VOL. 13, NO. 18, SEPTEMBER 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

APPLYING QUALITY IMPROVEMENT TOOLS FOR A CANNING PLANT

Rami Hikmat Fouad[1], Wisam Abu Jadayil[2] and Mwafak Shakoor[2]
[1]Department of Industrial Engineering, University of Jordan, Jordan
[2]Department of Mechanical and Industrial Engineering, American University of Ras Al Khaimah, United Arab Emirates
E-Mail: mwafak.shakoor@aurak.ac.ae

ABSTRACT

The purpose of this paper is to improve the quality of production by investigating the problems, which will lead to stronger competition in the markets. Canning Industries Company has been chosen in this study, to analyse its process line then applying several quality tools to improve the production quality. Statistical quality tools had been used to monitor the production process, including the Check Sheet, Histogram, Pareto Charts, Control Charts and Cause and Defect Diagram. Analyzing the results of all those quality tools identified that Slitters and Raw Material (RM) departments contains the majority of the defects. So causes were diagnosed with Cause and Effect diagram to find out that the man power has to be trained well, and more rigorous terms with the supplier should be agreed on.

Keywords: quality improvement, statistical process control, control charts, canning industry.

1. INTRODUCTION

Customer usually feels sense of disappointment when something has been purchased and does not meet their expectations. It could be a CD that is scratched and does not play properly, a new car with a number of rattles or customer service department who don't return your call. At the heart of meeting such expectations is the notion of quality. If a product has to meet or exceed customer expectations generally it should be produced by a process that is stable or repeatable. More precisely, the process must be capable of operating with little variability around the target or nominal dimensions of the product quality characteristics. Statistical process control (SPC) is a powerful connection of problem solving tools useful in achieving process stability through reduction of variability.

Every manufacturing organization is concerned with the quality of its product. While it's critical that the quantity requirements be satisfied and production schedules met, it is equally important that the finished product meet established specifications due to the fact that customer's satisfaction is driven from the quality of the products and services. Strong competition in the national and international level and consumer's awareness require production of high quality goods and services for survival and growth of the company. Quality is a relative term and it is generally used with reference to the end use of the product. The quality depends on the perception of a person in a given situation. The situation can be user-oriented, cost-oriented or supplier-oriented. Since, the item is manufactured for the usage of the customer, the requirements of the customer dictates the quality of the product. Quality is to be planned, achieved, controlled and improved continuously. Quality is inversely proportional to variability as defined by Montgomery (2012) [1]. Also, quality is defined as the ability of the material/component to perform satisfactorily in an application for which it is intended by the user. Thus, Quality of a product means conformance to requirements. Customers' needs have to be assessed and translated into specifications depending upon the characteristics required for specific application.

Quality control development in manufacturing and production sector begins with inspection (Dooley, 2000) [2]. Inspection means checking of material, product or components of product at various stages, with reference to certain pre-determined factors and detecting and sorting out the faulty or defective items. In inspection activity, the emphasis is placed on the quality of the past production. Quality control is a broad term, it involves inspection at particular stage but mere inspection does not mean quality control. As opposed to the inspection in quality control activity emphasis is placed on the quality of future production.

Quality policy refers to the basic principles which are used to guide the actions of the company in order to meet quality objectives. However, economy may be the additional factor while determining the quality policy. Quite logically, the cost of production will increase as the level of accuracy or quality of product is raised. Thus functional use of the product and cost should be considered simultaneously while formulating the quality requirements or policy.

A quality control system performs inspections, testing and analysis to ensure that the quality of the products is as per laid down quality standards. It is called "Statistical Quality Control" when statistical techniques are employed to control, improve and maintain quality or to sole quality problems. The role of Statistical Process Control in industry is demonstrated by Subbulakshmi *et. al.* (2017) [3].

Improving the quality of products starts with examining the production lines, testing the products and collecting data. The causes of the problems that lead to defects and nonconformities have to be solved and eliminated. This action will lead to a better quality, higher level of labor performance and a least loses of scrap. This study aims to monitor the products and the conformity to the specifications, define the type of defects in the products, use the SPC tools to investigate the products quality and the industries quality level, and locate the causes of the problems that lead to nonconformities.

The selected canning plant for this study is Al-Sayegh Company. Al-Sayegh Group is an industrial group that was established 70 years ago and now comprises 29 companies spread amongst the Arab world, Eastern and Western Europe and Asia. The companies are involved in different specialties chemical, engineering, real estate as well as general services that provide the consumer with several and various products. The total sales figure has reached a 200 Million USD yearly. The group consists of 2500 employees and labourers. The group mother company is National Paints Factories Co. (National Paints), now is ranking number twenty-three amongst the world's top paint companies and rank one in the Middle East with an annual production capacity of 145 thousand tons. The company started in Jordan then in UAE where it is considered the biggest industrial group in the Arab World and the Middle East in manufacturing of all kinds of paints, then to Qatar, Sudan, Palestine, Kazakhstan, Kyrgyzstan, and Egypt, also established show rooms in Russia, Syria, Lebanon, England and Romania.

2. LITERATURE REVIEW

Quality is determined as one of the most important decision aspect that customers consider in the selection process of products and services (Montgomery, 2012). Quality improvement can be achieved through different techniques and methodology such as statistical process control. Statistical process control (SPC) is an essential and effective tool of analyzing, monitoring, controlling, and improving the process performance through statistical analysis in order to reduce the variation in processes and improve the quality of the products or deliverables (2). Therefore, statistical process control (SPC) concentrates on the continuous analysis and reduction of variation in manufacturing operations (Oakland, 2008) [4]. Ishikawa (1985) [5] and Besterfield (2003) [6] specified the major magnificent seven statistical process control problem solving tools; histogram, check sheet, Pareto chart, cause-and-effect diagram, defect concentration diagram, scatter diagram and control charts. Ishikawa (1985) claimed that about 95% of the quality associated problems may be solved with the use of the basic seven SPC tools. Benton (1991) [7] and Talbot (2003) [8] summarized the implementation advantages of SPC as improve the quality of the product, decrease the fraction of defective produced items, preserve the required degree of conformance to design specifications, decrease rework and scrap rates, decrease the production cost, highlight any trends in the production process and decrease returns from clients due to products liability.

Variation reduction in manufacturing processes is considered as the key factors of products quality improvement. It is well - known in manufacturing that there are two major causes of variation in the production processes; by chance or common causes and special or assignable causes (Atienza *et al.*, 1997 [9]; Mason and Antony, 2000 [10]). The main objective of statistical process control is to quickly detect the occurrence of special causes of process shifts so that investigation of the process and appropriate corrective action may be undertaken before many nonconforming units are manufactured (Besterfield, 2012) [11]. Statistical process control is the most popular and appropriate statistical methodology applied in order to monitor, control, and reduce the variability in production processes (Mason and Antony, 2000) [10]. Public and private sectors have been widely utilized control charts as a process monitoring and control tool for quality improvement of deliverables (Yang and Yang, 2004) [12]. The investigation of quality issues revealed by control charts may indicate whether common causes or special causes are the reasons of variation in processes. Defective material, operators, and machines are examples of several sources of process variability in industry as highlighted by Montgomery (2012) [1].

Statistical process control technique was originated and developed in the industry sector, particularly in manufacturing processes and find it's widespread in other sectors such as service operations for quality control purposes. Different researchers and scientists applied statistical process control in various areas. Fouad and Mukattash (2010) [13] applied the statistical process control tools in a steel production processes that helped them to identify the vital quality problems related to the steel tensile strength. Mostafaeipour *et al.* (2012) [14] applied the SPC technique in ceramic tile manufacturing processes in order to decrease the defects and wastes ceramic tiles. SPC tools enabled them to identify and resolve the ceramic tiles defects and significantly improve the tiles quality. Awaj *et al.* (2013) [15] used the statistical process control tools in the glass bottles production line in order to decrease the defects, reduce wastes and improve quality. They applied a number of the seven basic quality tools such as cause and effect diagram, Pareto chart, p quality control chart that enabled them to identify the main causes of quality problems and provide remedy proposals. Furthermore, Prajapati (2012) [16] implemented two main techniques of the SPC tools, cause and effect diagram and control charts, in the sealing solution for different implementations in the automotive industry that enabled him to reduce the rejection rate and improve the process capability. Also, Godina *et al.* (2016) [17] suggested a systematic approach to the use of SPC in automotive industry for quality improvement and waste reduction objectives.

Many studies have been conducted recently [19-24] to improve the quality of service and production in industry. Different techniques have been followed including building simulation models and implementing lean manufacturing and cellular manufacturing principles. They could improve the production and service quality in industry, but still there was a need for direct measure of quality achieved, like statistical quality tools.

3. METHODOLOGY

The methodology followed in this research went through five main stages. The first stage started by enhancing the knowledge about quality control and statistical Process Control (SPC) tools. Then a comprehensive study of the company was conducted, where the process and the movement of objects were

VOL. 13, NO. 18, SEPTEMBER 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

tracked, and a clarification for the whole departments that the industry consists of was done. In the next stage the problem was defined using check sheet and Pareto chart, and choosing the vital few sections to focus on in the research. Then the problem was analyzed using histogram, control chart and cause and effect diagrams. In the last stage, the applicable solutions suggestions and recommendations were drawn.

4. RESULTS

In this part, the results of quality tools are demonstrated, which state how they were used to identify the problems, allocate the critical problems, figure the level of control that the industry reach.

4.1 Check sheets

Data has been collected and filled in the sheet and then counted the frequency. Table-1 shows the check sheet that performed for January.

Table-1. Check sheet of the nonconformities causes for January.

cause	Frequency	Frequency	Percentage
Man	~~IIII~~ ~~IIII~~ ~~IIII~~	15	37.5%
Machine	~~IIII~~ ~~IIII~~ ~~IIII~~	15	37.5%
Supplier	~~IIII~~	5	12.5%
method	III	3	7.5%
material	I	1	2.5%
process	I	1	2.5%

4.2 Pareto chart

Table-2 shows the frequency of the nonconformities and the percent and cumulative percent and they are organized in deseeding form.

Table-2. Frequency and percent of nonconformities in each section.

Section	Frequency	Percent frequency	Cumulative freq.
Slitters	75	42.13%	41.01%
RM store	38	21.35%	63.48%
printing	27	15.17%	78.65%
assembl y	25	14.04%	92.69%
pressing	10	5.62%	98.31%
Crown	3	1.69%	100%
Total	178		

The Pareto chart is constructed as shown in Figure-1. Was the horizontal axis represents the categories. The vital few are on the left and the useful many in the right.

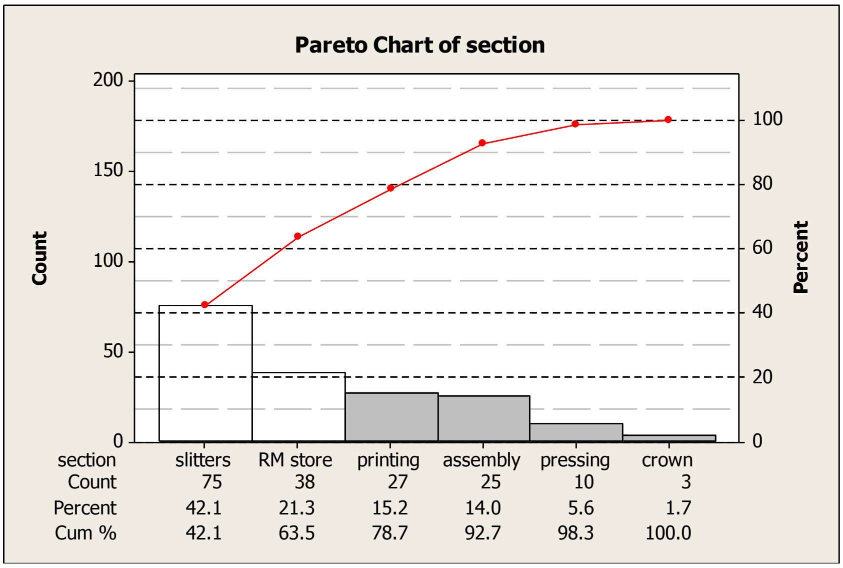

Figure-1. Pareto chart with cumulative line for section nonconformities.

After building up the Pareto for the sections and getting that, the slitters and RM store sections are the vital few so a deep investigating has been done to improve these sections for a better quality and performance. After collecting data about the causes of the defects in these sections, Table-3 has been drawn.

Table-3. Causes of nonconformities in the all sections.

Cause	Frequency	Percent
Man	73	41.14%
Machine	46	25.80%
Supplier	37	20.77%
Method	17	9.55%
Material	4	2.24%
Processes	1	0.50%
Total	178	100.00%

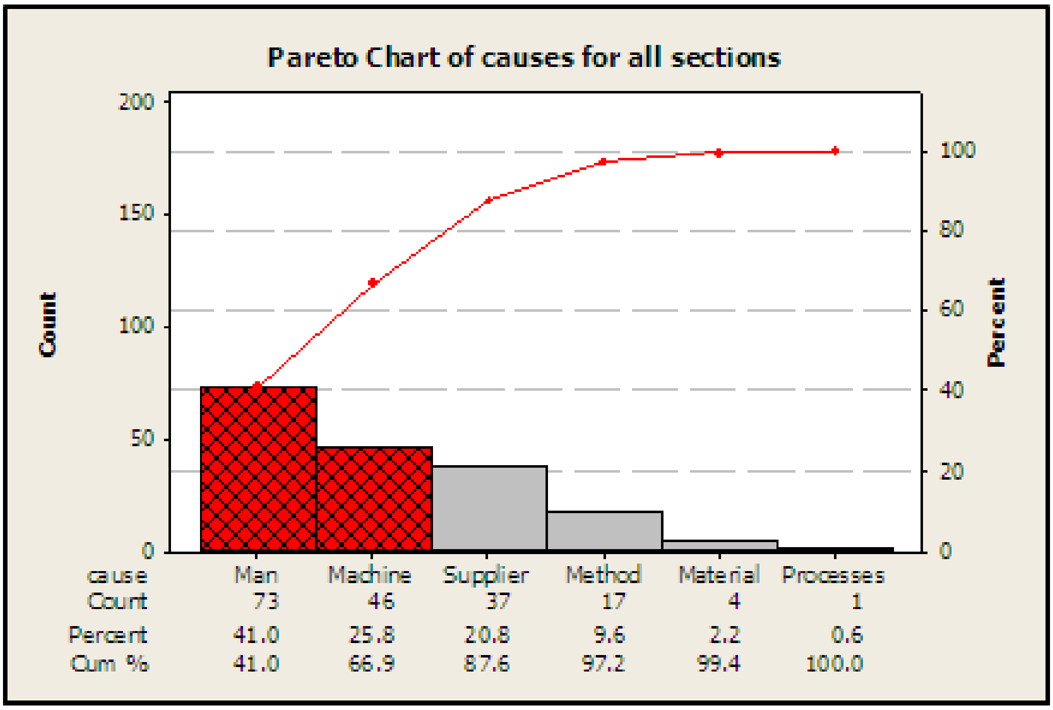

Figure-2. Pareto chart for overall nonconformities in all sections.

ARPN Journal of Engineering and Applied Sciences

For the slitters department we analyze the defects that happened and get Table-4.

Table-4. Causes of nonconformities in slitters department.

Cause	Frequency	Percent
man	55	72.60%
method	9	12.40%
machine	7	9.60%
supplier	3	4.10%
material	1	1.30%

A Pareto chart have been built to determine the vital few and trivial many, which is shown in Figure-3.

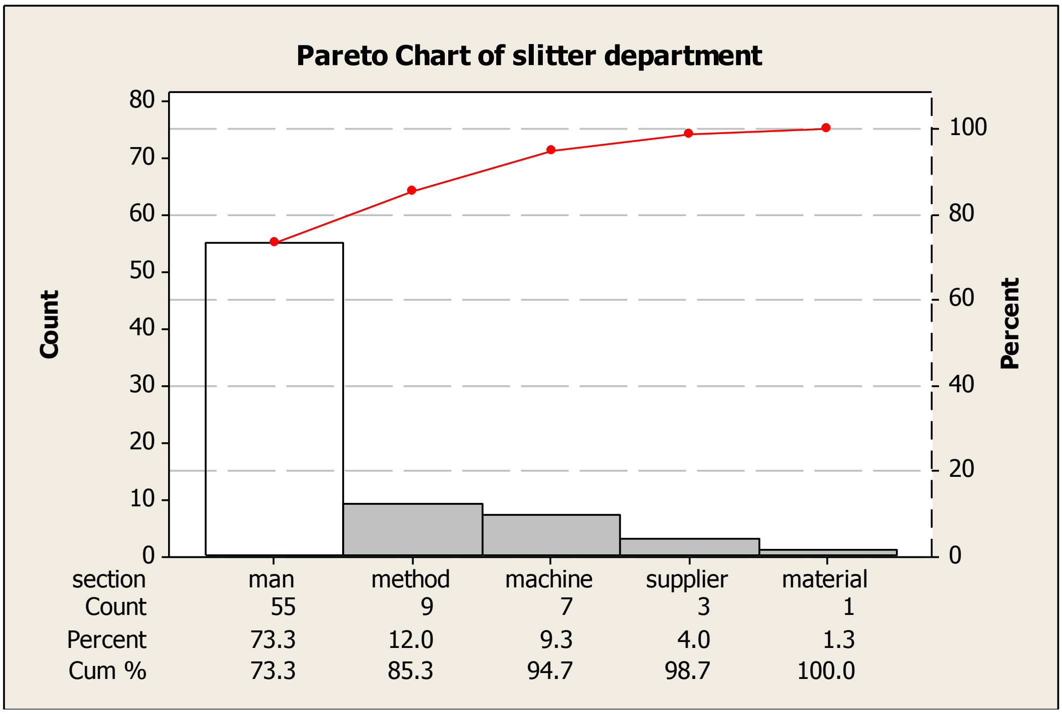

Figure-3. Pareto chart for slitters nonconformities.

A data has been collected for RM store department and the following data in the table shows the frequency of them.

Table-5. Causes of nonconformities in RM department.

Cause	Frequency	Percent
supplier	32	84.20%
method	3	7.90%
material	3	7.90%

VOL. 13, NO. 18, SEPTEMBER 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

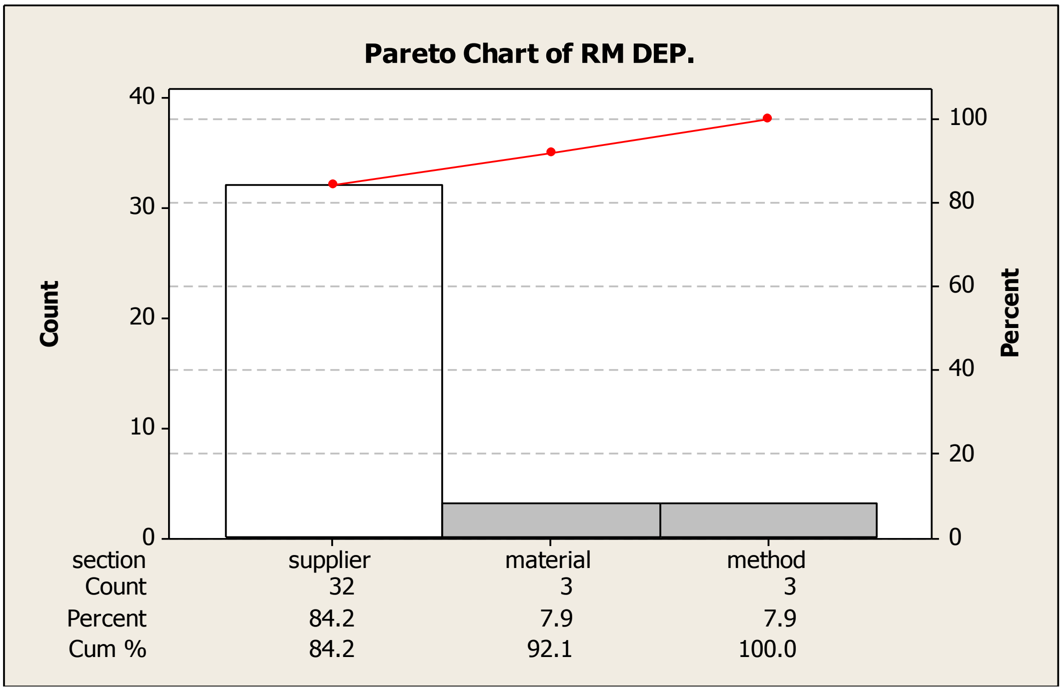

Figure-4. Pareto chart for RM store nonconformities.

4.3 Histogram

Data is collected on the outer diameter for 800 caps considering the result obtained from variation in the control chart, to establish the histogram, we must do certain things on these data.

Table-6. Tally sheet for the outer diameter of the caps.

Outer diameter	frequency	outer diameter	frequency	outer diameter	frequency
31.79	2	31.91	25	32.03	15
31.8	1	31.92	48	32.04	23
31.81	0	31.93	54	32.05	10
31.82	2	31.94	63	32.06	20
31.83	0	31.95	35	32.07	10
31.84	1	31.96	51	32.08	13
31.85	15	31.97	42	32.09	7
31.86	11	31.98	44	32.1	1
31.87	39	31.99	51	32.11	3
31.88	43	32	35	32.12	1
31.89	32	32.01	45	32.13	2
31.9	38	32.02	18		

Figure-5 represents the Histogram where frequency of the intervals represents the vertical axis, and the intervals midpoint represents the horizontal axis.

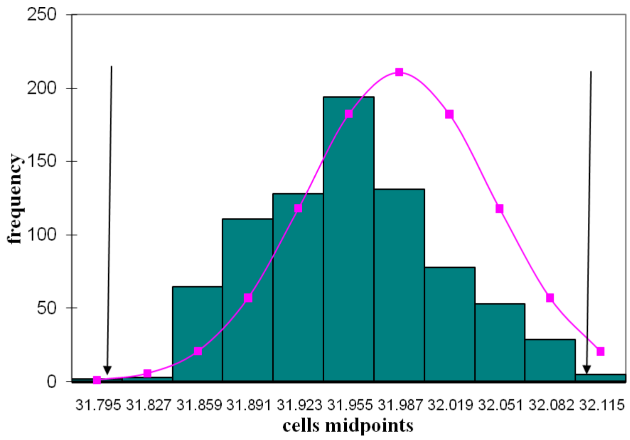

Figure-5. Histogram of outer diameter.

4.4 Control charts

When the process is subjected to unnatural pattern of variation, in which the assignable causes are appeared by out of control points in the control chart, the improvement of process performance starts with identifying the problems to reduce the probability of occurring assignable causes in the future.

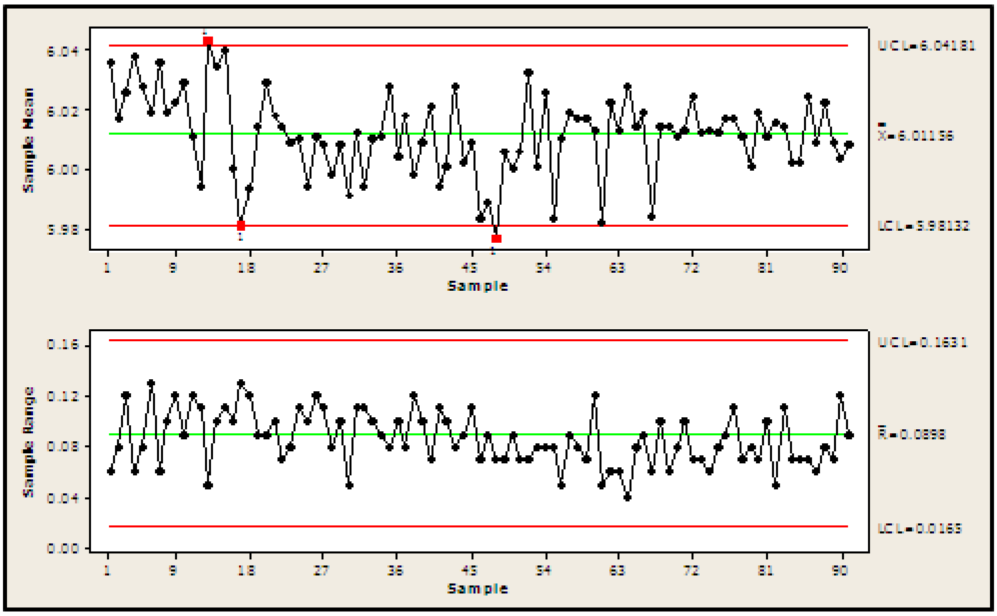

Figure-6. Mean and R chart for data with trial control limits.

The control charts that had done show that the subgroups that out of control in the average chart in (Mean, R) control charts, this points may indicate that there are problems in the process thus the assignable causes must be defined to take a corrective action.

Figure-6 shows the and charts in which the vertical axis represents the average and the range of the subgroup in weight (mm) and the horizontal axis represents the subgroup number, the central lines and the trial control limits for the and charts are also added.

4.5 Cause and effect diagram

Analysis helps to identify causes that warrant further investigation. Since Cause-and-Effect Diagrams identify only possible causes, Pareto Chart has to be used to determine the cause to focus on first.

After applying the previous steps the following figures have gotten:

VOL. 13, NO. 18, SEPTEMBER 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

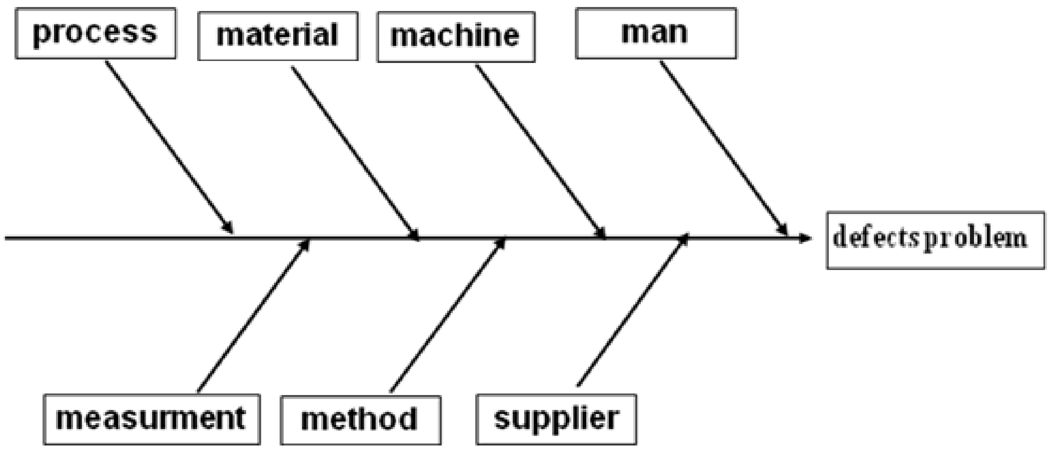

Figure-7. Cause effect diagram for defects in industry.

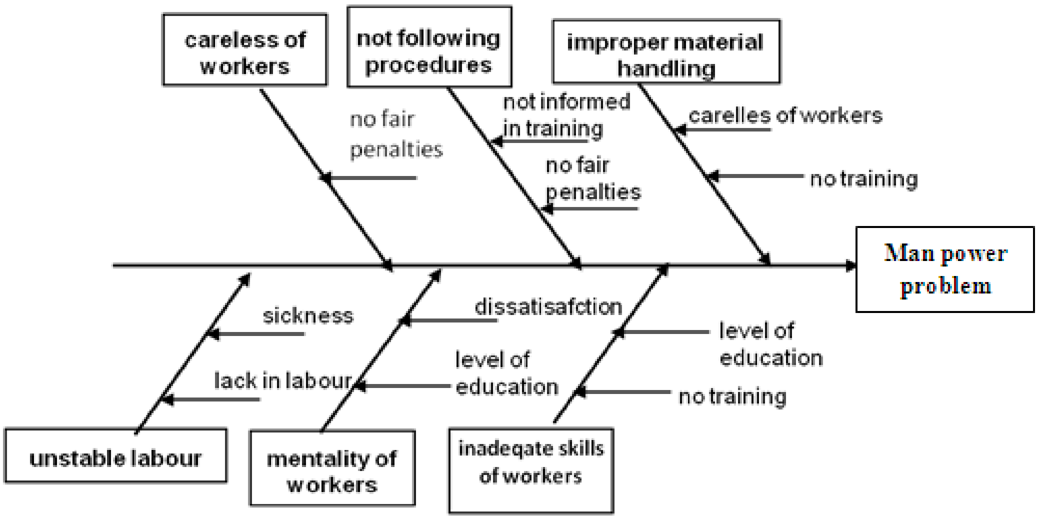

Figure-8. Cause effect diagram for man causes.

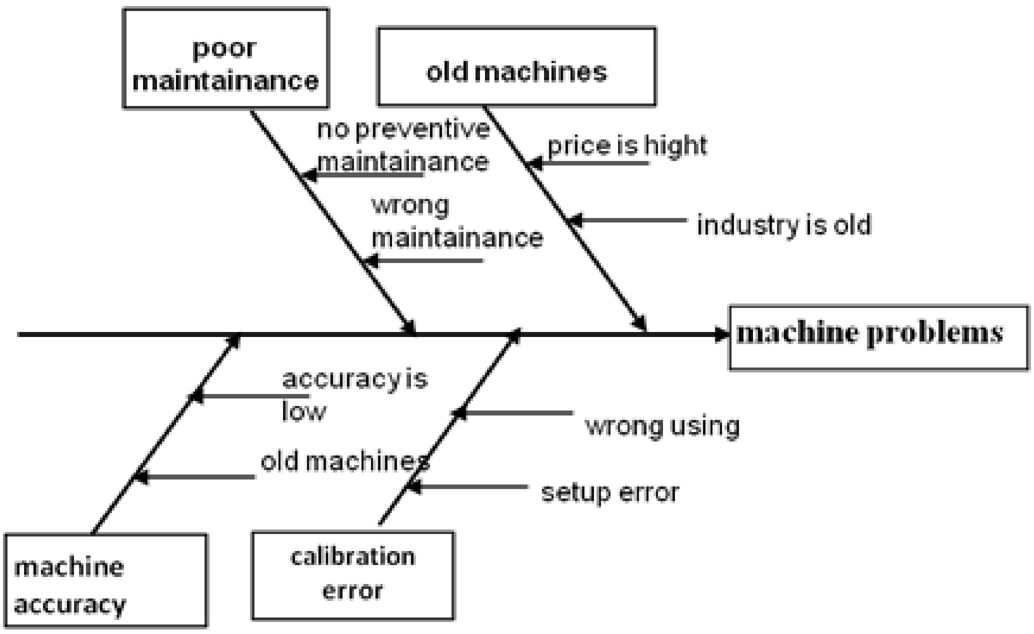

Figure-9. Cause effect diagram for machine cause.

5. DISCUSSIONS OF THE RESULTS

The main objectives behind this research were the application of statistical quality tools in determining the problems, solving them and improving the quality level of production in the plant.

Frequency of the defects is the premier efficacious in choosing the vital few in the corporation, the slitters and RM stores are the two sections which were chosen to their high frequency. Deep analysis was done to analyse the root causes for the defects. It has been found that the labor and the machines are the vital few in the slitters section. Using cause and effect diagram the root causes for each category have been identified.

One more tool which was exploited to seek in the quality of the products is the control charts. It was used to monitor the bottle caps characteristics which are: height, hardness, angels, inner diameter and outer diameter. After data were collected, the charts were portrayed and the out of controls were appointed and removed from the sample to draw the revised control limits. The breeders of the out of control were traced to be determined and solved, so that it will not iterate in the future.

It has been noticed from the collected data, that there are nonconformities of the products which the company receive from the supplier. They get the rolls with rust, dirt and indention in it, which causes a problem in the final products. So, new terms should be concurred. If this doesn’t happen it's better to find a better supplier if that is possible.

6. CONCLUSIONS

There are some conclusions which can be drawn out of this research results as follows:

- The Pareto chart, which we found necessary to implement as a technique for identifying the most significant section, and then to determine the most significant cause in that section.

- Histogram, the second statistical tool applied to provide an indication of an existing problem, if there is any, by comparing the process capability with specifications. Thus, by applying the histogram, controlling the capability of the caps with the required specifications has been confirmed.

- Control charts represent the bottle caps situation over time. From the analysis of the major mistakes which has been discovered, it has been found that they are caused by the company, because they don’t use the control charts to monitor the process.

- Cause and effect diagram has helped to identify the causes of the defects and problems in the plant, which should be analysed more specifically and being solved to improve the processes.

RECOMMENDATIONS

As researchers, some steps could not be performed as needed, but the company should follow the following steps and perform the following actions to improve the quality of their products:

- A new cutting machine should be brought to the slitters department, as most of the problems in this section are related to the manual feeding of the slices. Then if a new machine brought with a good setup, this problem will be resolved. If this is not possible, a training course should be given to the operators, to improve their accuracy in the feeding.

- Implement a preventive maintenance program, so that the machine is repaired before it breaks down.

- Finding an occasion such as ‘Quality Brainstorming Day” in the company, through which the mangers and the team leaders can hear from the operators how the processes can be improved, and how they think that a new product can be produced with high quality.

- The quality team in the factory should use the quality tools to monitor, define the problems and to ravel out the solutions and improvements.

- Finding a more trustful supplier, or if that can't be don’t, the industry should adopt more restricted regulations.

REFERENCES

[1] Montgomery D.C. 2012. Introduction to statistical quality control. 7TH edition, John Wiley, USA.

[2] Dooley K. 2000. The paradigms of quality: evolution and revolution in the history of the discipline. Advances in the management of organizational quality. 5, 1-28.

[3] Subbulakshmi S., Kachimohideen A., Sasikumar R., Bangusha Devi S. 2017. An Essential Role of Statistical Process Control in Industries. International Journal of Statistics and Systems. 12(2): 355-362.

[4] Oakland J.S. 2008. Statistical Process Control. Routledge, New York, 6TH edition.

[5] Ishikawa K. 1985. What is total quality control? New Jersey: Prentice Hall.

[6] Besterfield D. H., Michna C. B., Besterfield G. H. & Sarce B. M. 2003. Total quality management. 3rd Edition, Prentice Hall.

[7] Benton W. C. 1991. Statistical process control and Taguchi method. International Journal of Production Research. 29(9): 1761-1770.

[8] Talbot N. 2003. The use of automated optical testing (AOT) in statistical process control (SPC) for printed circuit board (PCB) production. Circuit World. 29(4): 19-22.

[9] Atienza O. O., Ang B. W. & Tang L. C. 1997. Statistical process control and forecasting. International Journal of Quality Science. 2(1): 37-51.

[10] Mason B. & Antony J. 2000. Statistical process control: An essential ingredient for improving service and manufacturing quality. Managing Service Quality. 10(4): 233-238.

[11] Besterfield D.H. 2012. Quality Improvement, 9TH edition, Pearson, USA.

[12] Yang S. F. & Yang C. 2004. Economic statistical process control for over-adjusted process mean. International Journal of Quality & Reliability Management. 21(4): 412-424.

[13] Fouad R.H., Mukattash A. 2010. Statistical Process Control Tools: A Practical guide for Jordanian Industrial Organizations. Jordan Journal of Mechanical and Industrial Engineering. 4(6): 693-700.

[14] Mostafaeipour A., Sedaghat A., Hazrati A., Vahdatzad M. 2012. The use of Statistical Process Control Technique in the Ceramic Tile Manufacturing: a Case Study. International Journal of Applied Information Systems 2(5): 14-19.

[15] Awaj Y.M., Singh A.P., Amedie W.Y. 2013. Quality Improvement Using Statistical Process Control Tools in Glass Bottles Manufacturing Company. International Journal for Quality Research. 7(1): 107-126.

[16] Prajapati D.R. 2012. Implementation of SPC Techniques in Automotive Industry: A Case Study. International Journal of Emerging Technology and Advanced Engineering. 2(3): 227-241.

[17] Godina R., Matias J.C.O., Azevedo S.G. 2016. Quality Improvement with Statistical Process Control in the Automotive Industry. International Journal of Industrial Engineering and Management (IJIEM). 7(1): 1-8.

[18] Abu Jadayil W., Abu Jadayil S., Khraisat W., Shakoor Jaber N. 2017. Creation of Different Cell Layouts Using Part Assignment Process for Manufacturing a Traction Drive Speed Reducer. International Journal of Modern Manufacturing Technologies. 9(2): 73-81.

[19] Shakoor M., Al-Nasra M., Abu Jadayil W., Jaber N., Abu Jadayil S. 2017. Evaluation of Provided Services at MRI Department in a Public Hospital using Discrete Event Simulation Technique: A Case Study. Cogent Engineering. 4(1403539): 1-11.

[20] Abu Jadayil W., Khraisat W. and Shakoor M. 2017. Different Strategies to Improve the Production to Reach the Optimum Capacity in Plastic Company. Cogent Engineering. 4(1): 1-18.

[21] Shakoor M., Al-Nasra M., Abu Jadayil W., Jaber N. 2017. A Simulation Model for Performance Evaluation of Resources in a Radiology Department. International Journal of Healthcare Management. Vol. 10.

[22] Shakoor M., Abu Jadayil W., Jaber N. and Jaber S. 2017. Efficiency Assessment in Emergency Department using Lean Thinking Approach. Jordan Journal of Mechanical and Industrial Engineering. 11(2): 97-103.

[23] Shakoor M., Jaber N., Qureshi M., Abu Jadayil W. and Jaber S. 2017. A Novel Model for Benchmarking the Performance of Retail Stores for Retail Operations using Lean Manufacturing Approach. International Journal of Applied Engineering Research (IJAER). 12(17): 6686-6692.

[24] Shakoor M., Qureshi M., Abu Jadayil W. and Jaber N. 2017. Assessment of Retail Practices for Providing Enhanced Value Added Services and Improved Customer Satisfaction Using Lean Manufacturing Approach. International Review of Management and Marketing. 7(2): 360-366.