the CI team should continue to work progressively to look for ways to improve upon their success. The organization must consistently send a strong message to employees that openness, trust, teamwork, CI and learning are the core values of the company. To sustain CI, a positive attitude throughout the organization must be evident. The manufacturing organizations must prepare for, implement and sustain improvement and their competencies cover a broad range of issues including: innovative thinking (structured problem solving, creative problem solving, visioning sessions, concurrent design, rapid product/service design); developing teams and individuals (change agent development, cultural assessment and alignment, change management, flexible working, performance coaching, emotional intelligence, multi-function teams, project based team building); effective leadership (strategic planning, operational planning, policy deployment, strategic negotiation, strategic procurement, future state planning, leadership potential, performance coaching); access to knowledge and expertise (lean service, lean manufacturing, risk management, process redesign, Six Sigma, project and program management, concurrent design, supply chain management, strategic procurement, outsourcing, knowledge management) and specific skills (value stream analysis, process analysis, 5S/visual management, SMED, Jidoka, SPC, DMAIC, Kanban, DFMA, FMEA/FMECA) for attaining long-term core competencies and market leadership. Similarly the manufacturing performance can also be evaluated by simultaneous implementation of CI and other related lean manufacturing initiatives like JIT, TQM, QFD, and TEI, etc. for enhancing overall performance of manufacturing operations. Further, the CI audit process and CI gap analysis must be put into place for evaluating the evolution of permanent changes taking place in the organization. The appropriate auditing and monitoring system should be developed to improve CI results continuously. This KAIZEN audit process brings structure and metrics to incremental changes and allows the steering team to place focused effort to move the implementation forward. Thus, sustained KAIZEN programs have the capability to achieve organization goals.

10. Conclusion

From the literature, it is concluded that there is reasonably vast literature available on KAIZEN philosophy, which provides a broad view of past practices and researches carried over the globe. The comprehensive listing of publications on the field in question and classification of existing literature will be useful for researchers, CI professionals and other concerned with this approach to understand the significance of CI practices carried out in different fields of application. Practitioners will find useful principles, methods, tools and technique used in implementing CI approach. CI approach has become a new management paradigm in all types of organizations. In recent years, many organizations have demonstrated that significant improvements in manufacturing sector can be achieved after successful implementation of CI practices. CI concept can be effectively employed to realize fundamental improvements of manufacturing performance in the organization successfully in the highly competitive environment. The literature survey clearly reveals that the successful implementation of CI practices can facilitate the manufacturing organization's quest for achieving their goals leading to the competitive advantage. However, awareness among employees regarding the different strategies that are involved in CI philosophy, various principles behind these

strategies and the use of these strategies in different circumstances plays an important role in successful implementation of CI approach. So more research is required which could improve these awareness aspects, as these factors are highly important for the success of the KAIZEN philosophy in most of the manufacturing industries across the globe. Furthermore, there is also need for research in the field of the hybrid CI methodologies that have developed in the recent past and to determine their applicability and to various organizations.

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