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QUALITY & RELIABILITY – THEORY AND PRACTICE IN INDIA

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SUMMARY

Though the study and the teaching of SQC (Statistical Quality Control) have been gradually developed in India thanks to ISI (Indian Statistical Institute), ISQC (Indian Society for Quality Control) and IAPQR (Indian Association for Productivity, Quality & Reliability), there has not been a corresponding impact on practical industrial applications. Then if on one hand there has been a wide diffusion of related theoretical research, e.g. on control charts, sampling plans and reliability analysis, on the other hand, probably owing to the lack of care by the top management and of orientations and guide by the Government and the Industrial Associations, industry chiefly focuses its attention on quality certification, which is often released by Associations sometimes not so competent in SQC methods. Anyway the situation is evolving and the statistical methods are more and more being adopted within companies in industrial research and the analysis and control of production characteristics.

1. INTRODUCTION

Statistical Quality Control (SQC) movement in India was spearheaded by statisticians thanks to the able leadership of Prof. P.C. Mahalanobis in the forties. To Mahalanobis, Statistics was a key technology and not just a branch of Mathematics.

Teaching and research in SQC was taken up at the Indian Statistical Institute (ISI) and some University departments, offering Statistics as a subject of study, and some Institutes of Technology.

Promotion of SQC methods and techniques in manufacturing industries started under the aegis of the ISI (through its SQC units spread throughout the country and subsequently through the SQC and Operational Research Division), the Indian Standards Institution (now designated as the Bureau of Indian Standards (BIS)), the National Productivity Council (NPC) and the Indian Society for Quality Control (ISQC).

Formed in 1948, ISQC provided a common platform to pursue, propagate and promote SQC theory and practice by statisticians, engineers and executives. Interactions with theoreticians as well as practitioners of SQC in developed countries were quite strong.

Today the network of SQC teaching and research has increased manifold, several professional societies have sprung up, industries now talk of Quality Systems and ISO 9000 standards, TQM (Total quality Management) clubs have been formed, and the message that Quality is a bad necessity has now reached the service sector also.

Contributions to statistical methods for quality and reliability in India have been quite impressive, though there has been a gradual shift to reliability analysis. Unfortunately, SQC in Indian industries has lagged behind and is picking up only recently.

The present article is a brief and sketchy portrayal of the more important activities in India carried out over the last fifty years or so in the area of Quality and Reliability. It reflects the author's perception and is not to be taken as a national status paper or even as a comprehensive historical account.

2. TEACHING OF SQC (INCLUDING RELIABILITY THEORY)

Elements of SQC theory like Shewhart charts, Dodge Romig Plans for Sampling Inspection, Tolerance Limits, etc. are covered by undergraduate statistics courses and by some courses in engineering and technology. At the postgraduate level, topics like cusum charts, continuous sampling plans, economic designs of process control plans, process capability analysis, industrial experimentation, etc. are taken up.

Optional courses in reliability (and survival analysis) are quite popular among postgraduate students. Some courses like the M. Tech (Master of Technology) course in Quality, Reliability and Operational Research offered by the ISI and the P.G. Diploma course in SQC offered by the Indian Association for Productivity, Quality & Reliability (IAPQR) cover Taguchi methods, besides management oriented topics like Quality Cost Analysis, Quality Circles, Total Quality Management, Quality Systems and ISI 9000 Standards, Kaizen, etc. M. Tech. programmes in Reliability Engineering are conducted in two Institutes of Technology.

IAPQR conducts correspondence courses to benefit employed workers and workers in remote areas. A correspondence course in Quality Management is also being arranged by the National Center for Quality Management.

IAPQR and ISI organize evening courses for one year and for four to six months. Short courses on selected topics like Quality Function/Policy Deployment, Quality Cost Analysis, Failure Mode and Effect Analysis (FMEA), etc. are conducted by a ecessity has now rea at various centres. Such courses are also organized by the Bureau of Indian Standards. Of late, short but intensive courses on Quality System Audit (courses to prepare assessors/lead assessors of Quality Systems) are being organized by several professional bodies, industry associations and consultancy houses mostly in collaboration with institutions recognized by the Institute of Quality Assurance (U.K.) to run courses approved under the National Registration Scheme there.

3. RESEARCH IN SQC AND RELIABILITY ANALYSIS

Some of the broad areas in which Indian scientists have contributed considerably are:

A. CONTROL CHARTS

1. Effects of nonnormality and dependence (among successive observations) on design of control charts and on their properties like ARL.
2. Control Charts for (correlated) multiple characters (using the desirability approach).
3. Charts based on gauging using member of exceedances beyond some gauge limits.
4. Economic Process Control Plans using different control charts, various control actions, different states of out of control and transitions among them, different outcomes of control actions and their probabilities, various process models, etc.

B. SAMPLING INSPECTION PLANS

1. Determination of plan parameters using decision theory (minimax, minimax regret, Bayes and Laplace criteria), and using fuzzy linear programming.
2. Price adjusting sampling plans.
3. Multi class and multi decision plans.
4. Plans for nonnormal distributions and for measurements subject to inspection errors.
5. Extension of Continuous Sampling Plans, ChSP, Skiplot plans, Multiple deferred sentencing plans, etc.
6. Plans indexed by Limiting Lot Quality.

C. RELIABILITY ANALYSIS

1. Characterizations and classifications of life distributions, dominance relations among these distributions their implications on ageing properties and their preservations under reliability operations like coherent system formation, convolution, mixture, weak limits, etc.
2. Multivariate extensions of life distributions, classes of distributions, class properties, dominance relations, etc.
3. System reliability (for various types of maintained systems), modular decomposition, component importance, etc.
4. Reliability Demonstration Plans in terms of variously censored data, using properties of TTT (Total Time on Test) transforms, etc.
5. Reliability Estimation from various types of data and using various estimation methods.

D. OTHER AREAS (EXCLUDING QUALITY MANAGEMENT)

1. Process Capability Indices, their sampling properties, extensions to multivariate cases, etc.
2 Prediction Limits for various distributions.

The above enumeration is not exhaustive and, in itself, is not indicative of the extent and content of work done in India on any of these topics. Research papers, review and expository articles as well as reports of application and case studies bearing on these topics have appeared in various journals, books and monographs. It is worth a mention that IAPQR Transactions and the Q & R Journal, published respectively by the Indian Association for Productivity, Quality & Reliability and the Indian Association for Quality & Reliability, are two refereed Indian Journals exclusively devoted to these topics whose contents are reviewed and abstracted in Mathematical Reviews, Zentralblatt für Mathematik, Quality Control and Applied Statistics, etc. IAPQR Transactions is exchanged with almost all journals on Quality and Reliability in the World.

4. USE OF SQC METHODS AND TECHNIQUES

Such uses are promoted by among other:

Indian Statistical Institute (having now a Quality Mission Project to build up a team of trainers in Quality Assurance Management for the Indian Industry).

Bureau of Indian Standards (with a Sectional Committee MSD:3 on Statistical Methods for Quality and Reliability that interacts with ISO TC 69).

Indian Association for Productivity, Quality & Reliability (through its Promotional Activities Division and its strong interaction with the Institute of Quality Assurance, U.K.).

Confederation of Indian Industry and Federation of Indian Chambers of Commerce and Industry (through their TQM Divisions and their interactions with counterparts abroad).

National Government (in terms of steps taken to set up a National Quality Council and several accreditation abroad).

At the level of individual industries, uses of SQC or SPC methods and techniques are not that extensive or intensive, possibly because of the absence of:

(a) top management commitment (management being swayed more by aspects of TQM like motivation, team work, work place improvement, etc.).

(b) a system approach (inspection/quality control/design groups to interact more vigorously with marketing, servicing and procurement groups).

(c) guidance and leadership from the Government and the Industry Associations and because of a dilution of the Quality Activity through a diverted attention to certification of Quality Systems (by Certifying Agencies not competent in SQC methods, generally).

5. CONCLUDING REMARKS

The gap between theory and contemporary practice has been known to be yawning in some branches of knowledge and close to insignificance in some others. Behaviour of Industry – including its interactions with Teaching and Research and its response to developments in theory and methods relating particularly to an area whose relevance or utility or necessity is not that obvious at least in the short run – is moulded by various macro – and metalevel policies like those guiding foreign trade, subsidy by the government, monopolistic and restrictive trade practices, etc. In India, this behaviour is changing fast and SQC practice is sure to pick up a lot.

Attempts to develop softwares for online process control through computer, numerical controlled machines, sensors and robots have to be strenghthened. Industrial Experimentation as well Taguchi methods for system, parameter and tolerance designs are finding greater and greater acceptance in industries. More and more manufacturing

and service enterprises are realising the need for using statistical methods for measuring, analysing and controlling variations in parameters of materials, machines, processes and products. Statistical methods are finding their way in the design of accelerated life tests, calibration methods, company image surveys, customer satisfaction surveys, and so on.

QUALITÀ E AFFIDABILITÀ: TEORIA E PRATICA IN INDIA

RIASSUNTO

Sebbene gli studi e l'insegnamento nel campo dell'SQC (Statistical Quality Control) si siano gradualmente diffusi in India grazie ad esempio all'ISI (Indian Statistical Institute), all'ISQC (Indian Society for Quality Control) e all'IAPQR (Indian Association for Productivity, Quality & Reliability), non si può dire altrettanto delle sue applicazioni pratiche nell'industria. Se da una parte, quindi, si è avuto un valido contributo di ricerche teoriche al riguardo, ad esempio, delle carte di controllo, dei piani di campionamento e dell'analisi dell'affidabilità, l'industria, a causa probabilmente della mancanza di impegno della alta direzione aziendale e di orientamenti e di una guida determinante da parte del Governo e delle Associazioni Industriali, concentra spesso la sua attenzione sulla certificazione della qualità, che viene rilasciata, purtroppo, da Enti talvolta non competenti nei metodi dell'SQC. La situazione sta comunque cambiando rapidamente e sempre più industrie utilizzano i metodi statistici per la misurazione, l'analisi e il controllo dei parametri della produzione.