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UTILITY OF QUALITY CONTROL TOOLS AND STATISTICAL PROCESS CONTROL TO IMPROVE THE PRODUCTIVITY AND QUALITY IN AN INDUSTRY

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ABSTRACT

Statistical Process Control (SPC) methods have been widely recognized as effective approaches for process monitoring and diagnosis. Statistical process control provides use of the statistical principals and techniques at every stage of the production. Statistical Process Control (SPC) aims to control quality characteristics on the methods, machine, products, equipments both for the company and operators with magnificent seven. Some simple techniques like the "seven basic quality control (QC) tools" provide a very valuable and cost effective way to meet these objectives. However, to make them successful as cost effective and problem solving tools, strong commitment from top management is required. Statistical process control (SPC) is one of the important tools in quality control (QC). In order to survive in a competitive market, improving quality and productivity of product or process is a must for any company.

Keywords: *Statistical Process Control (SPC) ; Statistical Quality Control (SQC); Quality Improvement; Quality Tools and Control Charts*

1. INTRODUCTION:

To control quality characteristics on the methods, machine, products, equipments both for the company and operators, the Statistical Process Control (SPC) , Statistical Quality Control (SQC), and Quality Improvement methods have been widely recognized as effective approaches for process monitoring and diagnosis.

Statistical Process Control (SPC)

The primary tool of SPC is the Shewhart control chart. The Shewhart control chart quantifies variation as either special cause or common-cause (natural) variation (**Fig. 1**). The control limits on control charts quantify variation as that inherent to the process (natural variation data inside the control limits), or variation caused by an event or assignable-cause (special cause variation data located outside the control limits). Data outside the control limits are also referred to as "out of control" points. The study documented the change in sawyer operating targets when sawyers are presented with real-time thickness data in the form of control charts.

Young et al. (2000a, 2000b, 2002a, 2002b, 2005) documented that most sawyers have an anecdotal knowledge of historical lumber thickness averages and variation, i.e., thickness measurements are made infrequently for setup at saw change, shift change, production reporting from last shift, or as a reaction to extreme variation. As saws wear from continuously sawing lumber, the sawyer may experience greater saw deflection at a constant carriage speed (i.e., increased within board variation). Sawyers are reluctant to slow carriage speed and tend to over-size lumber thickness given their imperfect knowledge of real-time lumber thickness at the time of sawing. Over sizing lumber is a costly "hedge" and is not competitive as a long-term business strategy.

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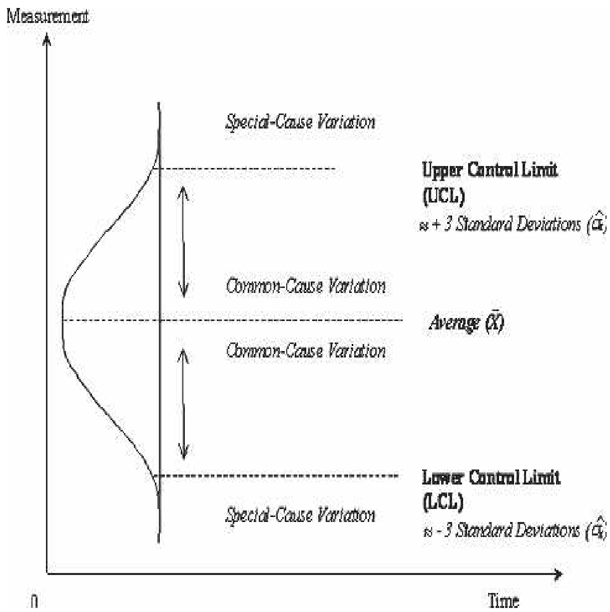

Figure 1. — Basic form of a control chart.

Statistical process control is used to describe the variability that can be controlled or cannot be controlled. This variability is also called common cause or special cause. Common cause occurs with the nature of the process. It exists in all processes and it is the variability from the system. Special cause is not the part of the process. It exists almost all processes because of some certain reasons. If there is not variability because of special causes, that means the process is statistically under control. For a process that is statistically under control, the researcher can conclude that, it has a definable identification and a definable capability. In a process that is under control, by removing all special causes that are noticed until then, the remaining variability would come from common causes. After taking the process under control, the next stage improves the process. The only target for the production is to get the statistically control, and to reduce the variables in the same time. Because as the variables reduce, the cost is going to be less, too.A large variety of Statistical Process Control (SPC) schemes have been developed for quality and productivity improvement since the 1960s. SPC utilizes statistical methods to monitor manufacturing processes with an aim to maintain and improve the product quality while decreasing the variance. Much research has been conducted on the issues of SPC and the resulting developments are readily available in the literature, see surveys of research on SPC by Lowry and Montgomery (1995), Woodall and Montgomery (1999) and Stoumbos et al. (2000). Nevertheless, conventional SPC methods are typically restricted to a single process stage in industrial and service applications.

Quality Control (QC) is an important function in factory as it deals with product inspection before the product was shipped to customers. Statistical process control (SPC) is one of the tools widely used in QC to monitor whether the production process is in control through the use of statistical control chart.

Many researchers have noticed the trend that service quality improvement has become a necessity in many industries. Wyckoff (1984) claimed that SPC is a good method for service managers to monitor service processes, and also helpful for staff to conduct self-improvement. Palm et al. (1997) also pointed out that SPC would have great possibilities in service industries, such as health care and education, and has already been proven to be useful in healthcare industry. The adoption of SPC into service operations provides a huge opportunity for service quality improvement. However, there are also some obstacles to applying SPC in services, such as what to measure and how to measure. The main difference between a manufacturing system and service system is that customers are involved into service operations. How to measure the customers' perceived quality is a challenge. Therefore, researchers investigated modification of quality definition in services (Lehtinen and Lehtinen, 1982; Gronroos, 1983). One of the most popular definitions was proposed by Parasuraman et al. (1985). Service quality was defined as the extent to which the service meets or exceeds customers' expectations of it.

Quality improvement program had been designed and implemented to increase the potential of making more profit. By improving the quality, it also means improvement in productivity and lower reject rate. Quality goals can be included in the business plan and as a degree of a product or service excellence provided to customer. Quality improvement should not only focused on external customer but also its internal customer.
Parasuraman et al. (1988) identified five service dimensions from their survey across industries

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and developed the service quality measurement scale called SERVQUAL, which has been a widely used measurement scale of service quality (Athanassopoulos, 1998; Lee et al., 2000; Soteriou and Chase; 1998; Soteriou and Zenios, 1999). TOPSIS (Hwang and Lin, 1987) and Loss Function (Ross, 1988) are also alternatives of perceptual quality measurement. Besides the perceptual measurement data of service quality, Klassen et al. (1998) identified the operating data of productivity, efficiency and effectiveness as three of the most widely used indicators in service operations.

2. STATISTICAL QUALITY CONTROL:

Statistical Quality Control (SQC) is a scientific method to analyze manufacturing data. Based on this analysis, measures are taken to maintain the quality of the manufactured product. One of the techniques that are used to monitor manufacturing processes and provide feedback is Statistical Process Control (SPC). The feedback is used to maintain and improve the capability of the process and to ensure product conformance. SPC is used to control the process by signaling when adjustments may be necessary. Some techniques associated with SPC include frequency histograms and control charts. A control chart is the tool used to monitor the variation in a process and ensure that the process is in a state of control. This allows the operator to monitor the trends occurring in the process. The control chart reflects the specification limits, namely, the Upper Specification Limit (USL) and the Lower Specification Limit (LSL). In addition, it has upper and lower control limits that lie within the specification limits. The Upper Control Limit (UCL) and the Lower Control Limit (LCL) are determined by evaluating the dispersion (variability) in process, see Fig. 1. In a well-controlled process, these limits can be chosen to be equal to $\mu \pm \mathbf{3}\sigma$ respectively, where σ is the process standard deviation and μ is the process mean. These statistical limits are normally called the .3 sigma control limits.. In a normal (Gaussian) distribution, 99.73% of the values measured lie in interval of width **6** σ.

3. QUALITY CONTROL TOOLS:

Statistical process control aims to produce the products in the most economic and useful way by using statistical principles and techniques at every stage of the production. In this manner, statistical process control aims faithfulness to the standards, provides the fitness of the specifications that have been determined earlier. It is used to reduce the defected products as much as possible. Statistical process control is powerful collection of problem-solving tools useful in achieving process stability and improving capability through the reduction of variability. The company had used some of the "seven basic quality control tools" in their problem solving technique. The seven quality tools are (Ishikawa, K. 1985). These tools, often called magnificent seven are;

- Check Sheet
- Pareto Chart
- Histogram
- Scatter Diagram
- Process Flow Chart
- Cause and Effect Diagram or Fish Bone Diagram
- Control Chart

The control chart is perhaps the most widely used of the "seven basic quality control tools". It is the key tools in statistical process control (SPC) because it displays process behavior graphically and it is used to monitor and control processes within the specified control limits (Bisgaard, S. 1993). There are two basic types of control chart, depending on the type of data collected; namely variable control chart and attribute control chart. Variable control chart are designed to control product characteristics and process parameters which are measured in continuous scale.

Examples of product characteristics are length, weight, and diameter and examples of process parameters are temperature, pressure, and PH value (Freeman, J, G. Mintzas. 1999). The primary variable control chart used are the *X*-bar and *R* chart and moving range chart, while the other two, rarely used charts include *X*-bar and *s* chart and median chart (Anjard, R.P. 1995).

Attribute control charts are designed to control the process. Measurements used are in terms of good or bad, accept or reject, go/no-go, or pass or fail criteria (e.g. conforming or non-conforming) (Freeman, J, G. Mintzas. 1999). The distinction between nonconforming or defective unit and nonconformities or defects is very important in attribute control chart because

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it will determine the selection in the type of attribute control chart used. A nonconforming or defective unit, however, may fail to meet the assessment criteria because of one or more nonconformities or defects exist. For attribute data, there are: *p* chart, *np* chart, *c* chart and *u* chart. The *p* and *np* charts are the most widely used. They are primarily used to monitor the fraction of nonconforming unit, while, the *c* and *u* charts are used to monitor the number of nonconformities or defects. Wodall (Wodall, W. H. 1997) discussed in detail the theory and future research of attribute control chart.

REFERENCES:

[1]. Anjard, R.P. 1995. SPC chart selection process. Microelectronic Reliability. 35(11): 1445–1447.

[2]. Athanassopoulos, A.D. (1998) 'An optimization framework of the triad: service capabilities, customer satisfaction and performance', in P.T. Harker and S.A. Zenios (Eds). Performance of Financial Institutions: Efficiency, Innovation, Regulation, Cambridge, UK: Cambridge University Press.

[3]. Bisgaard, S. 1993. Statistical Tools for Manufacturing. Manufacturing Review. 6(3): 192–200.

[4]. D. Raheja, . Assurance Technologies: Principles and Practices ., McGraw Hill, Inc., 1991.

[5]. FARNUM, N.R., Modern Statistical Quality Control and Improvement, Duxbury Press, Belmont, California, p.500, 1994.

[6]. Freeman, J, G. Mintzas. 1999. Simulating c and u Control Schemes. The TQM Magazine. 11(4): 242–247.

[7]. Gronroos, C. (1983) 'Strategic management and marketing in the service sector', Report No. 83-104, Marketing Science Institute, Cambridge, MA.

[8]. Hwang, C.L. and Lin, M.J. (1987) Group Decision Making Under Multiple Criteria: Methods and Applications, Berlin: Springer-Verlag.

[9]. Ishikawa, K. 1985. What is Total Quality Control. Prentice Hall. Englewood Cliff, N.J.

[10]. J. Heizer and B. Render, .Operations Management, 6th Ed., Prentice Hall, 2001.

[11]. Klassen, K.J., Russell, R.M. and Chrisman, J.J. (1998) 'Efficiency and productivity measures for high contact services', The Service Industries Journal, Vol. 18, pp.1–18.

[12]. Lee, H., Delene, L.M., Bunda, M.A. and Kim, C. (2000) 'Methods of measuring health-care service quality', Journal of Business Research, Vol. 48, pp.233–246.

[13]. Lehtinen, U. and Lehtinen, J.R. (1982) Service Quality: A Study of Quality Dimensions, Helsinki, Finland: Service Management Institute.

[14]. Lowry, C.A. and Montgomery, D.C. (1995) 'A review of multivariate control charts', IIE Transactions, Vol. 27, pp.800–810.

[15]. MONTGOMERY, D.C., Introduction to Statistical Quality Control, 3rd Ed., J. Wiley, New York, P.677, 1996.

[16]. Palm, A.C., Rodriguez, R.N., Spiring, F.A. and Wheeler, D.J. (1997) 'Some perspectives and challenges for control chart methods', Journal of Quality Technology, Vol. 29, pp.122–127.

[17]. Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1985) 'A conceptual model of service quality and its implications for future research', Journal of Marketing, Vol. 49, pp.41–50.

[18]. R. T. Amsden, H. E. Butler, and D. M. Amsden, . SPC Simplified: practical Steps to Quality, Productivity, Inc. , 1998.

[19]. Ross, P.J. (1988) Taguchi Techniques for Quality Engineering, New York, NY: McGraw-Hill.

[20]. Soteriou, A. and Zenios, S.A. (1999) 'Operations, quality and profitability in the provision of banking services',

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Management Science, Vol. 45, pp.1221–1238.

[21]. Soteriou, A.C. and Chase, R.B. (1998) 'Linking the customer contact model to service quality', Journal of Operations Management, Vol. 16, pp.495–508.

[23]. Stoumbos, Z.G., Reynolds, M.R., Ryan, T.P. and Woodall, W.H. (2000) 'The state of statistical process control as we proceed into the 21st century', Journal of the American Statistical Association, Vol. 95, pp.992–998.

[24]. Wodall, W. H. 1997. Control Charts Based on Attribute Data: Bibliography and Review. Journal of Quality Technology. 29(2): 172–196.

[25]. Woodall, W.H. and Montgomery, D.C. (1999) 'Research issues and ideas in statistical process control', Journal of Quality Technology, Vol. 31, pp.376–386.

[26]. Wyckoff, D.D. (1984) 'New tools for achieving service quality', Cornell Hotel and Restaurant Administration Quarterly, Vol. 25, pp.78–91.

[27]. Young, T.M, B.H. Bond, C. Boston, J. Wiedenbeck, R. James, and S. Morgan. 2002b. Tennessee Quality Lumber Initiative (TQLI) Phase III: Reducing lumber thickness variation and targets using real-time statistical process control. Final Report for Contract R112219-10, U.S. Forest Service Contract R112218-089 and The University of Tennessee Special Wood Utilization Grant R112218-054. 282 pp

[28]. Young, T.M, B.H. Bond, P.M. Winistorfer, and J.D. Cox. 2000b. Statistical process control for sawmills. In: Proc. of the 28th Annual Hardwood Symposium. (West Virginia Now-The Future for the Hardwood Industry?). National Hardwood Lumber Association. Canaan, West Virginia. pp. 31-42.

[29]. Young, T.M, C.E. Pope, and S. Peskar. 2005. Tennessee Quality Lumber Initiative (TQLI) Phase IV: Reducing lumber thickness variation using real-time statistical process control with wireless measurement technology. Final Report for Contract R112219-079. 152 pp

[30]. Young, T.M. 1997. Process improvement through "real-time" statistical process control in MDF manufacture. Proc. No. 7281. In: Proceedings of Process and Business Technologies for the Forest Products Industry. Forest Products Society, Madison, Wisconsin. pp. 50-51.

[31]. Young, T.M. 2000. Final report of project titled, Electronic micrometer interfaces for human machine interface platforms in hardwood lumber manufacture. The University of Tennessee, Institute of Agriculture Faculty Idea Grant R11221835/B11997401. Unpublished manuscript in preparation.

[32]. Young, T.M. and P.M. Winistorfer. 1998. Recovering more from your hardwood lumber: reducing thickness variation. In: Proc. of the 26th Annual Hardwood Symposium (Technology and Market Information for the Next Millennium). National Hardwood Lumber Association. Cashiers, North Carolina. pp. 109-120.

[33]. Young, T.M. and P.M. Winistorfer. 1999. Statistical process control and the forest products industry. Forest Prod. J. 49(3):10-17.

[34]. Young, T.M., P.M. Winistorfer. and J.D. Cox. 2000a. Tennessee Quality Lumber Initiative (TQLI) – Phase I: reducing lumber target sizes using real-time statistical process control. Final Report for Wood Utilization Special Research Grant R112218-054. 124 pp.

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