ABSTRACT

Purpose – The purpose of this paper is to investigate what distinguish effective continuous improvement approaches.

Design/methodology/approach – The empirical data was collected through interviews on several managerial levels in seven different companies. The companies were purposely selected to represent different resource consumption and outcome from their improvement work.

Findings - There are four different types of improvement approaches, parallel, integrated, coordinated and project. Companies with a project approach manage to realize minor improvements only, companies with parallel or coordinated approaches reach significant improvements but use more resources than companies with an integrated approach.

Practical implications – The paper shows and explains why project based improvement ought to be avoided, at the same time highlighting the benefits of an integrated approach with a strong emphasis on learning.

Originality/Value – This paper contributes to theory and practice by providing empirically based explanation to the outcome of different improvement approaches.

Keywords – Continuous improvement, Improvement approach, Improvement efficiency

Paper Type- -Research paper

1 INTRODUCTION

The last few decades have brought dramatic shifts with fierce competition from competitors that operate factories in low wage countries. In order to survive under these conditions still having the factories in western countries one critical competence is an organizations ability to manage changes and introduce assiduous improvement work for instance continuous improvement (CI). Several studies have shown a substantial potential for improvement even in companies that have an excellent reputation for CI (Imai, 1986, Liker 2004). For example, Doig et al. (2001) conclude that most manufacturers can still achieve 20 to 30% gains in direct-labour productivity. Another study demonstrates that easy adjustments can improve efficiency in assembly lines with at least 26% (Johansson & Kinnander, 2004). Liker (2004) provides an example showing a productivity improvement of 83% in a company that before the change had functioned as a role model for an effective company.
However it is far from easy to realize the potential. For example figures presented by Harari (1993), show that between 67% and 80% of TQM programs in United States and Europe have failed. Similar figures are presented by Jacobs (2002) who refers to an A.T. Kearney (1999) study that illustrates that only 20% of change projects are successful, while 63 % fail to make sustainable improvements and 17 % have no impact whatsoever. A major problem with these high failure rates is that it inoculates the organization against learning and change in the future (Asif et al, 2009).

One key factor to consider is the organization of the improvement work. An ideal improvement approach should result in substantial improvements combined with low resource consumption. The ratio between resource consumption and change in performance describes the efficiency of a change process (cf Harrington 1991). In several (Toyota production system, Lean) improvement concepts the focus is on eliminating waste. Waste in terms of improvement can be for instance not reaching sustainable improvements or using an excess of resources.

The paper is based on a multiple case study consisting of seven cases. The companies used different approaches for the organization of their improvement work, two approaches distinguish, one for having a high performance/resources ration and the other for having a low. The purpose of this paper is to investigate what distinguish effective continuous improvement approaches and the mechanisms behind the differences. More specifically, three questions are posed: What different approaches are used to improve performance? How efficient are different improvement approaches. How can the differences between the approaches be explained?

The paper is structured as follows. Next, the theoretical framework is outlined, which discusses organisation of continuous improvement in production and some bases for understanding the dynamics of innovation implementation in general. Then the research design is described. The following chapter present empirical data combined with in-case analysis. The in-case analysis is followed by a cross-case analysis. Finally the conclusions are drawn and the scientific contribution highlighted.

2 CONTINUOUS IMPROVEMENT IN MANUFACTURING

This chapter starts by discussing different key elements of CI based on some established, albeit different definitions of CI. This is followed by a framework for analyzing different CI approaches. The final part consists of a description of a simulation based approach to understand the dynamics of innovation implementation.

2.1 CI key elements

Traditionally CI was seen as binary, i.e. no CI or CI (Bessant et al, 2001), but it is increasingly considered as an evolutionary process where organizations reaches different levels as CI work matures (Bessant et al, 2001, Gertsen, 2001). For instance, Bessant et al (2001) proposes that the ultimate level of CI is the learning organization. Linking CI and learning is essential for facilitating organizational change processes (Busk-Kofoed et al, 2002) and Toyotas ultimate goal is to build a learning organization (Liker, 2004). Related to this is that managers at companies that successfully implement CI tend to have a process oriented focus, whereas managers at less successful firms had a result-oriented focus. Explanations for the detected differences is that process oriented managers tend to be more patient and focus on constant improvements that render long-term improvements (Liker 2004).

Moreover, Davidson et al. (2005, p. 197) argue that CI is “more than a manufacturing approach, it needs to be a way of life”, while Ehie and Sheu (2005) put a greater emphasis on CI in relation to methods such as six sigma and theory of constrains that improves manufacturing system performance. Another view is that CI is an approach for “improving organizational performance, with small incremental steps, over time” (Irani & Sharp, 2001 p 199). Rather than emphasizing filosphy or method used, this view stresses output in relation to probability that improvements will
continue over time. Others emphasize that CI must be a bottom-up approach such as Gertsen (2001, p. 304) who argues that CI is “an improvement process that is systematically applied, carried out in small steps, and to a large extent relies on employee participation”. All in all, there are different elements of CI and key elements include context in which improvements take place (i.e. manufacturing), kind of improvement that is realized (i.e. small steps), how it is realized (i.e. endurance, systematic principles), and by whom (i.e. employee participation). In fact, it is plausible to argue that a CI definition, as well as practical work, must entail all these elements if changes are going to improve organizational performance. This paper therefore defines CI as “an improvement process that is systematically applied, improves organizational performance, is carried out in small steps, is sustainable and to a large extent relies on employee participation”.

2.2 Organizational approaches for CI

Generally speaking, there are three basic approaches when working with CI: parallel, integrated and coordinated (Berger, 1997). First, a parallel approach means that improvements are separated from production processes and direct labour. Improvements are analysed and implemented by individual experts, or by small groups including cross-functional teams and project groups with limited involvement from operators (Docherty, 1996). Since it is not always possible for operators to determine the best overall solution, it is argued that this approach is suitable for handling improvements that are embracing, require investments and expertise. An advantage is that the approach is relatively easy to implement (Hart et al., 1996). In addition, cross-functional teams enable creation and transfer of knowledge across organizational boundaries (Karlsson & Åhlström, 2000). A disadvantage is that operators might resist change due to limited involvement and companies can easily overlook the large number of improvements that operators may be aware of, which can result in that significant improvement opportunities are unexploited.

Second, an integrated approach means that improvements are a part of the production process. They are analysed and implemented by operators individually, or in groups. It is, therefore, necessary to empower operators to implement improvements. The operators have two main tasks one is to produce and the other is to improve. In an integrated approach there is a supporting system for the operators to do the improvement work and time is allocated specifically for improvement work. An advantage is that this autonomy provides operators freedom and support to generate, transfer and utilize knowledge within daily work. This could lead to considerable improvement (Ellström, 2000; Nonaka, 2004). Disadvantages include difficulties to create the necessary commitment (Hart et al., 1996).

Third, a coordinated structure means that elements from both the parallel and integrated structure are combined. Some improvements are handled by experts and others are handled by operators. Depending on where the dividing line between experts and operators are drawn the coordinated structure can be more or less of the expert or integrated type. If for instance only a small amount of rather self evident improvements such as putting up a shelf or a new hook are done by the operators and all other improvement work is done by experts then the that specific coordinated structure will have almost the same strengths and weaknesses as the expert approach. If on the other hand operators do almost all the improvement work using experts only as a specific source of qualified knowledge then the strengths and weaknesses for this coordinated approach has great resemblance with those of the integrated approach.

Another possibility is that the continuous improvement work has limited endurance. This limited endurance will result in decreased motivation. There is a motivational threshold that has to be reached, if the threshold is not reach then the commitment for the innovation will fade, if the threshold is reached then the commitment will reach 100%. If the threshold is reach or not depends on the endurance and level on the normative pressure from the managers. If the managers give up to soon or initially are not totally committed to the innovation the threshold will not be reached and the implementation of the innovation will fail, causing a self fulfilling prophecy. (Repenning, 1999). The situation with limited endurance is termed project approach in this paper.
The role of experts acting as resources for training, advice and trouble shooting is also crucial. Assuming that these experts will allocate their resources on the area that shows positive results these experts will play a critical role in determining the success of an implementation effort (Repenning, 1999).

The analytical framework within this paper is to investigate the different companies approach in term of parallel, integrated, coordinated or project. Another area of interest is to what extent the improvement process is systematically applied and results in sustainable improvements. More specifically, the companies studied are first categorized according to the type of approach and then compared with the CI definition, i.e. to what extent they work with fundamental CI elements. This provides the foundation for determining whether the focus is on process or result, which is important for long-term performance (Liker, 2004). Finally, findings are compared with regard to outcome. By making this kind of comparison, it is possible to evaluate the usefulness of both the proposed CI definition and the different approaches.

3 RESEARCH DESIGN

In order to determine what distinguish effective continuous improvement approaches, a multiple case study was adopted since it provided an opportunity to collect rich, comparative data (Bengtsson et al., 1997; Bourgeois & Eisenhardt, 1988). Point of departure was results from a survey, which indicates that manufacturing organizations can realize significant improvements in production performance despite low input of resources (Von Haartman & Bengtsson 2009). Since the survey did not provide in-depth data that could explain detected differences, the next step was to collect case data that enable comparisons of concrete examples of improvement processes and approaches.

Based on the survey data, seven cases were purposive selected that had stated that they had reached various levels of improvements and had consumed different levels of resources. This allowed for a comparative analysis (Eisenhardt, 1989; Miles & Huberman, 1994). Table I provides an overview of the cases.

<table>
<thead>
<tr>
<th>Company</th>
<th>Industry</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfa</td>
<td>Motor vehicle accessories</td>
<td>World's largest producer</td>
</tr>
<tr>
<td>Beta</td>
<td>Metal frames</td>
<td>Large Swedish actor</td>
</tr>
<tr>
<td>Gamma</td>
<td>Lifting and material handling devices</td>
<td>World's largest producer</td>
</tr>
<tr>
<td>Delta</td>
<td>Motor vehicle components</td>
<td>World's largest producer</td>
</tr>
<tr>
<td>Epsilon</td>
<td>Motor vehicle components</td>
<td>Global actor</td>
</tr>
<tr>
<td>Digamma</td>
<td>Devices for buildings</td>
<td>Nordic leader</td>
</tr>
<tr>
<td>Zeta</td>
<td>Electronic components</td>
<td>Global actor</td>
</tr>
</tbody>
</table>

In total, 37 semi-structured interviews were carried out to allow for the case’s specific characteristics to emerge without restricting cross-case comparisons (Kvale, 1996; Miles & Huberman, 1994). The vast majority of the recorded face-to-face interviews were transcribed to promote reliability (Dahmström, 2000). In addition, notes were taken during the numerous informal discussions that took place. The cases were studied by one of the authors, but interview questions and data collected was carefully reviewed by both authors. The selection of respondents was done on a judgmental basis in order to embrace different organizational positions and departments. Focus was on the production department and departments for production support. Respondents’ positions ranged from operator to production director. Moreover, production processes were visually
observed as this can provide useful data (Goodson, 2002), data was gathered from the Internet, and company internal documents were consulted whenever possible. The data collection techniques were triangulated in order to improve construct validity (Saunders et al., 2003).

Finally, internal validity was addressed by a pattern-matching data-analysis in two steps: within-case analysis and cross-case analysis (Bengtsson et al., 1997; Bourgeois & Eisenhardt, 1988; Yin, 2003). The first step was undertaken to gain familiarity with each case and to generate a preliminary understanding. The second step allowed for a deeper understanding and involved a search for patterns by comparing variables.

4 PRESENTATION AND WITHIN-CASE ANALYSIS

In this chapter, case descriptions are provided in the form of background material, how the firm work with CI, improvements realized and resource consumption. Each description is concluded with a within-case analysis.

4.1 Alfa

Alfa is the world’s largest manufacturer of a particular kind of car accessories. Volume fluctuations are significant. The product price is only a fraction (<1%) of the car price so customers are not too sensitive to price changes, which means that production costs are secondary to appealing designs. The lack of cooperation between design and production generally results in that production spends a great deal of resources on improvements to adjust the production process to new designs. In order to secure production volumes, production management believes that Alfa must increase direct deliveries to car manufacturers, which will result in increased cost pressure and they are about to establish routines for CI.

Alfa conducted a pilot study on a sub-process and established that daily capacity can be increased from 220 units to 250 (+14%) with no investments. Apart from this there has been very limited CI-work. Alfa does only to a very limited extent work with the CI elements discussed in the theoretical framework. There has only been one pilot project, which resulted in useful albeit limited improvements. In other words, the focus seems to have been on projects as an engine for improvements rather than small steps. Generally speaking, it is rarely a successful approach to ignore incremental improvements and solely focus on projects (cf Liker, 2004). Moreover, there are no signs indicating that there are sustainability and employee participation in CI-work. Concerning the analytical model, it is therefore clear that Alfa focuses on a project based parallel approach where experts execute projects and the focus is more on results than process. The lack of sustainability will according to Repenning (2002) result in that the motivational threshold is not reached and the motivation will go down to zero.

4.2 Beta

Beta is a large Swedish supplier of metal frames. Volume fluctuations are limited and predictable. The production process and product require skilled operators and it takes a long time to learn the trade.

Beta has managed to improve productivity with 30-40% for a product that was recently ramped-up. A customer wanted Beta to deliver a functionally different product, but with a similar production process. A test product was produced and, according to the production manager, two factors contributed to productivity improvements. First, productivity was improved due to accumulation of produced units. Second, operators continuously searched for improvements. Beta did not use systematic procedures in order to gain these improvements. Investments were restricted to the time it took for two managers to visit other plants. Since Beta used the knowledge of the
operators to find improvement possibilities it has the feature of an integrated approach but since it was applied only on one specific product it is an integrated project.

4.3 Gamma

Gamma is the world’s largest supplier of particular kind of lifting and material handling devices. Volume fluctuations are small. Two years proceeding the study of the firm, Gamma carried out significant structural changes resulting in that one of three factories was closed. In this factory, improvements were carried out on an project basis, if they were carried out at all. The company has therefore realized that the other two plants must adopt a different approach so they are currently implementing more systematic methods in order to improve performance.

Gamma has managed to improve delivery accuracy from 54% to 85% and is approaching the goal of 95%. In addition, stock levels have decreased by 40% and production capacity has improved with 13% with 15% less staff. Hence, the productivity improvement, measured as volume/staff, is 30% or 25% if the effect of increased automation is deducted.

In order to stay competitive, Gamma is restructuring the production from functionally to process oriented. They are also increasing the degree of automation and are considering involving operators to a greater extent by implementing TPM (Total Productive Maintenance). Initially there were resistance from both operators and some managers so it was important to rapidly reach considerable results. The company undertook a process analysis to highlight potentials for improvements, which formed the foundation for production technicians who implemented measures using the PDCA-circle. For example, a more focused and intensified communication structure was implemented via meetings, monthly letters, and visualization of key performance indicators (KPI). According to the Site Manager, one of the most important and easily understood indicators is delivery accuracy. The change also involved implementation of cross-functional project-teams.

Gamma has worked in a more systematic manner with CI and has gained greater improvements in organizational performance compared to Alfa and Beta. In comparison with the theoretical framework, the element of small steps is evident, but it remains to be seen if they are sustainable. The employee participation has so far been limited due to initial resistance, which resulted in that CI is primarily run by experts (although they are involving employees to a greater extent). All in all, CI work is organized as a parallel activity driven by experts. Gamma has so far not reached the threshold where motivation increases.

4.4 Delta

Delta is the world’s largest manufacturer of a particular kind of motor vehicle components with a 75% market share. Volume fluctuations are predictable and limited. Delta has made significant investments in automation so the focus will be on achieving improvements without occurring further investments.

Recently, Delta improved productivity with 62.5% in a hardening process of steel. Assisted by consultants, the company performed a systematic process analysis that highlighted potential improvements that could significantly boost performance. The changes required 100,000 SEK worth of investments, which should be compared with an estimated annual saving of 200,000 SEK. The most significant explanation factor was that time was allocated for production technicians to systematically review the process. In general, the CI work is carried out by the production technicians in improvement projects with low involvement from the operators. The approach is parallel expert driven. When discussing the current situation (telephone interview 2009-08-14) things have changed due to the introduction of new technology. Epsilon has invested in several robots and the operators have been educated by the robot suppliers. Since there were no robot competence within production technology these operators has become the robot experts within the company. The do the troubleshooting on the robots and also directly contact the robot suppliers for additional information. This is an example of increased competence leading to enhanced motivation.
and taking a greater responsibility. Increased competence affects motivation. This is also the case in the next company.

4.5 Epsilon

Epsilon is the most successful company in terms of involving operators and it is done with a systematic approach. The firm is a global supplier of motor vehicle components. Volume fluctuations are limited and predictable. There is a constant pressure to improve the production process due to fierce competition and industry overcapacity.

Epsilon managed to increase the availability of a production line from 63% to 92%, while decreasing total cost per product (excl. material) with at least 20%. During the six-year period, production volumes and automation levels were constant, but the staff was reduced with 78%; hence, productivity measured as volume/staff was improved by 350%.

TPM was implemented in 1997 when the production line was in a poor condition. An educational program was launched that included, for example, preventive maintenance. TPS was, however, gradually replaced by 5S and a daily supervision of key parameters via checklists by operators and weekly supervision by managers, which are now key factors of the improvement process. The project consumed 150 hours and educational costs of 35,000 SEK per employee during the six-year period. Furthermore, in another project the firm implemented Kanban and more frequent deliveries. This resulted in a reduction of WIP (Work In Progress) from 120m SEK to 20m, while stock turnover increased from 13-14 to 60-62.

Epsilon has systematically improved their performance using an approach that is based on improvements in small steps. The performance has gradually improved during the six-year period so elements of sustainability and employee participation (at least among those 22% who are still employed) are evident. The CI-work can therefore be categorized as integrated and group driven. In addition, the CI work is focused on learning and increasing operator competence on a continuous basis, already from the start of the improvement work. Epsilon differs from the previously presented cases to the extent that the measures implemented and the outcomes are more process-connected than result-connected. For example, availability and WIP are process parameters. Since Epsilon has concentrated on increasing the competence of the operators the need for expert help has decreased this shows an alternative to the view of Repenning (2002) that where experts focus their efforts will have a major impact on the result. By increasing the competence level of the operators the need for expert help will decrease and the supply of expert resources will no longer be a bottleneck. The operators are highly motivated “there are many operators that don’t leave work without putting in an improvement suggestion, every day”. (Production manager Epsilon). The high motivation can be connected to the increase in competence since growth need strength (GNS) is one of the moderation parameters in the Hackman-Oldham motivation model.

“Some People have strong need for personal accomplishment, for learning, and for developing themselves beyond where they are now. These people are said to have strong “growth needs” and are predicted to develop high internal motivation when working in a complex challenging job” (Hackman-Oldham, 1980 page 85)

4.6 Digamma

Digamma is the largest Nordic manufacturer of ventilation devices for buildings. Volume fluctuations are large. The company manufactures a large number of variants, resulting in a need for thorough planning in production.

A new Managing Director was appointed in 2003, which lead to an increased focus on CI. This has resulted in improved stock turnover from 4-5 to 16-18 and delivery accuracy from 60% to 90% measured on an annual basis. In order to achieve the results, Digamma implemented an internal consultancy function called Process Excellence (PE) that uses Sex Sigma. Digamma regards Sex
Sigma as a profitable investment since it has lead to structured way to report and analyse production data, and to set clear improvement goals.

For example, the PE-team recently implemented JIT (Just In Time) in a production cell, which resulted in that all stock was removed and WIP was reduced. It also resulted in released floor space and reduced production lead-time. The team ran courses so that operators would understand the underlying theory and need for change. Operator resistance was evident, but persistence turned the opinion around. The new way of working also revealed other problems such as a need to streamline the order process. The project was technically easy to handle since it involved few operators, but it consumed a great deal of energy since the pilot-project could either leverage or restrict other improvement initiatives.

Digamma used to have a proposal box in which operators could submit improvement proposals that was rewarded, if implemented. Due to a number of reasons, the system collapsed when the liable employee left. For example, the system was too bureaucratic and it could take up to two years to process proposals. The common view is, nevertheless, that the system was rather successful in terms of engaging operators. For example, a proposal from an operator led to a 50% reduction of waste, worth 180,000 SEK, by changing the lengths of purchased material. In the new structure the proposal activity will be an integrated part of the production process. Each group of operators will run improvement meetings and the group leader can instantly decide whether proposals should be implemented and financially rewarded. More complicated improvements will be dealt with by one of the cross-functional teams that each production technician will lead. Each individual team will meet approximately every third week and the team constellation will change depending on need.

Digamma approach can be categorized as systematic and it has resulted in improved organizational performance. The kind of improvements varies, but smaller daily improvements are restricted due to the limited operator involvement. CI-work has so far been primarily driven by experts and has therefore been organized as a parallel group approach. The new proposal system has a more coordinated organization but a visit one year later than the original data collection showed little progress within the proposal system area. There has been some focus on learning and improved competence from the operators, but as a whole it has not progressed to any greater extent. There is a process focus with delivery accuracy and inventory turnover as interesting measures. That the initial operator resistance was overcome by persistence fits nicely with the Repenning (2002) model that shows that initially individuals are negative to change but if managers are persistence this will change and motivation for the change will increase.

4.7 Zeta

Zeta is a global supplier of electronic components. Volume fluctuations are very large. One part of the production is characterised by few products and high volumes, while the other part is characterised by numerous products and low volumes.

In 2003 Zeta launched a project, which aimed at reducing cost of poor quality with 65% (or 2.3m SEK), and improving OOE (Overall Operating Efficiency) from 20% to 60% in one of the production lines that specializes on low volume product with high product variety. OOE measures actual performance in relation to theoretical performance (=100%) with regard to process availability, product quality and process performance. The project was initiated due to an order that exceeded production capacity. A systematic review of the cell using Six Sigma has so far led to 77 measures. It was deemed necessary to involve operators in order to have the right competence base in the project group and to establish support among operators. A preliminary analysis points towards a 1500-hour consumption and a payback time of less than 7 months.

Zeta’s improvement work is systematically applied, results in improved organizational performance and is carried out in small steps. Results have been sustained or improved for at least two years to a large extent due to the high degree of operator participation. The organization of CI is coordinated with both expert groups as well as operator driven improvements. From the Repenning (2002) point of view management applied a strong pressure and involved the operators
creating commitment and effort among the operators. The positive results further increased commitment and a positive feedback loop was created.

4.8 Summing up

As Table 2 summarizes, the discussed cases and projects experience a wide range of outcomes with regard to resource consumption and performance improvement. These differences are analyzed in the following chapter.

### Table 2. Summary of improvements by the seven companies

<table>
<thead>
<tr>
<th>Company</th>
<th>Type of project</th>
<th>Productivity improvement</th>
<th>Other improvements</th>
<th>Initiated by</th>
<th>Resource consumption</th>
<th>Main method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfa</td>
<td>Process analysis</td>
<td>15%</td>
<td>None</td>
<td>Production manager</td>
<td>Medium</td>
<td>Process mapping</td>
</tr>
<tr>
<td>Beta</td>
<td>New product</td>
<td>30-40%</td>
<td>None</td>
<td>Customer</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Gamma</td>
<td>New production system</td>
<td>30%</td>
<td>Shorter production lead-time and reduced bound capital</td>
<td>Board of directors</td>
<td>High</td>
<td>PDCA-circle</td>
</tr>
<tr>
<td>Delta</td>
<td>Machine availability</td>
<td>60-65%</td>
<td>Reduced adjustments</td>
<td>Board of directors</td>
<td>High</td>
<td>PDCA-circle</td>
</tr>
<tr>
<td>Epsilon</td>
<td>Machine availability</td>
<td>350%</td>
<td>Availability +50%, manufacturing cost -20%</td>
<td>Board of directors</td>
<td>Low</td>
<td>5S</td>
</tr>
<tr>
<td>Stock reduction</td>
<td>N.A.</td>
<td>Stock turnover from 13-14 till 60-62, WIP from 120m to 20m</td>
<td>Board of directors</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digamma</td>
<td>Implementation of JIT</td>
<td>N.A.</td>
<td>No stock, less WIP; shorter production lead-time</td>
<td>PE-team</td>
<td>Low</td>
<td>Methods within Six Sigma</td>
</tr>
<tr>
<td>Stock turnover</td>
<td>N.A.</td>
<td>Stock turnover from 4-5 to 16-18</td>
<td>MD</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchasing routines</td>
<td>N.A.</td>
<td>Waste down 160,000 SEK (50%)</td>
<td>Operator</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zeta</td>
<td>Process analysis</td>
<td>300% (OOE)</td>
<td>Quality costs down 2,3m SEK</td>
<td>Customer</td>
<td>Medium</td>
<td>Methods within Six Sigma</td>
</tr>
</tbody>
</table>

5 CROSS CASE ANALYSIS

5.1 Approach and outcome

The firms studied adopt different approaches, which can help to explain differences in performance and resource consumption. First, Alfa and Beta lack a CI approach as they work in a project manner. There is little evidence of systematic CI procedures, which is an important element of successful CI (Bessant et al., 2001). Beta works integrated within a project manner and this seems to be more resource effective compared to Alfa which organizes improvement work as a parallel project. At Alfa one of the interviewed operators did not know there was ongoing improvement work. The performance level is lower for companies working in projects than for the other companies. It therefore seems to be safe to conclude that a project approach to CI-work will lead to lower performance and, potentially, at a high cost. Another observation is that integrated projects has a better performance/resources ration than parallel projects.

Second, Gamma, Digamma and Delta use a parallel approach to CI-work. They have realized greater improvements, compared to Alfa and Beta, with a medium to high resource consumption. The utilization of the CI elements is higher than for the project cases, but the degree of employee participation is limited. Thus, while the parallel CI approach is likely to lead to improvements, it could be at the expense of high resource consumption, for example, due to operator resistance.
Third, an integrated approach was adopted by Epsilon that works systematically with CI and manages to improve organizational performance in small steps. In fact, they have successfully involved the operators for six years. The firm emphasizes increasing employee competence and a significant proportion of the resources are spent on operator training. The firm utilizes all CI elements and consumes relatively little resources though performance is among the best of the firms studied.

Fourth, the only firm that had realized a coordinated CI approach was Zeta. The firm has a medium level of resource consumption and a high performance level and work with all CI elements in detail.

The findings above are illustrated in figure 1. On the X-axis is the input of resources to the CI approach within companies. On the Y-axis is the performance of the CI approach i.e. what impact it has made. There is a difference with the performance axis since the improvements are in different areas, productivity, tied up capital, availability of equipment and lead time, the positioning on the Y-axis is an aggregated estimation. The different companies are positioned in the figure and their approach to their CI-work is written in the parenthesis after their names. The positioning and identification of CI approach reveal some important patterns, which does not appear to be context specific, namely that project approaches are significantly underperforming compared to more systematic approaches. Project approaches seem to possess the undesired character of low improvement potential regardless of the level of resource input.

Moreover, parallel and coordinated approaches result in increased performance, but are likely to be more resource consuming than an integrated approach. An explanation may be that a parallel structure of experts consumes more resources, because much time must be spent on convincing the operators that the changes are useful. It seems more efficient if the operators can improve the process as part of their daily work (cf. Liker, 2004). Improvement activities that are not established among the operators will be difficult to implement (Bruzelius & Skärvad, 2004). There are motivational aspects of increased competence (cf Hackman & Oldham, 1989) and this will affect the commitment for the improvement work positively. This will in turn affect the effort allocated to improvement and the results (Repenning, 2002). The increased competence among operators will reduce the need for expert resources which otherwise can be a bottleneck.

Figure 1. Overview of CI approaches and results
Since a vast proportion of all change projects fail, it is vital to further investigate mechanisms behind sustainable CI. In this study, seven companies were studied that had adopted four different CI approaches: project, integrated, parallel and coordinated. Project is an unsystematic approach with low level of endurance. Integrated is where the CI-work is a part of the ordinary work for the employees. With parallel CI there are experts that perform the CI work. Coordinated approach is a mixture between integrated and parallel.

In this study, it is shown that an integrated approach, combined with a focus on learning for the operators, result in high levels of improvements despite low resource consumption. Building competence will increase the motivation (Hackman Oldham, 1989) and increase the commitment-effort and results (Repenning, 2002). That learning is vital for the success of continuous improvement is supported by Oliver (2009).

A parallel approach will be more resource consuming than the integrated but still improve performance. If the quality of the improvement is not (or only to a small extent) affected by the experts then the parallel approach is a waste of resources. To what extent experts are needed or not depends on the competence of the operators and how complicated the production process is. In the case of Epsilon they machined parts to high tolerances and assembled engines. The production process for engines has elements of both high tech and low tech, increasing operator knowledge thus not limited to low-tech production processes. There is however probably a limit where the knowledge needed to improve the production process is beyond what is possible to learn without academic background.

The project approach will result in very limited performance improvements regardless of the level of resources used. That unstructured improvement work is unsuccessful is supported both by Liker (2004) and Repenning (2002). Rather than following new trends in operations management and implementing new methods, this finding suggests that firms should first review and design an overall approach in order to achieve sustainable results.

Based on the findings of this paper, it is possible to conclude that firms that wish to implement or improve CI-work should focus on the overall approach rather than individual systematic methods that has been so actively praised by researchers and practitioners. The overall approach should foster operator driven improvements that are supported by tools such as training programs that focus on learning. This will provide advantages compared to the parallel approach in both the resource consumption dimension since operator creativity is free of charge if they at the same time perform other tasks and in the motivational dimension since increased competence and a possibility to use this knowledge in improvement work will positively affect both the job characteristics and the moderators of the Hackman & Oldham motivational model.

The contributions of this paper consist of three parts. The first is knowledge concerning what different continuous improvement approaches result in. The second is an alternative method to handle the problem of limited supply of experts compared to the Repenning (2002) model. The third is that the factor of increased competence among operators has a strong connection to commitment for the improvement work.

REFERENCES

