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Diagnostic Tools to Revive Sick Manufacturing Units using SPC (Statistical Process Control) Technique: A Review

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Abstract - *SPC is the most effective way for enhancing the quality process by systematically minimizing various assignable/special causes of variations. The application of Statistical Process Control techniques requires many skills such as management, statistical, teamwork, Brainstorming and Planning as well to get the intended results. Control charts are utilized by industrial units to augment quality of products and to minimize wastage but other aspects are equally important for the effective implementation of SPC in organizations. This paper depicts implementation of the Statistical Process Control techniques in various manufacturing units. In this research paper, various articles on the implementation of Statistical Process Control techniques in the manufacturing units are examined for the review.*

Keywords: **Statistical Process Control, Quality, Process effectiveness, 7QC Tools.**

1.INTRODUCTION

SPC is an analytical decision making tool which allows you to see whether a process is working effectively so that preventive measures can be taken at right time. In this era of strains on the resources and rising costs of manufacturing, it becomes apparent that decisions must be taken on the facts, not just opinions by gathering and analyzing data.

I. Introduction:

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1.1 Control Charts:

The foundation for SPC was laid by Dr. Walter Shewhart working in the Bell Telephone laboratories in the 1920's conducting research on methods to improve quality and lower costs. He developed the concept of control with regard to variation, and came up with SPC charts which provide a simple way to determine if the process is in control or not. Dr. W. Edwards Deming built upon Shewhart's work and took the concept to Japan following World war II. There, Japanese industries adopted the concept whole heartedly resulting high quality of Japanese products and are considered world renowed products. Dr. Deming is famous through out Japan as a "God of quality".
A typical control chart has control limits set at values such that if the process is in control, nearly all points will lie within the upper control limit (UCL) and the lower control limit (LCL).

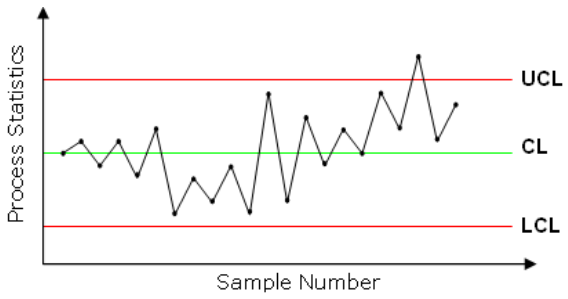

Fig.1 shows Sample of Control Chart

1.2 Basic 7 QC tools

1. Check Sheet
2. Histogram
3. Pareto Chart
4. Cause and Effect Diagram
5. Flow Chart
6. Control Chart
7. Scatter Diagram

1. Check Sheet: Check sheets are charts for gathering data and easy to understand and very clean to read.

2. Histogram: A histogram is a snapshot of the variation of a product or the results of a process. It often forms the bell-shaped curve which is characteristic of a normal process. The histogram helps to analyze what is going on in the process whether the data is falling inside the bell-shaped curve and within specifications.

3. Pareto Chart: The Pareto chart can be used to display categories of problems graphically so they can be properly prioritized. Pareto chart is a vertical bar graph displaying rank in descending order of importance for the categories of problems, defects or opportunities.

4. Cause and Effect Diagram: The Cause and Effect Diagram display the relationships between different causes for the effect that is being examined. The major categories of causes are put on major branches connecting to the main line, and various sub-causes are attached to the branches.

5. Flow Chart: Flow chart breaks the process down into many sub-processes. Analyzing each of these separately minimizes the number of factors that contribute to the variation in the process.

6. Control Chart: As discussed above they are used to monitor the process.

7. Scatter Diagram: A Scatter plot is used to show how a pair of variables is related and the strength of that relationship. It is constructed by plotting two variables against one another on a pair of axes.

2. Literature Review

Ignatio Madanhire and Charles Mbohwa [1] (2016) attempted to address in the literature of SPC implementation with the emphasis on early detection and prevention of the problems in the manufacturing industry based in Harare, Zimbabwe and investigated that there was need for the apparatus to be trained, gauges and machines. To achieve the purpose 7 SPC quality tools were utilized as a way to explore the natural variability of processes so that assignable causes can be eliminated such as pareto analysis and Brainstorming are applied. After conducting detail study by applying SPC techniques which indicated that some of benefits of SPC includes increase understanding between employee and processes. Employees ability to do trouble shooting and process diagnosis was improved which ultimately resulting in reduced cost of per unit of production and work efficiency. The study looked at the implementation of SPC tools in the Zimbabwe and manufacturing company, quite the number of the companies at various stages of implementing SPC to competitors in the global market utilizing SPC tools. There is an urgent need to undertake the awareness drive to adopt SPC tools in the manufacturing units to gain profit and customer satisfaction.

Héctor Ramírez, Eloy Mendoza, Miguel Mendoza, Eduardo González [2] (2015) depicted that augmented reality is an alternated to the traditional training methods where one can receive instructions on real-time on which tool used and how to use it. They conducted an experiment where two groups of young engineers were given asset of instructions to do a quality process measuring and on other team augmented reality was applied where the subject can watch on site the instruction on real time basis. After analysis of the result it was found that the group with augmented do the process 30% faster than the group with manual instructions. Augmented reality put addition information over the real world, this information can be 3D model with animation, images, text and videos.QDA(Quality Data Analysis) It is a software divided by several modules are being utilized which are: (1)Gage and Tool management (2) document management (3) SPC and data collection. From this study it can be concluded that if the company use augmented reality for the training, instead of a week they can have the same training on half a week which results in 41% of savings on the training for each new operator.

Ľubica Simanová and Pavol Gejdos [3] (2015) has been investigated that use of tools of operative quality management to prevent decrease in quality during operational processes and adhesive applications as well in the furniture manufacturing units. In addition to other tools they also use histogram and Ishikawa diagram frequently used to achieve quality. For evaluation of capability of processes, a list of process capability indexes was developed. The basic condition is that evaluated process must be in a statistically managed state. The information obtained from histogram and Ishikawa diagram played a vital role. From histogram an estimate of the position of the monitored quality feature, division shape, process changes and feasibility of processes can be determined a suitable method for finding positive factors i.e Brainstorming. From the results obtained it can be concluded that illustration of using specific tools of various process of furniture production and implementation in the identification process capability resulted in improve quality, competitiveness and performance of businesses.

Anna Satanova, Lukas Figuli, Mariana Sedliacikova [4] (2014) has been investigated a study on the factors in production process for the quality of solid wood panels, in order to improve quality of the final product and reduction of production cost. Various factors such as humidity, temperature of production environment an adhesive as well were observed which was analyzed by statistical method and correlation analysis. From the study it was observed that F-test proved that probability of existence of relationships between some production factors such as storage humidity, temperature of storage spaces, material temperature, adhesive temperature and compacting pressure and shear strength are not high. Therefore we consider these factors as insignificant. On the other side, production factor like raw material humidity and pressing time plays major influence of shear strength whose probability is more than 95%. Regression analysis was carried out to determine the size of impact of these factors on the bonding strength. The correlation coefficient between the compression time and shear strength comes out to be 0.0559. From the above carried assessment of production process gives company management key information, whether active systematic defects operate in process. The relationship between the production process characters and quality of manufacturing gives possibility to identify parameters of manufacturing process so that highest quality can be achieved by minimizing cost in the manufacturing of wood construction material.

Yonatan Mengesha Awaj, Ajit Pal Singh,Wassihun Yimer and Amedie [5] (2013) has been investigated SPC tools in the production processing in order to reduce defects by identifying occurrence of highest waste in the bottle and glass manufacturing industry established in 1973 located in Addis Ababa, Ethiopia, Africa. Through SPC tools monitoring of the process centre can be done by collecting data from samples at various points within the process. Thus, SPC will be able to reduce the probability of passing problems to the customers. Pareto charts helps to prioritize efforts and pays attention on most pressing problems and Fish bone diagram leads to the root cause of the problem. Five major defects have been identified but focus is given only on pressure failure and blister defects. Through these techniques 572 glass bottles were saved per month from pressure failure and 11 glass bottles were saved from blister defects. These various SPC tools like Brainstorming, control chart, pareto chart and fish bone diagram provided useful information in identifying major defects which can be categorized in to material, machine, human factor, machine setup and operation. The company also lacks the ongoing education and training of management and line staff on SPC tools. The furnace is being bottle neck for the individual section machine ,moulds overused and get worn out and operates need training to skillful in machine setting and operation control. Company should effectively use SPC tools or productivity improvement.

Prof B.R. Jadhav,and Santosh J Jadhav [6] (2013) has been investigated procedure top analyze and minimize casting defect cold shut in automobile cylinder block of grey cast iron Grade FG15O. Gaiting systems are not always responsible for the defect occurrence; this paper represents the defect reduction by controlling alloy composition and pouring temperature. 7QC Tools were utilized through which it can be assessed that cold shut requires higher pouring temperature and thus increase to 1432 degree Celsius. To increase the flow ability Phosphorous percentage level to be kept 0.2% and Silicon percentage recommended being 2%. Finally it was found that alloy composition and pouring temperature was the root cause for this major defect. The total rejection from cold shut reduced to 6.6% from 12.3% which is nearly up to 50% reduction.

Fabio A. Fernandes, Sergio D. Sousa and Isabel Lopes [7] (2013) has been studied to improve the level of quality through use of quality tools in a company producing leather components located in Portuguese for leather goods and is being installed. In this case a PDCA cycle is applied to trigger the use of quality tools in problem solving. The application of the Taguchi method to determine the optimum combination of factors of a station (together with other improvement actions) caused a 50% decrease of the most critical defective component and an overall reduction of 29% in the level of nonconformities in the preparation section. PDCA (Plan-Do-Check-Act). It is a four step management method use for controlling and improving processes and products. Quality tools and methods were applied at various stages for the reduction of non confirming components in the IG station. Through this technique helped to identify priority area to increase its quality level by putting the process under statistical control which resulted in reduction of non conformities to 50%. PDCA cycle showed that it is effective support for continuous improvement. Finally the methodology presented in detail can contribute for companies to start using quality tools efficiently.

Ali Mostafaeipour,Ahmad Sedaghat, Ali Hazrati, Mohammadali Vahdatzad [8] (2012) has been examined SPC technique in Yazd ceramic tile manufacturing plant in Iran for reducing unwanted

ceramic tile defects and wastages. The most important defect was a variety of cracks in different tiles. Control diagram, $\bar{X}$ and six-pack for a sensitive parameter and arrived at significant results. Using Pareto chart and Control chart, different causes for inappropriate effects can be categorized and defective products can be avoided by taking preventing actions. A defect from 588 different samples were examined and observed that 61% of problems occur only due to one factor i.e. types of cracks. Thus six pack sampling and evaluation were performed in dimensional sizes for different tiles of 20x20, 40x20 and 40x40. Reviewing the above cases indicates that applying a powerful preventing and improving maintenance and repairing system can prevent from many additional expenses to be imposed on the system.

Dr. D. R. Prajapati [9] (2012) has been investigated SPC techniques offering its customers the widest and latest range of sealing solutions for various applications in the automotive industry. Out of 7 QC techniques cause and effect diagram and Control chart are implemented in this industry. A study was conducted on defects in shocker seals of an automotive industry which resulted in reduction of rejection from 9.1% to 5% and process capability of 0.953 is achieved. The essential Tools for the discovery process are check sheet, cause and effect sheet, pareto chart, scattered diagram, histogram and control chart. Through SPC analysis efficiency of the manufacturing process can be improve by minimizing number of defective products, thus saving a lot of rework cost and valuable time after implementing the suggestive measures for shocker seals process capability got improved which was greater than required. 400 observations were made of outer diameter of shocker seals and found that no any observation os falling outside of control limits on both X bar and R charts.

Rami Hikmat Fouad, Adnan Mukattash [10] (2010) has been studied to monitor real life data in Jordanian manufacturing company that specialized in producing steel. Through SPC tools vital problems were identified and identified that steel tensile strength is the vital problem which account for 72% of the total problems. Quality team was trained to held an effective Brainstorming session and exploit these data in cause and effect diagram construction. Brainstorming technique was carried out to elicit a large number of ideas from a team which was performed under specific condition and procedures which helps in establishing Cause and Effect(C&E) diagram. This C&E technique was developed by Dr. Kauro Ishikawa which helps to lead to the root cause of the problem. Pareto diagram identified that the tensile strength is the vital view steel characteristic that need attention. The interpretation of Control Charts indicated that the defect occurred due to errors in calculations, poor storage conditions. So there was a need to train management and line staff through effectively use SPC tools by holding Brainstorming sessions according to standard rules and procedures.

3. Conclusion

Conclusion can be drawn from the above study that to survive in the market, sick manufacturing units need to produce the quality products. By using the quality tools and statistical techniques quality of the products can be achieved and wastage can be minimized up to great extent These tools and techniques are easy to implement and it needs the involvement and support of top management, manager employees and workers. In this paper it has found that the SPC tools can be applied to different Industrial units for reducing the defects. Thus SPC techniques is a diagnostic tool to revive the sick manufacturing units and enhancing quality of the product to strengthen the position of sick manufacturing units in Global market.

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