Review and Study of Quality Management Tools in Shipbuilding Industry

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ABSTRACT

Quality management is a tool and art of science implemented towards assisting in building up good decisions and thus will develop in prosperous earnings and reduction of errors and thus improving the working environment and will lead to improvement in both the productivity of a certain establishment.

There is now a tool called 6 Sigma that is being to be applied in order to have a transformational leadership from management by objectives. Therefore any applied quality auditing scheme within a management should contain breakthrough leadership assessments and driving decisions.

The intent of the current paper is to demonstrate a strategic plan for optimizing the management decisions and to comment on the deducted results. Also the work has been extended to deal with the competency-based human resource management. One of the main conclusions is that the suggested plant process could be started up after commissioning and the expected troubleshooting could all be demonstrated before the production can be started up.

1. INTRODUCTION

Variations in a work process are subjected to the results of handling the capability including workers, machines, tools, materials and procedures [1]. The dimensional variations occur in any work process as a result of common and special causes. Common cause variation in work process is the normal chance or random variation within the common production process. The resulted outcome of the production system is including raw materials, incoming parts or interim products, tools and machines, workers' training and environmental aspects. Variation due to common assets and causes cannot be altered without changing the work process or the control system. As one knows that the functional quality as well as the production process are being interacted and needs to apply a total quality management (T Q M) system. So usage of the statistical techniques is an essential element in controlling the level of the resulted accuracy of the system.

2. QUALITY MANAGMENTS SYSTEM (Q M S)

QMS is a set of policies, processes and procedures required for planning and executing of a production / development / service in the core business area of an organization. Also, **QMS** is the quality control or basic quality assurance organization or function [2, 3].

3. QUALITY SYSTEM PLANNING AND EVALUATION

Quality system planning [4, 5 & 6] is the first stage in setting up a quality management system within the company. This pertains to the identification and acquisition of resources, logistics, and manpower needed to define and to achieve the required that the company's quality system will eventually conform to all the requirements of the ISO-9000 quality of the company. If the company is to be certified to ISO 9000, then quality planning should ensure elements.

Quality planning should include compatibility among the various aspects of the company's operations from start to finish. Product design, production, and product inspection/testing are the main assets that required to be maintained. It should also include definition of product and process specifications. Identification of the necessary monitors as well as inspection/verification stations at suitable points along the production process should also be addressed as early as quality planning. Measurement capability requirements must likewise be defined during quality planning.

Regarding the quality system evaluation, it should be done through fulfilling of the achieved goals of quality system via the implementing of analysis to the recorded and collected data.

4. QUALITY SYSTEM DOCUMENTATION

Once the quality system plan of the company has been completed [4, 5, 6], the quality system must undergo full documentation that comprehends the complexity of the production process, the manpower skills required for production, and the training requirements to achieve these manpower skills. At the minimum, quality system documentation should include the company's quality manual and specifications showing the company processes, work instructions in support of these processes, and production/quality records required by these work instructions.

5. QUALITY SYSTEM EXECUTING (QSE)

QSE Is concerned with the following two tasks [4, 5 & 6]

1- Define who. When, how to measure?

2- Take measurements record data

Productive workers can monitor the work processes with the aid of control charts and make adjustments when necessary to maintain the desired state of control. Theoretically workers attached to any productive project should be aware of self checking, when and what to check, check methods, how to deal with check sheets and the measuring devices as well as tools and equipment. Of course, the theoretical applied tools and used methods for determining the accuracy as well as the associated control measurements will vary depending on type, size, locations and complexity of interim products.

Self checks are required to be carried out on the involved workers. Workers who have not yet completed a certain job till the moments of checking are classified as none checked. Till the moment which they are subjected to self checks, their work is considered to be a trivial and should be liable to insure compliance with the written accuracy instructions.

The question of when and what to check must be defined and carried out on all workers who are being undergoing and subjected to self checks. Those who are categorized as skilled labor force are those who have passed the self checks successfully. Accuracy checks are to be daily performed with schedules that require repeating the check tests on weekly basis. For each stage of work the items that need to be checked for conformance with accuracy standards and satisfying the following check points and field lines:

1-Performing regular checks on products are to reveal their quality standards.

2-Limiting variability in equipment functions is clearly defining the implementation of work standards.

3-Using standard codes and statistics to verify the accuracy of self checks is a must.

4-Presenting the obtained resulted and the predicted information in appropriate statistical literature forms should be implemented.

6. QUALITY SYSTEM IMPLEMENTATION (QSI)

The last stage of setting up a quality system is its well implementation [4]. By the time this stage is reached, the over-all quality system should have been defined and documented, and supported by product- or process-specific quality plans. Implementation should involve everybody in the company - the management for enforcing, reviewing, and continuously improving the quality system, and the personnel to comply with the quality system to achieve the company's quality objectives. Quality audits must be conducted regularly to ensure that the actual implementation of the quality system is in full conformance with the quality system documentation. The effective QMS requirements (EQR): are to be fulfilled. The analysis of the standard's requirements mentioned in terms of future predictions.
-Introduction of an interpretative scheme based on the author's experience and technical background.
-The top management decision on the total effort to be expended to produce the QMS (degree of responsiveness)
-Integration of business strategy with strategic quality management goals. Clear presentation of the strategic organizational policies documented in a quality manual (manual).Aggressive implementation of the designed QMS. Demonstrate the QMS is effective through the analysis of data that tracks QMS performance against quality objective.

7. TOOLS OF Q UALITY

The Basic Seven Tools made statistical analysis less complicated for the average person. Good Visual Aids make statistical and quality control more comprehendible. The Basic Seven (B7) Tools of Quality [7, 8, 9 & 10] are as investigated below to be:

7.1. Fishbone Diagrams

Those sets of diagrams are composed of:

- No statistics involved
- Maps out a process/problem
- Makes improvement easier
- Looks like a "Fish Skeleton"

Steps involved in constructing a Fishbone Diagram are:

Step 1 - Identify the Problem

Step 2 - Draw "spine" and "bones"

Step 3 - Identify different areas where problems may arise from

Step 4 - Identify what these specific causes could be

Step 5 – Use the finished diagram to brainstorm solutions to the main problems.

7.2 –Histograms

Those methods are presented by Bar chart and. heavily based on the use of graphic representation for different groups of data. Those data could be presented by a histogram that could be statistically constructed. It also makes an access to compute for the set of data for the seven parameters, e.g., sums, means (x), maximums, and minimums of ranges (max-min). Using ranges to estimate beginning and end as well as to calculate the width of each column by dividing the range by the number of columns are all could be computed. Histograms can be used a resource plan to determine the categories of work forces in a factory or a production sector.

7.3. Pareto Analysis

These types of analysis are considered to be very similar to histograms, but with the use of percentages to show the importance of statically formulation of the problem. The completed Pareto Analysis results in graphs.

7.4. Flowcharts

Flow charts can be used as tools for graphical presentation for indicating a process. This method of presentation defines symbols, which stays consistent and verify the accuracy of the process.

7.5. Scatter Plots

This process can be signified by dimensional X/Y plots, and show how to conclude the relationship between independent(x) and dependent(y) variables.

7.6. Run Chart

This method of presentation is a time based on the abscissa, x – axis, cyclical and a good model for patterns. The importance of those charts could be seen in the scheduled times of a process.

7.7. Control Charts

Those families of charts are being used to represent the deviation from mean, upper and lower bounds as well as the range of application. Also, samples within specifications which are acceptable. The One abnormally sample is "uncommon", nevertheless, should be examined for quality control.

8. 6-SIGMA AS EFFECTIVE QUALITY CONTROL TOOL

6-Sigma is a business process that allows companies to dramatically improve their Profitability by designing and monitoring everyday business activities in way that minimizes waste and resources while increasing Customer satisfaction [11]. The philosophy of 6-sigma: based on that one should work smarter, not harder. The business strategy however must be based on that one should gain competitive edges in quality, cost, and customer satisfaction. This method applies the theme of statistical measurements as input stored data while the output gives the optimum actual solution for the defined problem, as seen in Fig. 1. General deductions of the outcome of the application will result in statistical means and deviations that will lead to the minimisation of the bandwidth and the expected dealt error will be removed or the least could be minimised. One therefore has to measure defect rates in all process through an expanding statistical concept, and it can use "σ" in measuring process capability.

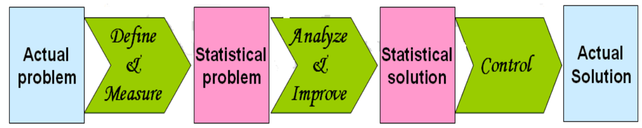


Fig. 1: flow chart for 6 sigma strategy

9. THE MAIN OBJECTIVE OF SIX SIGMA

Objective of 6-sigma [12] is to reduce standard deviation in order to meet the specifications. The data should lie within the specification limits with minimum Standard deviation. The data may be within specified limits.. But the estimated mean of the data may be shifted from the target. So the estimated and the resulted deduced mean of the data should match with the target. So at first meet the target then the process will reveal in reducing of variation, Fig. 2 [12]. Quality Function Deployment "QFD" is considered to be a method for selecting technical requirements and customer total quality "CTQ" from customer needs. Failure Mode and Effect Analysis "FMEA "is used to proactively identify and rank risks in a product design and assign appropriate actions to be taken to prevent the failure mode.

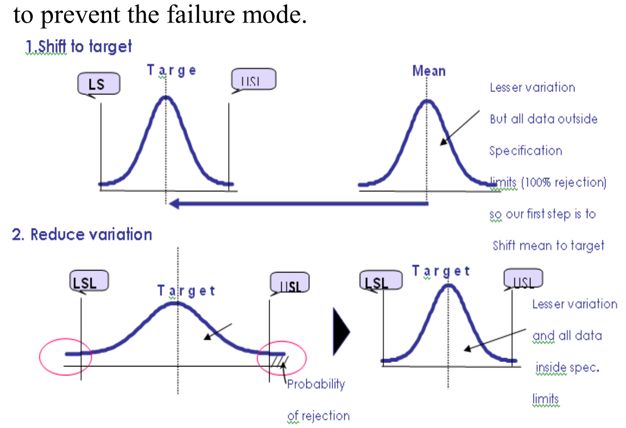


Fig. 2 shows the objective of 6-sigma [12]

Recently, global shipbuilding companies have been increasing their productivity or expanding their shipyards to accommodate a large amount of orders. However, few studies have been carried out on shipyard. This research presents that Block construction method for sister's vessels produced using the block by block method of assembly [13].

10. APPLCATION AND DISCUSSION FOR A SHIPYARD PRACTICE:

The intent of this part of the current paper is to highlight and to demonstrate an application of the 6-Sigma approach to a shipbuilding case. This application has been originally quoted from Ref. [13]. Block construction, common for large vessels, also is used for some smaller ones. Blocks can vary in size from approximately 50 tons for small vessels to up to 400 tons for large vessels such as very large crude carriers (VLCCs). A typical block is shown in Fig. 3. Block construction has advantages that are more dramatic than those for assemblies: higher productivity and, therefore, lower labors costs. But blocks also entail disadvantages: the need for highly accurate assembly, a larger investment cost in facilities, and a very high reliance on control of accuracy and on on-time delivery of materials. Frigates being designed and constructed in Spain for the Spanish and Norwegian navies use the block-construction approach, as shown in Fig. 4_However, these ships are employing a more traditional block approach, in which many small blocks (up to 100 tons) are fabricated in the same shipyard. This section of paper illustrate the application of six sigma technique in shipbuilding field assuming a production sample (block 10 m high and 15 m width as shown in fig.3) of workshop contains 20 blocks will be random selected to examine the effectiveness of the applying six sigma technique .

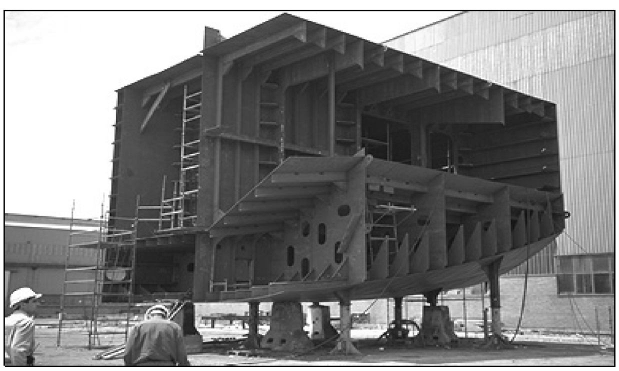


Fig. 3: [13]: Typical Structural Block

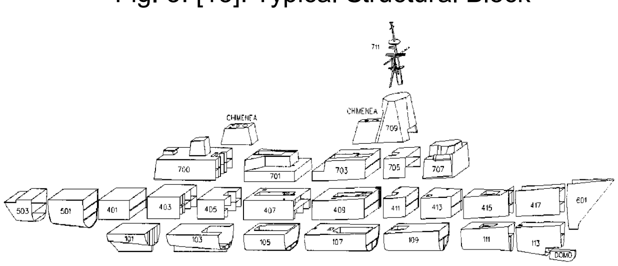


Fig. 4: Ship Structure Block Breakdowns [12].

The problem one shall be exposed to face is the variation in the workshop dimension of the block. The block size and weight will be liable to the shipyard cranes capacities as well as the production facilities within the sub-assembly yard. So, the only variable to be investigated here is the variation in length and height of each produced block. Of course the investigation as such is aiming at reducing tolerances between different blocks in the assembling of the block at the assembled yard.

A random survey for the workshop under consideration is assumed to produce 20 blocks as product samples in quality control tools analysis to improve productivity for that shipyard. Of course the quality of the productivity is assumed to be pending to the quality control standards and the respective quality assurance requirements. The investigated case can be distinguished by the production of two different in heights blocks. The first is designated by C1 which is for a height of 10 m block, while C2 is the second alternative to C1, but with each is having a width of 15 m respectively.

The following are the main inputs to the application: Input survey data which collected by quality auditing and those required to entering the MINITAP 13 program are to satisfy the following main seven quality requirements.

1. First step: carrying out Quality Auditing shall establish the required data to be fed within the process of capability analysis for **C1** (block 10 M high) and **C2** (15 M width) respectively. Accumulative defect percentage in 20 samples which illustrates the degree of effect of each defect and fault have been found to be statistically distributed before and after carrying the corrective survey..
2. Establishing the limits for the upper and lower bounds could be determined for each item. (limits assumed in this application but it always indicated as CTQ and quality control rules)
3. The deviation from the mean for each item C1 and C2 by using MINITAP 13 (output data from MINTAP13)can then be deduced.
4. Thus the analysis for establishing the causes and effect diagrams of a workshop have to be investigated within the major effects on quality and productivity using MINITAP13 program specifically for the main items and sub items from previous experience and regular survey.
5. Improve workshop quality and increase productivity by decreasing factors which affect the productivity of a workshop.
6. Second survey after applying the corrections and the remedial actions has to be carried out. The impact will be

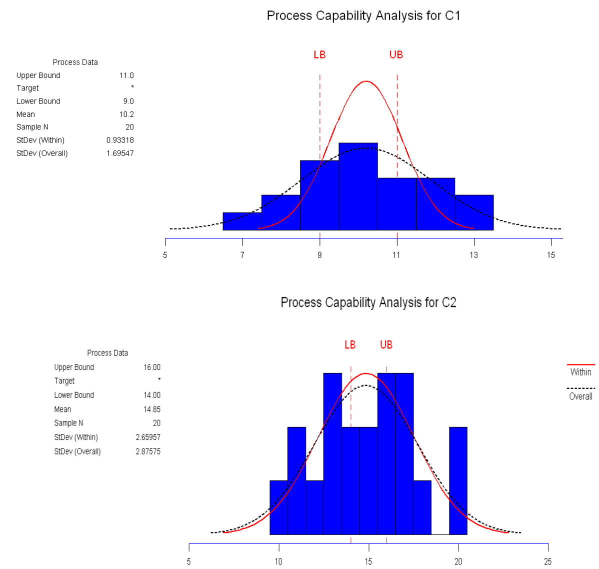
reflected on improving by eliminating drastic factors which affect the productivity of a workshop, through determining the deviation from the mean for each item C1 and C2 by using MINITAP 13 Computer program, must be implemented.

7. Random steps until one reaches the minimisation and reducing the deviation to the least value must follow. This will result in improving of the productivity as well as will lead to higher quality by implementing and the validation of the moving target quality senses.

Figures 5 indicate the deduced deviations from the mean for the C1 and C2 cases to be within the range of 9 up to 11 before carrying out corrective survey and modified to be at the range from 14 and 16 respectively. The predicted corresponding accumulative percentage of errors in the 20 block samples defects indicated on Pareto charts, Figs. 6 finalise the analysis for the productivity of the concerned shipyard. Causes and the carried out remedies resulted in affecting the productivity diagram. From Figs. 7 it could be deduced that the analysis for workshop problem causes and the effect diagram after correcting surveys have been significantly improved by applying the accuracy level, i.e., ± 1 %. The resulted improving in quality and productivity due to reducing discrepancies and by narrowing the gap between deviated factors all will resulted in feasible shipyard productivity.

Analysis for workshop (cause and effect diagram) to improve workshop quality and increase productivity and decrease factors which effect in workshop productivity.

To make sure that the accuracy and the tolerance levels have been improved, a second run after sorting out the deviation problems solving the model by minimizing the effective causes for errors, thus the improvement could be noted in Figs. 8 which indicates the same upper and lower bounds of 9 and 11 respectively for the case before carrying out remedial and corrective action survey as well as to be within 14 and 16 but noting that the areas outside of the overall out of range samples have been significantly reduced. The results of application are seen in Fig 8 that deviation out from upper and lower boundary is decreased and most of samples in range and its quality acceptable. Applications of the proposed scheme of quality management to fields of marine field of practice have been demonstrated.



Figs. 5: The distributing of capability before carrying out any correction measures

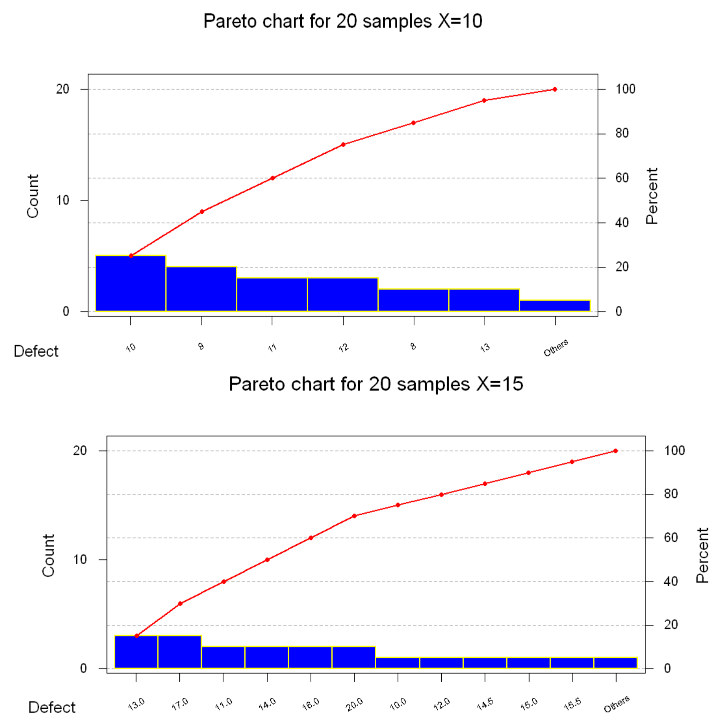
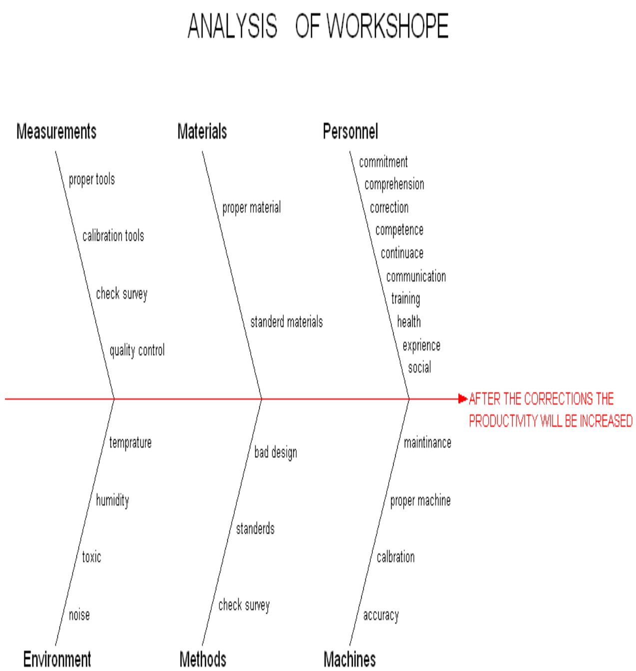
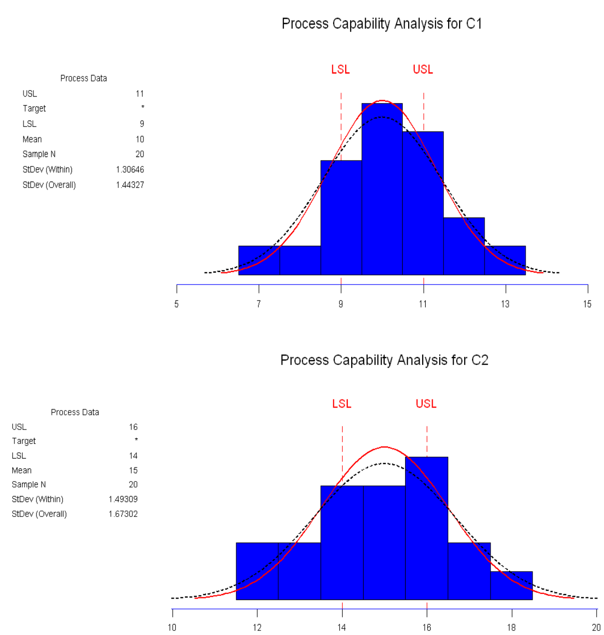


Fig.6: shows Pareto charts by using MINITAP 13



Figures 7: The cause and effect diagram by using MINITAP13



.Fig.8: The second survey for the process capability charts by using MINITAP 13 after applying the corrections from cause & effect diagram

CONCLUSIONS

The following are brief main points of summary to the conclusions prevailed from this paper:

1-Managing the training development is now a must.
2-Competencies based approach to training and development should be thoroughly followed.
3-Successful planning organizing control must be implemented.
4-This includes documentation facilities and management records on the one hand and by adopting of proper quality assurance, control and auditing.
5-The implementation will lead to better management leadership and will promote the least errors.
6-The human errors will be under control and thus the earning capacity and the earning power will be very much in the gain side.
7-Thus good earning from marine activities will be in the positive side.

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ACKNOWLEDGEMENT

The Authors would like to thank Egypt Basic Industrials Corporation (EBIC) for kindly and generously sponsoring this work presented in this paper.