Application of Quality Tools to Improve Quality: A Case Study of a Building Remediation Contractor

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The purpose of the study was to apply some of the quality tools to find out the root causes of the quality problems like defects in a remediation contractor organization. Common defects for the projects undertaken by the company are investigated through direct observation and from the quality data provided by the company. A questionnaire survey was also carried out to elicit the opinions from the workers related to quality. It was found that final cleaning works was the major cause of quality related problems and the company is required to hire better quality final cleaning workers if it is to improve the quality and decrease the cost associated with defects. Although the concept of using Pareto analysis and cause and effect diagrams have been around for a considerable period of time, the paper has successfully shown how a small company can make use of these simple quality tools to find out the root causes of the problem and allocate resources to eliminate such problems.

Key Words: Quality Tools, Pareto Chart, Cause and Effect Diagram, Remediation Projects

Introduction

Quality remains a critical issue for the construction industry. While the cost of quality rectification problems is of the magnitude of 3.4 percent to 6.2 percent (Thomas *et al.*, 2002), some of the researchers have put the cost of rework as high as 12 percent (Burati *et al.*, 1992). Although there may be a disparity among the researchers in quantifying the magnitude of cost of quality rectification, all of them agree on the fact that there is an enormous amount of cost savings if the construction companies focus on improving the quality of the construction service. Among some of the techniques and strategies to improve the quality related problems include identifying the causes, magnitude and cost of defects (Love, 2002; Josephson and Hammralund, 1999). These strategies aim to gather and analyze information at a fundamental level, in order to get to the root of the problem, by taking into an account various perspectives such as type of defects, their frequency of occurrence, cost of rectification and their origin or cause (Karim *et al.*, 2006). For very small companies the root cause of quality problems may be obvious but once we get beyond the very small business, most decision points and problem's root cause or the best-course decision will remain obscure until valid data are studied and analyzed. It is for these cases that quality management tools play an important role to improve the quality standards of the projects that the company undertakes.

Some of these tools very often used in the quality management system are Pareto chart, cause-and-effect diagrams, check sheets, histograms, scatter diagrams, run charts and control charts, stratification, flow charts etc. Although most of these tools originated in the manufacturing industries, they can be applied quite satisfactorily to construction processes as well when sufficient data is available. These quality tools enable today's employees, whether engineers, technologists, production workers, managers, or office staff, to do their jobs efficiently. When these tools are applied to problem solving or decision making, better solutions and decisions are developed. The application of these tools begins only after

understanding the company policy, managers and workers viewpoints, and challenges faced by the company.

Craft and Leake (2002) favor the use of simple data analysis tools such as Pareto chart in decision making. The Pareto chart is a very useful tool whenever one needs to separate the important from the trivial. Despite its simplicity, 'Pareto Principle' is quite powerful and has been used quite widely (Karim *et al.*, 2006). When root cause of the problem is identified by using Pareto charts, 'cause and effect diagram', also known as fishbone diagram can then be used to identify and isolate causes of a problem. Such diagrams separate causes from symptoms and force the issue of data collection and can be used with any problem (Goetsch and Davis, 2006). Since they are not based on statistics, they do not demand a collection of large data samples as required by other quality tools.

Company Background

The company that is being investigated is a U.S. based Environmental and Construction Company, specializing in mold remediation, restoration, and general contracting. Founded in 1987, E&C Inc. (real name changed) is comprised of experienced industry professionals including trained and certified principals, project managers, supervisors, and customer service personnel. Equipped with state-of-the-art technology, engineering controls, and expertise in the indoor air quality industry, E&C Inc. became a good choice for a complete and comprehensive mold remediation, construction and reconstruction project. The E&C Inc. team has successfully completed, on time and within budget, hundreds of mold remediation and restoration projects for a wide variety of clients from its operation centers in Florida, New York, and Virginia. With over sixteen years of experience, the company has worked with a multitude of groups such as: insurance companies, real estate management companies, homeowners, condominium and co-op associations, commercial building owners, educational and healthcare facilities, developers / builders. Since E&C Inc. was founded, it has continuously set the standard for environmental remediation and restoration/construction through its comprehensive, dedicated, and reliable service, and to continue fulfilling its commitment to quality.

Initially launched as an asbestos-removal company, which is a mandated service (federal and state regulated) prior to any renovation and demolition, E&C Inc. is a family business. Over the first ten years, a process of price decline, higher cost of insurance and operation, competition, and a shrinking market, had E&C Inc. faced with the challenge of developing new services. Since the use of asbestos in the construction market has been declining over the years, it was clear that the company cannot solely rely on asbestos-removal.

Identification of Challenges

In order to understand more clearly the history and challenges of the company, an interview was taken with the company president. The president revealed that the company's biggest challenge was to get adapted to the market conditions. Along its history, the company had to keep finding new targets within the remediation niche. "E&C Inc. realized that it needs to look for new services, and the personal injury case of Ballard vs. Farmers grabbed our attention," said the President of the company referring to a famous mold case that occurred in Texas. The Ballard family had purchased a twenty-two-room house in Texas and soon after

moving in, they found that the house was infested with "black mold" and sued Farmers Insurance Group. This case became known nationally when the jury returned a verdict against Farmers for $32 million.

While other asbestos removal companies moved into the demolition market, E&C Inc. adapted operations to meet the demand for mold remediation. This service was performed mainly for insurance companies and policy holders. The mold market was fueled by litigations and health concerns, without any federal and state regulation. The shift caused E&C Inc. to compete with insurance restoration contractors, which was a big challenge for them. The main criteria for project awards were technical know-how, industry reputation, and strong marketing.

The shift from asbestos abatement to mold remediation caused E&C Inc. to be faced with the sequence of challenges related to personnel training, corporate goals, and field operations. E&C Inc.'s workers had to be re-trained to learn remediation principles and guidelines. Instead of working in the demolition process, they started to work in the residential market and with personal contents. Unfortunately, some experienced employees who were resistant to changes had to leave. In that time, E&C Inc. had to focus on quality control as well as price. Asbestos services are federally regulated, and fall under the category of "life-safety" issues. The absence of federal regulation in the mold business puts more responsibility on the owner.

The challenge to adapt to external conditions is constant in the remediation projects. The intensive 2004 and 2005 hurricane seasons caused major damage which presented an opportunity as well as a challenge for E&C Inc.. E&C Inc. stepped up successfully to meet the challenges of large drying and restoration operations. This type of customer service has been important to the company's success in the face of a slowing mold market which is due to an insurance cap on mold damage payouts, lack of regulation, and uncontrolled competition. In 2005, the Florida Insurance Commission authorized a cap of $10,000 per occurrence per policy, causing E&C Inc.'s revenue to decrease approximately 50 %, compared to the prior year. E&C Inc. shifted its focus from home owner's insurance work that accounted for 65% of the total revenue, to commercial work where the catalyst for work orders, is liability, and less dependent on insurance coverage. In 2005, the revenues were 25% higher than the previous year only because of hurricane related projects.

Internal challenges also present themselves daily at E&C Inc.. The shift in market trends can cause a conflict between sales and estimating. While sales feels the pressure to better serve the existing customers, estimators and project managers are pressed to perform more efficiently and decrease costs, as competition drives prices down. To deal with such a difficult goal, the company decided to invest in marketing and technology. The company focuses on customers that appreciate and are willing to pay a premium for E&C Inc.'s quality. Due to the fact that summer in Florida and active hurricane seasons require E&C Inc. to employ a large amount of workers, while slow winter periods require less than half the labor force, the company president classifies the biggest challenge of the company to maintain a steady flow and keep the quality. The solution here was to keep a qualified team of supervisors and project managers. An investment in technology, lead to developing and implementing a computerized data base of workers (name, contact info, and work history) coupled with a biometric worker registration system.

In summary E&C Inc.'s challenges are listed below.

Internal Challenge:

- Personnel Training (demolition process, working in residential properties)
- Difference in perception (resistance for change)
- High Turnover (summer periods vs. winter periods)
- Sales vs. Marketing (pressure to serve better vs. pressure to perform more efficiently and cheaper)
- Accidents (restructuring of the firm due to the death of the president)
- Technology (to develop its own technological process)

External Challenge:

- Adaptation to market conditions (Change from asbestos to mold remediation, to hurricane response)
- Shrinking market
- Competition
- High Cost of Insurance
- Technology (awareness to new methods and processes)
- To get the "job done" each time more efficiently and effective.

Methodology

The study team used different data gathering methods in order to understand the company and find existing problems. Some of these methods included: questionnaires, interviews, company facts etc. This information led the team to find some problems and apply diverse techniques (Pareto chart, cause-and-effect diagrams, check sheets, and brainstorming) to identify solutions. After applying these techniques, possible solutions were organized and presented to the management team.

The questionnaires and interviews that were conducted in 2007 allowed the study team to understand the company better and identify the areas where this brief study would be more useful. Quality programs should work first on small problems which have a high probability of success, and this could be done, by choosing operations that seem to be going well. The study team met with president of the environmental department and chief of the financial department, to collect some data in order to develop a Pareto chart.

The study team sent a questionnaire to all of the office employees. The goal of the questionnaire was to check the employee opinion of the company, and to check his/her satisfaction with his/her job without revealing individual responses to the managers. Questionnaires are valuable, because experience has shown that workers often have a better perception and greater knowledge of reality and specific situations than do higher-level management. When using questionnaires it must be clear that the questionnaires will be used, not to punish or discipline, but to help make the job go better.

Data Analysis

Pareto Analysis

From the data gathered through different sources Pareto chart was developed and important causes of the problems related to quality were analyzed.

The top five cause factors are as shown in Table 1.

Table 1: Top Cause Factors and Number of Occurrence

Cause Factor	Unit cost	# of occurrences per year
Violations	5000	2
Communication errors	185	80
Over Staffing	240	60
Failed Clearance	1500	36
Cross contamination	12000	1

The mold remediation activity requires a fail or pass final test. It is what the company manager calls "failed clearance cause". "Cross contamination cause" occurs when the products used to clean the molds, for some reason, are spread out over an area that should not be involved, consequently causing contamination. Since mold is an activity with extreme high turnover rates, the managers prefer to keep some good employees even when the company does not have work for them. They felt that the price to keep those employees is less than the loss that the company would have if it has to refuse a project for not having enough staff. This cause was named as "over staffing". "Violations cause" occurs when some employees do not follow the contract terms. Lastly, "Communication errors cause" occurs when an employee does not completely understand the service that he/she is supposed to perform, and because of that, he/she does something correct but not the specified, which causes duplication of work. The total cost of each cause factor is as shown in Table 2.

Table 2: Cause Factors and their Cost

Cause Factor	Total Cost
Violations	10000
Communication errors	14800
Over Staffing	14400
Failed Clearance	54000
Cross contamination	12000

If anyone were to look at the figure above, they might say that the company should concentrate its efforts to solve the communication errors as it happens most frequently. Table 1 was showed to the manager and three employees of the environmental department. All of them agreed that the focus should be on the communication errors factor. However, after the study team obtained financial data as shown in Table 2 from the company after a meeting with the director of the financial department and produced Table 3, the focus of the project team shifted to failed clearance factor. This is very obvious with the generation of a Pareto chart as shown in Figure 1.

Table 3: Cause Factors with their Cost Contribution

Cause Factor	# of occurrences per year	Unit Cost	Total Cost	% of the Cost	Cumulative %
Failed Clearance	36	1,500	54,000	51.33	51.33
Communication errors	80	185	14,800	14.07	65.40
Over Staffing	60	240	14,400	13.69	79.09
Cross contamination	1	12,000	12,000	11.41	90.49
Violations	2	5,000	10,000	9.51	100.00
Total # of occurrences	179		105,200		

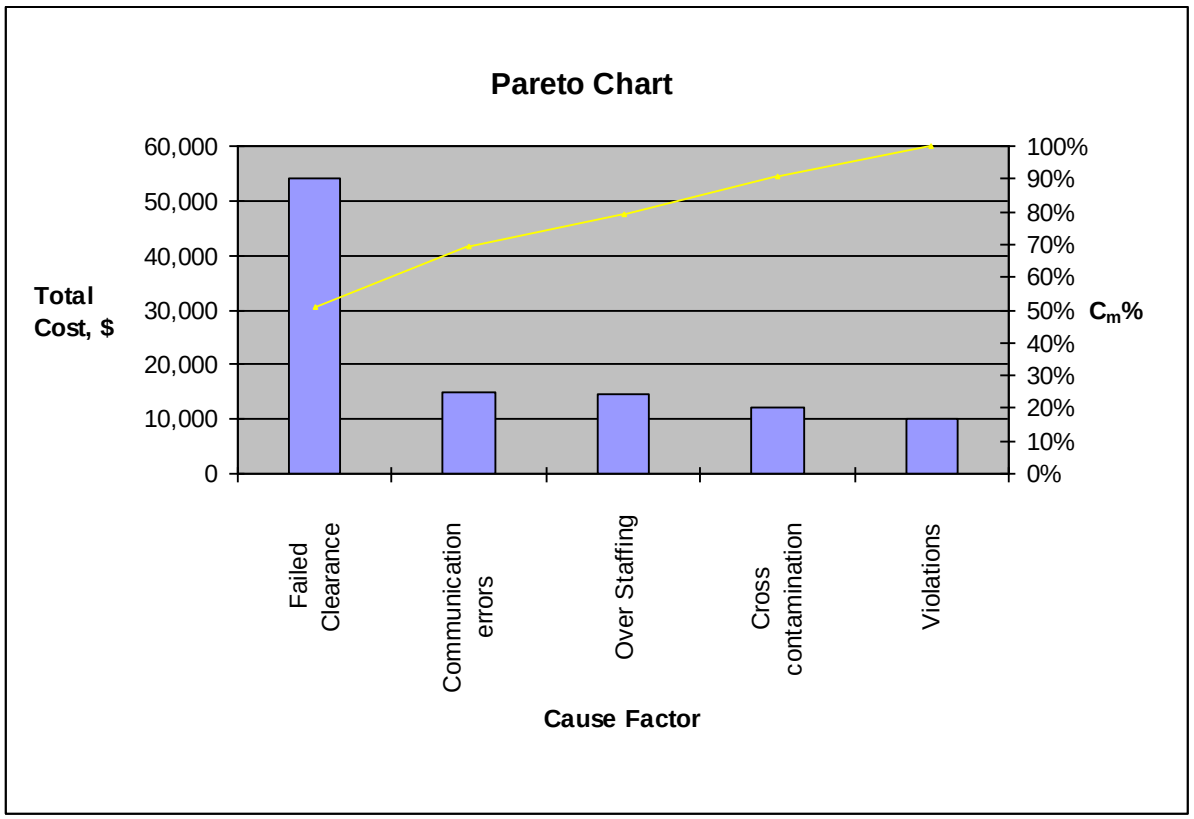

Figure 1: Pareto Chart

The analysis of this graph shows that failed clearance corresponds to 51% of the costs, and it is related with 20% of the occurrences. Thus, the company should focus its attention on this topic.

Cause-and-effect Diagrams

It was important to determine the causes that were brought as a result of the 'failure clearance'. The study team then used the cause-and-effect diagrams in order to identify all the possible causes. The technique that was developed by late Dr. Kaoru Ishikawa, a noted Japanese quality expert, therefore, the diagram is called an Ishikawa diagram.

The study team met with the following company employees in order to apply the cause-and-effect diagram: President of the environmental department, engineer, supervisor, worker

(demolition), worker (final cleaner), worker (contents). The group was told that the issue to be discussed was the failed clearance, and the objective was to list all the factors in the process that could possibly have an impact on the failed clearance. The group used brainstorming to generate a list of possible cause factors. From the list generated, the group agreed that there were six major factors, or causes, that might have an impact on the effect as follows: machine, operator, materials, methods, measurement, and environment. Having assigned the major causes and the list, the next step was to assign all the other causes to the major causes they affect.

A fishbone diagram as shown in Figure 2 is produced. It represents a picture of the major factors that can cause failure clearance and in turn the smaller factors that affect the major factors.

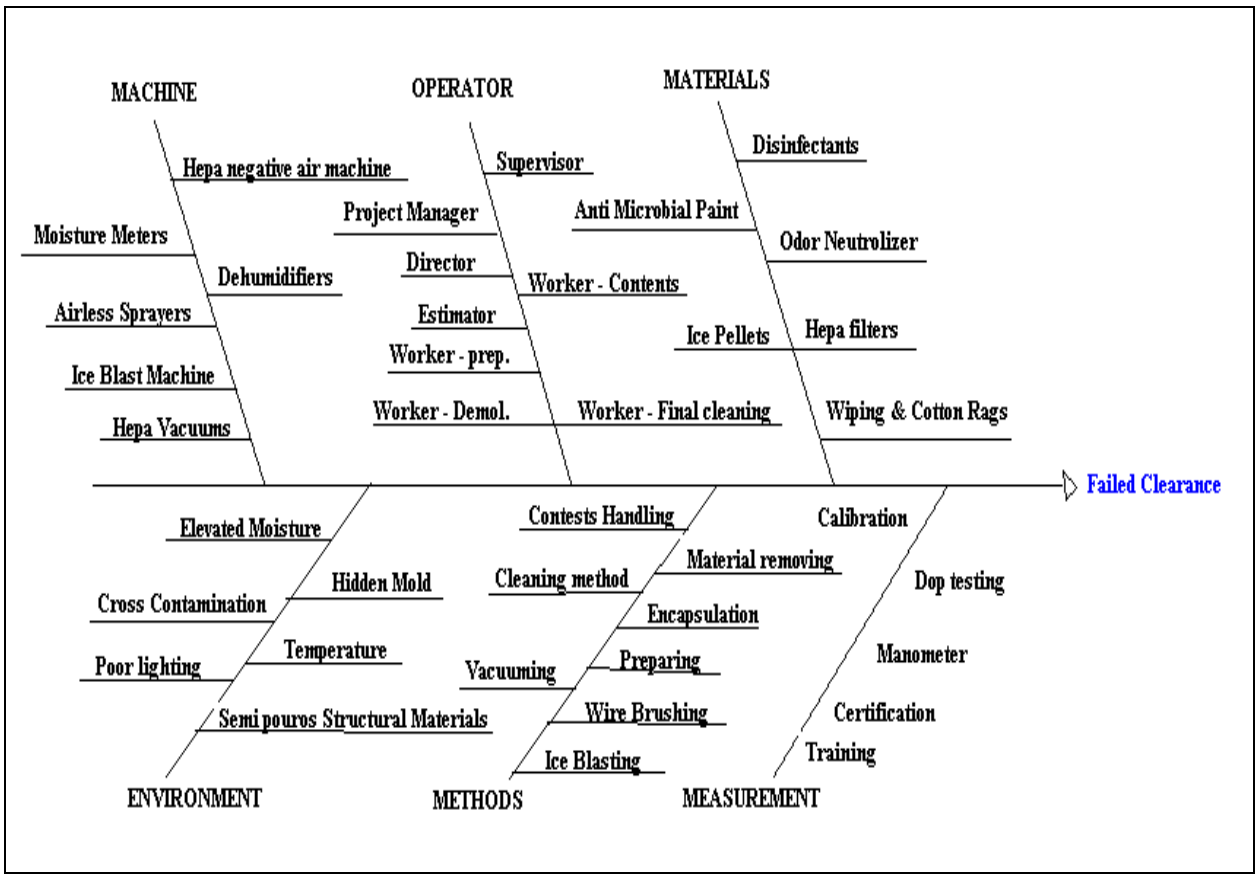

Figure 2: Fishbone Diagram

The key to the diagram's usefulness is that it is very possible that no one individual had all that knowledge and information. That's why cause-and-effect diagrams are normally created by teams of people widely divergent in their expertise. The cause-and-effect diagram serves as an excellent reminder that the items noted on it are the things the company needs to pay attention to if the process is to continually improve. Even in processes that are working well, continual improvement is the most important job any employee or team can have.

General analysis

The first Pareto chart showed that the failure clearance was the most relevant factor. The cause-and-effects diagrams showed the environmental department the list of causes that may cause this outcome. From that list, the director and the engineers scheduled a meeting, and after consulting financial and historical data they selected the top five causes. When it was agreed that the most important factor was 'failed clearance', the cause factors for 'failed clearance' was further deduced as shown in Table 4.

Table 4: Cause Factors for Failed Clearance

Cause Factor	**# of occurrences Per year**	**% of occurrence**	**Cumulative %**
Final cleaning	15	41.67	41.67
Supervisor	5	13.89	55.56
Hidden Mold	4	11.11	66.67
Calibration	2	5.56	72.22
Semi pouros materials	2	5.56	77.78
Other	8	22.22	100.00
TOTAL	36	100.00	

Now it is clear that the environmental department should concentrate its efforts in hiring better final cleaning workers in order to minimize the cost associated with defects in the projects undertaken by the company.

Conclusion

It is evident from the study that by analyzing the data available within a company with the help of various quality tools managers make better decisions. Management can focus their attention most in that particular source of defect or quality problem that costs them most. This was exemplified in a company involved in building remediation project with the help of simple yet effective quality tools such as Pareto analysis and cause-and-effect diagrams. For the company investigated, it was found that the environmental department of the company should try to retain and hire better final cleaning workers. This should be one of the strategies of the company in order to maintain its quality image in the market. However, further study is required in order to quantify the capital that the company should invest in hiring better final cleaning workers to maximize its profit without compromising on quality.

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