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THE IMPACT OF QUALITY CONTROL CIRCLES (QCCS) ON OPERATIONS PROCESSES: A CASE STUDY

Salaheldin Ismail Salaheldin

College of Business & Economics, Qatar University, Qatar

ABSTRACT

This paper aims to highlight how QCC can enhance operations processes in a manufacturing environment of the rolling mill electric plant of Qatar steel company (QASCO). To the authors' knowledge, no previous research have been published on the successful implementation of QCC by a manufacturing firm within the Gulf Cooperation Council (GCC) countries such as the State of Qatar. The methods used in this case study include observation, in-depth interviews and secondary data analysis. The results of this case study have shown that after the QCC members have tried to facilitate all sorts of modifications to the electrical equipment so that it could run with the minimum troubles, their efforts have enhanced the operations processes of the mill. Specifically, their efforts have produced many positive results including eliminating power supply failures, reducing start-up time and minimizing work load. This paper hopes to create more awareness among management and employees of the strategic importance of QCC to operations processes. More importantly, the cost/benefit analysis of results attained would be a motivating factor for manager to use QCCs. Finally avenues for further research are recommended.

1. INTRODUCTION

A Quality Control Circle (QCC) was defined by Ishikawa (1985) as "small group of workers, from the same work place, who meet together on a regular, voluntary basis to perform quality control activities and engage in self and mutual development." A QCC is a team of up to 12 people who usually work together and who meet voluntarily on a regular basis "to identify, investigate, analyze and solve their work-related problems" (Department of Trade and Industry, UK, 1992, in Millson and Kirk-Smith, 1996).

The main purpose of the regular meetings among the team members is to achieve customer (internal and external) satisfaction through continuous improvement and teamwork (Goh, 2000). To achieve this result it is important for the members to have a good understanding of the role of customer and the involvement and commitment of employees throughout the organization (Besterfield, 1994). In other words, to be successful the initiative requires intense focus on customers and on business processes, a strong spirit of continuous improvement, coordinated teamwork, and proactive employee participation (Harris, 1995). In the area of teamwork, it is important that many parties including employees (managers and non-managers), various functional areas of the company, and the firm and its external business partners such as its suppliers are able to collaborate and work together (Dean and Bowen,1994).

Since its first development and introduction in Japan in the early 1960s, the use of QCCs is now widespread throughout the world, particularly in Japan (with more than a million QCCs) and USA (with more than 200,000 QCCs) (Moore, 1992), even though the rate of success, particularly in the USA were reported to be mixed (Gray, 1993).

In any case, there has not been any reported cases of success in the use of QCCs in any of the Gulf Cooperation Council (GCC) countries. Thus, this paper represents a first attempt at reporting a success story of the effective use of the technique in the State of Qatar, a member of the GCC countries.

Basically, this case study attempts to highlight how a major steel manufacturing firm in Qatar (QASCO) has undergone a successful journey in using QCCs to achieve continuous improvement in its operations processes.

2. LITERATURE REVIEW

A considerable number of literature on QCCs has developed over the past three decades since the first time the program was used in Japan in 1962, in the US by Lockheed in 1974, and in the UK by Rolls-Royce in 1978 (Boaden and Dale, 1993). Nowadays, there are many applications of the program in both manufacturing (for e.g., see Dale, 1984; Banas, 1988; Collard and Dale, 1989; and Pinnington and Hammersley, 1997) and service (for e.g., see Berry, Bennett and Brown, 1989; Smith and Lewis, 1989; and Millson and Kirk-Smith, 1996) industries.

According to Piczak (1988), among the potential advantages of QCCs include: they involve and develop employees, and can directly address problems in areas such as quality, productivity, efficiency, costs, communication, absenteeism, staff turnover and grievances as well as competition. Furthermore, the techniques also result in other benefits including helping: employees learn to work towards a common goal with people at different organizational levels and from different parts of the organization, thus reducing communication barriers between managers and staff; increase in job satisfaction and decrease in frustration among them; increase the members' skill levels; and increase their control over their own environment (Piczak, 1988).

Past researches have found both successes as well as failures with the use of QCCs by organizations. For example, research by Lee and Lam (1997) on the use of QCCs by Kowloon-Canton Railway Corporation has found that the use of QCCs together with the ISO 9001 quality system has resulted in significant increase in the reliability of the electric passenger train service while at the same time it resulted in a decrease in the maintenance costs. Also, according to Johns and Chesterton (1994), ICL of UK was saved from bankruptcy because of the introduction and implementation of a system of QCCs throughout the manufacturing division in 1983.

Moreover, in another example, an empirical study of the use of QCCs within Land-Rover in the UK by Pinnington and Hammersley (1997) did not produce positive results, where after nine years of operating, Land-Rover's QCC program was terminated in early 1997. The researchers argue that the program was a failure because the management of the company did not want to experiment further with a participative approach to management. Nevertheless, Hill (1995) and Hill (1996) claim that the failure of many British and Western QCC programs to achieve what was expected of them during the 1980s were due to the setting of inappropriate objectives and faulty implementation and not their lack of intrinsic merit.

However, the literature review also indicates that there are very few case studies which explore and illustrate, in detail, how QCC is implemented and used in manufacturing firms whether in developed or less developed countries. In particular, cases where the concept is implemented at the operational level in manufacturing is hard to find (Pinnington and Hammersley, 1997; Goh, 2000; and Canel and Kadipasaoglu, 2002). Furthermore, it reveals that there has also been a request for further research on QCC applications in different contextual situations.

Because there has been little case studies undertaken on the subject whether in developed or less developed countries, the researcher has found it feasible to conduct this case study.

3. METHODOLOGY

Since this study is based one single company, i.e. Qatar Steel Company or Qasco, it is pertinent for us to use the case study approach (Yin, 2002; Kohn, 2006). A case study method is a qualitative research method that can be used to complement other research methods.

In this case study, a combination of interviews and analysis of formal documents was used. Accordingly, data for this case study was collected via personal interviews with QCC members at the company's Electrical Repair Shop and the Rolling Mill including the QCC leader, QCC facilitator, 4 managers from various levels, 2 supervisors, and 3 technicians during the months of May and June 2006. Data was also gathered from secondary sources such as the company's internal publications and newsletters as well as the Internet.

4. QASCO PROFILE

Qatar Steel Company (Qasco) is a wholly-owned subsidiary of Industries Qatar (a Qatari shareholding company) is the first integrated steel plant in the whole Arabian Gulf. The company was established on 14 December 1974, but steel production at the plant started only in 1978. The mill is located in Mesaieed Industrial City, 45 kilometers south of Doha, the capital of Qatar.

The integrated plant consists primarily of four units: Direct Reduction, Electric Arc Furnace, Continuous Casting, and Rolling Mill. Other auxiliaries include the Material Receiving/ Handling, Main Power Substation, Quality Control Centre, Maintenance Shops, and other facilities as sea/fresh water, compressed air, natural gas and a clinic. The whole plant including its administrative offices occupies a land area of 707,000 sq. meters. Adjacent to the land is a further land area of 375,000 sq. meters reserved for future development and expansion of the plant.

Over the years, QASCO has gained a reputation as a manufacturer of first class products. Its product quality is tailored in accordance with international standards. For example, in addition to getting ISO 9002 certification in 1992, the product and management quality of the company has been endorsed by the UK-based Certificate Authority for Reinforcing Steels (CARES), an authority which is accredited by the United Kingdom Accreditation Service (UKAS) to ISO Guide 65 (product certification) and ISO Guide 62 (quality management systems certification using ISO 9001 (*http://www.qasco.com.qa/*, 14 Oct 2006). The product is supported by an effective and reliable delivery and after sales service. Its proximity to the Gulf Cooperation Council (GCC) countries enables it to supply a sizeable portion of the regions' requirements, as well as Qatar's own domestic need.

5. THE CASE STUDY

Quality Circles Activities in the Rolling Mill

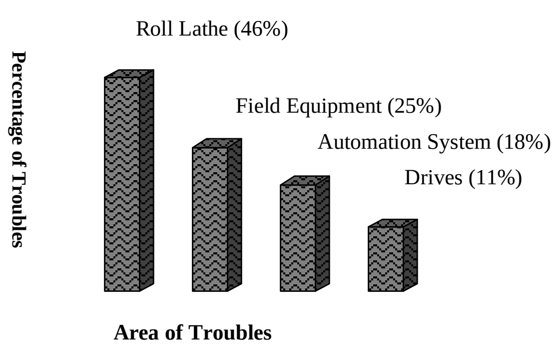
In accordance with the trend of QCC program which started throughout QASCO in 1980, the rolling mill electric plant has participated actively in the program. This has enabled the plant to solve many critical problems, thus enhancing its production capability as well as reducing its break down times.

In order to avoid unsafe practices and to improve and speed up their trouble shooting efforts, the managers and employees have tried their best to facilitate all sorts of modifications to the electrical equipment so that it could run with minimum troubles. Their efforts have certainly produced many positive results. For example, in 2005 the company experienced a remarkable achievement in that they were able to solve one of the major problems in the field of carbide roll ring notching, the machine used to cut notches in the carbide roll rings.

To carry out QCC activities for the year 2005, the QCC team studied various troubles and problems occurring throughout the rolling mill. The results were collated in a sequential graphical manner using different Pareto graphs, to help the QCC team understand in detail the root causes of the various troubles which have been the main critical problems faced by the plant. By carrying out this exercise the team was able to pinpoint the problems and to take the necessary corrective actions to overcome them.

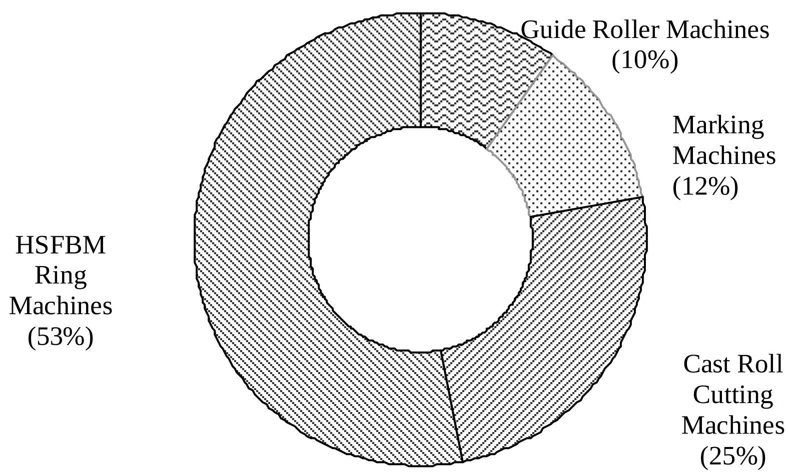
Pareto Graph 1: Pareto graph 1 (Figure 1) shows the areas of troubles encountered came from the roll lathe (46%), the field equipment (25%), the automation system (18%) and the drives (11%). As can be seen from this figure, the most number of troubles found were in the roll lathe where the cast rolls of the rolling mill #1 and the tungsten carbide rings of rolling mill #2 were prepared for different sizes as per the requirements of the rolling process.

Figure 1: Main Area of Troubles



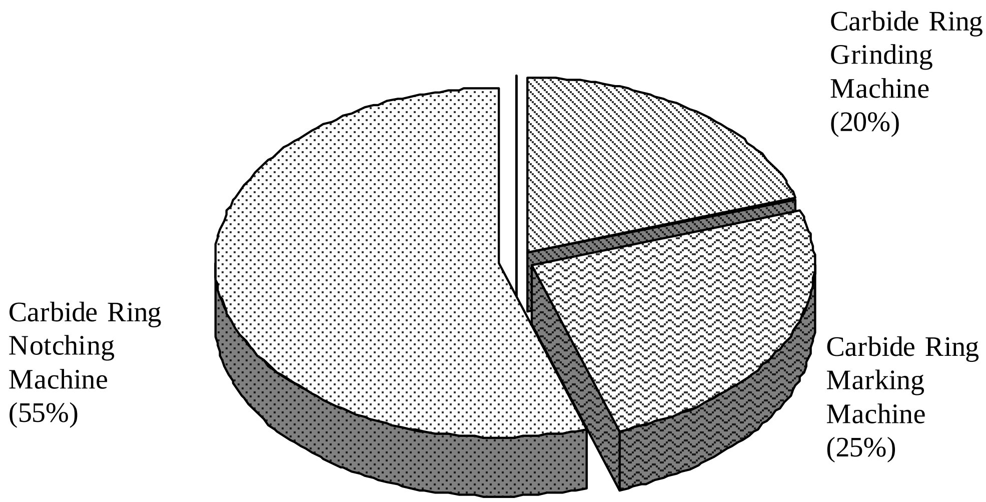
Graph 2: The secondary Pareto graph (Figure 2) clearly indicates that the majority (53%) of the troubles in the roll lathe area came from the HSFBM ring preparation machine. This high rate of troubles (53%) could be considered as alarming when compared to the troubles encountered by other machines in the roll lathe.

Figure 2: Secondary Area of Troubles



Graph 3: The third and final Pareto graph (Figure 3) shows that the carbide ring notching machine of the HSFBM was affecting the system mostly with the maximum number of troubles encountered compared to the marking machine and the grinding machine of the tungsten carbide ring.

Figure 3: Tertiary Area of Troubles

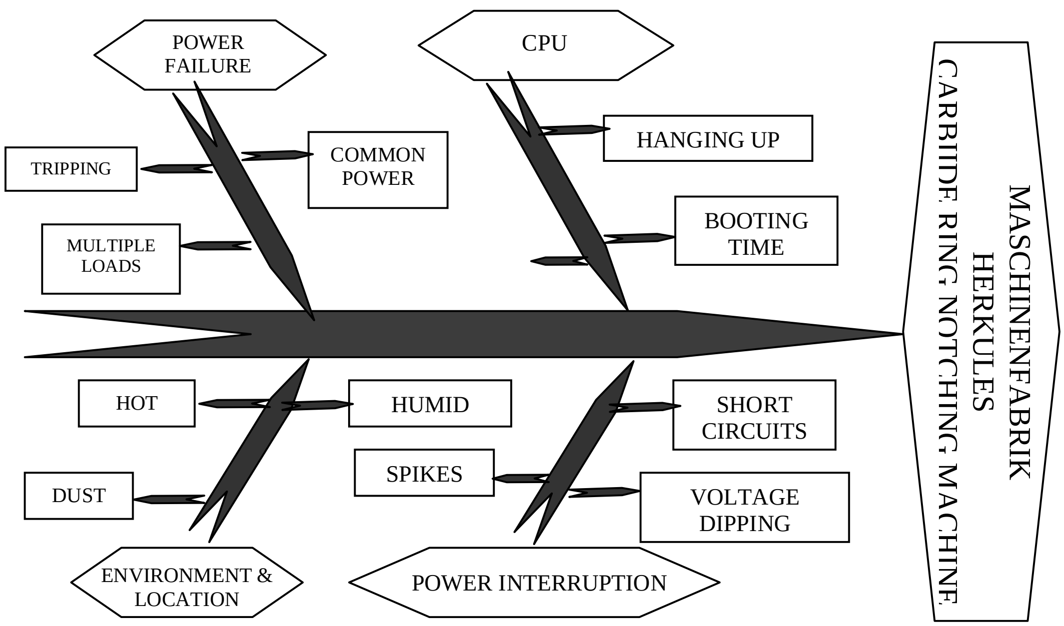


As discussed above, the majority of the problems in the roll lathe were coming from the tungsten carbide ring notching machine of HSFBM. Specifically, the main problems encountered include: frequent hanging of the central processing unit (CPU), frequent power failure of the machine, frequent power fluctuation, and time consuming machine start-up. Thus, based on these problems, the QCC team decided to come up with a QCC theme for 2005 as "Ensuring maximum availability of the carbide ring notching machine."

Causes and Effects of the Problems

In order to identify the root causes of the problems faced by the plant, the QCC team used the cause and effect or fishbone diagram as shown in Figure 4.

Figure 4: Determining the Root Cause of the Problems in the Notching Machine



As can been seen from Figure 4, on order to determine the possible causes of the problems the team conducted a detailed study on four specific areas: power failure, the CPU, environment & location, and power fluctuation. Based on the above analysis of the troubles, the team decided to target four specific areas of improvement (code-named IDEA): improving machine efficiency, developing an alternative cooling system, ensuring maximum availability of machine, and assuring smooth ring notching.

Planning for the Implementation of QCC Activities

To execute the QCC activities in the rolling mill, the QCC team members charted out the execution schedule as shown in Figure 5.

The Roll Lathe Machine

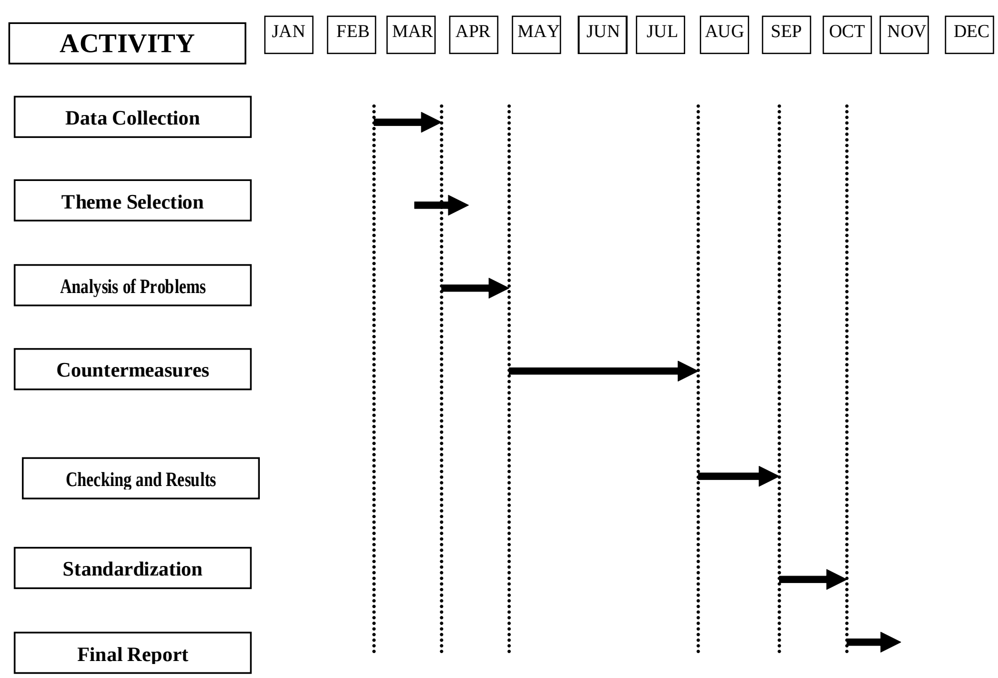
The activity of the QCC team was concentrated on the roll lathe area of the rolling mill. Altogether, there were 13 machines used for the preparation of cast rolls as well as the tungsten carbide rings for rolling mills #1 & #2. The most sophisticated and complicated among these machines was the tungsten carbide (TC) ring notching machine from Herkules of Germany, which prepares the notches in the TC rings used for the HSFBM as per the requirement. The machine was very crucial in terms of production as well as quality of the finished product of HSFBM.

During the past five years the plant faced many critical problems with the carbide ring notching machine. For example, the condensation water coming out from the air conditioning unit of the electric control panel of the machine has damaged the CPU and its accessories. Moreover, frequent tendency of the CPU to hang was a major drawback of the machine as its power source was connected to one of the miscellaneous power sources from the HSFBM sub-station. Also, minor variations in the line voltage has caused the electronic system to malfunction causing the machine stop and to disrupt the ring preparation. Thus, as far as the HSFBM rolling is concerned, the readiness and the availability of the said machine was a major requirement of the offline rolling process.

Tungsten Carbide Roll Ring

Ever since QASCO's rolling mill #2 has started in 1990 its normal production, it produces only ring size D10 & D12 in the HSFBM. These sizes were experiencing high demand from

Figure 5: QCC Execution Schedule, 2005



the local as well as the GCC markets. The shape and size of the product mainly depends on the quality of the ring notches. Hence, the tungsten carbide ring notching machines plays a vital roll in shaping QASCO's finished product. The readiness and availability of the carbide ring notching machine is most important and essential as the operation of the said machine continues round the clock when the HSFBM is running. This mill was then running almost 15 days in the month to accommodate the rising demand of the production.

Activities Carried Out Under the QCC Program

Prior to the adoption and implementation of QCC program, the rolling mill plant was experiencing an increase in the frequency of troubles involving frequent hanging-up of the CPU, frequent power failure and power fluctuation of the machine, and time consuming machine start-up time. Detailed descriptions of these problems are given below.

Frequent Hanging of CP

The tungsten carbide ring notching machine was controlled by different hardware under the exclusive control of the programmable logic controller of Herkules (version 2.0). All the controlling equipment were installed in three panels, out of which one panel consisted of its CPU. An air conditioning unit was installed just above the CPU for the purpose of cooling it as well as its accessories. As a result, water condensation in the cooling system occurred resulting in water droplets to fall on the CPU, thus causing it to hang or even to be damaged on several occasions.

Frequent Power Failure of the Machine

The main power supply to run the machine came from the 400v distribution panel from the HSFBM. At the same time, this panel was supplying 400v to different miscellaneous loads in the old as well as the new rolling mills. Whenever this feeder tripped due to certain problems in any of the distributed loads, it directly hampered the operation of carbide ring preparation. Moreover, slight fluctuations in the power caused the machine CPU to go to on a stop mode or to hang and it has to be restarted. This procedure took a lot of time since machine initialization has to be carried out before the notching operation could be started. So, overall it added an additional job for the roll lathe people in setting up the machine from zero position.

After having understood the causes of the problems faced by the rolling mills, the QCC teams carried out a number of countermeasures to overcome the problem, as described below.

Countermeasure #1

As the condensed water from the air conditioning unit was dropping on the machine CPU causing it and its accessories to be damaged, the QCC team decided to remove the cooling unit and to cover the whole machine area by enclosing it in a cabin. The air conditioning unit was replaced by the split-type air conditioning units. This has brought an additional benefit in the sense that the machine area became free from dusts. This countermeasure eliminated the possibility of damaging the CPU and its accessories, and at the same time, created a dust free environment for the operator as well as cooling the temperature inside the cabin. Nevertheless, the problem of frequent failure of the machine's main power supply persisted. Thus, another countermeasure needed to be taken by the QCC team.

Countermeasure #2

The main power supply for the Carbide ring notching machine was coming from the HSFBM 400 V feeder to which a lot of miscellaneous loads were connected. When there was a fault in any of the distributed loads, the main feeder and the notching machine power supply became tripped. As this machine is controlled by sophisticated software and hardware, the start-up time of the machine was time consuming since it has to go through the initialization process after certain adjustments were made to it. To overcome this deficiency, the QCC team decided to connect the notching machine main power supply to one of the spare 400V feeders from the old rolling mill. With the help of the ERS people, a power cable was laid from the old rolling mill distribution panel and connected to the panel of the notching machine. Through this action, the machine main power supply was re-established and the problem of frequent tripping of the power was eliminated. Despite overcoming this second problem, the plant was still facing the problem of CPU malfunction resulted in machine stoppage. Thus, a third countermeasure needed to be carried out to overcome this problem.

Countermeasure #3

In a subsequent brain storming session, one of the QCC members pointed out that the tendency of the CPU of the notching machine to hang could be the result of the spikes in the line voltage or voltage fluctuation, which is a very common phenomenon in steel industries. To overcome this problem an uninterrupted power supply (UPS) system was installed at the site. This third countermeasure subsequently eliminated the problem of voltage fluctuation occurring in the notching machine. This final countermeasure resulted in smooth and trouble-free operations of the notching machine.

Benefits Achieved

After the long strive and sincere efforts undertaken by the QCC members, the carbide ring notching machine became the most available machine in the roll lathe section of the rolling mill. The various countermeasures carried out by the QCC members have overcome all the major problems faced by the mill (see Table I).

Table I
The Situations Before and After the QCC Activities

Before QCC	*After QCC*
Condensed water from the cooling unit damaged the CPU & accessories	Provision of split unit cooling unit eliminated the same
Frequent failure of main power supply to the machine	Separate feeder eliminated the power supply failure
Line voltage fluctuation leading to the malfunction of CPU	UPS totally eliminated this problem
Time consuming job for initialization and start-up	Modified reduced the start-up time
More work load on the roll lathe operators	Work load has been minimized

Hence, the theme of the 30th QCC activity was considered as a very appropriate one since it resulted in the success of the QCC team to solve the main problems faced by the mill as elaborated above. Furthermore, the success has brought courage as well as enthusiasm among the QCC members and has made them more ready to face any future problems in the rolling mills. Specifically, the plant was able to reap certain benefits from the use of QCCs. Among the benefits enjoyed by the plant include: stability in the carbide ring preparation; timely preparation of carbide rings; smooth operations of the machines; and stability in the power supply system of the machine. In monetary terms, the various countermeasures have resulted in an annual saving of 88,340 Qatari Riyals (QR) (US$1 = 3.65 QR) to the company.

Table II
The Cost/Benefit Analysis

Cost of new split type cooling unit	20,000 QRS
Cost of CPU unit	96,000 QRS
Cost of cancelled cooling unit	12,000 QRS
Net Annual Saving	108,000-20,000 = 88,340 QRS

6. CONTRIBUTION, IMPLICATIONS AND CONCLUSION

A major contribution of this case study is to provide useful insight into the successful adoption and implementation of QCCs in a manufacturing firm in a developing country of the Middle East where published research results on the successful use of QCCs have been rather scarce.

Since limited case studies have been found to be concentrated on the role of QCCs in supporting operations processes within manufacturing firms, this paper provides important ideas and insights to academics and practitioners for undertaking a deeper investigation into the impact of QCCs implementation on continuous improvements and on the enhancement of the operations processes of manufacturing firms.

In general terms, the practical example given within this paper clearly supports the view of the authors that QCCs philosophy can be applied to everyday activities and tasks. A major benefit of such an application is a greater understanding of the process of the successful adoption and implementation of QCCs by a manufacturing firm in a developing country of the Middle East where published research results on the successful use of QCCs have been rather scarce.

From our research here, serious benefits from the programs have been clearly demonstrated, not only in terms of the ability of the QCC members to identify and eradicate problems, but also in terms of the increased readiness of the team members to overcome future quality problems.

The case reaffirms the need for all employees to work in teams, and to measure and chart the quality of their own work in order to enable them to identify and solve quality problems and to eventually enhance its manufacturing operations.

Managers should realize that while the QCC may appear to be a simple and straightforward activity, there is in fact a great deal of behind-the-scene support from the management needed to keep the QCC activities alive and well.

One of the common mistakes made by management is to think that once these circles have been launched and the initial training has been completed, all that management has to do is to sit back and wait for results. In reality, the workers' enthusiasm for participating in QCC activities is in direct proportion to the management interest and support.

QCC can only flourish in an organization where management is open to genuine two-way communication with the workers, where there is a reasonably good level of industrial relations, and where there is a total organizational commitment towards quality and productivity. Thus, policy makers should understand that in order to manage QCC activities successfully, they need to have a proper plan to take care of operational activities.

Furthermore, manufacturing firms can have successful QCC only if they can get both the relevant management support and the support of first line people. Therefore, managers should facilitate QCCs initiatives in their organization, reward the members for their successful implementation and exercise control only when necessary. Finally, the overall conclusion is that QCC can be of assistance in relation to managing operations processes, especially in overcoming operational problems.

7. LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Consistent with previous studies, the present study results indicate that management and employees involvement in implementing QCC is important. Thus, the impact of management and employees involvement upon the implementation of QCC philosophy in a similar manufacturing and country environment may be investigated. Also, an exploratory study is needed to provide better understanding of the mechanisms by which the role of each QCC elements in a QCC implementation can be made more effective. Furthermore, developing a deeper understanding of the deriving and inhibiting forces to QCC implementation in practice remains a task that requires further attention from researchers, whatever their motivations. Finally, further investigation is needed to highlight the relative strength of the deriving and restraining forces in adopting and implementing QCC initiatives in different developing or less developed countries.

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