Jurnal Teknologi

Full paper

Application of a Computer Based System for Statistical Process Control in a Semiconductor Company : A Case Study

Nor Kamaliana Khamis[a], Baba Md Deros[a]*, Nizaroyani Saibani[a], Syamsinar Baizura Ahmad Sabki[a]

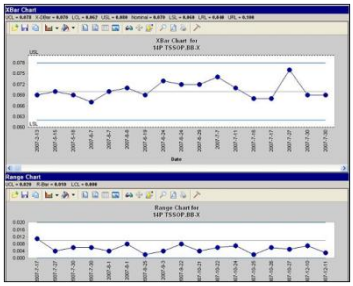
[a]*Department of Mechanical and Materials Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 Bandar Baru Bangi, Selangor*

*Corresponding author: hjbaba@eng.ukm.my

Article history

Received : 2 April 2012
Received in revised form : 19 June 2012
Accepted : 30 October 2012

Graphical abstract



Abstract

The use of Statistical Process Control (SPC) in the manufacturing process has been historically proven to increase the quality of the product. Recent trends show that companies are becoming increasingly reliant on computer based-SPC because it can save a significant amount of time compared with traditional SPC. In addition, labor-intensive tasks, such as manual data collection and entry, can be eliminated, thus reducing human error. This paper aims to prove the benefits of computer based system for SPC known as e-SPC in a semiconductor manufacturing environment. Specifically, this paper will present the case study's finding that show how one semiconductor manufacturing company's use of e-SPC can detect a process abnormality at an early stage and in real time compared with manual SPC. The case study involves interviews with the company representatives and observations on the manufacturing environment. This paper will also show how e-SPC can be used to control and then to stabilize the manufacturing operation. In conclusion, this paper demonstrates that e-SPC can significantly improve the performance of a manufacturing environment. Moreover, this paper can also be used as a reference for the implementation of e-SPC in any company.

Keywords: Statistical process control; quality; semiconductor company; control limit

Abstrak

Pengunaan Proses Kawalan Berstatistik (SPC) di dalam proses pembuatan telah terbukti membantu meningkatkan kualiti produk. Perkembangan semasa menunjukkan syarikat pembuatan semakin bergantung kepada penggunaan sistem computer untuk SPC kerana ia dapat menjimatkan masa jika dibandingkan dengan kaedah tradisional SPC. Selain itu, penggunaan tenaga manusia seperti melakukan pengumpulan dan pemasukan data secara manual, dapat dihapuskan dan seterusnya mengurangkan kesalahan manusia. Kajian ini akan membuktikan faedah sistem komputer SPC yang dikenali e-SPC di dalam persekitaran pembuatan semikonduktor. Secara khususnya, kajian ini akan membentangkan data yang menunjukkan cara syarikat ini menggunakan e-SPC dan dapat mengesan proses yang janggal pada peringkat awal berbanding dengan penggunaan SPC secara manual. Kajian ini melibatkan temubual dengan pihak syarikat dan pemerhatian di syarikat tersebut. Kajian ini juga akan menunjukkan cara e-SPC mengawal dan mengembalikan kestabilan kepada operasi pembuatan tersebut. Secara rumusannya, e-SPC mampu meningkatkan prestasi syarikat pembuatan. Selain itu, kajian ini juga boleh digunakan sebagai rujukan kepada mana-mana syarikat yang ingin menggunakan e-SPC dalam operasi pembuatan mereka.

Kata kunci: Proses kawalan statistik; kualiti; syarikat semikonduktor; had kawalan

1.0 INTRODUCTION

Statistical Process Control (SPC) is an important technique in quality control. The application of statistical methods enables manufacturing companies to control the production process and to enhance the quality of products. One of the main outcomes of the modern industrial quality movement has been the widespread use of SPC methods to eliminate the special causes and to reduce the common causes of variation in the manufacturing processes [1, 2, 3]. Based on previous research, SPC has been implemented in various types of companies worldwide [4,5,6,7].

The effective implementation of SPC can be achieved if a company has an understanding of such a system. However, the development of SPC in Malaysian small and medium enterprises (SME) is limited by the postponement of the installation of SPC software to save money [4]. In addition, although employees may have an excellent understanding of SPC, they may find difficulty

in adapting to and dealing with the statistical tools and techniques in a real environment.

In addition, no standardization format exists in the current system. The lack of quality data management is another weakness of the traditional or manual practice of SPC [8]. Therefore, more practical and effective methods of SPC, such a computer based statistical packages, are required. According to [9], computer has become a medium major in manufacturing companies to manage data and distribute information through an existing software package. Moreover, [10,11] noted that, in order to remain competitive in business environment, the need of user-friendly statistical packages could considerably impact for successful of SPC application.

[12] indicated that an online statistical system allows a user to assess real time data and to detect a problem early as it occurs during operation. SMEs-SPC is one of the dynamic tools for SPC that allows the online monitoring of statistical operations, which can be accessed by multiple users within the company [13,14]. Another study conducted by [4] demonstrated eight companies that used SPC tools at their manufacturing operation. Based on the findings, out of those companies that fully implemented SPC, only one company prefers to use manual system (plot on the graph paper), while other companies used computer and SPC software to analyze the data. It shows that nowadays, companies are becoming increasingly dependent on computer based-SPC because it has a lot of benefit compared with traditional SPC.

In particular, this paper presents on implementation of computer based system for SPC, called as e-SPC at the semiconductor company in Malaysia. The study only focused on the application of e-SPC at the company and how the company used the system in order to improve their process performance in real practice. It also explored the different conditions that the company needs to tackle if the data indicates an error and shows the weird trend. This is considered as one of the learning process for the user of this system.

2.0 METHODOLOGY

This study was conducted in the semiconductor company, known as Company A at Kuala Lumpur, Malaysia. It was established on 3rd of July, 1974. Their commitment in quality, cost and delivery has made them one of the leading semiconductor manufacturers in Malaysia. Their continuous effort in achieving the excellence is evident in technical innovation and comprehensive employee training programs. In this paper, Company A was used computer based system for SPC, known as e-SPC. With regards to the interview with respondent, e-SPC is really useful especially in saving their time and energy. Even though at first stage it takes some effort and money to train the worker on that tool, but at last, the worker give positive feedback when using this system.

Figure 1 shows the process control flow chart at Company A. With regards to Figure 1, the machine will operate at the normal operation. After that, the data will be collected and the chart will be plotted by the system. If the data is out of specification, the worker will stop the machine and it will be referred to individual at MSQ Specification for machine or production treatment. On the other hand, if the data is within specification, the system will identify the control limit and the trend judgment, and the data will be collected continuously. The process control also will be continuously running. At this stage, there will be two conditions of the data.

The first condition is, if the plotted data is out of control limit, the alarm is triggered and the data need to resample to confirm the error. Identification of control limit and trend judgment will be executed again based upon judgment criteria. If the data is under control, the data will be collected endlessly. Inversely, if the alarm is still activated, the flow of particular lot and the machine will be stopped. Afterward, the machine will be repaired by the technician. After the machine is confirmed can be use, the data collection will be continue. Then, the control limit and trend judgment will be executed again. If the alarm still triggered, the process will be back to the technician to perform the maintenance and repair. However, if the data is under control and trend is good, the production will be proceed and the control limit and capability process will be reviewed by the person in charge.

The second condition is, if the warning is activated, the lot will be uninterruptedly running. The plotted data will provide information to an engineer, and they will judge the action required for that particular process. The production will be proceed and the control limit and capability process will be reviewed by the user

3.0 RESULTS AND DISCUSSION

3.1 Implementation of E-SPC at Company A

In this section, implementation of e-SPC at Company A will be discussed and reviewed. In the first part, explanation on method of data collection was presented based on the diagram. There are two types of diagram in this part, namely X-bar chart and Range Chart or R-Chart. The specification limit, SL and control limit, CL are auto judge by the system based upon the judgment criteria. In the second part, review of control limit will be discussed based on the practice and information from the company.

With regards to Figure 1, data is directly updated into the system by the operator. It is based upon real time data. X-bar R Chart and Range Chart will be automatically plotted as shown in Figure 2. With respect to Figure 2, the upper control limit, UCL for X-bar Chart is 0.078 and the lower control limit, LCL is 0.062. The nominal limit is 0.070. The upper specification limit, USL is 0.080 and the lower upper specification limit, LSL is 0.060. Based on this value, SL should be below than CL for the lower limit and should be above than CL for the upper limit. For the R-Chart, UCL is 0.020, nominal limit is 0.010 and LCL is 0. Normally, if the data is under control, the point will be indicated as blue dot.

If data is not within specification limit, operator must stop machine operation and refer to individual control procedure for machine or product treatment. Some data may lies within specification but falls outside control limit. Red dot as indicated in Figure 3 shows that alarm is triggered and the machine is compulsory to stop its operation because one of its points falls outside control limit.

Therefore, by following normal SPC Control Flow, the data should be re-sampling to avoid false alarm as shown in Figure 4(a) and Figure 4(b). In some cases, there is a possibility of wrong data input by operator.

If the machine needs to be repaired, another data sampling will be taken to confirm machine is in good condition before proceed to normal operation. Some warnings are judged as 'Accept' as highlighted in Figure 5, even though the proceeding points are observed as warnings provided that all the points are still within specification limit, as shown in Figure 6

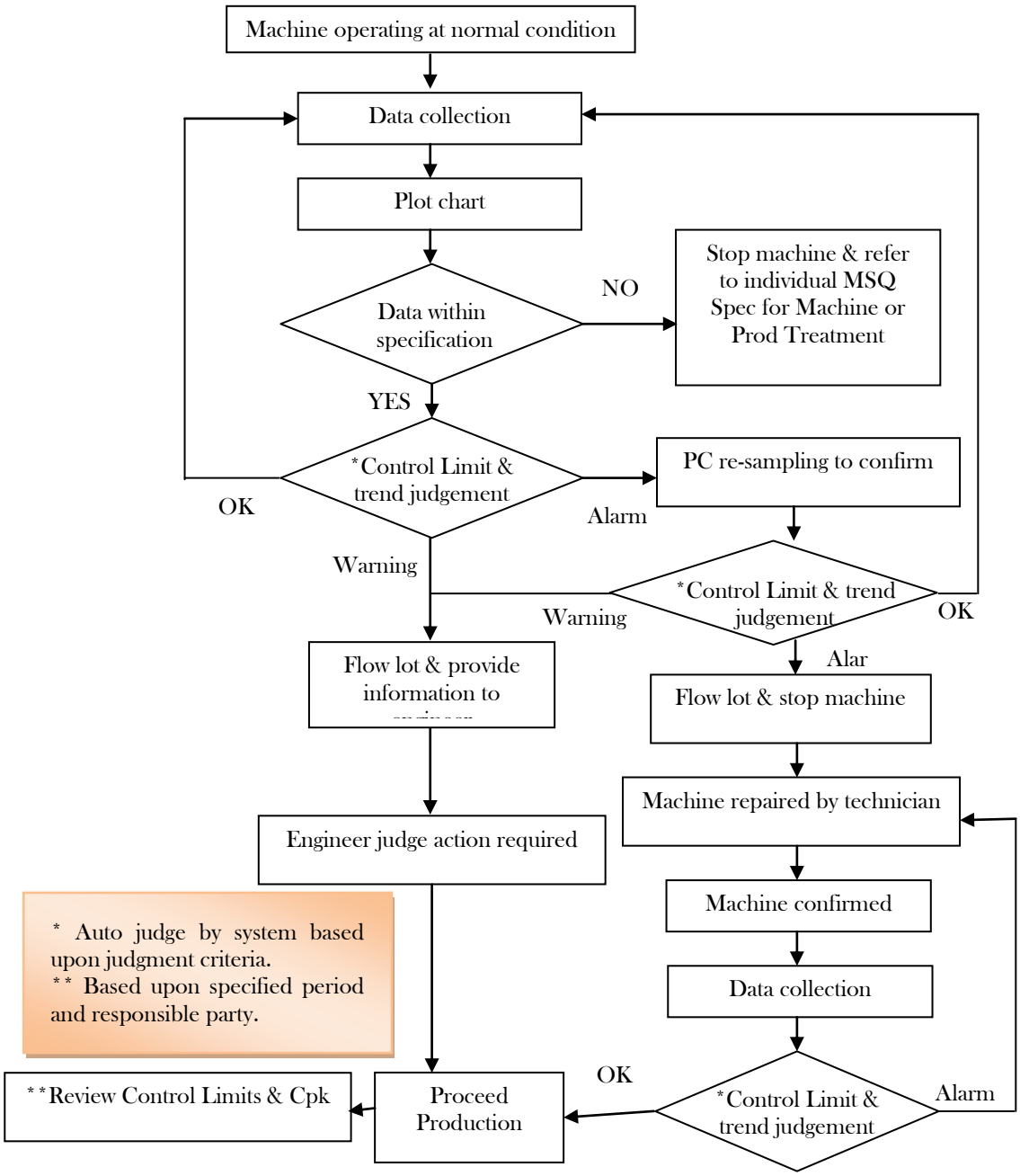


Figure 1 Process control flow chart (Source: Company A)

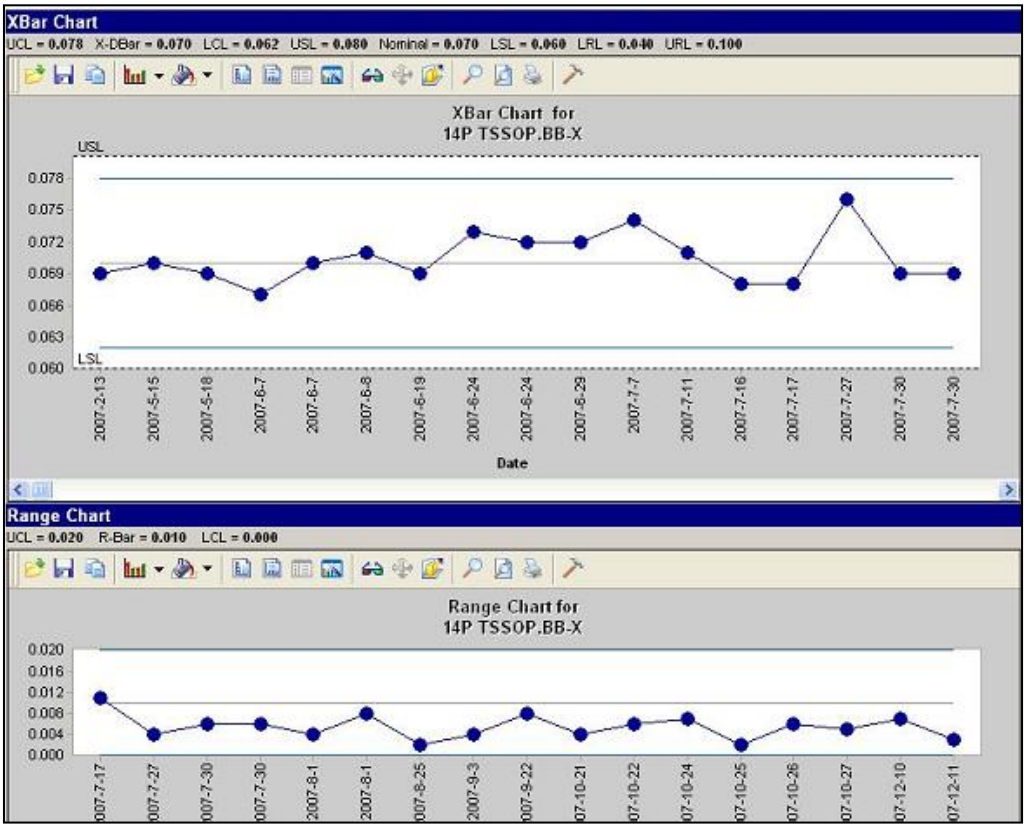


Figure 2 X-bar chart and range chart

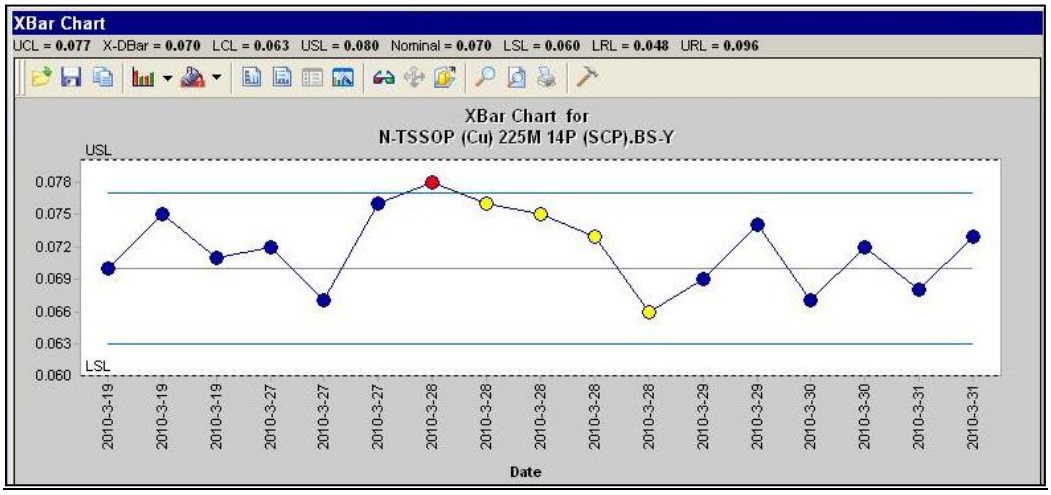


Figure 3 Process is out of control

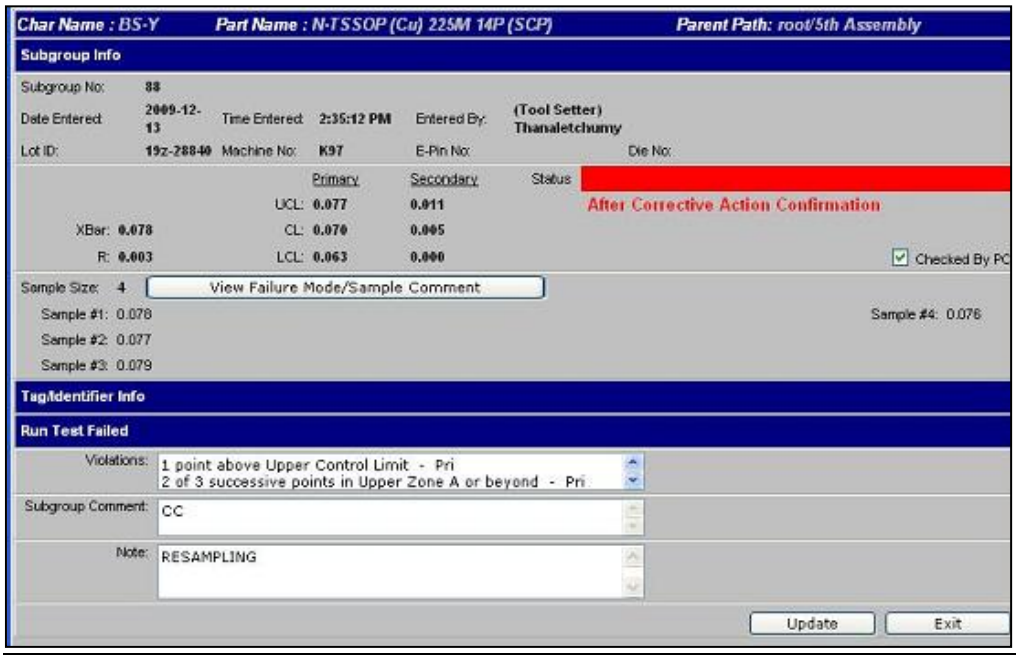


Figure 4 (a) Resampling to avoid false alarm

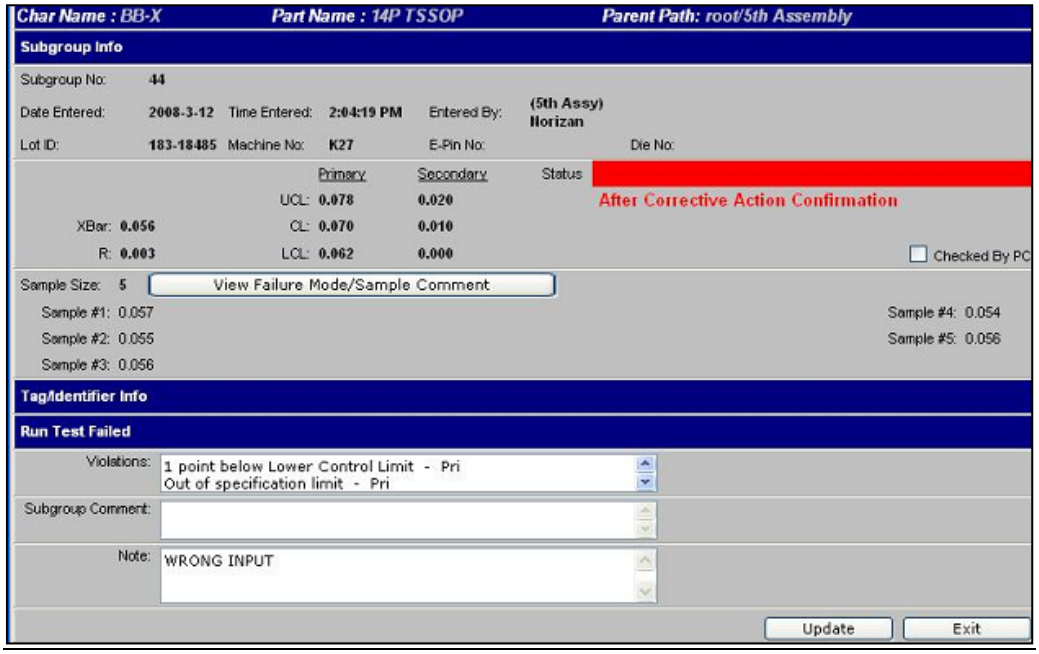


Figure 4 (b) Resampling to avoid false alarm

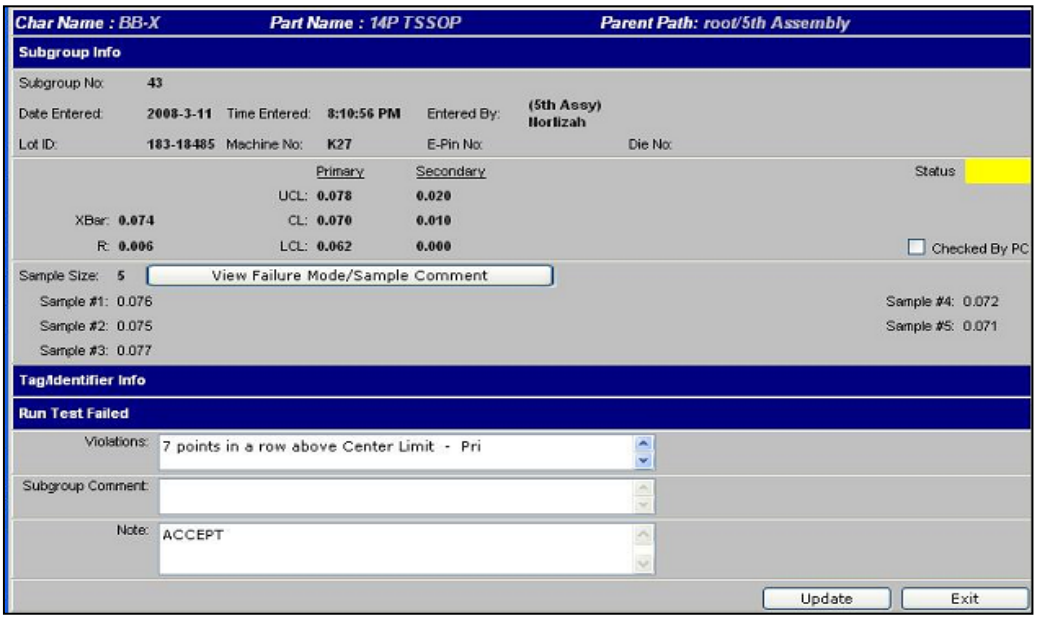


Figure 5 Accept note

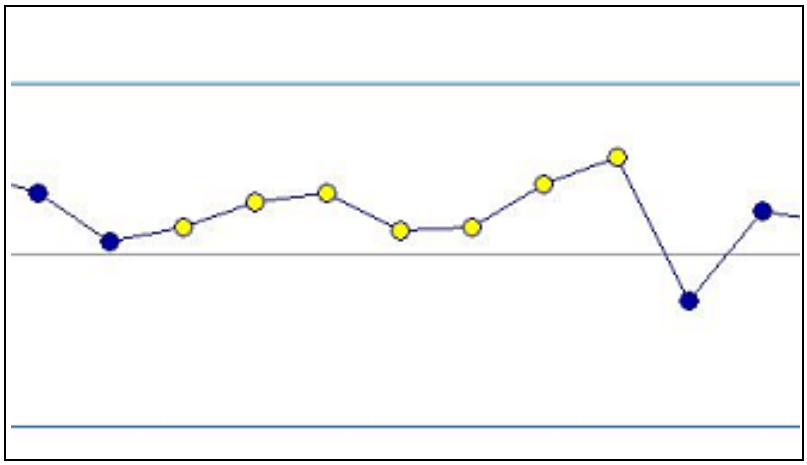


Figure 6 Proceeding points are observed as warnings, indicated by yellow dot

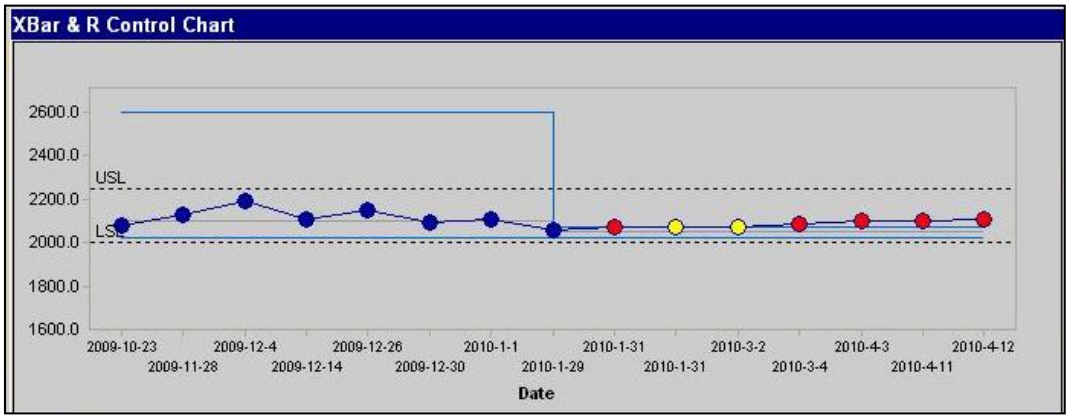


Figure 7 Sample of X bar and R control chart

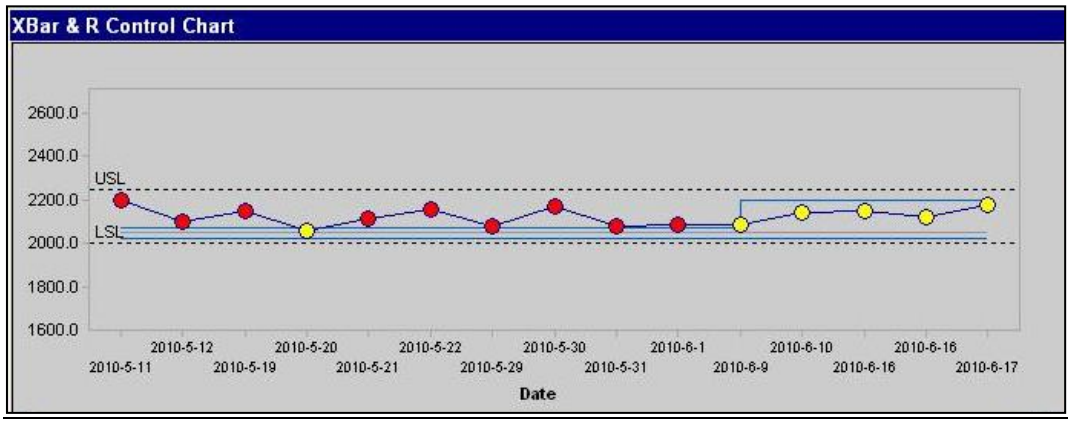


Figure 8 Sample of X bar and R control chart

Engineers may require some time to study and do a proper treatment in order to get a normal trend of the plotted chart.

3.2 Review of Control Limit

There may have some changes on the specification and/or the control limit is no more valid for a specific process. An analysis and study of the manufacturing conditions or a revision of the control lines if necessary must be made when the following occur:

i) a design is changed
ii) a job method, equipment or worker is changed
iii) an operation is suspended more than 1 month and is restarted

Figure 7 and Figure 8 shows a few samples of control chart that need to be review by the worker. In Figure 7, the data start shows the weird pattern or trend at 9th point onwards. With respect to Figure 8, the plotted data also shows a strange trend. The alarm is triggered for this kind of the data. Therefore, as explained in previous section, there are a few procedures that should be performer by the responsible party.

■4.0 CONCLUSION

This study describes the application of e-SPC at the Company A. With the application of e-SPC in Company A, they are able to ensure their manufacturing process is in "Statistical Control", capable to meet customer requirements and hence aid in continuous improvement. E- SPC provides real time analysis to establish controllable process baselines; learn, set, and dynamically improve process capabilities and focus business on areas needing improvement. The system moves away from opinion-based decision making. The management of quality data can be categorized at an excellent level compared to manual SPC. As a conclusion, implementation of e-SPC at the company would be very helpful to improve the manufacturing process, and in turn will help to improve the quality and productivity. Also, at the end the company will realize that e-SPC really help their company in saving the money and energy.

References

[1] Anthony, J., Balbontin, A. and Taner, T. 2000. Key Ingredients for the Effective Implementation of Statistical Process Control. *Integrated Manufacturing System*. 49: 242–247.
[2] Rodriguez, R. N. 1994. *Recent Issues in Statistical Process Control: SASâ Solutions Using Statistical Modeling Procedures*. SAS Institute Inc.
[3] Dale, B. 1994. *Managing Quality*. Eaglewood Cliffs: Prentice Hall.
[4] Rahman, M. N., Mohd Zain, R., Mohd Nopiah, Z., A. Ghani, J., Deros, B. M., Mohamad, N. and Ismail, A. R. 2009. Implementation of SPC in Malaysian Manufacturing Companies. *European Journal of Scientific Research.* 26(3): 453–464.
[5] Giligan, S. & Walters, M. 2008. Quality Improvements in Hospital Flow May Lead to a Reduction in Mortality. *Clinical Governance: An International Journal*. 13(1): 26–34.
[6] Law, T. H., Radin Umar, R. S., Wong, S. V. 2005. The Malaysian Government's Road Accident Death Reduction Target For Year 2010. *IATSS Research.* 29(1): 42–49.
[7] Cartwright, G. & Hogg, B. 1996. Measuring Processes for Profit. *The TQM Magazine*. 8(1): 26–30.
[8] Rahman, M. N., Mohd Zain, R., Mohd Nopiah, Z. & Abdul Rahman, S. 2009. Knowledge Translation of SPC in Malaysian SMEs Companies from Academic Point of View. *Seminar (III), Advanced Manufacturing Research Group, UKM, 29 July 2009*. 1–14.
[9] Das, S. R., Yaylacicegi, U. & Canel, C. 2008. Using ISO 90003 for Software Design and Development in Large Virtual Teams. *Industrial Management & Data Systems.* 108(6): 775–793.
[10] McCarthy, B. L. and Wasusri, T. 2002. A Review of Non-standard Application of SPC Charts. *International Journal of Quality & Reliability Management*. 19(3): 295–320.
[11] Rahman, M. N., Mohd Zain., R., Abdul Rahman, S. and Mohd Nopiah, Z. 2010. Best Practices for Manufacturing Company in Managing Quality Control Using Smes-SPC System. *International Journal of Industrial & Systems Engineering*.
[12] Ahmad, S. and Hassan, M. 2003. Survey and Case Investigations on Application of Quality Management Tools and Techniques in SMIs. *International Journal of Quality and Reliability Management.* 20(7): 795–826.
[13] Rahman M. N., Mohd Zain., R. Mohd Nopiah, Z. and Abdul Rahman, S. 2009. Improving Process Performance through Statistical Quality Tools. *Journal of Quality Measurement and Analysis*. 5(2): 1–12.
[14] Rahman, M. N., Mohd Zain, R. & Mohd Nopiah, Z. 2009. Design an Online SMEs-SPC Computer Based System. *International Conference on Information Management and Engineering (ICIME), Seri Kembangan*, April 2009. 437–440.