Training Practice as Integration of Total Quality Management and Incremental Innovation: Case of K Korean Electronics Company

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I. Introduction

Industries in Korea have many challenges under the rapid changing domestic and international economic circumstances. As Korea has lost the competitive advantage in low wage in the early 1990's, Korean industries have pursued an alternative strategy of improving products' quality and cutting down the costs not by remaining wages low but by removing the inefficiency. In line with the strategy, many companies have introduced the total quality management(hereafter TQM) techniques and tried to implement them company wide. Because of the vicinity in not only geography but culture, management environment as well, Japan's quality management practices have been implanted in Korean industries.

In the early stage, however, the performance was not conspicuous, and the process of implantation into the shop-floor was not smoothly going well all the time. Even some conflicts and resistance took place leading to management crisis from time to time. As going through such difficult early stage, some companies began to come up with big achievement in process incremental innovation as a result of the successful implementation of TQM around late 1990s.

One of the standard examples is the K electronics manufacturer, the company for our case study. The company has become well known for process incremental innovation since it introduced the 6 sigma TQM techniques [1] company-wide in 1997 through benchmarking General Electronics. Of course, it tried to implement many other quality managements before like 100 ppm activities and so on, particularly Japanese style of TQM. The performance, however, is reported to be much higher after the company-wide introduction of the 6 sigma TQM than before. Following the success of the company, the 6 sigma quality management has been spreading out into many other Korean companies.

TQM is a very familiar term in business and academic circles, but surprisingly, there is little consensus on what it means and how it works (Marler, 1998). To deploy TQM company-wide,

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however, most reach to the consensus that TQM training of employees is necessarily required. Kanji(1991) argued that training in TQM should be used to change the culture of the people because the successful implementation of TQM requires not simply installing systems and procedures but cultural change companies as well. Oakland and Waterworth (1995) also paid attention in their study on the role of training as a key element in the successful deployment of TQM. Not only in the academic circles, but also in practice, organizations deploying TQM often train large numbers of employees in problem finding and problem solving techniques (Marler, 1998; Hackman and Wageman, 1995).

The argument for the important role of the training is based on the assumption that trainees in TQM problem finding and solving methods would apply the methods to the dairy work place and so incremental innovation would occur leading to the cost-down, product improvements, lead time reduction, productivity increase. However, the underlying assumption needs to be examined because of few studies showing the clear evidence for positive association between TQM training and incremental innovation. Rather, Marler (1998) suggested implications that training all employees in problem solving methods may not be effective and better performance may be contingent upon how the work is designed and integrated into flexible work and technology.

As mentioned above, TQM training may not lead to good performance in incremental innovation. The effectiveness of TQM training needs to be examined. Accordingly, this study will examine the association between TQM training and incremental innovation. Furthermore, training practice in TQM will be discussed with special attention. The reason is that the 6 sigma TQM K company is implementing has an unique training practice of belt certification institution, integrated part of the TQM. The belt institution will be discussed later in detail.

This study has been done on the basis of data provided by the company and interviews with supervisors, engineers and managers in charge of 6 sigma quality management at Changwon factory and managers at the headquarter of the company in Seoul.

II. Theoretical background

1. TQM and Incremental Innovation

Innovation can be split onto two different types: radical innovation and incremental innovation.

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1) 6 sigma in fact is referring to a level of 3.4 defects out of every million unit in process and final goods, that is 3.4 PPM (parts per million). The level of 6 sigma is evaluated as the apex of quality that a company could reach. A incremental innovation process suggested in the 6 sigma management is called 6 sigma incremental innovation process comprising of DMAIC (the stages of Define, Measure, Analyze, Improve and Control). Briefly explained for each stage of DMAIC, the Define stage is to define what is to be improved and the process to be improved by mapping the process flow. The Measure stage is usually to collect data from many sources and estimate current level of defects, productivity and cost etc. The stage of Analyze is to analyze data collected and identify root causes of defects and opportunities for improvement. The Improve stage is to improve the process targeted with innovate solutions. The Control stage is to keep the improved process on the new course and institutionalize the improvements.

Radical innovation involves a step-change improvement in a state quo as a result of a large investment in new technology and/or equipment in most cases. On the contrary, incremental innovation [2], according to Bessant et al (1994), is defined as “a company wide process of focused and continuous incremental improvement”. Therefore, incremental innovation does not call for a large investment in capital but, rather, continuous and substantial commitment of time and efforts from all levels of management. Accordingly, Terziovski and Sohal (2000) pointed out that investment in incremental innovation means investment in people and Champman and Hyland(2000) mentioned that one of the most important among attractions of incremental innovation strategy is a potential low-cost approach.

On the other hand, TQM is defined as a never ending process of improving work processes according to Palo and Padhi (2003). For the reason of never ending, that is continuous process, in TQM definition, organizations implementing TQM puts considerable emphasis on incremental innovation activities characterized of a continuous low-cost approach. That is, TQM is a company wide activity to aim for cost reduction, time management, product quality and productivity improvement, zero defect, new product development and so on, by pursuing incremental innovation activities, and so eventually to strengthen competitive advantage and organizational performance.

2. Training Transfer and Incremental innovation as a performance of TQM

The incremental innovation process draws on any management tool including suggestion schemes, improvement team, small group problem-solving, statistical techniques, brainstorming or work study. However, the incremental innovation is something beyond a simple issue of incremental innovation techniques, for performance varies with organizations in spite of TQM implementation. Rather, incremental innovation is a result of organizational incremental innovation culture including incremental innovation techniques, employees’ participation, employees’ capability, technical supporting and so on (Palo and Padhi, 2003).

For the reasons, training is necessary not only to teach the incremental innovation techniques but also share the philosophy of incremental innovation company widely. According to Popular practice.

We would like to consider training and incremental innovation performance from two perspectives; improvement in incremental innovation skill and training transfer. Learning on incremental innovation is the first step. Without that, high performance of incremental innovation is not achieved. Therefore, organizations trying to deploy TQM provide company wide training in various ways such as formal off-the-job training, informal on-the-job training at the daily job place and in the project teams as well (Hackman and Wageman, 1995). The first step to achieve high

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2) This is a methodology for incremental innovation, composed of four stages: Plan, Do, Check, and Act. The plan stage consists of studying the current situation, gathering data and planning for improvement. In the Do stage, the plan is implemented on a trial basis. The Check stage is designed to determine if the trial plan is working correctly and if any further problems or opportunities are found. The last stage, Act, is the implementation of the final plan to ensure that the improvements will be standardized and practiced continuously. This leads back to the Plan stage for further diagnosis and improvement. (Terziovski and Sohal, 2000)

incremental innovation performance is that employees need necessarily understand incremental innovation and incremental innovation techniques to apply them to their workplace or in problem solving project team. That is, they must be taught and trained to improve their capability and skill in incremental innovation.

Training transfer is a key element for successful incremental innovation (Marler, 1995, Tesluk et al., 1995). Training transfer is defined as the extent to which training for a specific purpose is used in the intended context (Tesluk et al., 1995). For successful training transfer, enthusiastic involvement of trainees is important factor. Accordingly incentives are necessarily provided to induce employees' participation. Employees should be encouraged and motivated enough so that they may get involved and utilize their improved ability for incremental innovation activities. In this regard, top manager's long-term commitment, incentives and rewards must be given to employees. Successful incremental innovation requires two aspects as explained above; employees' capability enhance through training and education and employees' strong participation led mainly by incentives.

III. Training Practice and Incremental Innovation in K company

1. K Electronics Profile

K Electronics Inc. was established in Oct. 1, 1958 and has grown to have 30,840 employees in Korea and 25,375 overseas, 56,215 in all and to record 14.3 trillion won (15 billion US dollar, approximately) in total revenue and 2.9 trillion won (about 3.1 billion dollar) in ordinary profit as of 2000. K electronics is involved in two business areas: Electronics and Information & Communication. In order to respond to rapidly changing market circumstances, it has been divided to 6 sub-companies strongly independent from one another as well as the headquarter of the whole company: three sub-

Table 1 Factories of Digital Appliance Division

Factory	Location	Major Products	Capacity (in million)	Employees
Changwon 1	Changwon, Kyoungnam	Refrigerator	2.3	2,082
		Microwave Oven	2.3	
		Refrigerator Compressor	6.5	
Changwon 2	Changwon, Kyoungnam	Airconditioner	3.2	2,068
		Washer	1.5	
		Vacuum Cleaner	2.4	
		Airconditioner Compressor	4.3	
Kimhae	Kimhae Kyoungnam	Electronic Motor	19.2	552
Overseas Production Affiliates: 9 in all/4 in China, 1 in England, 1 in Vetnam, 1 in Thailand, 1 in Turkey, 1 in India				

Source: Information provided by K company.

companies get involved in electronics business area and the other three in information & communication.

The three sub-companies involved in electronics business area are Digital Display Company, Digital Multimedia Company and Digital Appliance Company. The object of this case study is limited to only Digital Appliance Company but not the entire K Electronics. As a matter of fact, K company in this study means Digital Appliance Company only. The Digital Appliance Company centers on production for white-color consumer electrics and runs three domestic factories and nine overseas affiliates at present. Its major products, capacity and employees are presented shown in Table 1.

The company had also minus growth rate in total sales in 1998 when Korean economy struggled with finance crisis in the wake of the Asian monetary crisis. Looking at the figure in more concrete, however, exports expanded dramatically in 1998. It was due to the rapid Korean won depreciation. On the contrary, domestic sales declined sharply in the same year due to the influence of the crisis. In 1999 the company turned to the plus growth rate in sales, both in domestic and overseas sales.

2. Background on introduction of 6 sigma

K company introduced 100 PPM quality management tool for the first time in Korean consumer electronics industry and actively implemented to various business areas as well as shop-floor. Thanks to the active implementation of 100 PPM quality management tool, defects had declined considerably for several years. In addition K electronics contributed to spreading of 100 PPM tool to small and medium sized companies. K electronics won the award of 100 PPM Company by government.

However, defects decrease activities through 100 PPM quality management tool had not been so effective since 1994. That's because 100 PPM tool was very effective tool to eliminate defect factor that can be seen but in the case of defects hidden, it is difficult to get rid of them with 100 PPM tool. In fact quality defect cost was defined in the traditional way as being measurable and seeable like inspection, after-service, junk, re-working and so on. This traditionally defined quality defect cost is averagely estimated to only 5 to 8% of total sales. On the contrary, hidden quality defect cost which is difficult to measure is estimated much higher to 15 to 20% of total sales, for instant long cycle time, change in design, over-inventory, delivery retardation, falling down in company credit and so on. K electronics after 1994 had to find new quality innovation tool to replace 100 PPM tool with which the company could not eliminate hidden defect causes.

Table 2 Sales of K company

Sales (in Billion won)	1997	1998 (growth rates)	1999	2000
Domestic	1,732.9	1,076.1 (–37.90%)	1,276.9 (18.70%)	
Exports	1,135.2	1,600.7 (41.00%)	1,755.4 (9.70%)	
Total	2,868.1	2,676.8 (–6.70%)	3,032.3 (13.30%)	5,350

Source: Information provided by K company.

3. Training and skill improvement

The company benchmarked GE in 1996, learned 6 sigma management and implemented it to production process for the first time, and since then the company has gradually expanded the application of the 6 sigma methods company-widely. The 6 sigma process is a little different from the previous incremental innovation process K company adopted. The improvement process of 6 sigma is D-M-A-I-C[1] while the process of the previous one was P-D-C-A[2]. So the company needed to train employees to make them able to apply new incremental innovation methods to workplace.

The company has basically provided two kinds of training to workers; General training and 6 sigma training. General training includes basic educations in various areas such as managerial skill, quality improvement culture and innovative inspiration etc. On the other hand, training for 6 sigma focuses on specific techniques for 6 sigma incremental innovation. According to interviews with persons in charge of incremental innovation education, these techniques such as statistical quality control and other various tools are not completely trained informally on-the-job. Rather, formal off-the-job training is more efficient as to training for incremental innovation. That's why the industry has been increasing formal off the job training more relatively than informal on-the-job training[3).]

Of course, training courses are a little different with departments. In spite of a little difference in training course, the company basically let all employees attend certain hours of 6 sigma incremental innovation training programs on yearly base. (See Table 3).

Needless to say, training must be improving employees' skill on continuous improvement. However, it is almost impossible to see the improved skill after training. K company takes a system of certifications in which there are consisting of 3 certifications; Green Belt (GB), Black Belt (BB) and Master Black Belt (MBB). Due to the certification system, it is possible to some extent to see the skill improvement by looking at the numbers in certification obtainers.

A certain certification is given to trainees who have taken a certain course of 6 sigma incremental innovation, passed exams, and carried out incremental innovation projects practically on the job or in incremental innovation project teams. Black belt[4)] for instant is given to one who necessarily participates in 40-hour black belt training program and then passes the qualification exam consisting

Table 3　Training Hours for 6 sigma

	Shop-floor worker	Sub-Leader	Leader	Foreman	Engineer-level
Trainees (%)	100%	100%	100%	100%	100%
Hours per year	20	30	30	30	40

Source: K company

3) On the other hand, for workers' technical skill Korea has been considerably dependent on informal on-the-job training historically.

4) Black belt is the leader of a project team who is encouraging the project team to achieve epoch-making performance by applying 6 sigma technique to the shop-floor and solving problems scientifically. The role of black belt is to (1) implement 6 sigma projects independently as a leader of project team (2) train team members as an expert on 6 sigma and support team members with scientific and statistic data (3) diffuse the 6 sigma within organization by educating GB and other team members.

of written exam and oral exam and in addition, carries out two 6 sigma improvement projects as a leader of project team. Therefore, certification obtainers can be said to improve their skill on incremental innovation. Employees obtaining certifications have been increasing in number according to data provided by K company (See Figure 1).

The belt certification system has positive effects on employees' motivation. One of the effects is from exclusion effect. Company is easy to distinguish belt obtaining workers form the others so that it can exclude from promotion and various rewards the others who do not obtain a belt. Another is rivalry effect. Given a colleague beside you has got the belt while you have not, you will feel uncomfortable. The colleagues are partner on one hand, however, sometimes rivals on the other hand when it comes to promotion.

Figure 1 shows that belt certification obtainers have outnumbered planned numbers for all years considered. It proves to some extent the fact that the effects of belt certification system explained above stimulate employees to receive training more enthusiastically.

4. incremental innovation performance

High levels of belt obtainers are supposed to train the team members on the spot if needed. A kind of informal on-the-job training takes place within incremental innovation project teams. At present, K company makes it a rule that all employees take part of more than at least one project.

Projects carried out during all the years have been increasing both in number and in incremental innovation effects expressed in terms of money (See Figure 2) accompanied with increase in belt qualification obtainers (Compare Figure 1 with Figure 2) who can be surely said to improve their skills through trainings. This concurrent increase in belt obtainers and incremental innovation effects results from the fact that the skill improved employees have participated in incremental innovation project teams and utilize their improved skills in those teams. That is, skill improvement on incremental innovation through training has connected to incremental innovation performance.

The company's performance is conspicuous. K company carried out 1300 incremental innovation

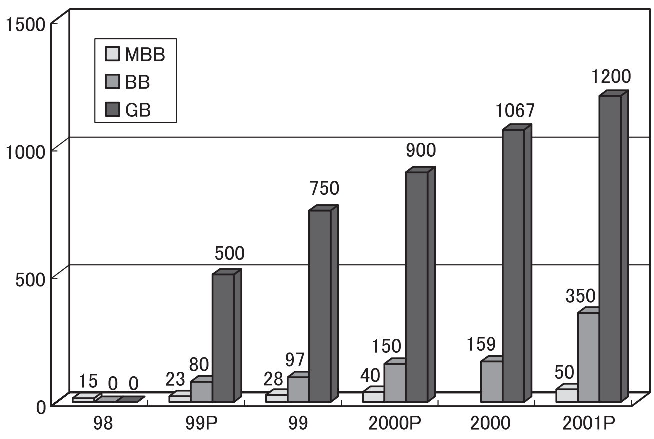

Fig. 1 Belt certification obtainers
Source: K company

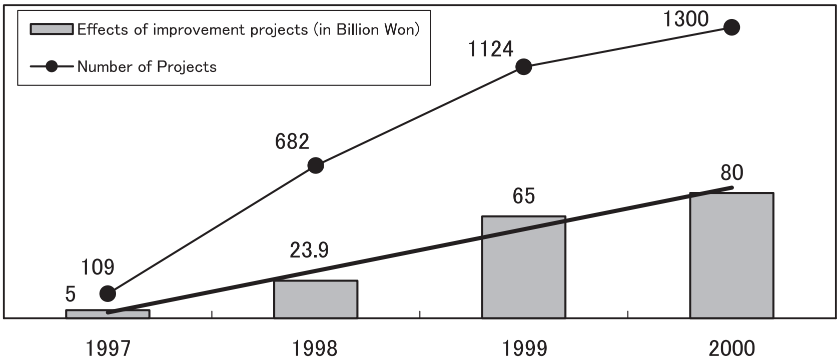

Fig. 2　Effects of 6 sigma improvement projects by year
Note: all projects in this figure are carried out through 6 sigma DMAIC process
Source: K company

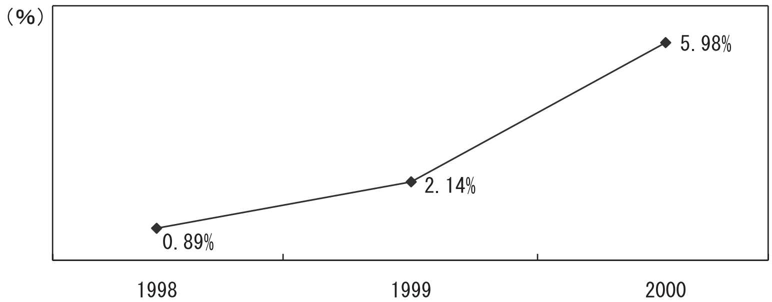

Fig. 3　Ratio to sales of money-based effects of 6 sigma improvement

projects in 2000 whose effects were estimated at around 80 billion won (80 million dollar, approximately) (See Figure 2) and the ratios of the money-based effects of incremental innovation to sales have inclined from 0.89% in 1998 to 5.98% in 2000 (See Figure 3).

The performance is not entirely attributed to skill improvement through training. "We have picked up abundant fruits from a tree of 6 sigma since 1998 for several reasons. One of those reasons is that the top managers have understood the potential of 6 sigma incremental innovation management very well from early implementation stage, so propelled 6 sigma implementation with strong will of top manager. The second of reasons is that on the base of strong back up from top managers, various incentive systems were set up for encouraging the employees to join 6 sigma incremental innovation enthusiastically. Training is also a reason for good results from 6 sigma incremental innovation management." This is quoted from the interview with a manager in charge of 6 sigma incremental innovation Without the strong leadership and top manager and incentives to get employees participate in incremental innovation activities in spite of skill improvement through training, the incremental innovation effects could not have been as high as shown in Figure 2 and 3. However, it must be a necessary condition because the incremental innovation effect through 6 sigma tool would not be expectable without training on 6 sigma incremental innovation techniques.

IV. Findings and discussion

With a case of K electronics, this study examines the association between the training practice in 6 sigma TQM and the performance in terms of incremental innovation. First of findings is this study also observed company-wide training in the company along with adoption of 6 sigma TQM like the argument by Hackman and Wageman (1995). In addition this study supports the hypothesis that company wide training of employees in TQM tools plays an important role for incremental innovation. Training within company is positively related to skill improvement and the performance. This fact is proved with data provided from K company. As shown in figure 1, and 2, qualification obtainers have been increased through training and the incremental innovation performance has been increased along with incline in numbers of qualification obtainers who surely improve their skill.

However, skill improvement through training is a necessary condition for successful incremental innovation. That is, skill improvement alone does not assure the good performance but favorable organizational culture for incremental innovation is additionally required such as supportive institution, incentive systems, leadership, flexible workplace, employees' participation, for instance. In other words, the effectiveness of training would lower without successful training transfer.

In that sense, the belt certification system has been critically conducive to employees' participation in incremental innovation activities together with promotion-related incentive. The belt obtainers are easily distinguished from the non-obtainers. The belt as earlier chapter explained is bestowed only when the trainees meet all requirements consisting of three steps, attendance to formal training program off the job, pass of written examination, and practical execution of improvement projects. Training effect can be more strengthened with training-integrated supportive scheme like the belt system in this study than when training is simply provided without any supportive schemes.

One more notable fact will be discussed here, not directly related to this topic. It is about association between product life cycle and training forms. We observed during visits to the company that the company has enhanced training within industry recently in the ways of both formal off-the-job training and informal on-the-job training. However, the reliance on formal off-the-training is relatively increasing rather than informal on-the-job training. This is a little surprising in Korean industry, where on-the-job training is major way of training.

That phenomenon probably is related to various reasons. One of the reasons we think has something to do with more frequent product innovations. The kinds of products the company produces at the same time are more than those of the past and besides, products the company produces are quickly changed as product cycle is shorter. This frequent product innovations bring about many opportunities for process innovation. If the product life of a product last long, there are a number of the rapid process innovation opportunities in introduction stage of the product, but as time goes up, rapid innovation opportunities becomes fewer, accordingly, the focus of the company turns to incremental innovation.

In reality, product life cycle becomes shorter, and product innovations take place more often. As a result, rapid process innovations are more often required. The K company faces the situation. That is, K electronics has many innovation opportunities followed by frequent change in products. To let employees deal with the increased innovation opportunities, the company needs to enhance employees training in off-the-job training form because higher quality of knowledge is needed to cope with radical innovation opportunities and because the higher quality of knowledge is not easily acquired from senior colleagues on the job.

For the same reason, more educated employees tend to receive more training (See Table 2). That is, rapid innovations are not easily carried out by shop floor workers, supervisors who usually are high school graduates. Therefore, engineers who graduated from university or above are expected to play more roles for finding innovation opportunities and ways to innovation.

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インクリメンタル・イノベーションと TQM の統合としての職務訓練（6 シグマ）―韓国の電子企業 K 社の事例を中心に―

李　根載
具　承桓

最近，韓国企業の競争力が高まりつつある．従来の競争優位性といわれる低賃金による低コストから製品の品質力の向上への戦略的転換が見られる．その背後には，現場レベルでの 6 シグマ運動の成果がある．これまで，韓国企業は強い労働組合問題を抱えており，現場レベルでの改善活動は非常に困難であった．

本研究は，韓国で最初に 6 シグマ制度を導入し，TQM 活動を成功した K 社の事例を通じてその実態と成果を分析しつつ，こうした職務訓練とイノベーションとの関連について考察する．K 社の成功要因として，全社的なトップダウン型のプロセス，資格制度と結びついたインセンティブ制度，職務能力レベルの繰り返し検証制度などの仕組みの構築が挙げられる．