"Creating Cause and Effect Diagram through brainstorming sessions in a Jordanian factory"

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ABSTRACT

The use of Total Quality Managements (TQM) Quantitative Tools ensures better decision-making, better solutions to problems, and even improvement of quality and productivity for products. A case study has been carried out to monitor real life data in a Jordanian company. SPC seven magnificent tools is the most popular quantitative tools, were used to identify the most important cause of defects then a Cause and Effect (C&E) Diagram was created through brainstorming sessions to investigate the major causes of nonconformities, root causes of the quality problems. The main conclusions drawn out of this work is that everyone can use some or all of these tools to advantage, and they will serve company well for your future prospects.

Keywords

Cause and Effect (C&E) Diagram, Fish Bone Diagram, Ishikawa Diagram, Check Sheets, Pareto Diagram, Process Flow Diagram, SPC and Seven Tools of Quality .

INTRODUCTION

A process that is stable and repeatable should produce products to meet or exceed customer expectations. More precisely, the process must be capable of operating with little variability around the target or nominal dimensions of the product's quality characteristics.

Total Quality Management (TQM) quantitative tools is a powerful problem solving-tools useful in achieving process stability and improving capability through the reduction of variability. Statistical Quality Control (SQC) is a branch of TQM that defined as both a philosophy, and set of guiding principles that represent the foundation of a continuously improving organization. SQC is the collection, analysis, and interpretation of data for use in quality control activities. SPC and Acceptance Sampling are the two major parts of SQC. TQM Tools and techniques divided into the categories of quantitative and non-quantitative.

The quantitative ones are statistical process control (SPC), acceptance sampling, reliability, experimental design, Taguchi's quality engineering, failure mode and effect analysis (FMEA), and quality function deployment (QFD).

The non-quantitative ones are ISO9000, ISO14000, benchmarking, total productive maintenance (TPM), and the management tools. SPC is receiving increasing attention as a management tool in which important characteristics of product are observed, assessed, and compared with some type of standard. The various procedures in quality control involve considerable use of statistical principles. It has become clear that an effective quality control program enhances the quality of product being produced and increases profits.

SPC is comprised of seven tools often called "The Magnificent Seven", Pareto Chart, Histogram, Process Flow Diagram, Control Charts, Scatter Diagram, Check Sheets and Cause and Effect Diagram Besterfield [1].

Writing about the use of statistical methods in Japan, Dr. Ishikawa said:" The above are the so called seven indispensable tools…… that are being used by everyone: company presidents, company directors, middle management, foremen, and line workers. These tools are also used in a variety of [departments], not only in the manufacturing [department] but also in the [department] of planning, design, marketing, purchasing, and technology." Goetsch [2].

The main objective of this paper is to apply basic statistical tools of quality control. SPC seeks to maximize profit by the following ways: Improving product quality, improving productivity, reducing wastage, reducing defects and improving customer value. A Jordanian manufacturing company was chosen to implement SPC tools and concepts in order to improve the product quality and reduce process variability.

COMPANY BACKGROUNG

Jordan Steel (JS) is a Public Limited Shareholding Company (P.L.C.) that was established in 1993 with a production capacity of 300,000 MT tons per year. It's the largest steel manufacturing company in Jordan .JS produces construction steel (Re bars) (diameters 8 - 32 mm) utilizing a fully automated production line.

The manufacturing process is controlled, tracked and recorded by computer that enables on line quality test and inspection. JS got ISO 9002 certification in 1998. Quality control procedure at JS works along the value chain starting from the supplier's evaluation and selection, receiving raw material (Billets) all the way to after sales services. Billets are initially classified according to their chemical composition and stored in predetermined locations. Final products are tested for mechanical properties and results are handed to customers upon request. Production tractability is ensured through a label that shows the date of production and other information such as diameter, length, weight of bundle and grade. In order to develop process definition, understanding, and workflow a process mapping of JS is shown in Figure 1.

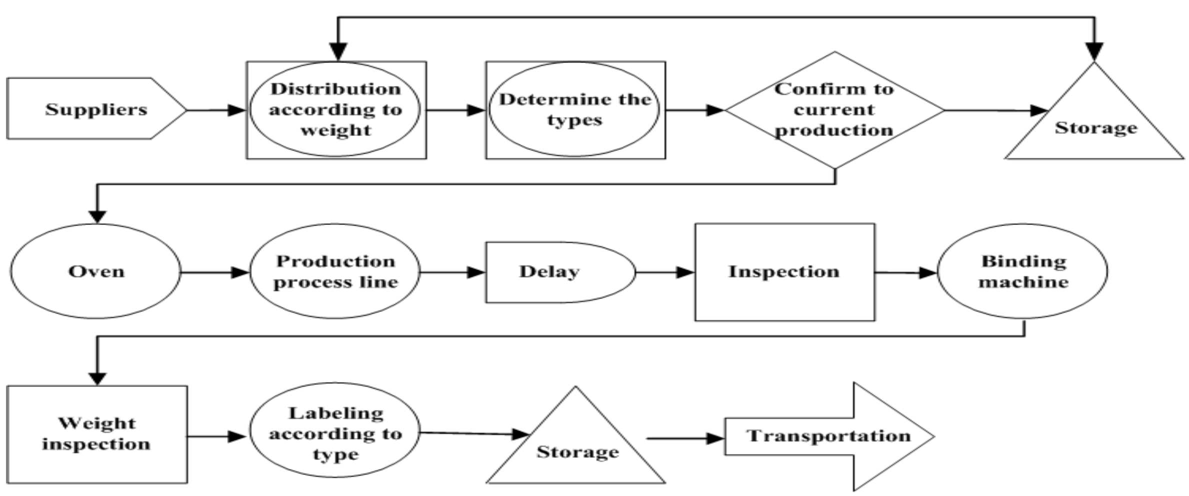

Figure 1: The Process Flow Chart of JS factory

SEVEN MAGNIFICENT

Currently the QC department at JS implements only one QC tool, which is the Control charts, and reviews the results on weekly basis. The purpose of this paper is to promote and implement other statistical tools, particularly C& E Diagram. Check sheets were designed to systematically collect data, followed by Pareto Diagram analysis to identify the Vital Few problem in JS Company, and then a C&E Diagram is constructed to identify the root cause for the most important problem as follows:

CHECK SHEET

The Check Sheet is introduced here as the first of the seven traditional tools. The fuel that powers the total quality tools is data. In JS Company, as the case in many companies, elaborate systems of people, machines, and producers exist for the sole purpose of collecting data. At times, the quest for data has become zealous to the point of obstructing the reason for data collection in the first place. Many organizations are literally drowning in their own data while at the same time not knowing what is actually going on; they are "data rich and information poor". With the advent of powerful desktop computers, information collection has become an end unto itself in many instances.

Having access to data is essential. However, problems arise when trivial data cannot be winnowed from the important and when there is so much of it that it cannot be easily translated into useful information. Check Sheets help deal with this problem.

The check sheet shown in Table 1 was designed in the shape of tally sheet to give visual record summarizing frequencies and percentages of nonconformities for various types of tests carried on steel.

Table 1: Check Sheet for various steel tests with respective frequency & percentage

Category	*Repetition*	*Frequency*	Cumulative Frequency	%	Cumulative percent
Tensile strength	~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ III	28	28	72%	72%
Yield Strength	~~IIII~~	5	33	85%	85%
Elongation Percent	III	3	36	92%	92%
Effective diameter	II	2	38	97%	97%
Effective Weight	I	1	39	100%	100%

PARETO CHART

A Pareto Chart is a very useful tool wherever one needs to separate the important from trivial. The chart is named after the Italian economist and sociologist Alfredo Pareto Goetsch [2].

Pareto chart simply a frequency distribution (or Histogram) of attribute data arranged by category Montgomery [4]. It ranks data classification in descending order from left to right (the most to the least significant ones). The chart first promoted by Dr. Joseph Juran. He recognized this concept as a universal that could be applied to many fields. Juran coined the phrases Vital Few and Useful Many in quality problems Besterfield [1].

Pareto chart was constructed based upon data collected by check sheet for the main tests performed on steel and shown in the following Table 1 and Figure 2. The figure plots the total frequency of occurrences of each nonconformity type against the various nonconformity types and reveals that the tensile strength is the vital few quality problems and represents around 72% of the total cumulative percentage of non-conformities so that the main reason of most rework is the tensile strength. Useful many factors are the Yield Strength, elongation percent, effective weight, and density problem and represents around 28% of the total cumulative percentage

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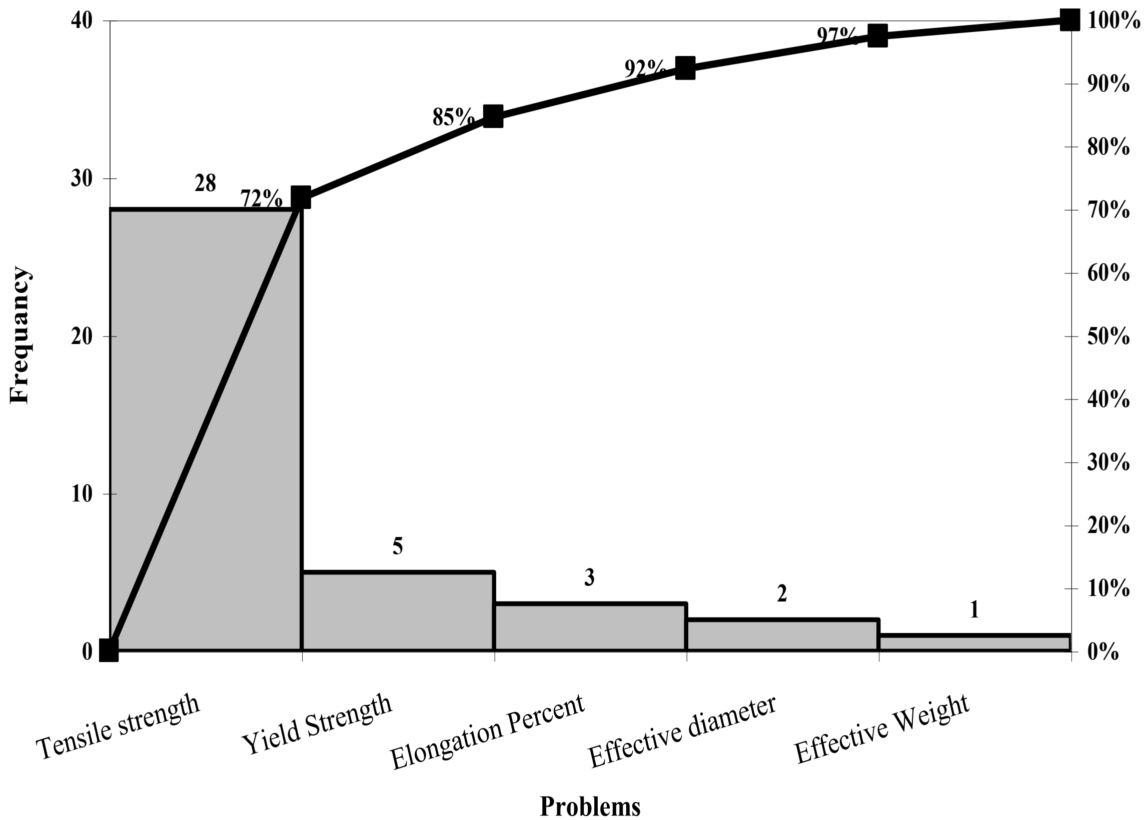

Figure 2: Pareto Chart for tensile strenghth test

CAUSE AND EFFECT DIAGRAM

A team typically uses a Cause-and-Effect Diagram to identify and isolate causes of a problem. Dr. Kaoru Ishikawa, a noted Japanese quality expert, developed the technique so sometimes the diagram is called an Ishikawa Diagram. It is also called a Fishbone Diagram because that is what it looks like.

In his book, Ishikawa [3] explains the benefits of using cause-and-effect diagrams as follows:

- Creating the diagram itself is an enlightened, instructive process.
- Such diagrams focus a group, thereby reducing irrelevant discussions.
- Such diagrams separate causes from symptoms and force the issue of data collection.
- Such diagrams can be used with any problem.

The C&E diagram is the only tool of the seven tools that is not based on statistics. This chart is simply a means of visualizing how the various factors associated with a process affect the process's output. The same data could be tabulated in a list, but the human mind would have a much more difficult time trying to associate the factors with each other and with the total outcome of the process under investigation. The cause-and-effect diagram provides a graphic view of the entire process that is easily interpreted by the brain.

Pareto Chart proves that the tensile strength of produced steel was the most important problem facing JS Company. This research was focusing on analyzing the process to see what can done; this was begin with calling together a group of people to get their thoughts in a brainstorming sessions. The group is made up of engineers, machines operators, inspectors, test laboratory specialists, production control specialists and quality control specialist. All the groups in the plant who have anything at all to do with Steel Production and tensile test were represented, which is necessary to get the broadest possible causes.

The brainstorming session team leader did pay attention to a few essentials that ensures a more accurate and usable result as follows:

- Each member taking a turn giving one idea at a time facilitates participation by every member of the team; if a member cannot think of a minor cause, he or she passes for that round. Another idea may occur at a later round, by following this procedure, one or two individuals do not dominate the brainstorming session.
- Quantity of ideas, rather than quality, is encouraged. One person's idea will trigger someone else's idea, and a chain reaction occurs. Frequently, a trivial or "dumb" idea might lead to the best solution.
- Criticism of an idea is not allowed. There should be a freewheeling exchange of information that liberates the imagination. All ideas are placed on the diagram. Evaluation of ideas occurs later.
- Visibility of the diagram is a primary factor of participation. In order to have space for all the minor causes, a 2-ft by 3-ft piece of paper is recommended. It should be taped to a wall for maximum visibility.
- Create a solution-oriented atmosphere and not a gripe session. Focus on solving a problem rather than discussing how it began. The team leader should ask questions using the why, what, where, when, who, and how techniques.
- When no more ideas are generated, the brain- storming activity is terminated.

The team leader let the ideas incubate overnight, and then had another brainstorming session to accomplish the evaluation of the C&E diagram. Provide team members with a copy of the list of possible causes generated from team ideas after the first session. The procedure is to have each person vote on the minor causes. Team members may vote on more than one cause, and they do not need to vote on a cause they presented. Those causes with the most votes were circled, and the six most likely causes of the effect on tensile strength problem are determined. The designated six major factors, or causes, are those that the group thinks might have an impact on the quality of output of the production line: machine, people, materials, methods, measurements, and environment. The Cause and effect fishbone diagram developed from this information has six ribs (major Causes). Next step is to assign all the other minor causes to the ribs they affect, as shown in Figure 7.

The same procedures explained above were employed to construct another C&E Diagram for the steel production line problems in JS Company shown in Figure 8. The aim was to encourage consultative decision-making techniques by all the groups in the plant who have anything at all to do with Steel Production process.

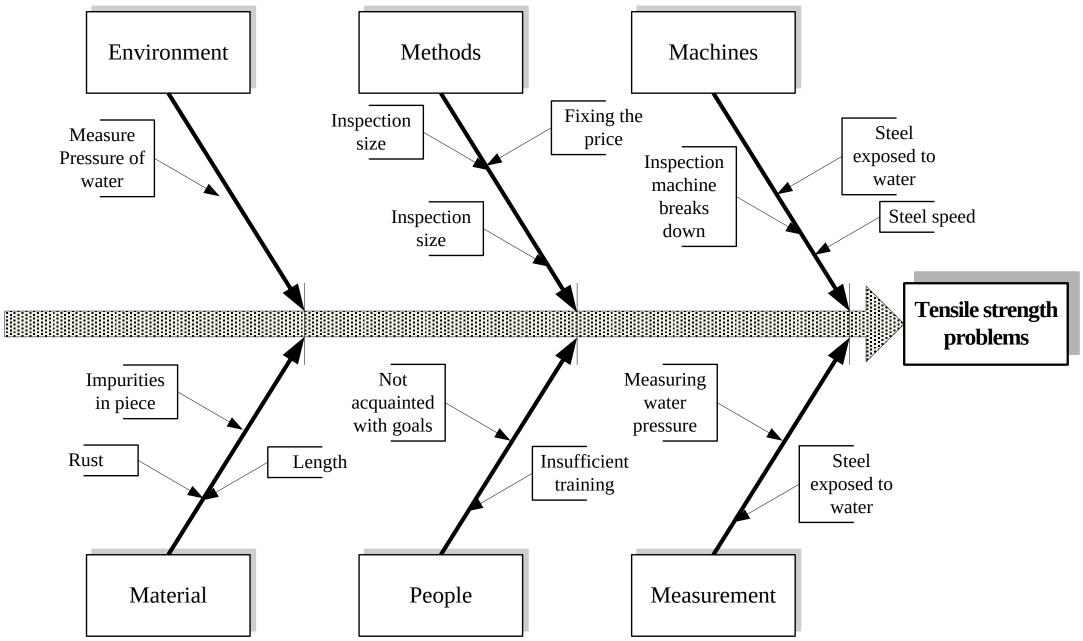

Figure 3: Cause &Effect Diagram for Tensile strength Problems.

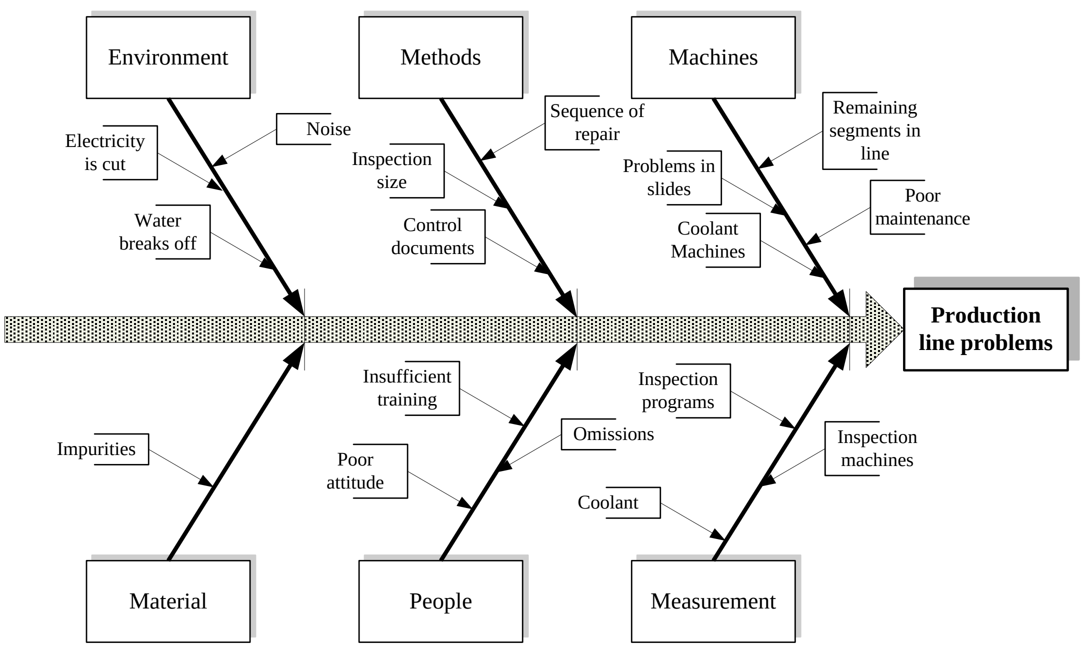

Figure 4: Cause &Effect Diagram for Production Line Problems

The cause-and-effect diagram has nearly unlimited application in research, manufacturing, marketing, office operations, and so forth. One of its strongest assets is the participation and contribution of everyone involved in the brainstorming process.

Solutions are developed to correct the causes and improve the process. Criteria for judging the possible solutions include cost, feasibility, resistance to change, consequences, training, and so forth. Once the solutions have been agreed to by the team, testing and implementation follow.

Diagrams are posted in key locations to stimulate continued reference as similar or new problems arise. The diagrams are revised as solutions are found and improvements are made.

The diagrams are useful in:

- ♦ Analyzing actual conditions for the purpose of product or service quality improvement, more efficient use of resources, and reduced costs
- ♦ Elimination of conditions causing nonconforming product or service and customer complaints
- ♦ Standardization of existing and proposed operations
- ♦ Education and training of personnel in decision-making and corrective-action activities

CONCLUSIONS

- Jordan Steel lacks the required management involvement and commitment to learning and using SPC tools.
- Jordan Steel lacks the ongoing education and training of management and line staff on SPC tools.
- The purpose of Check Sheets constructed in Jordan Steel company is to make it easy to collect data for specification and to present it in a way that facilitates conversion from data to useful information.
- Pareto diagram identifies that the tensile strength is the vital view steel characteristic that need attention.
- Jordan Steel shall introduce process improvements throughout encouragement of consultative decision making techniques through teamwork approach and brainstorming sessions.
- Jordan Steel benefited a lot from Cause and Effect Diagram as it:
    - Encourages team work through different departments in the company
    - Created by teams widely divergent in their expertise
    - Helps organizing the random ideas for intelligent decisions
    - Visualizes the various factors associated with a process affect the steel quality.
    - Can be made in surprisingly short time
    - Reveals relationships that had previously not been obvious
    - Serves as an excellent reminder that the items noted on it are the things the JS company needs to pay attention to if the process is to continually improve

RECOMMENDATIONS

It is recommended that the SPC methods and tools can provide significant payback to Jordan Steel if can successfully implement them. Management involvement and commitment to the quality improvement process at JS are the most vital components of SPC's potential success. A team approach is also important; it is usually difficult for one person alone to introduce process improvement. The basic SPC problem-solving tools must become widely known and widely used throughout JS. Ongoing education of quality and line staff about SPC and other methods for reducing variability are necessary to achieve this widespread knowledge of the tools.

ACKNOWLEDGMENTS

Thank you for reading this text.

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