Kaizen Philosophy: A Review of Literature

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The ultimate objective of manufacturing industries today is to increase productivity through system simplification, organizational potential and incremental improvements by using modern techniques like Kaizen. Most of the manufacturing industries are currently encountering a necessity to respond to rapidly changing customer needs, desires and tastes. For industries, to remain competitive and retain market share in this global market, continuous improvement of manufacturing system processes has become necessary. Competition and continuously increasing standards of customer satisfaction has proven to be the endless driver of organizations performance improvement. Kaizen refers to continuous improvement in performance, cost and quality. Kaizen strives to empower the workers, increase worker satisfaction, facilitates a sense of accomplishment, thereby creating a pride of work. It not only ensures that manufacturing processes become leaner and fitter, but eliminate waste where value is added. Kaizen by now is a widely discussed, and applied manufacturing philosophy, in a variety of industries across the globe. This paper discusses different articles that have been published in this field and presents a review of literature.

Introduction

Kaizen is a Japanese word that has become common in many western companies. The word indicates a process of continuous improvement of the standard way of work (Chen *et al*., 2000). It is a compound word involving two concepts: Kai (change) and Zen (for the better) (Palmer, 2001). The term comes from *Gemba* Kaizen meaning 'Continuous Improvement' (CI). Continuous Improvement is one of the core strategies for excellence in production, and is considered vital in today's competitive environment (Dean and Robinson, 1991). It calls for endless effort for improvement involving everyone in the organization (Malik and YeZhuang, 2006).

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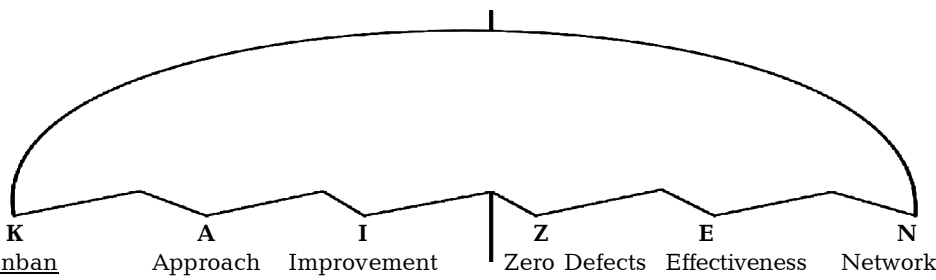
Kaizen originated in Japan in 1950 when the management and government acknowledge that there was a problem in the current confrontational management system and a pending labor shortage. Japan sought to resolve this problem in cooperation with the workforce. The groundwork had been laid in the labor contracts championed by the government and was taken up by most major companies, which introduced lifetime employment and guidelines for distribution of benefits for the development of the company. This contract remains the background for all Kaizen activities providing the necessary security to ensure confidence in the workforce (Brunet, 2000). First, it was been introduced and applied by Imai in 1986 to improve efficiency, productivity and competitiveness in Toyota, a Japanese carmaker company in the wake of 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).

Kaizen forms an umbrella that covers many techniques including *Kanban*, total productive maintenance, six sigma, automation, just-in-time, suggestion system and productivity improvement, etc. (Imai, 1986) as shown in Figure 1.

Figure 1: The Kai□en Umbrella



Customer Orientation	Just-In-Time	Suggestion System
Six Sigma	Small Group Activities	Discipline
Total Productive Maintenance	Automation	*Poka-Yoke*

Source: http://afr.kaizen.com; Imai (1986).

A growing and developing literature on this subject was published after 1986. The present article presents a review of literature and attempts to identify the important and useful contributions on this subject. The relevant literature can be classified in three basic categories:

- Reviews of literature related to concept of Kaizen philosophy.
- Reviews of literature related to case studies.
- Reviews of literature related to surveys.

Review of Literature Related to Kaizen Concept

The philosophy of Kaizen has kindled considerable interest among researchers because it increases productivity of the company and helps to produce high-quality products with minimum efforts. Several authors have discussed the concept of Kaizen including Deniels (1996), and Reid (2006) etc.

According to Imai (1986), Kaizen is a continuous improvement process involving everyone, managers and workers alike. Broadly defined, Kaizen is a strategy to include concepts, systems and tools within the bigger picture of leadership involving and people culture, all driven by the customer.

Watson (1986) says that the origin of Plan-Do-Check-Act (PDCA) cycle or Deming cycle can be traced back to the eminent statistics expert Shewart in the 1920s. Shewart introduced the concept of PDCA. The Total Quality Management (TQM) guru Deming modified the Shewart cycle as: Plan, Do, Study and Act. The Deming cycle is a continuous quality improvement model consisting of a logical sequence of these four repetitive steps for Continuous Improvement (CI) and learning. The PDCA cycle is also known as Deming Cycle, the Deming wheel of CI spiral. In 'Plan phase', the objective is to plan for change 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', the organization takes action to improve the process.

Suzaki (1987) explains that CI is a philosophy widely practiced in manufacturing and quality circles. As the name implies, it relies on the idea that there is no end to make a process better. Each incremental improvement consists of 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) describes the contribution of teamwork to make the concept of Kaizen. The key role and authority of each supervisor as a leader of his team has been described by taking an example of Nissan Motor Plant in the UK. Emphasis is placed on teamwork, flexibility and quality. Teamwork and commitment do not come from involving the representatives of employees, but from direct contact and communication between the individual and his boss.

Teian (1992) describes 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) explain that Kaizen generates process-oriented thinking since processes must be improved before better results are obtained. Improvement can be

divided into 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—improvements in the status quo as a result of large investments in new technology and equipments or a radical change in process design using Business Process Re-engineering (BPR) concept.

Bassant and Caffyn (1994) define 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 CI tools and techniques. As an organization-wide process, CI requires the efforts of all employees at every level.

Deming (1995) highlights 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 of them are in a constant state of flux. This highly competitive and constantly 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) explains that the way to achieve fundamental improvement on the shop floor is to enable operators to establish their own measures, to align business strategies and to use them 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) describe 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 phrase 'do it better each time' (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.

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

Womack and Jones (1996) refer to Kaizen as a lean thinking and lay out a systematic approach to help organizations systematically to reduce waste. They describe waste 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

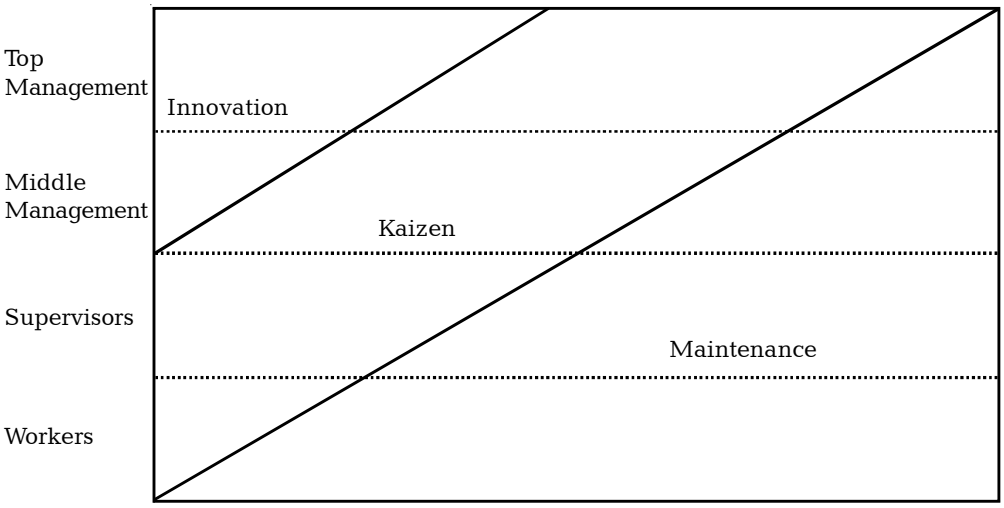
unfortunately the waste that they identify is only the tip of the iceberg. The authors state that until these employees have been taught the essentials of lean thinking, they are unable to perceive the waste actually present in their environment. They provide an example involving preparing a newsletter 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 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 process of Kaizen carries many other benefits as well.

Ghalayini *et al.* (1997) describe 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 lower the 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 the process may be erratic and fragmented.

Imai (1997) describes that the improvement can be divided into Kaizen and innovation. Kaizen signifies small improvements as a result of ongoing efforts. Innovation involves a drastic improvement as a result of large investment of resources in new technology or equipment. The author also explains that 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 (Figure 2).

Williamson (1997) highlights the target costing and Kaizen costing concept, one of the manufacturing techniques, which has been developed in Japan. Target costing is a process, ensuring that the products are designed in such a way that the company can sell them cheaply and still make a fair profit. Kaizen costing focuses on the value and profitability of 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.

Figure 2: Improvement Divided into Innovation and Kaizen



Source: Imai (1997).

Cheser (1998) explains 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 to manufacturing settings, it is now commonly applied to service business processes as well.

Kim and Mauborgne (1999) call incremental improvement as 'imitation' and not 'innovation'. According to them, 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.

Williams (2001) highlights 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) describe 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 events 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) explain that CI can be generated and sustained through the promotion of good improvement model and management support. In fact, it is not easy in reality. The improvement case may fail without carefully examining the problem in the activity.

Hyland *et al.* (2004) highlight 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) describe how to use CI tools in different life periods of the organization. Organizations are facing the problem of which CI tool should be used during different stages and life periods of organization. Methodologies of applying both quantitative and qualitative tools in different life periods of an organization have been discussed.

Review of Literature Related to Case Studies

The case studies are the important means to check the effectiveness of Kaizen philosophy in different fields of applications, especially in manufacturing industries. Many researchers have performed case studies to cover wide range of benefits like increased productivity, improved quality, reduced cost, improved safety and faster deliveries, etc. (Powel, 1999).

Jayaraman *et al.* (1995) demonstrate 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 saving has been obtained.

Radharamanan *et al.* (1996) apply Kaizen technique to a small-sized custom-made furniture industry. The various problems that have been identified through brainstorming process are 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 to meet customer requirements.

Chaudhari (1997) describes 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 the 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 collaboration between Morris and Hitachi metals and its impact on the development of the higher-level competencies.

Sheridan (1997) has applied Kaizen events to Allied Signal Inc., jet engine manufacturing industry to overcome the difficulties like low production rates and large floor space requirements. The result indicates 89% improvement in WIP (work in process), 88.5% increase in productivity and floor space requirements are saved over 2000 sq. ft. by applying Kaizen events.

Erlandson *et al.* (1998) apply 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% and the error rate drops from above 50% to about 1%. 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) explain 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 and simple models of the process are a good way to start.
- Interpreting the results with management can be beneficial.
- Animation features of the simulation give an ability to provide insight into the factory working.

Bond (1999) has 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) has 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. The 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. The results show that the dynamics of CI implementation process is cyclic in nature, which progresses at different speeds and with varying intensity.

Burns (2000) describes the importance of two techniques namely Overall Equipment Effectiveness (OEE) and set up 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 business-70 capital equipment CNC machines.

Chen *et al.* (2000) apply 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% of the unit cost, reduces floor space requirement by 15% and it also develops a better communication network throughout the organization.

Lee (2000) has 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) describe 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 100 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 the existing system in all manufacturing-focused programs to assure that graduates are sufficiently familiar with this important concept.

Ashmore (2001) discovers that Kaizen is a hardheaded weapon in hard–pressed manufacturing industries. Kaizen technique has been applied to Toyota in response to increasing competition and costs. It has found that after implementation of this technique, the sale is increased by multiple of not less than 69% and its profit by 54 times in an economic year. The author has also discussed the role of SS by eliminating waste and JIT in making CI.

Palmer (2001) has 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 hours to 290 hours. Ultimately the Kaizen event results in saving well over million dollars per year.

Ahmed *et al.* (2005) conduct a study in a casting based manufacturing plant, which is currently implementing Kaizen to achieve higher productivity. The study has focused on 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) study the target and Kaizen costing concept in a construction 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 the construction company by assuring value for the customer at a low but profitable price.

Dehghan *et al.* (2006) describe the case study of Kaizen project that is performed by National Productivity Improvement Program (NPIP), at Chaharmahal-Bakhtiari 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 and decrease in financial expenses result in increasing the satisfaction level of both domestic and foreign customers. Results show the decrease in 11% stations, decrease in 11.7% moving around, 16% time saving, 34.2% length decrease and 53% saving in transportation cost.

Vaidya and McCartney (2006) explain the application of Kaizen to welding operations by taking two examples of a small sample of over 100 welding performance appraisals that has been carried out in Canada in recent years. To control semiautomatic welding processes, 27 different parameters have to be controlled to ensure quality of the weld. The authors suggest that Kaizen should be applied to three welding parameters including wire feed speed, welding technique and welding speed, as a start. He also explains that it requires the involvement of everyone in the organization. By following these rules, spectacular results can be produced.

Kikuchi *et al.* (2007) aim at applying OEE method to cost reduction by using Kaizen technique to a semiconductor industry. The consumption of gases and chemicals for a specific process is very high. Two different methods of Overall Consumable Effectiveness (OCE) technique are adopted to reduce the consumption of gases and chemicals for 12-items. The result indicates a cost reduction of 7% annually for the use of gases and chemicals. This experience has raised the awareness that the Kaizen process can be applied to other areas also.

Chandrasekaran *et al.* (2008) apply Kaizen technique to solve the 'part mismatch problem' 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 saving.

Reviews of Literature Related to Surveys

Surveys are the effective means to check the performance of different Kaizen practices, determining the extent of use of these practices and to check how the industries are deploying various Kaizen practices to achieve their goals.

Gibb and Davies (1990) have identified and highlighted the 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) investigate 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 innovative management in French SMEs. The respondents are asked to consider a recent and successful innovation of a product and then to indicate just how important the number of items used as a source of particular innovation. The top nine sources of innovation that have been found are introduction of the new product, CI of work processes, radical change (e.g., through business

process re-engineering), increased focus in marketing/sales efforts, reduction of indirect staff numbers, improvement of staff competence, improvement of the quality of product and services, improvement of the quality of management, and 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 the 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.

Based on the survey in a small-scale manufacturing company, Irane and Sharp (1997) suggest that CI strategy should be ingrained as a belief into the employees' heart. The ideal situation of CI strategy is its integration with the corporate culture.

Bassant (2000) presents a survey that has been conducted by CI Research Advantage (CIRCA) at UK firms. The survey suggests that 65% of companies consider CI to be important strategically, around 50% have instituted some form of systematic program to apply these concepts, 19% claim to have a widespread and sustained process of CI in operation, and of those firms using CI, 89% claims that it has an impact on productivity, quality, delivery performance or combination of these.

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

Mackle (2000) presents a survey conducted by a Kaizen institute that has been designing and implementing various CI programs in most of the companies in UK. The institution has conducted a survey with all of its 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) presents 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 multiple regression analysis. The author concludes that CI innovation management strategy and system are significant predictors of SME performance.

Gonsalves (2002) performs a survey on 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) perform a survey in 105 Spanish and 50 Pakistani companies to analyze the outcome of CI practices carried out in these industries. The questionnaire is circulated to different industries. Twelve CI tools have been investigated. The result shows that the Spanish industries utilize these tools more than Pakistani industries. The Spanish industries are comparatively more experienced and advanced than Pakistani industries.

Tseng *et al.* (2006) investigate the effects of CI and cleaner production on operational performance. A total of 223 responses have been obtained after distribution of the questionnaire. A sample 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) conduct a survey by using the data of 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. The 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) conduct a survey by a 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 the improvement activities, effects of improvement activities and company background and its characteristics. The result shows that the industries in both of the countries are deploying CI methodologies, but with different proportions.

Conclusion

From the literature, it can be concluded that there is a reasonably vast literature available on Kaizen philosophy, which gives a broad view of past practices and researches carried across the globe. But as Kaizen is a widely accepted philosophy in manufacturing industries, more research work is required in this field. The authors feel that Kaizen philosophy can also be applied to different areas like business, service, commerce, etc. So a great scope of research is available for new researchers in this field. Success stories reveal that it requires team efforts involving every employee in the organization to fully implement the system. However, awareness among employees regarding different strategies that are involved in Kaizen philosophy, various principles behind these strategies and the use of these strategies in different circumstances plays

an important role. So more research is required which could improve the awareness aspects, as these factors are highly important for the success of the Kaizen philosophy in most of the manufacturing industries across the globe. ❖

References

1. Abdolshah M and Jahan A (2006), "How to Use Continuous Improvement Tools in Different Life Periods of Organization", IEEE International Conference on Management of Innovation and Technology, Vol. 2, pp. 772-777, Singapore.
2. Adams M, Componation P, Czarnecki H and Schroer B J (1999), "Simulation as a Tool for Continuous Process Improvement", Proceedings of Winter Simulation Conference, Vol. 1, pp. 766-773, Phoenix, USA.
3. Ahmed S, Hassan M H and Fen Y H (2005), "Performance Measurement and Evaluation in an Innovative Modern Manufacturing System", *Journal of Applied Sciences*, Vol. 5, No. 2, pp. 385-401.
4. Ashmore C (2001), "Kaizen and the Art of Motorcycle Manufacture", *Manufacturing Engineer,* Vol. 80, No. 5, pp. 220-222.
5. Bassant J and Caffyn S (1994), "Rediscovering Continuous Improvement", *Technovation,* Vol. 14, No. 1, pp. 17-29.
6. Bassant J (2000), "Developing and Sustaining Employee Involving in Continuous Improvement", IEE Seminar, Kaizen: From Understanding to Action (Ref. No. 2000/035), Vol. 2, pp. 1-18, London, UK.
7. Bond T C (1999), "The Role of Performance Measurement in Continuous Improvement", *International Journal of Operations and Production Management*, Vol. 19, No. 12, pp. 1318-1334.
8. Brunet P (2000), "Kaizen in Japan", IEE Seminar, Kaizen: From Understanding to Action (Ref. No. 2000/035), Vol. 1, pp. 1-10, London, UK.
9. Burns A (2000), "Choosing the Right Tool from the Tool Box: Some Examples of Gemba Kaizen Practice", IEE Seminar, Kaizen: From Understanding to Action (Ref. No. 2000/035), Vol. 6, pp. 1- 10, London, UK.
10. Chandrasekaran M, Kannan S and Pandiaraj P (2008), "Quality Improvement in Automobile Assembly Production Line by Using Kaizen", *Manufacturing Technology Today*, Vol. 7, No. 3, pp. 33-38.
11. Chaudhari S (1997), "Kaizen at Morris Electronics: Key to Competitive Success", *Portland International Conference on Management and Technology,* p. 365, Portland, USA.
12. Chen C I and Wu C W (2004), "A New Focus on Overcoming the Improvement Failure", *Technovation*, Vol. 24, pp. 585-591.

13. Chen J C, Dugger J and Hammer B (2000), "A Kaizen Based Approach for Cellular Manufacturing Design: A Case Study", The Journal of Technology Studies, Vol. 27, No. 2, pp. 19-27.

14. Chen J C, Dugger J and Hammer B (2001), "A Kaizen Based Approach for Cellular Manufacturing Design: A Case Study", *The Journal of Technology Studies*, Vol. 27, No. 2, pp. 19-27.

15. Cheser R N (1998), "The Effect of Japanese Kaizen on Employee Motivation in US Manufacturing", *International Journal Organizational Analysis*, Vol. 6, No. 3, pp. 197-212.

16. Dean M and Robinson A (1991), "America's Most Successful Export to Japan: Continuous Improvement Programs", *Sloan Management Review*, Vol. 3, p. 67.

17. Dehghan R, Zohrab M, Momeni A and Hoseini M (2006), "Continuous Improvement Approach in the Agriculture Sector", *Asian Pacific Productivity Conference*, Seoul National University, South Korea, available on http://www.fdp.ir

18. Deming W E (1995), *The New Economics for Industry Government and Education*, 2nd Edition, MIT Press, Cambridge, MA.

19. Deniels R C (1995), "Performance Measurement at Sharp and Driving Continuous Improvement on the Shop Floor", *Engineering Management Journal*, Vol. 5, No. 5, pp. 211-214.

20. Deniels R C (1996), "Profit-Related Pay and Continuous Improvement: The Odd Couple", *Engineering Management Journal*, Vol. 6, No. 6, pp. 233-236.

21. Doolen T L, June W Q, Akan V, Eileen M and Jennifer F (2003), "Development of an Assessment Approach for Kaizen Events", *Proceedings of the 2003 Industrial Engineering and Research Conference*, CD-ROM.

22. Erlandson R F, Noblett M J and Phelps J A (1998), "Impact of Poka-Yoke Device on Job Performance of Individuals with Cognitive Impairments", *IEEE Transactions on Rehabilitation Engineering,* Vol. 6, No. 3, pp. 269-276.

23. Ghalayani A M, Noble J S and Crowe T J (1997), "An Integrated Dynamic Performance Measurement System for Improving Manufacturing Competitiveness", *International Journal of Production Economics*, Vol. 48, No. 2, pp. 20-25

24. Gibb A and Davies L (1990), "In Pursuit of Frameworks for the Development of Growth Models of the Small Business", *International Small Business Journal*, Vol. 9, No. 1, pp. 15-31.

25. Granja D A, Picchi F A and Robert G T (2005), "Target and Kaizen Costing in Construction", Proceedings IGLC-13, Sydney, Australia, pp. 227-233.

26. Gonsalves G C (2002), "Business Process Management: Integration of Quality Management and Reengineering for Enhanced Competitiveness", Pro-Quest Information and Learning Company, Vol. 7, No. 1, pp. 120-128.

27. Hammer M, Champy J and Tathan R L (1993), *Reengineering the Corporation: A Manifesto for Business Revolution*, Harper Collins, New York.

28. Hongming H, Sun H and Xu Y (2000), "An Empirical study on Quality Management Practices in Shinghai Manufacturing Industries", *Total Quality Management*, Vol. 11, No. 8, pp. 1111-1122.

29. Hyland P W, Milia L D and Terry R S (2004), "CI Tools and Technique: Are There any Difference Between Firms?" Proceedings 5th CINet Conference, Sydney, Australia.

30. Imai M (1986), *Kaizen: The Key to Japan's Competitive Success*, McGraw Hill, New York, USA.

31. Imai M (1997), *Gemba Kaizen: A Commonsense, Low Cost Approach to Management*, McGraw Hill, New York, USA.

32. Irane Z and Sharp J M (1997), "Integrating Continuous Improvement and Innovation into a Corporate Culture: A Case Study", *Technovation*, Vol. 17, No. 4, pp. 225-226.

33. Jayaraman A, Green J A and Gunal A K (1995), "Continuous Improvement Applied to Simulation Modeling: A Case Study", *Proceedings of Winter Simulation Conference*, pp. 930-935, Arlington, USA.

34. Kikuchi K, Kikuchi T and Takai T (2007), "Method of Overall Consumable Effectiveness", *IEEE International Symposium on Semiconductor Manufacturing*, pp. 1-4, Santa Clara, USA.

35. Kim W C and Mauborgne R (1999), "Strategy, Value Innovation and the Knowledge Economy", *Sloan Management Review*, Spring, pp. 41-54.

36. Lee M (2000), "Customer Service Excellence Through people motivation and Kaizen", IEE Seminar, "Kaizen: from Understanding to Action" (Ref. No. 2000/035), Vol. 5, pp. 1-21.

37. Lee S S, Dugger J C and Chen J C (2000), "Kaizen: An Essential tool for Inclusion in Industrial Technology Curricula", *Journal of Industrial Technology*, Vol. 16, No. 1, pp. 1-7.

38. Mackle K (2000), "A Framework for Implementation of Kaizen Management System Audit", IEE Seminar, "Kaizen: From Understanding to Action" (Ref. No. 2000/035), Vol. 3, pp. 1-6.

39. Malik S A, Li-bin L, YeZhuang T and Xiao-Lin S (2007), "Continuous Improvement Practices in Asian Developing Countries: A Comparative Analysis Between Chinese and Pakistani Manufacturing Industry", 14th International Conference on Management Science and Engineering, pp. 692-697, Harbin, PR China.

40. Malik S A and YeZhuang T (2006), "Execution of Continuous Improvement Practices in Spanish and Pakistani Industry: A Comparative Analysis", IEEE International Conference on Management of Innovation and Technology, Vol. 2, pp. 761-765, Singapore.

41. Newitt D J H (1996), "Beyond BPR and TQM—Managing the Processes: Is Kaizen Enough?", Proceedings of Industrial Engineering, pp. 1-5, Institution of Electric Engineers, London, UK.

42. Palmer V S (2001), "Inventory Management Kaizen", Proceedings of 2nd International Workshop on Engineering Management for Applied Technology, pp. 55-56, Austin, USA.

43. Powel J A (1999), "Action Learning for Continuous Improvement and Enhanced Innovation in Construction", Proceedings of IGLC-7, pp. 433-444, University of California, USA.

44. Radharamanan R, Godoy L P and Watanabe K I (1996), "Quality and Productivity Improvement in a Custom-Made Furniture Industry Using Kaizen", *Computer and Industrial Engineering*, Vol. 31, Nos. 1/2, pp. 471-474.

45. Reid R A (2006), "Productivity and Quality Improvement: An Implementation Framework", *International Journal* of *Productivity and Quality Management*, Vol. 1, Nos. 1/2, pp. 26-36.

46. Savolainen T I (1999), "Cycles of Continuous Improvement: Realizing Competitive Advantage Through Quality", *International Journal of Operation and Production Management,* Vol. 19, No. 11, pp. 1203-1222.

47. Sheridan J H (1997), "Kaizen Blitz", *Industry Week*, Vol. 246, No. 16, pp. 18-27.

48. Soderquist K (1996), "Managing Innovation in SMES: A Comparison of Companies in UK, France and Portugal", *International Journal of Technology Management*, Vol. 12, No. 3, pp. 291-305.

49. Suzaki K (1987), *The New Manufacturing Challenge-Techniques of Manufacturing Systems*, John Wiley and Sons, Inc., New York.

50. Teian K (1992), *Guiding Continuous Improvement Through Employee Suggestions*, Productivity Press, Portland, US.

51. Terziovski M (2001), "The Effect of Continuous Improvement and Innovation Management Practices on Small to Medium Performance", Proceedings of 5th International Conference on Quality and Innovation Management, pp. 1-22, Euro-Australian Co-Operation Centre for Global Management.

52. Tseng M L, Chiu A S F and Chinag J H (2006), "The Relationship of Continuous Improvement and Cleaner Production on Operational Performance: An Empirical Study in Electronic Manufacturing Firms, Taiwan, China", *International Journal of Management Science and Engineering Management,* Vol. 1, No. 1, pp. 71-80.

53. Vaidya V and McCartney A (2006), "Applying Kaizen to Welding Operations", *Canadian Welding Association Journal*, International Institute of Welding Special Edition, available on http://www.cwa-acs.org

54. Watson M (1986), *The Deming Management Method*, Perigee Books.

55. Wickens P D (1990), "Production Management: Japanese and British Approaches", *IEE Proceedings Science, Measurement and Technology,* Vol. 137, No. 1, pp. 52-54.

56. Williamson A (1997), "Target and Kaizen Costing", *Manufacturing Engineer*, Vol. 76, No. 1, pp. 22-24.

57. Williams M (2001), "Maximum Cost Reduction Minimum Effort", *Manufacturing Engineer*, Vol. 80, No. 4, pp. 179-182.

58. Womack J P and Jones D T (1996), *Lean Thinking*, Simon & Schuster, New York.

59. Yan-jiang C, Dan W and Lang X (2006), "Influencing Factors of Continuous Improvement and Tendency to Change", *IEEE International Conference on Management of Innovation and Technology,* Vol. 1, pp. 181-185, Singapore.

60. Yan-jiang C, Lang X and Xiao-na W (2006), "Empirical Study of Influencing Factors of Continuous Improvement", *International Conference on Management Science and Engineering*, pp. 577-581, Lille, France.

61. Yeo C H, Goh T N and Xie M (1995), "A Positive Management Orientation for Continuous Improvement", *Proceedings of IEEE Annual Engineering Management Conference on 'Global Engineering Management: Emerging Trends in the Asia Pacific'*, pp. 208-213, Dayton North, USA.

Annexure

Table 1: Works on the Concept of Kaizen Philosophy	
Author and Year	**Key Findings**
Imai, 1986	Kaizen means continuing improvement involving everyone in the organization.
Watson, 1986	The Deming or PDCA (Plan-Do-Check-Act) cycle is a continuous quality improvement model modified from the Shewart cycle.
Suzaki, 1987	Kaizen signifies incremental improvements and each incremental improvement consists of many phases of development.
Wickens, 1990	The author discusses the role of teamwork to make through the concept of Kaizen by taking an example of Nissan Motor Plant.
Teian, 1992	Kaizen is more than a means of improvement and can be applied to any area in need of improvement.
Hammer *et al*., 1993	Kaizen signifies small improvements and it generates process oriented thinking.
Bassant and Caffyn, 1994	Kaizen means incremental innovation and this incremental innovation is supported by many tools and techniques.
Deming, 1995	To compete in this highly competitive and constantly changing environment, managers have embraced the Kaizen philosophy.
Deniels, 1995	The author describes the role of operators in achieving fundamental improvement on the shop floor and performance measurement in fashioning the world class company.
Yeo *et al*., 1995	'Zero Defects' and 'Do it better each time' are the important ways of making CI.
Newitt, 1996	Kaizen in business process management provides a climate in which creativity and value addition can flourish.
Womack and Jones, 1996	The authors refer to Kaizen as lean thinking and a way to reduce waste by taking an example of preparing a newsletter for mailing.
Ghalayini e*t al*., 1997	Kaizen can be easily generated by identifying problems on the shop floor, proposing solutions and making small changes in the system.
Imai, 1997	Kaizen means small improvements. Improvement can be broken down into Kaizen and innovation. Maintenance and improvement are the major functions to be performed by management under Kaizen.
Williamson, 1997	The author describes the role of target costing and Kaizen costing concepts in making continuous improvement.

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Table 1: Works on the Concept of Kai□en Philosophy	
Author and Year	**Key Findings**
Cheser, 1998	Kaizen signifies small changes and a way to achieve different benefits by reducing waste.
Kim and Mauborgne, 1999	Kaizen strategy emphasizes mainly on value and customers and this will make this strategy to go beyond incremental improvements.
Williams, 2001	Quality Function Deployment is a CI technique of making significant reduction in production costs.
Doolen *et al.,* 2003	The authors describe different variables that are used to measure the impact of Kaizen events on human resource.
Chen and Wu, 2004	Continuous improvement can be easily achieved by careful investigation of the problems.
Hyland *et al*., 2004	Increased business and people performance are the major potential benefits of continuous improvement.
Abdolshah and Jahan, 2006	The authors describe the methodologies of applying CI tools in different life periods of the organizations.

Table 2: Case Studies Related to Kai□en Philosophy	
Author and Year	**Key Findings**
Jayaraman *et al*., 1995	The authors describe the application of continuous improvement approach in simulation model development.
Radharamanan *et al*., 1996	Kaizen technique aims at developing the product with higher quality, lower cost and higher productivity in a furniture Industry.
Chaudhari, 1997	The author demonstrates the application of Kaizen in improving productivity and sustained competitiveness at Morris Electronics Limited.
Sheridan, 1997	The author describes the benefits of Kaizen event in Allied Signal Inc., a jet engine manufacturing industry.
Adams *et al*., 1999	The authors describe the application of simulation approach to make continuous process improvement.
Bond, 1999	The author identifies the key performance factors by studying Kaizen and re-engineering programs in a company, manufacturing surgical products.
Savolainen, 1999	Two case studies have been performed to increase the understanding of the processes and dynamics of continuous improvement implementation.

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Table 2: Case Studies Related to Kaizen Philosophy	
Author and Year	**Key Findings**
Burns, 2000	The author describes the importance of continuous improvement methodologies namely OEE and set up reduction in Weston EU company.
Chen *et al*., 2000	The authors describe the application of Kaizen technique to a cellular manufacturing designing system.
Lee, 2000	The paper describes the application of Kaizen methodologies like 5S and team training to a company manufacturing food products.
Lee *et al*., 2000	The paper describes the steps to implement lean thinking in a company manufacturing tri-resin fiberglass rod.
Ashmore, 2001	Kaizen technique aims at increasing sales and profit in Toyota.
Palmer, 2001	The author demonstrates the application of Kaizen in removing muda at 'BAE SYSTEM'.
Ahmed *et al*., 2005	The paper describes the case study of casting-based manufacturing plant currently implementing Kaizen technique by taking into account of the performance indicators.
Granja *et al.,* 2005	Two matching approaches namely target and Kaizen costing contributes towards continuous improvement.
Dehghan *et al*., 2006	The paper describes the advantages of applying Kaizen methodologies including 5S and process improvement at Chaharmahalbakhtiari Agriculture Organization.
Vaidya and McCartney, 2006	The authors explain the application of Kaizen in controlling different welding parameters by taking two examples.
Kikuchi *et al*., 2007	Kaizen methodology namely OEE aims at reducing consumption of gases and chemicals in a semiconductor industry.
Chadrasekaran *et al.,* 2008	The authors describe the application of KAIZEN technique to solve the part mismatch problem in automobile assembly production line.
Gibb and Davies, 1990	The authors describe the critical success factors of continuous improvement and innovation strategy in Australian SMEs.
Soderquist, 1996	The authors examine the drivers of change, the sources of innovation and the nature of innovation management in French SMEs.

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Table 3: Studies on the Application of Kai□en Philosophy in Other Fields	
Author and Year	**Key Findings**
Irane and Sharp, 1997	The authors discuss the ideal situation of implementing continuous improvement approach.
Bassant, 2000	The outcomes of the survey performed by CI research advantage at UK firms have been described in the paper.
Hongming *et al.*, 2000	The authors describe the situations of achieving significant impact of CI approach based on a survey in Chinese companies.
Mackle, 2000	The results of the survey performed by Kaizen institute at UK firms have been described in the paper.
Terziovski, 2001	The author investigates the relationship between CI and innovation practices in Australian SMEs.
Gonsalves, 2002	The author describes the effect of ERP and CI on the performance of manufacturing companies.
Malik and YeZhuang, 2006	The authors compare the extent of utilization of continuous improvement tools in Spanish and Pakistani industries.
Tseng *et al.*, 2006	The paper investigates the effect of CI and cleaner production on operational performance.
Yan-jiang *et al.*, 2006	The survey analyzes the influencing factor of continuous improvement by using the data of global CI innovation network.
Malik *et al.*, 2007	The authors investigate the level of deployment of CI methodologies in China and Pakistan.

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