PEER REVEIEW JOURNAL

ISSN 2321-0877

SANKHYA VIGNAN

સંખ્યા વિજ્ઞાન

NEW SERIES (NSV 12) OCTOBER 2016 SPECIAL

CONTENTS

Published by
GUJARAT STATISTICAL ASSOCIATION

Special Issue On World Statistics Day
20th October, 2016

SANKHYA VIGNAN

સંખ્યા વિજ્ઞાન

(e-mail ID : svgsa2015@gmail.com)

EDITORIAL BOARD

EDITORIAL

We are happy to present this issue of SV Journal as a Special Issue on the Occassion of World Statistics Day (20th Oct. 2016). Also SV is now a PEER REVIEWED JOURNAL since June 2016 issue. At this occassion, We thank our contributors, evaluators, readers and well wishers for their overwhelming support which has always helped us to do progressive work with sincere efforts.

This issue contains 3 articles, 4 research articles, 1 technical note, 1 biography and other sections as usual.

Very first article by **Jayesh R. Purohit** gives some prior useful informations for WSD event and celebration. This is accompanied by photographs with brief summary of 10 great statisticians of the world.

Under the caption **Statistics and Management** there are two articles. **First one by Jayesh R. Purohit** concerns about **Importance of data management.**

Second article is by **A.C. Brahmbhatt** which describes in a lucid manner about famous **Conjoint Analysis.**

First Research Article is presented by **Rajesh Kumar** which discusses in detail about a specific agricultural expermentation work analysed statistically with fruitful results.

Second Research Article is on **BIBD** and **PWBD** applications as discussed by **D.K.Ghosh** and **S.Ahuja**

Third Research Article concerns about an interesting agricultural application for pre harvest forecasting of irrigated wheat yield in Gandhinagar district. This work is done by **C.M.Chaudhari**, **M.B.Thaker** and **N.V.Patel**.

Fourth Research Article describes a specific statistical analysis pertaining to GSRTC. This work is carried out by **H.M.Dixit, P.M.Parmar** and **S.N.Jaiswal.**

There is a **Technical Note** on a specific survery work concerning higher education

done by **Neeta Mandaliya.**

A **Biographical Sketch** for very famous statistician **W.A.Shewhart** is presented by **H.D.Budhbhatti.**

There are very sad news that our seniormost editorial board member **Dr. M. N. Gopala**n expired on 30th June, 2016. It has been a great loss for SV team. His biography is presented in **SV News Letter** by **K. Muralidharan** with other details also.

As usual, we have **Readers Forum** giving feedback from different persons. This is presented by **Prin. A. M. Patel**.

We are highly indebted to our following **Referees** who have carried out an excellent job for evaluating the articles submitted for publication in this issue. (The names are taken **one by one** in order of their appearance in the journal)

(1)	**A. C. Brahmbhatt**	**(2)**	**R. G. Bhatt**
(3)	**D. K. Ghosh**	**(4)**	**Pravendersingh**
(5)	**P. P. Prajapti**	**(6)**	**M. B. Thaker**
(7)	**H. M. Dixit**	**(8)**	**A. M. Patel**

We shall send **Digital Copy** of this issue to all our readers whose email ID are with us. **Printed copy** will follow soon.

On this event of receiving **Peer Review Status** we thank all of you.

We express our best wishes for a very **Happy Dipavali** and **Prosperous New Year** to all of you.

We wish you pink health and season's greetings.

Ahmedabad
Dated: 20-10-2016. **(World Statistics Day)**

SANKHYA VIGNAN

PEER REVIEWED REFREED BI-ANNUAL JOURNAL

ISSN :2321-0877

- **Listed at International ISSN Directory, PARIS**

Average Circulation Rate of past two Years: 832 (Along with Digital Copies)
Average Journal Evaluation Score: 6.41 (As on 20 June, 2016)

GUJARAT STATISTICAL ASSOCIATION

FROM EDITOR'S DESK

SANKHYA VIGNAN is a peer reviewed refereed Bi-Annually journal that publishes empirical, conceptual and review papers of exceptional quality that contribute to Statistics Theory and enriched Applications of Statistical Techniques in various fields. The objective of the Journal is to disseminate knowledge, which ensures good practice of professional management and its focal point is on research and reflections relevant to academicians and practitioners in the field of Applied Statistics.
Read more: About IJBARR

PEER REVIEW PROCESS:

(1) To maintain PEER REVIEW REGISTER giving full details about authors, Refrees, decisions and internal rankings, before printing the Issue

(2) All research articles published in the **SANKHYA VIGNAN** will undergo full peer review process. It should be clear for authors that the Editor In Chief is responsible for the final decision about the submitted papers; have the right to accept\reject any paper. The Editor In Chief will choose any option from the following to review the submitted papers:

   a). send the paper to two reviewers, if the results were negative by one reviewer and positive by the other one; then the editor may send the paper for third reviewer or he take immediately the final decision by accepting\rejecting the paper. The Editor In Chief will ask the selected reviewers to present the results within 7 working days, if they were unable to complete the review within the agreed period then the editor have the right to resend the papers for new reviewers using the same procedure. If the Editor In Chief was not able to find suitable reviewers for certain papers then he has the right to accept\reject the paper.

   b). sends the paper to a selected editorial board member(s) or reviewer.

   c). the Editor In Chief himself evaluates the paper.

(3) The authors of the papers/ Articles accepted for publication need to submit a duly signed copyright form within maximum one week of their receiving intimation of acceptance of their paper/ article.

(4) To give each published issue for evaluation by two external Refrees other than editors) obtain evaluation reports and journal evaluation Score out of 10 points.

(5) To declare average Journal Evaluation Score on the basis of the scores given by these two Refrees for each published issue.

(6) To keep all records in perfect order.

(7) Invite and accept suggestions made by the Refrees for Peer Review.

PEER REVIEW COMMITTEE:

It consists of six members:

- Editor In Chief
- Two Joint Editors
- Two External Refrees
- Editorial Secretary

PAPERS/ MANUSCRIPT EVALUATION CRITERIA

Each submitted manuscript is evaluated on the following basis:

- The originality of its contribution.
- The soundness of its theory and methodology.
- The coherence of its analysis.
- The ability to communicate to readers (grammar and style).
- All research papers are reviewed by at least two suitably qualified experts.
- All publication decisions are made by the journals' Editor on the basis of the reviews provided.
- Normal turn-around time for evaluation of manuscripts is 21 days from the date of recipient.

GUIDELINES FOR AUTHORS:

1. The first page of the article should contain full name of authors with designation and correspondence address, contact Numbers and E-Mail Ids (Both Institution and residential)
2. The research must be original in nature and is neither published nor under consideration for publication anywhere else.
3. The review process may take 2-3 days and the status would be known within 24 hours of submission of the article. It is mandatory to mention a valid email and mobile number. We acknowledge the receipt of your article and subscription fee by email.
4. The abstract should not be more than 200-250 words and it should adequately describe the work and highlight its significance. Avoid the use of abbreviation and reference in the abstract. The abstract should be followed by relevant keywords.
5. The main paper (Manuscripts) should not exceed more than 3,000 to 4,000 words(including graphs&charts).
6. Article should be typed in 12 point - Times New Roman Fonts English with a one and half space and single column with 1 Margin on a Standard A4 size Paper. The Page numbers should be at the center of every page. All headings & sub headings must be in bold letters.
7. Table should be numbered consecutively,the title of the table should be placed above the table. The source should be indicated at the bottom.
8. All the tables, charts, graphs, diagrams should be in black and not in colors.
9. Footnotes, italics, and quotation marks should be kept to the minimum.
10. References should be mentioned in APA Referencing Format.

HOW TO SUBMIT:

a) We will accept soft copies of article through online submissions at the E-Mail ID: (i) svgsa2015@gmail.com, (ii) drjayesh.purohit@gmail.com (iii)bbjani2012@gmail.com

b) Submissions in Hard Copies are also accepted addressing:

To

Dr. B. B. Jani

Chief Editor, Sankhya Vignan

B/14, Bansidhar Appartments, Mirambica Road, Naranpura, Ahmedabad - 380 013

WORLD STATISTICS DAY

Jayesh R. Purohit*

On 3 June 2015, the United Nations General Assembly adopted a resolution officially designating **20 October** 2015 as the second **World Statistics Day**, under the general theme **Better data, Better lives**. In addition, the General Assembly decided to celebrate **World Statistics Day on 20 October; every five years**.

This resolution, which was co-sponsored by Hungary and 96 other Member States, follows the recommendation by the United Nations Statistical Commission at its 46th session to celebrate 20 October 2015 as World Statistics Day. H.E. Ambassador Bogyay of Hungary delivered a statement introducing the draft resolution to the General Assembly before its adoption.

In the resolution, the General Assembly invites all Member States, members of specialized agencies, organizations of the United Nations system and other international and regional organizations, as well as civil society, including non-governmental organizations, such as research institutions, media and all producers and users of official statistics, to observe World Statistics Day.

Noting that the **first World Statistics Day, held on 20 October 2010**, was an overwhelming success, with activities being organized in more than 130 Member States and by at least 40 international and regional organizations and entities,

Noting also that 2015 marks the bicentenary of the birth of George Boole, whose work on the application of the principles of logic as a form of algebra underpins modern computer science and which form of algebra today bears his name,

Noting further that some Member States and regions already celebrate official statistics through a variety of national and regional initiatives, such as designated months, weeks, days or events, and welcoming their support and willingness to coordinate such events under the auspices of the United Nations,

1. Decides to designate **20th October 2015 as the Second World Statistics Day**under the general theme "**Better data, better lives**";

* MANTRA Consultants; Ahmedabad.
e-mail : drjayesh.purohit@gmail.com

2. Also decides **to celebrate World Statistics Day**,**every five years on 20 October;**

3. Invites all Member States, members of the specialized agencies,organizations of the United Nations system and other international and regionalorganizations, as well as representatives of civil society, including non-governmental organizations, such as research institutions, media and all producers and users of official statistics, to observe World Statistics Day in an appropriate manner;

4. Stresses that the cost of all activities that may arise from the implementation of the present resolution should be met from voluntary contributions;

5. Requests the Secretary-General to take the necessary measures for the observance by the United Nations of World Statistics Day in 2015 and to bring the present resolution to the attention of all Member States and members of the specialized agencies and United Nations organizations.

Today is World Statistics Day – 20th October

- Better Statistics,
- Better Decisions and
- Better Lives.

Something worth to Celebrate.

ON THIS OCCASION OF WORLD STATISTICS DAY, We remember some Great Statisticians of the world.

1 R. A. Fisher

Sir Ronald Aylmer Fisher, FRS (1890 - 1962) was an English statistician, evolutionary biologist, and geneticist. Richard Dawkins described him as "The greatest of Darwin's successors" and the historian of statistics. Anders Hald said **Fisher was a genius who almost single-handedly created the foundations for modern statistical science**.His contributions to experimental design, analysis of variance, and likelihood based methods have led some to call him **The Father of Statistics**.

2 Karl Pearson

Karl Pearson (1857 - 1936) was a major contributor to the early development of statistics and founder of the world's first university statistics department at University College London in 1911. He was also an ardent and controversial proponent of eugenics. His most famous contribution is the Pearson's chi-square test. He was an influential English mathematician who has been credited for establishing the discipline of mathematical statistics.

3 Prasanta Chandra Mahalanobis, known as **P C Mahalanobis**

Prasanta Chandra Mahalanobis (29 June 1893 – 28 June 1972) was an Indian scientist and applied statistician. He is best remembered for the Mahalanobis distance, a statistical measure and for being one of the members of the first Planning commission of free India. He made pioneering studies in anthropometry in India. He founded the Indian Statistical Institute, and contributed to the design of large-scale sample surveys.

4 Calyampudi Radhakrishna Rao, known as**C R Rao**

Calyampudi Radhakrishna Rao, known as**C R Rao** (born 10 September 1920) is an Indian born, naturalized American, mathematician and statistician. He is currently professor emeritus atPenn State University and Research Professor at

the University at Buffalo. Rao has been honoured by numerous colloquia, honorary degrees and festschrifts and was awarded the USNational Medal of Science in 2002.

The American Statistical Association has described him as **A living legend whose work has influenced not just statistics but has had far reaching implications for fields as varied as economics, genetics, anthropology, geology, national planning, demography, biometry and medicine**. The Times of India listed Rao as one of the top 10 Indian scientists of all time. Rao is also a Senior Policy and Statistics advisor for the Indian Heart Association non-profit focused on raising South Asian cardiovascular disease awareness.

5 Gertrude Cox

Gertrude Mary Cox (1900 - 1978) was an influential American statistician and founder of the department of Experimental Statistics at North Carolina State University. She was later appointed director of both the Institute of Statistics of the Consolidated University of North Carolina and the Statistics Research Division of North Carolina State University.

Her most important and influential research dealt with experimental design; she wrote an important book on the subject with W. G. Cochran. In 1949. Cox became the first female elected into the International Statistical Institute and in 1956; she was president of the American Statistical Association.

Cox received many honours. In 1949 she became the first woman elected into the International Statistical Institute. In 1956 she was elected President of the American Statistical Association while in 1975 she was elected to the National Academy of Sciences.

6 Kirstine Smith

Kirstine Smith (1878 - 1939) was born in Denmark. She was admitted as a candidate for a doctorate in statistics in 1916 at the University of London and wrote a thesis that was a precursor to modern optimal design theory, published in 1918 *Biometrika*. Karl Pearson considered her to be one of his most brilliant mathematical statisticians. Her work with Pearson on minimum chi-square spurred a controversial dialog between Pearson and Fisher, and led to Fisher's introduction of sufficient statistics. She returned to teaching in Denmark and ended her career there.

7 Frank Yates

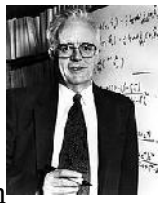
Frank Yates (1902 - 1994) was one of the pioneers of 20th century statistics. He worked on the design of experiments, including contributions to the theory of analysis of variance and originating Yates' algorithm and the balanced incomplete block design. He became an enthusiast of electronic computers, in 1954 obtaining an Elliott 401 for Roth Amsted and contributing to the initial development of statistical computing.

During World War II he worked on what would later be called operations research.After the war he worked on sample survey design and analysis.

8 George E. P. Box

George Edward Pelham Box, born on October 18, 1919, was a pioneer in the areas of quality control, time series analysis, and design of experiments. Still on the engineering faculty of University of Wisconsin, he is well-known for the quote "…all models are wrong, but some are useful". His books **Statistics for Experimenters and Time Series Analysis: Forecasting and Control are classic texts.**

9 David R. Cox



Sir David R. Cox, born in 1924, is a British statistician who has made pioneering and important contributions to numerous areas of statistics and applied probability. Perhaps the best known of his many developments is the proportional hazards model, which is widely used in the analysis of survival data. He is now an Honorary Fellow of Nuffield College and a member of the Department of Statistics at the University of Oxford.

10 Jerome H. Friedman

Jerome H. Friedman is one of the world's leading researchers in statistical **data mining**. He has been a Professor of Statistics at Stanford University for nearly 20 years and has published on a wide range of data mining topics including nearest neighbour classification, logistic regression and high-dimensional data analysis, and machine learning.

IMPORTANCE OF DATA MANAGEMENT

Jayesh R. Purohit*

We are living through a data revolution. It is changing our world. Our choices as individuals are increasingly informed by more and more complex sources of data. Businesses are making decisions drawing on diverse and sophisticated information systems. Governments are making laws and reforming public services with an ever widening evidence base at their disposal.

But how well equipped are we to be confident and competent in this world of data? In my view, there are reasons to be positive. In jobs ranging from journalism to government policymaking, the demand for training in statistical literacy is increasing – fuelled by examples, such as the Guardian Data blog, that show just how much better you do your job, if you have these skills.

In universities, there has been excellent take up for initiatives, such as the Economic and Social Research Council's Q-Step programme, that teach quantitative methods to students in disciplines outside statistics, so that they can get greater impact from their studies.

In schools, data skills are being taught throughout the curriculum in subjects from geography to biology in ways that bring the subject to life and capture the imagination of pupils. Anyone these days who says: **I don't do mathematics** is missing out. It is becoming a truth to say that those who get status get on and those that don't get left behind.

However, there is still a lot to do before we can feel that we are, as a society, at ease in a data-rich world. We need to be much less tolerant of those who use numbers in ways that mislead, either deliberately or inadvertently. We should hold accountable those in positions of authority who act without drawing on the data that

* MANTRA Consultants; Ahmedabad. email : drjayesh.purohit@gmail.com
(rcd. Aug.'16 / rvd. Sept.'16)

could inform their decisions. **Decisions are judgments but assessment of the evidence can reduce the risk of making a terrible mistake.**

We could also be much more questioning, asking ourselves when we read a headline: can that really be right? If it is something that affects us, in a few clicks we could find out for ourselves what is really going on. We do not all need degrees in statistics, we just need to be curious and apply some critical thinking and common sense.

The abundance of data means that it is feasible to generate evidence in a much quicker and more targeted way to inform almost any decision of importance.

Statistics are always provisional and capable of improvement, but if you can be confident that they have been honestly compiled they can be mobilised to add real value when you need to know what is really going on. Ignorance, prejudice and spin are not a good foundation for judgment.

An attribute of data is that we cannot sniff it or feel it like a piece of fruit. We cannot judge its quality by looking at it. We have to decide whom to trust. Is this information trustworthy and fit for my purpose? Which brands can I believe in?

I think that, this is arguably the most important question in the next stage of the data revolution. Data continues to be generated at an ever greater pace. We have more and more of the raw material. We are giving ourselves the skills to use it to improve our lives. But we need to have confidence in those that are holding our data, analysing it and serving it back to us.

Across the private sector, this brand value of data is increasingly measured in billions - and billions get wiped off the valuation if trust is betrayed. As consumers we are asking harder questions about what is going on inside the algorithms, about where our data are going and who is getting access to it. We are demanding transparency and redress. Companies know they will be out of business if their users lose faith in them.

In the arena of data for the public good the question is more open. The potential value to a nation of public data open and available to all can surely also be measured in billions but it seems to me that two things need to happen for that value to be fully realised.

First, those in a position to create public value from data need to be as creative and innovative as those delivering data services in the market. There is a demand for more public good information directly targeted to the issues of the day – both the big national questions, such as how to improve nation'sproductivity and the more personal questions, such as where should I rent my next flat. If we are to benefit from data we want it to be presented in ways we can understand – less complex tables and more easy to use visualisations. We need it in real time and at a level of granularity that makes it relevant to the choice that has to be made.

Second, trustworthiness demands that the utmost respect is given to the data and to the rights of the data subject – whether it is a person or a business. The ethics of what it is right to do with data are challenging as the new data landscape is posing many novel questions. Yet good judgment about what it is right to do is a prerequisite for public confidence. Security and confidentiality matter a great deal to us.

We can build on the trust that already exists in our National Statistics. Over the last week new figures on inflation, jobs and crime, to name but three topics, have fuelled debate and are informing decisions. These statistics are based on personal, administrative and commercial data drawn from all parts of the country, collected, analysed and safeguarded. They provide vital new insights into the state of the nation while protecting all personal or sensitive information. Across the National Statistics system the data revolution heralds a radical upgrading in the usefulness of the figures in the years ahead.

There is an extraordinary prize to be won, for us as citizens and for the India as a nation. It is within our reach to have at our fingertips trustworthy data that helps us make good choices. That same data could also give us the means to hold accountable those in positions of authority in government, business or elsewhere – ensuring that they too are both respecting our personal data and using better statistics to make better decisions in the interests of our future prosperity.

ACKNOWLEDGEMENTS

I thank the referee for his comments to revise this article.

CONJOINT ANALYSIS

A. C. Brahmbhatt*

In the purchase decision of a product or a service , normally a customer becomes choosy of the several attributes of that product or service.For example buying a car , the customer would mostly look for the attributes like its price, fuel efficiency, warranty etc. But if we fathom in his or her choice process before buying a product or service , we would find that he/she does not look for price per se or fuel efficiency per se; in fact he/she is further interested in the levels of these attributes –say for example three levels of price—Rs. 3 lakh , Rs. 3.5 lakh , Rs. 5 lakh . Fuel efficiency may have three levels—15km. per hour, 20km.per hour, 25km. per hour.Similarly warranty may have 3 levels—5 years, 7 years, 10 years. Therefore while making a purchase decision he is influenced by his/her preferred combination of the levels of these three attributes, e.g. One customer may have his/her preferred combination—Rs.3 lakh price, 15km. per hour fuel efficiency and 7 years of warranty. The other customer may have his/her preferred combination as Rs. 3.5 lakh price, 20 km. per hour fuel efficiency and 7 years of warranty , so on and so forth. With 3 attributes each at 3 levels , there are 27 possible combinations and customer will choose any one of them.

The customer while opting for a particular combination of the levels of the attributes, attaches different value to the different levels of the attributes .Each customer has his/her own evaluation for different levels of the attributes. The value that he/attaches is known as the ‘utility’ or ‘part worth’.For example a middle income earning customer attaches higher utility to the lowest price level as he is more price-sensitive.

For the marketer it is not enough to know as to how the customers rate price or fuel efficiency per se, he should also know as to which is the most preferred combination out of these 27 combinations, which is the second most preferred combination, what is the third preferred combination in that order and even the least preferred combination.

The versatile statistical technique –CONJOINT Analysis provides the mechanism

* Research Mentor, PDPU, Gandhinagar. email : acbpramukh@hotmail.com
(recd. Sept. ’16 / rvd. Sept. ’16)

for finding out the utilities to each level of the attributes and adding the highest utilities attached to the level of each attribute identifies the most preferred combination , next most preferred combination so on and so forth.

The operational part is simple.For example a battery of above stated combinations are given to the respondents and asked to rate them –the most preferred combination is assigned the rating 27 and the least preferred is assigned the rating 1. If there are more attributes with different levels the number of possible combinations goes up. For example in the above example if we add the fourth attribute of the different car manufacturing companies say Maruti, Hundai and Toyota , the possible combination will shoot up to 81. Similarly with the fourth attribute added, it would move up 243.In such cases ,by using Fractional Factorial design they could be reduced to a manageable number.

By using relatively simple Dummy Variable Regression Analysis where the ratings is a dependent variable and the different levels of attributes as the independent variables ,the implicit utilities(the corresponding Betas of the regression analysis) could be calculated.

By adding the highest utility of the level in each attribute, we may find out the most preferred combination . second most preferred combination and other combinations in that order. The marketer always aims at satisfying customers by offering them their most preferred combination.

CONJOINT is thus a method that helps the marketer to Consider all the things jointly. If he wants to alter the level of some attribute in his offering, he can also find out what would be the drop or increase in the utility and whether it is worth shifting the level or not. For example, in above case if he increases the price from Rs. 3 lakh to Rs.3.5 lakh , he can decide whether the drop in utility is alarming or otherwise.

The professor of marketing Prof. Paul Green at the Whorton School of the University of Pennsylvania and Srinivasan of Standford University in the year 1978, first developed this technique. **(Green Paul and Srinivasan(1978) : Conjoint Analysis in consumer research, issues and outlook, Journal of Consumer Research, Vol.5, Sep 78, pp 103-123).** Richard Jhonson **(founder of Sawtooth Software)** then developed the Adaptive Conjoint Analysis Technique in 80s.

CONJOINT estimates psychological trade offs that consumers make while evaluating several attributes jointly. It unearths the hidden drivers for purchase decision that may not be apparent even to the consumers.

ACKNOWLEDGEMENTS

I thank the referee for his review of my article.

RESEARCH ARTICLE

SIMULTANEOUS SELECTION OF HIGH SUGAR YIELDING AND STABLE GENOTYPES OF SUGARCANE IN INDIA

Rajesh Kumar*

ABSTRACT

The selection of sugarcane genotypes is based on the performance of sugar yield at different locations across the zone and ranking of genotypes is done on the basis of mean data. The same criterion has been used in AICRP on Sugarcane till 2011-12. A new approach involving simultaneous selection indices using Additive Main Effects and Multiplicative Interaction (AMMI) model for advanced varietal trial (AVT) has been applied for simultaneous selection of high yielding and stable sugarcane genotypes. The simultaneous selection index (2.1) has been used for simultaneous selection of high sugar yielding and stable sugarcane genotypes of East Coast Zone in India under the AVT (Early) of East Coast Zone of AICRP on sugarcane. CoC 08336, CoV 09356 and CoA 09321 were better genotypes than the best standard CoA 92081 in first stage. Out of these three genotypes, CoC 08336, CoV 09356 and CoA 09321, **CoA 09321** had top rank against the test genotypes based on index value having the highest stability value. Though CoC 08336 had the highest sugar yield but was ranked lowest in stability. Thus based on the proposed approach, CoA 09321 was adjudged the best entry in the trials as high sugar yielding and stable genotype. The information obtained from such an analysis may be useful to the planners for notification and release of a variety in the zone by Central Sub - Committee on Crop Standards Notification and Release of Varieties

***Keywords**:* Sugar yield, AMMI model, Stability, Simultaneous selection, Multi-environment East Coast Zone, AICRP(S)

* All India Co-ordinated research project on Sugarcane ICAR-Indian Institute of Sugarcane Research P.O. Dilkusha Lucknow - 226 002, Uttar Pradesh, India
e-mail : rajesh_iisr@hotmail.com
(rcd. Aug. ’16 / rvd. Sept’16)

1. Introduction

The All India Coordinated Research Project on Sugarcane (AICRP on Sugarcane) under ICAR, New Delhi is playing a pivotal role in development of improved, location-specific sugarcane varieties for five agro-climatic zones viz., Peninsular, East Coast, North West, North Central and North East Zones of India. The first workshop on sugarcane research (Anon, 1970), held at the Indian Institute of Sugarcane Research, Lucknow during January 15-18, 1970, suggested that under a coordinated variety trial on the basis of performance at the zonal trial centers, the promising genotypes should be selected and tested at all sub-centers and on farmer's holding. Since then a large number of improved varieties have been identified through AICRP trials, and some have occupied sizeable area in most parts of the country. Such varieties have contributed in improving the sugarcane productivity.

The required genetic variability for meeting the varietal needs of the country is generated through a large number of crosses carried out every year at the National Hybridization Facility at Sugarcane Breeding Institute, Coimbatore (Anon, 2007). The hybrid progenies generated from these crosses by over 35 participating centres located in the five agro-climatic zones of the country are evaluated at different stages as the respective locations to identify locally adapted superior clones. The genotypes thus developed at the research centres are pooled zone-wise and evaluated in two stages in a number of locations in the respective zones. In the Initial Varietal Trial (IVT), entries are evaluated for one year and those with poor performance are discarded and the remaining entries are tested in two plant and one ratoon crops under the Advanced Varietal Trial (AVT). The varieties for release in individual zones are identified based on the overall performance across the locations within the zone in both plant and ratoon crops. The best performing genotypes across the zone are proposed at AICRP(S) workshop and varieties are identified by Variety Identification Committee after scrutinizing the genotypes for cane yield, juice quality, reaction to pest and diseases and tolerance to salinity and drought. The identified genotypes are then proposed for notification and release in the zone by Central Sub - Committee on Crop Standards Notification and Release of Varieties as per the guidelines of Government of India (Tandon et al., 2015). Evaluation of genotypes for stability of performance under varying environmental conditions for yield is a essential part of any varietal development programme. An analysis of G x E interactions can add an extra value to the genotype, if carried out before Variety Identification Committee

meeting, for identifying superior genotypes for cultivation in different zones of the country.

Under AICRP on sugarcane, for the first time, use of simultaneous selection indices using Additive Main Effects and Multiplicative Interaction (AMMI) model in Advanced Varietal Trials was initiated during 2011-2013. AMMI model offers a more appropriate statistical analysis to deal with such situations, compared to traditional methods like ANOVA, Principal Component Analysis (PCA) and linear regression. Currently, selection of sugarcane genotypes is based on the performance of cane yield across the location in a zone and ranking of genotypes is done on the basis of mean data. Ranking of genotypes based on simultaneous selection of high yielding and stable genotypes gives better and reliable picture in identifying a variety for its release in a zone. The present article summarizes the results obtained from an Advanced Varietal Trial (Early) conducted at five locations in East Coast Zone of *AICRP(S)* during 2011-13 using AMMI model and suggests a novel approach for selection of high sugar yielding and stable genotypes in sugarcane.

2. Materials and Methods

Combined analysis of AVT(Early) trials conducted in a randomized complete block design for three years (two plant crop and one ratoon) over five locations in East Coast Zone was performed for stability of sugar yield. Stability in performance is one of the most desirable properties of a genotype to be released as a variety for wide cultivation. In case the variance due to Genotype x Environment interaction is found significant, one of the various approaches known for measuring the satiability of genotypes can be used and the variety may be ranked accordingly (Singh and Chaudhary, 1997). In literature, a large number of stability measures are available (Prabhakaran and Jain, 1994). However, the stability measure alone is of limited use. For a successful breeding or cultivars testing programme, both stability and yield (or any other trait) must be considered simultaneously. Also integration of stability of performance with yield through suitable measures will help in appropriate selection of a variety. Bajpai and Kumar (2001) proposed a new method of simultaneous selection for yield and stability in sugarcane which was further modified by Rao and Prabhakaran, 2005. In this approach, it integrated measures of performance and stability as a most informative index. Bajpai and Kumar. (2006) also applied selection criteria for high yielding and stable genotypes in sugarcane. A brief outline

of AMMI and bio-plots procedure is discussed as follows.

AMMI and simultaneous selection procedure

The AMMI method combines the traditional ANOVA and PCA into a single analysis with both additive and multiplicative parameters (Gauch, 1992). The first part of AMMI uses the normal ANOVA procedures to estimate the genotype and environment main effects. The second part involves the PCA of the interaction residuals (residuals after main effects are removed). The model formulation for AMMI shows its interaction part consists of summed orthogonal products. Because of this form the interaction lends itself to graphical display in the form of so-called bi-plots (Gabriel (1971)). Here, it is assumed that the first two PCA axes suffice for an adequate description of the GxE interaction. It is evident from earlier sections that the scope of bi-plots is very much limited. The inferences drawn from bi-plots would be valid only when the first two PCAs explain a large portion of interaction variation. In situations, where more than two PCA axes are needed to accumulate considerable portion of GEl variation, what should be the approach for identifying varieties which are high yielding as well as stable. Keeping this in mind, a new family of simultaneous selection indices was proposed by Rao and Prabhakaran (2005) which can select varieties for both yield and stability was applied in this study. The proposed selection indices (I_i) consists of (i) a yield component, measured as the ratio of the average performance ($\bar{Y}_{i.}$) of the i-th genotype to the overall mean performance of the genotypes under test, and (ii) a stability component, measured as the ratio of stability information ($1/ASTAB_i$) of the i-th genotype to the mean stability information of all the genotypes under test. The simultaneous selection index is given below

$$I_i = \frac{\bar{Y}_{i.}}{\bar{Y}} + a\frac{\frac{1}{ASTAB_i}}{\frac{1}{T}\sum_{i=1}^{T}\frac{1}{ASTAB_i}} \qquad (2.1)$$

Where $ASTAB_i$ is the stability measure of the i-th genotype under AMMI procedure and is mean performance of i-th genotype. α is the ratio of the weights given to the stability components (w_2) and yield (w_i) with a restriction that $w_1+w_2 = 1$. The weights considered in the index are, in general, as per the plant breeders'

requirement. By considering the values of α as 1.0 ($w_1 = w_2 = 0.5$), 0.66 (w_1=0.6, w_2=0.4), 0.43 (w_1=0.7, w_2=0.3) and 0.25 $w_1 = 0.8$, $w_2 = 0.2$), a new family of indices consisting of four indices I_1, I_2, I_3 and I_4 was proposed.

3. Multi-location trials and data collection in East Coast Zone

East Coast Zone (ECZ) of AICRP on Sugarcane is an important zone where sugarcane is an important commercial crop. It is cultivated in almost all the districts of the zone. The zone occupies an area of 3.92 lakh ha, representing 7.61 per cent of the total sugarcane area in the country. ECZ stretches from the Balasore district of Odisha in the North to the Tirunelveli district in the Tamil Nadu and broadly comprises thirteen districts of Odisha, eleven districts of Andhra Pradesh and twelve districts of Tamil Nadu, besides the Union Territory of Puducherry. The zone has congenial climatic conditions for the growth of sugarcane under irrigated conditions. The highest yields are obtained from this region with more than 110 t/ha in some of the districts of the zone. Nearly 50 % of the net cropped area is irrigated, though widely distributed between districts in the region (17 to 83 %).

Multi-location advanced varietal trials (AVT) were conducted with six early elite sugarcane clones namely, CoA 08323, CoA 09321, CoC 08336, CoC 09336, CoV 09356 and PI 09376 and three standards, Co 6907, CoC 01061 and CoA 92081, at five different locations viz., Sugarcane Research Station, Nayagarh (Odisha)**,** Regional Agricultural Research Station, Anakapalle (Andhra Pradesh), Sugarcane Research Station, Vuyyuru (Andhra Pradesh), E.I.D. Sugarcane Research & Development Centre, Nellikuppam (Tamil Nadu) and Sugarcane Research Station, Cuddalore (Tamil Nadu).

Advanced varietal trials (Plant I) was conducted at all the locations of the zone during 2011-12. The same set of clones was evaluated in the following year (2012-13) as Plant II as well as ratoon crop of the clones of AVT (Ratoon). Combination of two years of plant crops (2011-12 and 2012-13) and one ratoon crop during 2012-13 and five locations were treated as 15 environments for stability analysis. At each location, the trial was conducted in randomized block design with three replications of gross plot size 8 rows of 6.0 m with 0.8 m row to row distance. Net plot size was taken as 6 rows of 5.0 m with 0.8 m row to row distance. Seed rate was used as 12 buds per meter. Planting of the crop was done during February / March for Plant I (2011-12) and Plant II (2012-13). Data on sugar yield (t/ha) were recorded

at harvest stage of 300 days after planting of the crop both for Plant Crop I and II. Where as for ratoon crop, data on sugar yield (t/ha) were recorded at harvest stage of 270 days after harvesting of plant I. The planting and the harvesting were performed manually. AMMI analyses and simultaneous selection indices analyses were conducted using SAS 9.3 (SAS Institute, 2002-2010). Other statistical analysis was done using Ms-Excel (2014).

4. Results and Discussion

Combined analysis of variance of sugar yield (t/ha) over five locations and three years (two plant crop and one ratoon) resulted in highly significant differences ($P<0.01$) in the year, location, year x location, genotype, year x genotype, location x genotype and year x location x genotype (Table 1.1). Highly significant difference among the years (plant I, plant II and ratoon) indicated that there was highly significant difference between plant I, plant II and ratoon crop of different early genotypes which also contributed of 13.73 % variation of the total variation. Interaction effect of year (plant I, plant II and ratoon) and locations was found highly significant indicated that sugar yield of genotypes varied with plant and ratoon crops across the locations which shared 8.88 % variation of total variation. Genotypes, location x genotypes and year x genotype contributed 7.75 %, 15.41 % and 1.85 % variation of total variation respectively. Average sugar yield varied from 6.50 to 14.87 t/ha in the zone. Significant interaction of year x genotype indicated that yield of genotypes varied between plant crop and ratoon crops over the locations. Significant effect of genotype x locations indicated that the genotypes had variable performance in the tested locations in East Coast Zone of AICRP(S) and had possibility of selection of stable genotypes. Chandra et al. (1974) also reported that GE interaction with location is more important than GE interaction with year. The present study provides an ample opportunity for appropriate evaluation of performance of sugar yield of early genotypes and their stability in East Coast Zone of AICRP(S).

Combination of two years of plant crops (2011-12 and 2012-13) and one ratoon crop during 2012-13 and five locations were treated as 15 environments for AMMI and stability analysis (Table 1.2). The significant interactions of genotypes × environments (locations and years combination) suggest that sugar yield of genotypes varied across plant and ratoon crop. Significant differences for genotypes, environments and genotypes x environments interaction indicated the effect of environments in the

GE interaction, genetic variability among the entries and possibility of selection for stable genotypes (Table 1.2). AMMI analysis of variance for yield at 15 environments indicated that the effects of genotype, environment and their interaction on sugar yield were significant, with the proportion of the total treatment variation of 7.57 % for genotype, 58.23 % for the environment and 23.48 % for interaction (Table 1.2). Similar results on sugarcane obtained by Silveira et al. (2013) and observed that the AMMI analysis of variance of the variable tons of pol per hectare (TPH) across two cuttings and nine environments showed that 73.36 % of the total SS was attributable to environmental effects, 12.01 % to genotypic effects and 14.63 % to G × E in- teraction effects. Environment effect was found highly significant indicated that locations of East Coast Zone are diverse in nature. A large yield variation explained by environments indicated that the environments were diverse, with large differences among environmental means causing most of the variation in sugar yield (Mitroviæ et al., 2012).

In this study, a large SS for environments indicated that the environments were diverse ranging the sugar yield from 6.50 to 14.87 t/ha. In this sense, AMMI analysis represents a potential tool that can be used to deepen the understanding of factors involved in the manifestation of the G × E interaction. Silveira et al. (2013) also indicated that the AMMI method allowed for easy visual identification of superior genotypes for each set of environments. According to Gauch and Zobel (1996), in standard multi-location trails, 80% of the total sum of treatments is environment effect and 10% effect of genotype and interaction. Similarly, in East Coast Zone, GxE interaction portion is very high and significant which capture more than 95% by only five significant PCA axis (Table 1.2). Cornelius (1993) suggested that the number of multiplicative terms appropriate for a given data set may also be determined by a test of significance. The use principal component analysis, the first interaction axes contain a greater standard percentage, with a decrease in the subsequent axes. Thus, as the number of selected axes is increased, the noise percentage increases, reducing the predictive power of the analysis (Oliveira et al., 2003).

Simultaneous selection criterion proposed by Rao and Prabhakaran (2005) is used in this study which selects genotypes for both high yield and stability in multi-environmental trials using AMMI model by assigning 80 % weight to yield and 20 % to stability value of the genotypes. Such weights were assigned because Hogart (1976) inferred that 75 % of the gains in cane yield in Australia were attributed

to the varietal improvement and Edme et al. (2005) estimated that genetic improvement along contributed 69 % of the sugarcane yield. This method is used for selection the superior genotypes conducted in AVT (early) of I and II plant and ratoon crop (2011-12 and 2012-13) of East Coast Zone.

Six entries, CoA 08323, CoA 09321, CoC 08336, CoC 09336, CoV 09356 and PI 09376 and three standards, Co 6907, CoC 01061 and CoA 92081 were evaluated during three crop cycle (I and II plant and ratoon crop) at five locations in East Coast Zone. The data on sugar yield (t/ha) was subject to stability analysis by the use of AMMI criterion and simultaneous selection of high sugar yielding and stable genotypes was done by the use of index value based ranking proposed by Rao and Prabhakaran (2005). Estimated Index value, sugar yield (t/ha) value and stability value of different genotypes along with their ranks are presented in Table1.3. Results based on index of simultaneous selection of high sugar yield (t/ha) and stable genotypes revealed that entry CoA 09321 was top ranker among the entries which was also better than all the three standards, Co 6907, CoA 92081 and CoC 01061. Though it recorded slightly lower sugar yield than the entry CoC 08336 and CoV 09356 but CoA 09321 showed higher stability**.**

5. Conclusion on criterion for selection of high yielding and stable genotypes

In this paper, I have proposed an approach for the analysis of crop variety evaluation data involving simultaneous selection indices using AMMI model. In this approach, three steps are involved in selection high yielding and stable genotype. In first step, select the genotypes based on only yield performance, which performed better than the best standards in the trial. In AICRP(S), same criterion (only step one) was used before 2012-13 as given in last column of table 1.3. In second step, out of selected genotypes, we judge the selected genotypes based on index value which is based on both yield and stability. Genotypes are considered high sugar yielding and stable and best if their respective ranks are better than the ranks of best standard or at least of the standard. In third step, we judge the selected genotypes of step one and two, if their ranks based on stability value are better than the best standard, it is a best situation. If their ranks are inferior to the best standard then we judged the top ranks among the tested genotypes. Proposed approach was applied in Advanced Varietal Trail (Early) of East Coast Zone of AICRP(S). In this trial, CoC 08336, CoV 09356 and CoA 09321 were found better genotypes than the best standard CoA 92081 in first stage (Table 1.3). Out of these three genotypes, CoC

08336, CoV 09356 and CoA 09321, CoA 09321 had top rank among the test genotypes based on index value in the second stage. CoA 09321 also had the highest stability among the test genotypes in the third stage. However, despite the highest sugar yield in the entry CoC 08336, it recorded the lowest stability in the trial (Table 1.3). Based on the above findings, CoA 09321 was found to be the best entry with high sugar yielding and stable genotype in the trials and it may be considered for release and notification in the East Coast Zone.

6. Acknowledgements

Author is thankful to Dr. N. Vijayan Nair, Ex-Director, ICAR-Sugarcane Breeding Institute, Coimbatore and Ex-Principal Investigator (Crop Improvement) of All India Coordinated Research Project on Sugarcane (AICRP(S)) and Dr. O.K. Sinha, Ex-Project Coordinator (Sugarcane), AICRP(S), ICAR-IISR, Lucknow for their support and guidance. Author is also thankful to Heads/In-charges of Sugarcane Research Station, Nayagarh, Regional Agril. Research Station, Anakapalle, Sugarcane Research Station, Vuyyuru, E.I.D. Parry Sugarcane Research & Development Centre, Nellikuppam and Sugarcane Research Station, Cuddalore for conducting the trials and providing the data. I also thank the referee (anonymous) for his valuable suggestions which has helped in revising the earlier draft of this paper.

7. References

[1] **Anonymous (1970).** The first workshop on sugarcane research workers, Indian Institute of Sugarcane Research, Lucknow during January 15-18, 1970.

[2] **Anonymous, 2007.** Principal Investigator's Report (Varietal Improvement Programme), All India coordinated Research Project on Sugarcane, Sugarcane Breeding Institute, Coimbatore.

[3] **Bajpai, P.K. and Rajesh, Kumar. (2001).** New method of simultaneous selection for yield and stability. *Indian J. Sugarcane Technol*. 16 (2) : 32-35.

[4] **Bajpai, P.K. and Rajesh, Kumar. (2006).** Selection criteria for high yielding and stable sugarcane genotypes. *Sugarcane International (UK)*, 24 (5) : 3-7.

[5] **Chandra, S., Sahoo, M.S. and Singh, K.P. (1974)** Genotype-environment interaction for yield in ram. *J Res.* 8, 165-168.

[6] **Cornelius, P.L. (1993).** Statistical tests and retention of terms in the additive and main effect and multiplicative interaction model for cultivars trials. *Crop Sci*. 33, 1186-1193.

[7] **Edme´, S.J., Miller, J.D., Glaz, B., Tai, Y.P. and Comstock, J.C. (2005)** Genetic contribution to yield gains in the Florida sugarcane industry across 33 Years. *Crop Science*. 45, 92–97.

[8] **Gauch, H.G. (1992)** Statistical analysis of regional yield trials: AMMI analysis of factorial designs. Elsevier, Amsterdam.

[9] **Gauch, H.G. and Zobel, R.W. (1996)** AMMI analysis of yield trials. Chap. 4. p. 85–122. In: Kang, M.S.; Gauch, H.G., eds. Genotype by environment interaction. CRC Press, Boca Raton, FL, USA.

[10] **Gabriel, K.R. (1971)** The biplot-graphical display ofmatrices with applications to principal component analysis. *Biometrika*. 58, 453-467.

[11] **Hogarth, D.M. (1976)** New varieties lift sugarcane production. Producers Rev. 66(10), 21-22

[12] **Mitroviæ, B., Mitroviæ, B., Stanisavljev, D., Tresk, S., Stojakoviæ, M., Ivanoviæ, M., Bekavac, G. and Rajkoviæ, M. (2012)** Evaluation of experimental maize hybrids tested in multi-location trials using AMMI and GGE bi-plot analyses. Turkish Journal of Field Crops 2012. 17(1), 35-40

[13] **Oliveira, B.A., Duarte, J.B. and Pinheiro, J.B. (2003)** Emprego da análise AMMI na avaliação da estabilidade produtiva em soja. Pesquisa Agropecuária Brasileira. 38, 357-364.

[14] **Prabhakaran, V.T. and Jain, J.P. (1994)** Statistical techniques for studying genotype x environment interactions. South Asian Publishers, New Delhi.

[15] **Rao, A.R. and Prabhakaran, V.T. (2005)** Use of AMMI in simultaneous selection of genotypes for yield and stability. J. Ind. Soc. Ag. Stat. 59(1), 76-82.

[16] ***Silveira, L.C.I., Kist, V., Paula, T.O.M., Barbosa, M.H.P., Peternelli, L.A. and Daros, E. (2013)*** AMMI analysis to evaluate the adaptability and phenotypic stability of sugarcane genotypes, Sci. Agric. 70(1), 27-32.

[17] **Singh, R.K. and Chaudhary, B.D.(1977)** Biometrical methods in quantitative genetics analysis, Kalyani Publishers, New Delhi.

[18] **Tandon, J.P., Sharma, S.P., Sandhu, J.P., Yadav, D.K., Prabhu, K.V. and Yadav, O.P. (2015)** Guidelines for testing crop varieties under the All India Coordinated Crop Improvement Projects, Indian Council of Agricultural Research, New Delhi.

8. Appendix

Table 1.1 : Combined analysis of variance for CCS (t/ha) of Advance Varietal trials (Early) of East Coast Zone

Source of varition	D.F.	SS	MSS	F - valus	% contribution to SS
Environment	4	1258.69	314.673	145.13**	35.62
Replication (within Environment)	10	9.12	0.912	0.42NS	0.26
Year	2	485.29	242.646	111.91**	13.73
Environment x Year	8	313.75	39.219	18.09**	8.88
Error 1	20	43.36	2.168		1.23
Genotype	8	267.51	33.439	24.59**	7.57
Genotype x Environment	32	544.42	33.439	12.51**	15.41
Genotype x Year	16	65.37	4.086	3.00**	1.85
Genotype x Environment x Year	64	220.03	3.438	2.53**	6.23
Error 2	240	326.41	1.36		
CV(%)		9.89			

Table 1.2 : AMMI analysis of CCS (t/ha) of nine genotypes over fifteen environments in East Coast Zone

Source of variation	**DF**	**SS**	**MSS**	**F Values**	**% of PCA cumulative contribution**
Genotype	8	89.17	11.15	24.59**	
Environment	14	685.91	48.99	108.07**	
Genotype x Environment	112	276.60	2.47	5.45**	
PCA1	21	111.89	5.33	11.75**	40.45
PCA2	19	67.82	3.57	7.87**	64.97
PCA3	17	44.30	2.61	5.75**	80.98
PCA4	15	23.41	1.56	3.44**	89.45
PCA5	13	15.60	1.20	2.65**	95.08
PCA6	11	7.31	0.66	1.47NS	97.73
Residual	16	6.29	0.39		
Average Error	240	108.81	0.45		
Total	404	1177.99			

Table 1.3 : Ranking of genotypes of Advance Varietal trials (Early) of East Coast Zone according to their (i) mean performance, (ii) stability and (iii) value of simultaneous selection index of genotypes in respect of CCS(t/ha)

Variety	Estimated value of			Rank based on estimated value of			PI(CI)
	Index Value	CCS(t/ha) Value	Stability Value	Index Value Based rank	CCS(t/ha) Based Rank	Stability Based Rank	Report Based Rank
CoA 08323	1.13	11.78	71.95	8	6	9	
CoA 09321	1.41	12.32	26.74	1	3	2	3
CoC 08336	1.28	13.12	57.84	4	1	8	1
CoC 09336	1.13	10.69	43.28	9	8	4	
CoV 09356	1.27	12.55	47.39	5	2	5	2
PI 09376	1.14	11.22	51.92	7	7	7	
Standard							
Co 6907	1.36	10.49	20.69	2	9	1	
CoC 01061	1.20	11.89	49.75	6	5	6	5
CoA 92081	1.34	12.08	30.86	3	4	3	4

PI-(CI) - Anonymous (2013) Principal Investigator's Report (Varietal Impro.garcane Breeding Institute, Coimbatore

RESEARCH ARTICLE

ON BALANCED INCOMPLETE BLOCK DESIGNS AND PAIR WISE BALANCED DESIGNS.

D. K. GHOSH[1] AND SANGEETA AHUJA[2]

ABSTRACT

In this paper another method of construction of complementary balanced Incomplete block designs using orthogonal main effect plan is discussed. Again pair wise balanced designs are also constructed by deleting one and more than one columns of orthogonal main effects plans.

Key Words : BIBD, PWBD, Orthogonal effect

1. INTRODUCTION

It is true that if the number of replications is large, the precision will be more. In other words, one can say that the precision of the estimates of treatment effects depend upon the number of replication. Similarly, the precision of the estimates of the difference between two treatments depend upon the numbers of times two treatments are replicated. Considering this facts in the mind, the incomplete block designs are required to study further when each pair of treatments in a block design occurs the same number of times, such an incomplete block design is called balanced incomplete block designs (BIBD). In this class of block design each pair of treatment has equal precision. Keeping this in the mind, Yates (1936) introduced a class of design, called balanced incomplete designs for agricultural experiments. . An incomplete block design is said to be balanced incomplete block design if v distinct treatments are arranged in b blocks, each block contains k treatments, such that $k < v$, each treatment is replicated r times while each pair of treatment occur in ë blocks provided the following conditions hold true: (i) $vr=bk$ (ii) $\lambda(v-1)=r(k-1)$ and (iii) $b \geq v$. Because of all this constraints, it was not easy to construct BIBD so easily. However Yates (1936) and Bose (1939) made an effort to construct BIBDs. Yates

[1]Dep. of Statistics, Saurashtra University Rajkot, Gujarat. (Corresponding author)
[2]Computer Science Division, IASRI New Delhi. email: dilipghoshsep@gmail.com
(recd. Aug : 16 / rvd. sept.'16)

(1936) developed many series of BIBD considering practical point of view for Agricultural Experiments while Bose (1936) developed BIBD considering combinatorial point of view, for an example, difference method. Further various authors like Atiqullah (1961), Chakraborty (1969), Connor (1952), etc. developed the construction and properties of BIBD.

A BIBD is said to be complementary BIB design if it is constructed from an existing BIBD by selecting all those treatments from a block which are absent in that block and keep them in another block. This process is continued for all blocks. This ensures that the number of treatment and number of blocks remain same for the complementary BIBD, however r, k and λ get chances. Accordingly the parameters of the complementary BIBD are $v_1=v$, $b_1=b$, $r_1=b-r$, $k_1=v-k$, and $\lambda_1=b-2r+\lambda$, where v, b, r, k and λ are the parameters of existing BIBD.

So far complementary BIB design is obtained through a existing BIBD. In this paper, complementary BIB design of a series $v=2^n-1=b$, $r=k=2^{n-1}$ and $\lambda=2^{n-2}$ is constructed directly using an Orthogonal mail effect plans of strength where level of each factor is two. A main effect plan is said to be orthogonal main effect plan if all the possible treatment combinations of level of any two factor occurs an equal number of times.

Bose and Shrikhande (1960) introduced a class of incomplete block design, called pair wise balanced design and then studied in detailed about its construction and some properties with combinatorics point of view. Recently Ghosh and Desai (2014) constructed optimal pair wise balanced designs from Triangular Partially balanced Incomplete Block designs with v=10 only. Very recently Rajarathinam et al.(2016) developed pair wise balanced designs using factorial designs.

In this investigation we have first developed complementary Balanced Incomplete Block designs using orthogonal main effect plans which are shown in section 2. Next we developed the construction of pair wise balanced designs using the same orthogonal main effect plan by deleting p rows. This is shown in section 4.

2. METHOD OF CONSTRUCTION OF COMPLEMENTARY BIBD

First of all we discuss the construction of orthogonal main effect plan of strength two. This method is already available in literature. Consider n factors each at level two. Develop 2^n factorial experiments by taking all possible combinations of each level of n factors. Next develop $n_{c_2}, n_{c_3}, \ldots\ldots\ldots\ldots n_{c_n}$ columns by taking all possible combinations of 2, 3, …, n factors together respectively. Under these columns, levels

of the factors are Xi + Xj = 0 mod 2, Xi + Xj + Xk = 0 mod 2, Xi + Xj + Xk + … + Xn= 0 mod 2 ¥ i ≠ j ≠ k ≠ … ≠ n = 1, 2, …, n. This gives an orthogonal main effect plan of strength with 2^n-1 factors each at two levels in 2^n runs. Next we develop the techniques to construct complementary BIB designs of series v = 2^n-1 = b, r = k = 2^n – 1 and λ=2n – 2 . The method is discussed in the following way.

Let us first construct an orthogonal mail effect plan using 2^n factorial experiment. To have the columns for orthogonal main effects plan, we have n factors as n columns and $n_{c_2}, n_{c_3}, \ldots\ldots\ldots n_{c_n}$ columns from developing all possible combinations of 2, 3, …, n factors together. So all together we have $n + n_{c_2} + n_{c_3} + \ldots\ldots + n_{c_n} = 2^n - 1$ columns and 2^n rows. This way we get orthogonal main effect plan of 2^n–1 in 2n runs.

When we construct an orthogonal main effect plan of 2^n–1 in 2^n runs, one can see that out of 2^n treatment combinations, one treatment combination is (0 0 0 0) which is also called control treatment. Delete this treatment combination. So we have now 2^n-1 columns as 2^n-1 blocks and 2^n-1 rows as 2^n-1 treatments. Consider this as an incidence matrix of an incomplete block design having 2^n-1 treatment and also 2^n–1 block. In this incidence matrix we observed that in each column, element ‘1’ occurs 2^n–1 times, so k=2^n–1. Again in each row, element ‘1’ occurs 2^n–1 times, so r=2^n–1. For this incomplete block design now we have v=b=2^n–1, r=k=2^n-1. Since the incidence matrix is binary and the corresponding incomplete block design is proper, equi replicated and hence using the parametric relation of a BIB design λ (v–1) = r(k–1), we get λ = 2^{n-2}.

In this method, the information matrix, C is computed as

$$C = \frac{2^{n-2}(2^n - 1)}{2^{n-1}}\left[I_v - \frac{E_{vv}}{2^{n-1}}\right] \qquad (2.1)$$

Expression (2.1) can be compared with $C = \Theta\left[I_v - \frac{E_{vv}}{2^{n-1}}\right]$ which is required condition of a variance balanced design, where Θ is the non zero eigen value of the C matrix of the Variance balanced design with multiplicity (v–1). Finally we can say that C matrix in (2.1) is the information matrix of a complementary BIB design with usual parameters.

Remarks: The beauty of this method is that it gives two structure of a complementary BIB designs. One is obtained considering rows as blocks and columns as treatments

while other structure is obtained by considering rows as treatments and columns as blocks but with the same parameters. It is remarkable to observe that one structure is the dual of another structure of the Complementary BIB design. However some of the blocks in both the structures are same while the remaining blocks are distinguished. Hence this way constructed complementary BIB design is self dual design.

3. Example. Construct a Complementary BIB design with parameters v =b =7, r=k=4 and λ=2.

In this example, v=b=7=2^n–1 ,which implies n=3 and hence construct a Factorial design with three factors each at two levels. That is, we have three columns and eight rows. Further develop, 3_{C_2} = 3 and 3_{C_3} = 1 more columns. Finally we have 3+3+1=7 columns with 8 rows. Under this columns fill up the elements by considering (a+b) mod 2, (a+c) mod 2, (b+c) mod 2, and (a+b+c) mod 2. This is shown in Table 3.1.

Table 3.1

a	b	c	a + b	a + c	b + c	a + b + c
0	0	0	0	0	0	0
0	0	1	0	1	1	1
0	1	0	1	0	1	1
0	1	1	1	1	0	0
1	0	0	1	1	0	1
1	0	1	1	0	1	0
1	1	0	0	1	1	0
1	1	1	0	0	0	1

Delete the first row, whose all elements are zero, from table 3.1. With remaining seven rows and seven columns, call it as in incidence matrix of a incomplete block design. This incidence matrix is binary, proper and equi replicated with seven treatments arranged in seven blocks. It is easy to observed that in each column and each row element ‘1’ occur four tomes. Hence the incidence matrix of the incomplete block design is the incidence matrix of a complementary BIB design with parameters v=b=7, r=k=4 and λ=2.

It can be noticed from Table 3.1 that, we obtain complementary BIB design with

following two different block structures.

Structure 1: If we consider columns as blocks and rows as treatments then the blocks of the resulting BIB design are (4 5 6 7), (2 3 6 7), (1 3 5 7), (2 3 4 5), (1 3 4 6), (1 2 5 6) and (1 2 4 7).

Structure 2: If we consider columns as treatments and rows as blocks then the blocks of the resulting BIB design are (3 5 6 7), (2 4 6 7), (2 3 4 5), (1 4 5 7), (1 3 4 6), (1 2 5 6) and (1 2 3 7).

In both the structures, blocks (2 3 4 5), (1 3 4 6) and (1 2 5 6) are common while other blocks are different. Further it is obvious that one structure is self dual of another structure.

This BIB design is available in literature which is constructed as a complementary design from an existing BIB design with parameters v=b=7, r=k=3 and λ=1. However we constructed here directly and hence it is an alternate method of constructing Complementary BIB design. Secondly different structures of the same complementary BIB design are not discussed.

4. PAIR WISE BALANCED DESIGNS USING ORTHOGONAL MAIN EFFECT PLANS.

In section 2, we have discussed the construction of Orthogonal main effect plans(which is available in the literature). Using this Orthogonal main effect plan, we further discussed how to construct complementary BIB designs of a series $v=b=2^n-1$, $r=k=2^n-1$ and $\lambda=2^n-2$. Now in this section we discuss how to construct pair wise balanced design deleting some of the columns from the Orthogonal main effect plans. An incomplete block design is said to be a pair wise balanced designs of index λ of type (v, k_1, k_2,…, k_b) if (i) each set contain (k_1, k_2,…,k_b) distinct symbols (ii) $k_j \leq v$; $k_j \neq k_j'$ and (iii) every pair of distinct treatments occur in exactly λ sets of block design. This pair wise balanced design satisfied the following parametric relations: (a) $b = \sum_{j=1}^{b} b_j$ (b) $^{a}v(v-1) = \sum_{j=1}^{b} b_j k_j (k_j - 1)$. As per the characterization point of view in terms of concurrence matrix, NN', a block design is said to be pair wise balanced design if all the off diagonal elements of NN' matrix is same, that is, NN' matrix can be characterized as

$$NN' = (r - {}^{a})I_v + {}^{a}E_{vv} \qquad (4.1)$$

Where I_v is an identity matrix of order v and Evv is an unit matrix of order v x v, where all the elements are one.

Theorem 4.1 From an Orthogonal main effect plan if the last column (row) is deleted, a pair wise balanced design with parameters $v=2^n-2$, $b=2^n$, $r=2^n-1$, $k=\{2^{n-1}-1,\ 2n-1\}$ and $\lambda=2^{n-2}$ can be constructed.

Proof: Consider an orthogonal main effect plan of 2^n-1 factors in 2^n runs. We can construct pair wise balanced designs by deleting last row/column from orthogonal main effects plans in the following two ways (a) considering columns as treatments and rows as blocks and (b) considering rows as treatments and columns as blocks. Let us select case (b). In this case delete first row and last row from orthogonal main effects plan, so we have now 2^n-1 columns and 2^n-2 rows. Consider 2^n-1 columns as 2^n-1 blocks and 2^n-2 rows as 2^n-2 treatments. This way we get an incidence matrix of an incomplete block design. Call this incidence matrix as N with 2^n-2 rows and 2^n-1 columns of an incomplete block designs. Since two rows are deleted and hence number of treatment becomes 2^n-2 arranged in 2^n-1 blocks. In this incidence matrix each rows contains 2^n-1 elements so each treatment is replicated 2^n-1. Since last row is deleted which has 2^n-1 treatment and hence those blocks where this treatment is present, block size will be $2^{n-1}-1$, otherwise, block sizes will remain as 2^{n-1}. The concurrence matrix NN' is expressed as

$$NN' = \begin{bmatrix} 2^{n-1} & 2^{n-2} & \dots & 2^{n-2} \\ 2^{n-2} & 2^{n-1} & \dots & 2^{n-2} \\ | & | & | & | \\ 2^{n-2} & 2^{n-2} & \dots & 2^{n-1} \end{bmatrix} \qquad (4.2)$$

Further (4.2) can be reduced as $NN' = (2^{n-1}-2^{n-2})I_v + 2^{n-2}E_{vv}$ (4.3)

Since (4.3) is in the form of $(r-\lambda)Iv + \lambda Evv$ and hence the resulting incomplete block design is Pair wise balance design with parameters $v = 2^n-2$, $b=2^n$, $r=2^{n-1}$, $k = \{2^{n-1}-1,\ 2^{n-1}\}$ and $\lambda = 2^{n-2}$.

Remarks: We can have more than one pair wise balanced designs from the same orthogonal main effect plan by deleting (2n – p) rows starting from the last rows with reducing number of treatments. However number of blocks, number of replications and ? will remain same. Since number of treatment is reducing and hence block seizes will also be reducing.

4.1 Example : Construct a pair wise balanced design with parameters v=5, b=7, r=4, k={2, 3, 4} and λ=2.

Solution: Let n = 3. Construct an orthogonal main effect plan of 2^3–1(=7) in 2^3(=8) runs. Consider Columns as blocks and rows as treatments. Delete first rows and last two rows. So we have five rows and seven columns. Consider this matrix with 5 blocks arranged in 7 treatments as the incidence matrix of a pair wise balanced design. Now we can check here easily that r=4, k{2, 3, 4} and λ=2. The blocks of this pair wise block design are below:

(4 5), (2 3), (1 3 5), (2 3 4 5), (1 3 4), (1 2 5) and (1 2 4)

Conclusion: This method provides pairwise balanced designs with smaller number of treatments, smaller number of block sizes, even with block sizes 2.

ACKNOWLEDGEMENTS

First author is thankful to UGC for providing him UGC BSR Faculty Fellow. We thank the referee (anonymous) for reviewing and revising our paper.

References:

[1] **Atiqullah, M. (1961).** An a property of balanced designs. *Biometrika, 48, 215 – 18.*

[2] **Bose, R. C. (1939).** On the construction of balanced incomplete block designs. *Ann. Eugen. 9, 353 – 99.*

[3] **Bose, R. C. and Shrikhande, S. S. (1960).** On the composition of balanced incomplete block designs.

[4] **Chakrabarti, M. C. (1963).** On the C matrix in design of experiments. *Jour. Indian Stat. Assoc., 1, 8 – 23.*

[5] **Connor, W. S. (1952).** On the structure of balanced incomplete block designs. *Ann. Math. Stat. 23, 57 – 71.*

[6] **Ghosh, D. and Desai, N. R. (2014).** Optimal pair wise balanced balanced designs from Triangular PBIB designs with v = 10. Int. *J. Agricult. Stat. Sci. 10, 2, 297 – 304.*

[7] **Rajarathinam A, Mahalaxmi, S., A. and Ghosh D. K. (2016).** Construction of pairwise Balancd design. *J. Modern Applied Statistical Methods. 15, 1, 193 – 205.*

[8] **Yates, F. (1936).** Incomplete randomized blocks. *Ann. Eugen. 7, 121 – 40.*

RESEARCH ARTICLE

"A STUDY FOR PRE-HARVEST FORCASTING OF IRRIGATED WHEAT YIELD IN GANDHINAGAR DISTRICT OF GUAJARAT"

Chandrika M. Chaudhari[1], Manish B. Thaker[2], N.V.Patel[3]

ABSTRACT

Climate of the world is changing due to global warming, resulting in having impact on agricultural productivity. Present study is aboutinvestigating pre-forecast of Wheat yield with respect to weather variables in Gandhinagar district of Gujarat state in India. Data were used for Wheat crop during the time period 1980-81 to 2014-15. Regression analysis is carried out for wheat crop as dependent variable and considering weather variables like Maximum and Minimum Temperature in degree Celsius, Relative Humidity in morning and evening in percentage, Sun-Shine hours per day and Annual Rainfall in mm as independent variables. Conclusions are drawn on the basis of analysis.

Key Words : Weather variables, Wheat yield, Statistical approach.

1. INTRODUCTION

In the dominion of food crop production in the world, wheat occupies the number one position. India is one of the principal wheat producing and consuming country in the world. Its importance in Indian agriculture is next to rice. It's also useful as fodder for cattle. In Gujarat, irrigated wheat is mainly grown in Mahesana, Banaskantha, Sabarkantha, Kheda, Gandhinagar and Saurashtra region, while un-irrigated wheat is grown in Bhal region consisting of some parts of Kheda, Ahmedabad, Bhavnagar and Surendranagar Districts. Pre-harvest yield forecast is one of the important tools in taking policy decisions with greater confidence in matters relating to the food procurement and distribution, price, export-import and for exercising several administrative measures for storage and marketing of agricultural commodities.

[1] Research Scholar, Pacific University Udaipur, Rajasthan, India, chandrika_m71@yahoo.co.in

[2] M.G. Science Institute, Ahmedabad, Gujarat, India, mbthaker2768@gmail.com

[3] Research Scholar, Pacific University Udaipur, Rajasthan, India, manas1708@hayoo.com

(rcd. Aug.'16 / rvd. Sept.'16)

2. LITERATURE REVIEW

Fisher (1924) was the first who assumed that in wheat crop, the effects of change on weather variables in successive weeks would not be an erratic change but an orderly one that follows some mathematical law**.** He further assumed that these effects are composed of the terms of a polynomial function of time**.**

Pandey and Singh (1993) developed pre-harvest forecasting model for wheat at Pantnagar. The forecasting model based on week numbers as weight was found superior (R^{-2} = 0.87). It was possible to forecast yield in 15th week after sowing the crop (i.e. February), almost two months before the harvest. The weather index based on correlation coefficient as weights was also found to be superior and explained more variation in the yield.

Chaurasia and Minakshi (1997) studied wheat crop yield and climatological data for the period 1961-1995. Yearly fluctuations were discussed. Regression equations were developed to predict the wheat yield in the central part of Punjab state. The multiple regression equation using maximum and minimum temperature, morning and evening relative humidity, sunshine hours and wind speed resulted high coefficient of determination (R^2 = 0.88).

An empirical statistical yield weather model for wheat in the Varanasi district of Uttar Pradesh was described by Malik and Gupta (2000). The weather parameters from the year 1970-71 to 1998-99 in Varanasi were selected for the regression equations. Yield was significantly related to rainfall, temperature, sunshine and rainy days from 51^{st} to 2^{nd}, 4^{th} to 6^{th}, 49^{th} to 2^{nd}, and 51^{st} to 3^{rd} weeks, respectively. Predicted yield using 4, 6 and 10 parameter models were within +15, +15 and +10% of actual district yield.

Data on the different weather variables, i.e. rainfall, maximum temperature, cloud amount and relative humidity, from 1970-71 to 1989-90 were collected by Sarkar (2000) to develop an agrometeorological model for forecasting wheat yield in Gujarat state, India. The model was developed based upon the statistical technique of regression analysis. The model could explain approximately 94% variation in yield and predicted the wheat yield for a further period of 8 years.

Sarkar and Thapliyal (2003) conducted a study to develop state-wise wheat yield forecast model and to compare the performance of this newly developed model with that of the subdivision-wise models (east and west of Uttar Pradesh, India). The correlation coefficient was 0.99 and 98% of the variation in wheat yield as accounted by the model. A good agreement was observed between the reported and the forecast yield during the study and outside the study period. Further it was reported that during the study period, only ±10 percentage deviation of the forecast yield and reported yield was observed. The state-wise model developed for Uttar Pradesh was found to be appropriate to forecast wheat yield for the entire state.

Khistaria et al. (2004) identified the most suitable pre-harvest forecasting model for predicting wheat yield from different approaches i.e. week-wise approach; crop stage-wise approach; week number as weight approach; and correlation coefficient as weight approach. The data on the different meteorological parameters during the past 29 years (from 1970-71 to 1998-99) were collected. Results showed that the week-wise approach using original weather variables was the best among the approaches, providing a suitable pre-harvest forecasting model that can predict yield at 6 weeks before harvest. This approach explained >95% variation in the yield. The deviation of the predicted yield from the actual yieldswas observed up to 7.51 %.

Varmora et al. (2004a) studied the influence of weather parameters and time trend on wheat yield in Junagadh district of Gujarat state with the objective to develop regression equation to predict the yield of wheat. The step-wise regression approach was used taking weather parameters and time trend (T) as independent variables and crop productivity as dependent variable. They observed positive and significant influence of time trend (T), total rainfalland maximum temperatures of 7th and 10th weeks and morning relative humidity of 10th week. Negative significant influence of maximum temperatures of 3rd, 5th and 9th weeks and sunshine hours of 9th week on wheat yield was observed. The R^2 value was 98%. The predicted yield showed 5.85 to 9.05 per cent deviations from observed yield.

Varmora et al. (2004b) fitted a pre-harvest forecast model for wheat yield based upon weather parameters using step-wise regression technique. Models based on original weather variables with week-wise and the crop stage-wise approach and the generated variables taking week number and correlation coefficient as weights were tried. They identified the model based upon generated weather variables using correlation coefficient as weight to predict the wheat yield at the end of 12th week after sowing.

3. STUDY AREA

Gandhinagar district is located in the north- central zone of Gujarat state and western zone of India. It was organised in 1964. Gandhinagar district is divided into four talukas (sub districts) namely Mansa, Kalol, Dehgam and Gandhinagar, divided in 386 Panchayats, 656 villages. ((“Indianetzone”))

GEOGRAPHY

Gandhinagar District is located at North Latitude 23.56 to 23.01 and 73.33 to 72.33 East Longitude in Western India and north- central in Gujarat. It is in the 78 meters to 103 meters elevation range. Gandhinagar district is bounded by the districts of Sabarkantha and Aravalli to the northeast, Kheda to the Southeast, Ahmedabad to the southwest and Mehsana to the northwest. Gandhinagar district

occupies an area of approximately 649 square kilometres. ("Indianetzone")

There are four rivers, namely Sabarmati, Watrak, Salty, Meshwo and no mountain or hill, most of land is plane land in this district.This District has mostly black, sandy and clayey soil. Due to availability of different kinds of soil, a variety of seasonal crops are practiced by farmers as Bajara, Rice, Maize, Wheat, Cotton, Tobacco, Potato, Tomato, Castor, Mustard, Citrus fruits, Ber, Guava, Pomegranate, Papaya, Pulses and Vegetables etc. Mostly farmers use water from Tube wells and Narmada Canal facility for farming.

CLIMATE

Gandhinagar district has a tropical wet and dry climate with three main seasons namely summer (from March to May), monsoon (from June to September) and winter (from December to March). The climate is generally dry and hot without monsoon season. The weather is too hot in summer. The weather is hot through the months of March to June when the maximum day temperature stays in the range of 32 ^{0}C to 45 ^{0}C and the minimum is the range of 14 ^{0}C to 27 ^{0}C. The cold northerly winds are responsible for a mild chill in January. It is warm from December to February, the average maximum temperature is around 29 ^{0}C, the average minimum is 14 ^{0}C, and the climate is extremely dry. The southwest monsoon brings a humid climate from mid- June to mid-September. The annual rainfall is around 667mm but infrequent heavy torrential rains cause local rivers to flood and it is not uncommon for droughts to occur when the monsoon does not extend as far west as usual. The highest temperature recorded is 45 °C and minimum temperature is 7.5 ^{0}C. ("Indianetzone")

4. RESEARCH METHODOLOGY

Data on average yield (productivity) of Wheat crop of Gandhinagar district - from 1980-81 to 2014-15 were collected from District-wise Area, Production and Yield of Important Food & Non-food Crops in Gujarat State of respective years published by Directorate of Agriculture, Gandhinagar and Gujarat state. The weekly Average data of weather parameters viz.(1)Maximum temperature (^{0}C) (2)Minimum temperature (^{0}C) (3) Morning relative humidity (%) (4)Evening relative humidity (%) (5)Bright sunshine hours/day (6) Annual Total Rainfall (mm) of the respective years of Gandhinagar district from years 1980-81 to 2014-15 was collected from the Meteorological Centre, Ahmedabad.

There are broadly three approaches for forecasting the crop yield (Singh *et al*., 1977). They are, (i) Based on eye observations of the growing crop, (ii) Based on weather and other input parameters and (iii) Based on biometrical characters observed

during the crop growth.These approaches are complementary to each other and may be combined. The most frequently used approach is based on crop weather relationship studies in which, the periodical data of crop yields and weather variables are used. The forecast based on such relationship is objective in nature and do not require survey.

For this study the effect of important weather variables on yield of wheat crop, following weather variables with time trend were considered.

Variables	Description
Y	Average wheat yield of Gandhinagar district in kg/ha
T	Time trend, year number included to correct upward or downward trend in yield
X_1	Maximum temperature (^{0}C)
X_2	Minimum temperature (^{0}C)
X_3	Morning relative humidity (%)
X_4	Evening relative humidity (%)
X_5	Bright sunshine hours/day
R	Annual Rainfall (mm)

For selecting the best regression equation among a number of independent variables, the step-wise regression procedure was adopted (Draper and Smith, 1966). SPSS software was used for thedata analysis. Three sets of multiple linear regression equations were obtained separately for model-I(30 years), model-II (31 years) and model-III (32 years) and wheat yield for the subsequent years were predicted. Following model (Agarwal et al.,1980) has been studied.

WEEK-WISE APPROACH USING ORIGINAL WEATHER VARIABLES:
The mathematical expression of this approach is as under,

$$Y = A_0 + \sum_{i=1}^{p}\sum_{j=1}^{w} a_{ij} X_{ij} + b\,T + cR$$

Where,
Y = Average wheat yield of Gandhinagar district (kg/ha)
A_0 = Constant
X_{ij} = Observed value of i^{th} weather variable in j^{th} week, i=1, 2,...,p = 5 and j = 1,2,...,w = 11, 12, and 13
T = Year number included to correct the long term upward or downward trend in wheat yield.(T=1 to 35)
R = Annual rainfall for the respective years.

a_{ij}, b and c are partial regression coefficients associated with each X_{ij}, time trend and total rainfallrespectively.

In this approach, weekly averaged data of different weather variables were considered in original form for 46nd to 6th meteorological standard weeks. With a view to forecast wheat yield, different models based on 11, 12, and 13 weeks crop periods were fitted.

Table 1: Description of variables included in the model week-wise approach up to 13 weekscrop period is given in table below.

Std Week No.	Crop Week No. J	Temperature		Relative Humidity (Morning) (X3j)	Relative Humidity (Morning) (X4j)	Bright Sunshine Hours (X5j)
		Max. Temp. (Xij)	Min. Temp. (X2j)			
46	01	X_{101}	X_{201}	X_{301}	X_{401}	X_{501}
47	02	X_{102}	X_{202}	X_{302}	X_{402}	X_{502}
48	03	X_{103}	X_{203}	X_{303}	X_{403}	X_{503}
49	04	X_{104}	$X2_{04}$	X_{304}	X_{404}	X_{504}
50	05	X_{105}	X_{205}	X_{305}	X_{405}	X_{505}
51	06	X_{106}	X_{206}	X_{306}	X_{406}	X_{506}
52	07	X_{107}	X_{207}	X_{307}	X_{407}	X_{507}
1	08	X_{108}	X_{208}	X_{308}	X_{408}	X_{508}
2	09	X_{109}	X_{209}	X_{309}	X_{409}	X_{509}
3	10	X_{110}	X_{210}	X_{310}	X_{410}	X_{510}
4	11	X_{111}	X_{211}	X_{311}	X_{411}	X_{511}
5	12	X_{112}	X_{212}	X_{312}	X_{412}	X_{512}
6	13	X_{113}	X_{213}	X_{313}	X_{413}	X_{513}

5. RESULTS AND DISCUSSION

In this approach, original week-wise weather variables were utilized. The partial regression coefficients, coefficients of multiple determinations and the t values, for three different models corresponding to 11, 12 and 13 weeks crop periods are presented in Table A.1, Table B.1 and Table.C.1. The corresponding simulated forecasts for the subsequent years which were not considered for models and their percentage deviations from actual district average yield are presented in Table A.2, Table B.2 and Table C.2.

The results related to 11 weeks crop period were presented in Table A.1. The set of explanatory variables observed to enter in equations consisted of weekly weather variables weretime trend (T), X_{204}, $X_{105}$and X_{506}. These variables explained 65.10%to 66.80% variation in yield of wheat in all the three models. The results indicated that the partial regression coefficient for time trend(T) was positive and significant

While PRC(partial regression coefficient) for rest of variables was negative and significant. The simulated forecasts of wheat yield for fitted equations (Table A.2) showed deviations ranging from 0.05% to 7.27% from observed yield. Here negative estimate reflects to over estimation while positive estimate indicates under estimation.

In case of 12 weeks crop period (Table .B.1 and Table .B.2) same results were observed as in results related to 11 weeks crop period.

The results related to 13 weeks crop period were presented in Table C.1. The set of explanatory variables observed to enter in equations consisted of weekly weather variables were time trend (T), X_{204}, X_{413}, X_{411}, X_{507},X_{105}, X_{506}, X_{203}, X_{305}, X_{304}, X_{205} and X_{301}. These variables explained 81.60%to 93.30% variation in yield of wheat in all the three models. The results indicated that the partial regression coefficient for time trend (T), evening relative humidity of 13th week (X_{413})andmorning relative humidity of 4th week (X_{304})were positive and significant While, PRC(partial regression coefficient) for rest of variables were negative and significant. The simulated forecasts of wheat yield for fitted equations (Table C.2) showed deviations ranging from -13.53% to 41.15% from observed yield. Here negative estimate reflects to over estimation while positive estimate indicates under estimation. Here * = Significant at 5% level of significance and ** = Significant at 1% level of significance in each table.

Table A.1: Partial regression coefficient of yield on different original weather variables in week-wise approach (11 weeks)

Variables In the equations	Years		
	1980-81 to 2009-10 (Model-I)	1980-81 to 2010-11 (Model-II)	1980-81to 2011-12 (Model-III)
Constant	7513.17**(6.22)	7539.61**(6.36)	7481.54**(6.37)
T	32.49**(4.72)	33.56** (5.53)	34.93**(6.06)
X_{204}	-128.14**(-5.03)	-127.88** (-5.11)	-125.95**(-5.09)
X_{105}	-78.36* (-2.61)	-81.49 (-2.89)	-82.63(-2.95)
X_{506}	-122.59* (-2.33)	-117.05* (-2.37)	-111.47*(-2.30)
R^2 (%)	65.1%	66.2%	66.8%

(Figures in parenthesis indicate t value.)

Table A.2: Simulated forecasts based on the fitted equations (11 weeks)

Year	Observed Yield (kg/ha)	Simulated forecasts (kg/ha)		
		1980-81 to 2009-10 (Model-I)	1980-81 to 2010-11 (Model-II)	1980-81 to 2011-12 (Model-III)
2010-11	3268	3158(3.36)	—	—
2011-12	3310	3069(7.27)	3092(6.60)	—
2012-13	3245	3020(6.94)	3039(6.35)	3071(5.36)
2013-14	3426	3249(5.17)	3268(4.60)	3299(3.71)
2014-15	3490	3435(1.57)	3457(0.94)	3488(0.05)

(Figures in parenthesis are percent deviations from observed yield.)

Table B.1: Partial regression coefficients of yield on different original weather variables inweek-wise approach (12 weeks).

Variables In the equations	Years		
	1980-81 to 2009-10 (Model-I)	1980-81 to 2010-11 (Model-II)	1980-81to 2011-12 (Model-III)
Constant	7513.17**(6.22)	7539.61**(6.36)	7481.54**(6.37)
T	32.49**(4.72)	33.56** (5.53)	34.93**(6.06)
X_{204}	-128.14**(-5.03)	-127.88** (-5.11)	-125.95**(-5.09)
X_{105}	-78.36* (-2.61)	-81.49 (-2.89)	-82.63(-2.95)
X_{506}	-122.59* (-2.33)	-117.05* (-2.37)	-111.47*(-2.30)
R^2 (%)	65.1%	66.2%	66.8%

(Figures in parenthesis indicate t value.)

Table B.2: Simulated forecasts based on the fitted equations (12 weeks)

Year	Observed Yield (kg/ha)	Simulated forecasts (kg/ha)		
		1980-81 to 2009-10 (Model-I)	1980-81 to 2010-11 (Model-II)	1980-81 to 2011-12 (Model-III)
2010-11	3268	3158(3.36)	—	
2011-12	3310	3069(7.27)	3092(6.60)	—
2012-13	3245	3020(6.94)	3039(6.35)	3071(5.36)
2013-14	3426	3249(5.17)	3268(4.60)	3299(3.71)
2014-15	3490	3435(1.57)	3457(0.94)	3488(0.05)

(Figures in parenthesis are percentage deviations from observed yield.)

Table C.1: Partial regression coefficients of yield on different original weather variables inweek-wise approach (13 weeks)

Variables In the equations	Years		
	1980-81 to 2009-10 (Model-I)	1980-81 to 2010-11 (Model-II)	1980-81to 2011-12 (Model-III)
Constant	9838.35**(8.29)	3812.41**(10.57)	7120.30**(16.84)
T	14.17*(2.63)	20.80**(4.08)	-
X_{204}	-106.28**(-5.17)	-71.65*(-3.94)	-74.64**(-5.89)
X_{413}	26.18**(4.34)	24.49**(4.06)	32.43**(8.50)
X_{411}	-26.15**(-4.89)	-23.02*(-3.85)	-24.87**(-6.99)
X_{507}	-137.17**(-4.28)	-	-108.14**(-5.53)
X_{105}	-89.82*(-3.93)	-	-
X_{506}	-118.91*(-3.28)	-	-152.82**(-6.00)
X_{203}	-47.30*(-2.09)	-	-
X_{305}	-	-15.09*(-3.88)	-11.71**(-4.46)
X_{304}	-	12.33*(3.07)	14.99**(5.65)
X_{205}	-	-	-47.46**(-4.97)
X_{301}	-	-	-9.10*(-3.19)
R^2 (%)	87.7%	81.6%	93.3%

(Figures in parenthesis indicate t value.)

Table C.2: Simulated forecasts based on the fitted equations (13 weeks)

Year	Observed Yield (kg/ha)	Simulated forecasts (kg/ha)		
		1980-81 to 2009-10 (Model-I)	1980-81 to 2010-11 (Model-II)	1980-81 to 2011-12 (Model-III)
2010-11	3268	3710(-13.53)	—	—
2011-12	3310	2919(11.83)	2698(18.71)	—
2012-13	3245	2628(19.00)	2130(18.50)	2385(26.51)
2013-14	3426	3693(-7.80)	2700(21.19)	3560(-3.91)
2014-15	3490	2525(27.64)	2054(41.15)	2264(35.12)

(Figures in parenthesis are percentage deviations from observed yield.)

6.. CONCLUDING REMARKS

It could be observed from the above results that variation explained (i.e. R^2) by fitted models ranged from 65.10% to 93.30% for all the three models. It could be seen that the deviations between observed yield and forecasted yield in percentage (Table A.2 to Table C.2) were ranged from -13.53% to 41.15%. Among the equations fitted under this approach, in models of 13 weeks crop period of 32 years (Model-III) R^2 was 93.30% which was found suitable for early forecast model under this approach.

Therefore, at least 6 weeks before actual harvest of the crop, reliable pre-harvest forecasting of irrigated wheat yield in Gandhinagar district can be made using original weather variables, week wise (13 weeks) approach by the following model:

$Y = 7120.30-74.64^{**}X_{204}+32.43^{**}X_{413}-24.87^{**}X_{411}-108.14^{**}X_{507}-152.82^{**}\ X_{506}-11.71^{**}\ X_{305}+14.99^{**}X_{304}-47.46^{**}X_{205}-9.10^{*}X_{301}$

(R^2 = 93.30%)

The above equation can be made useful for the prediction purpose.

7. ACKNOWLEDGEMENTS

We are highly thankful to the referee for the review of our paper which has helped us in its revision.

8. REFERENCES

[1] AGRAWAL, RANJANA, JAIN R.C., JHA M.P. and SINGH D. (1980). Forecasting of rice yield using climatic variables.*Ind. J. Agric. Sci.*, **50**(9): 680-84.

[2] ANONYMOUS (1980-2015). District-wise Area, Production and Yield of Important Food & Non-food Crops in Gujarat State. Directorate of Agriculture, Gujarat state,Gandhinagar.

[3] CHAURASIA R. AND MINAKSHI (1997). Wheat yield prediction using climatic parameters. *Ind. J. of Soil Conservation*, **25**(2): 147-50.

[4] DRAPER N. R. AND SMITH H. (1966). Applied regression analysis. John Wiley & Sons, New York.

[5] FISHER R.A. (1924). The influence of rainfall on the yield of wheat at Rothamsted Roy. Soc. (London), *Phil. Trans. Ser. B.***213**: 89-142.

[6] I N D I A N E T Z O N E , h t t p : / / w w w . i n d i a n e t z o n e . c o m / 1 0 gandhinagar_gujarat_district.htm

[7] KHISTARIS M. K. VARMORA S. L., DIXIT S. K., KALOLA A.D. AND RATHOD D. N. (2004). Pre-harvest forecasting of wheat yield from weather variables in Rajkot district of Gujarat. *J. Agrometerol.*, **6** (sp. issue): 197-203.

[8] MALIK R. K. AND GUPTA B. R. D. (2000). Wheat yield forecast models based on meteorological parameters. *J. Agrometerol.*, **2**(1): 83-87.

[9] PANDEY A. K. AND SINGH J. B. (1993). Pre-harvest forecasting of wheat in Tarai Region of U.P. on the basis of weather variables. *Jour. Ind. Soc. Ag. Stat.*, **45**(1): 100.

[10] SARKAR J. (2000). Wheat yield forecasting over Gujarat using

agrometeorological model. *J. Maharashtra agric. Univ.*, **25** (3): 294-297.

[11] SARKAR J. AND THAPALIYAL V. (2003). Forecasting wheat yield over Uttar Pradesh using agrometeorological model. *J. Maharashtra agric. Univ.*, **28** (3): 299-302.

[12] SINGH D., JHA M. P., KRISHNA K. S., IYAR V. N. AND RANJANA AGRAWAL (1977).*Crop forecasting methodology*. Report of I.A.R.S.

[13] VARMORA S. L., PANDYA H.R., AND PARMAR B. A. (2004A). Prediction of wheat yield on the basis of weather variables in Junagadh district of Gujarat State. *J. Agrometerol.*, **6** (sp. issue): 204-206.

[14] VARMORA S.L., DIXIT S. K., PATEL J. S. AND BHATT H. M. (2004B). Forecasting of wheat yield on the basis of weather variables. *J. Agrometerol.*, **6** (2): 223-228.

SOME SPECIFIC INFORMATIONS

- Inquiries regarding subscription and other particulars regarding **Sankhya Vignan** should be addressed to the **Editorial Secretary**. You may also mail to **drjayesh.purohit@gmail.com**
- **GSA membership** fees and other querried should be address to **Secretary, GSA, C/o. Statistics Dept., Gujarat University, Ahmedabad 380009 (INDIA)**
- Each author will receive a copy of the published journal. The first named author will receive 10 copies of offprints.
- All payment can be made either by cash or M.O. or Bank draft in favour of Gujarat Statistical Association, payable at Ahmedabad

Note : In order to meet with the administrative, printing and postal expences, it is decided by the editorial board to accept advertisements from interested resources. Normal rates of advertisements are as under :

Last full cover page	**Rs. 7,000/-**
Last inner coverpage	**Rs. 5,000/-**
Second Colour full page	**Rs. 5,000/-**
Inner Colour half page	**Rs. 3,000/-**
Inner full page	**Rs. 2,000/-**
Inner half page	**Rs. 1,000/-**
Inner quarter page	**Rs. 500/-**

Note : Members of editorial board are in no way concerned with the views, opinions or ideas expressed in this issue. Authenticity responsibility lies solely with the persons presenting them.

RESEARCH ARTICLE

TREND MODELS FOR SOME OPERATIONAL FACTORS OF GSRTC

H.M.Dixit[1], P.M.Parmar[2] and S.N.Jaiswal[3]

ABSTRACT

Growth and development aspects of any country (or region) depends upon many physical and qualitative factors. During the developmental process proper infrastructure and efficient modes of transportation can boost the pace for development. Surface transport is one of them.

In Gujarat state, Gujarat State Road Transportation Corporation (GSRTC) is among the largest public service provider in road transportation. The prime objective of GSRTC in to provide efficent services at affordable rate to the people, eventhough they reside in mofussil or remote areas. Though railway is also one type of transportation provider, it has limitations for reaching to remote areas. In such situations GSRTC is the only option left out for public services.

This paper deals with identification for the trend pattern of some major operational factors of GSRTC by means of using regression analysis Based upon the models, projections are given for further period which may be useful for policy planning in future.

Key Words : Operational factor, Vehicle Utilisation, Routes, Projects

1. INTRODUCTION

The Gujarat Road Transport Corporation has been functioning since inception of separate state of Gujarat in 1960. The development aspects of Gujarat state should be viewed in the light of its polulation growth, their needs of transportation and increasing number of national highways, state highways, and approach roads in the state.

[1] Arts, Commerce and Science College, PILWAI.

[2] H.L.College of Commerce, Ahmedabad.

[3] R.L.Mehta Science and C.L.Parikh Commerce College, Palanpur,

(rcd. July ’16 / rvd. Sept. ’16)

GSRTC is the largest service provider to all those people who travel or comute through road transport facilities especially. Among nationwide network for railways and civil aviation facilities, road transport has its own indispensability because it caters services to the people who cannot afford airtravel and / or reside in remote areas, where railway network is not yet reached.

GSRTC is fully owned by the government of Gujarat and operated through corporation. Unlike private operators, GSRTC is supported to take care of people's interest first. Hence it has to provide all the services at an affordable rate, eventhough they are not financially viable. Appeart from most celebrated short and long route services to the people, GSRTC also provides cargo service and chartered services too. GSRTC is also functioning for neighbouring states like Rajasthan, MP and Maharashtra.

From a beginning with 7 divisons, 76 depots and 7 divisional workshops, it is now expanded to 16 divisions, 126 depots, 226 bus stations, 1554 pickup stands and more than 8000 buses. GSRTC has purchased more than 1500 new buses, including airconditioned, sleeper coaches and volvo buses in 2009. With passage of time GSRTC also provides online and mobile phone ticket booking facilities. It also provides wi-fi internet services in its volvo buses for free. Unlike its competitors paybill and PF system for all employees has been computerised. It renders exemplary services for concessional journey to genuine students and commuters with no prime objective of earning profit. This also leads to the problems for its financial growth since inception.

In this paper we want to highlight certain operational factors for the system of GSRTC based upon suggested statistical analysis. Based upon the models fitted for the data published by GSRTC in its reports from 1960-61 to 2010-11, projections are obtained for a further period upto 2017-18 which may be useful for policy planning of GSRTC.

2. METHODOLOGY AND ANALYSIS

For the secondary data obtained from GSRTC, we consider for our analysis log-level trends model corresponding to certain different operational factors like Gross Earnings, Total Cost, Number of Passengers, Number of Vehicles under utilisation, average number of vehicle, number of routes in GSRTC.

The statistical model is represented by the following relationship

$L_n(OF)_{ij} = L_n\ \alpha + \beta t_i + U_i$

When $(OF)_{ij}$ is the j^{th} operational factor the given point of time t_i years, U_i is the disturbance term for ith year.

α nd β are the parameters of the model.

(i = 1, 2, 3, ...51)and j stands for the specific operational factor such as

j_1 = Number of passengers

j_2 = Gross earnings

j_3 = Total cost

j_4 = Number of vehicles under utilisation

j_5 = Average number of vehicles

j_6 = Number of Routes

The unknown parameters α and β are to be estimated under the usual assumptions. This represents six bivariate semilog linear models with time as independent variable. These models are listed below as M_1, M_2, M_3, M_4, M_5 and M_6 models respectively.

Table : 1

Model Number	Operational factor of dependent variable
M1	Gross Earning (Lac Rs.)
M2	Total Cost (Lac Rs.)
M3	Number of passengers (Lac)
M4	Number of Routes
M5	Average number of vehicles
M6	Vehicle utilisation (Lac kms.)

Once the parameters are estimated for the respective models, usual statistical testing can be done for significance and projections on the basis of fitted models can be given for further periods.

Table 2 given below represents regression analysis details with conclusions.

Tabel 3 gives the projections based upon the fitted models for the years 2011-12 to 2017-18.

Table 2

Model No.	Dependent Variable	Independent Variable	
		Constant	**Time (t)**
M_1	Earnings	6.9158	0.1148
	t	(88.319)**	(43.816)**
	S.E.	(0.07830)	(0.00262)
	R^2 = 0.9751, F = 1919.83, n = 51		
M_2	Cost	6.9196	0.1177
	t	(84.509)**	(42.913)**
	S.E.	(0.08188)	(0.00274)
	R^2 = 0.9741, F = 1841.54, n = 51		
M_3	No. of Pass.	8.1909	0.0311
	t	(60.932)**	(6.921)**
	S.E.	(0.1344)	(0.0044)
	R^2 = 0.4943, F = 47.90, n = 51		
M_4	No. of Routes	8.1078	0.0415
	t	(86.708)**	(13.285)**
	S.E.	(0.0935)	(0.0031)
	R^2 = 0.7827, F = 176.50, n = 51		
M_5	Av. No. of Vehicles	7.5656	0.0344
	t	(101.052)**	(13.572)**
	S.E.	(0.0748)	(0.0025)
	R^2 = 0.7899, F = 184.21		
M_6	Vehicle Uti.	5.2921	0.0149
	t	(312.248)**	(26.400)**
	S.E.	(0.0169)	(0.005)
	R^2 = 0.9343, F = 696.95, n = 51		

3. CONCLUSIONS

1. For the above regression Model-M_1 pertaining to Gross earnings it is found that model is statistically significant. About 97.51% variation is explained by the model. Elasticity is 0.1148 which indicates that due to unit change in time, earning of GSRTC increas by about 11.48% per years.

2. Regression Model-M_2 for total cost of GSRTC suggests that 97.41$ variation is explained by the model. It seems that unit change in time accounts for 11.76% increase in total cost of FSRTC every year.

3. The regression Model-M_3 for number of passengers is found to be statistically signification. On an average the logarithmic value of regressand (No. of passengers) increases by 3.11% with unit change in regressor (i.e. time) and about 49.43% variation is expalined by the model.

4. Model-M_4 pertaining to number of routes is found to be significant, 78.27% variation is explained by the model and with unit change of time (i.e. year) it accounts for 4.15% increment in number of routes.

5. Model-M_5 for average number of vehicles owned by GSRTC shows that every year number of vehicles increases by about 3.99%. R^2 is 0.7879 which is satisfactory.

6. Regressing output for vehicle utilization (Model-M_5) shows that with upward unit change in time, vehicle utilization increases by 1.49% and the explained variabtion is 93.43%

Table : 3

Projections based upon data analysis

Year	Operational Factors					
	Earning (Lakh m)	Cost (Lakh Rs.)	No. of Passengers (Lakh)	No. of Routes	Av. No. Vehicles	Vehicle Utilization (Lakh.km.)
2011-12	395264.67	458213.26	18219	28850	11318	433.06979
2012-13	443364.08	515398.08	18795	30075	11710	439.60409
2013-14	497316.65	579719.55	19389	31352	12115	446.23704
2014-15	557834.67	652068.31	20003	32683	12354	452.97006
2015-16	625717.08	733446.16	20636	34070	12968	459.80468
2016-17	701860.03	824979.94	21288	35517	13416	466.74241
2017-18	787268.75	927937.10	21692	37025	13880	473.78483

The above projected statistics indicate that in the future course of above 7 years time, the earnings with passengers can increase from 18219 lakhs to 21692 lakhs. The number of routes can increase from 28850 to 37025, average number of vehicles are likely to increase from 11318 to 13880, whereas the vehicle utilisation will increase from 433 lakh kms. to about 474 lakh kms. GSRTC policy planners can use these facts for their further palnning excercises.

4. ACKNOWLEDGEMENTS

We thank Dr. H. D. Budhbhati (Ex. CSO) and Shri B.G.Patel (CSO) for detailed discussion on this issue. We also thank the referee for his review of our paper which has helped un in its revison.

5. SE;ECTED REFERENCES

[1] **Allen RGD (1990)** Mathematical Analysis for Economists (Chapman and Hill)
[2] **Damodar Gujarati (1994)** Econometrics (Prentice Hall Co.)
[3] **Draper and Smith (1992)** Econometric Analysis (Wiley Int. & Co.)
[4] GSRTC Annual Reports and Budget Summary from 1960 to 2011.
[5] **James Murphy (1973)** Introductory Econometrics (Richard D. Irwin Inc.)
[6] **Johnston (1995)** Econometric Methods (John Wiley Co.)
[7] **Potluri Rao and R.A.Miller (1972)** Applied Econometrics (Prentice Hall Co.)

TECHNICAL NOTE

A REVIEW OF QUALITY MANAGEMENT MEASURES IN HIGHER EDUCATION USING SERVQUAL MODEL

Neeta Mandaliya*

ABSTRACT

It is desired to study and evaluate the service quality for education in Gujarat University and Gujarat Technical University in Ahmadabad. The population for this study consists of students from all the Commerce colleges UG, PG students and engineering students of Gujarat University and GTU at Ahmadabad. 650students were selected by stratified random sampling method as the study sample. Data analysis was carried out by means of suitable nonparametric test. From this study it appears that there is a significant difference between the students satisfaction in all the five dimensions of the service quality by means of using Non-parametric tests. The findings of the study showed a significant difference between the students satisfaction in all the five dimensions of service quality

Key Words : *SERVQUAL Model, Kruskal Wallis Test, Tangible and Assurance Variables.*

1. INTRODUCTION

Education can be viewed as a service industry. It needs to adopt techniques that help to measure the quality of services and students satisfaction. In the socio economic context, the service factor has become more important, revealing the desire to know and study certain issues that are required for the specific course management skill. It is necessary to understand that service processes are different from manufacturing processes, especially due to their intangible nature and the direct participation of the

* Assistant Professor, Department of Statistics, Lokmanya college of Commerce, Gujarat University. Ahmadabad, Gujarat, India. Email: neeta9825603570@yahoo.com
(rcd. Aug.'16 / frvd. Aug.'16 / srvd. Aug.'16 / trvd. Sept.16)
This paper is to be presented at the National Seminar on Higher Education to be held on Sept. 30, and Oct. 1 2016, at HLCC, Ahmedabad.

students.

Higher education institutions are generally always in search of improvements in teaching service quality to satisfy the expectations of their students and also for the market requirements. However, since education services have very particular characteristics, the SERVQUAL model must be adopted according to the most important determining factors like reliability, tangibility, responsibility, security, and empathy. The quality of Higher Education is of fundamental importance for any country's development because universities are the ones that prepare the professionals who will work as managers in companies and manage public and private resources and also care for the health and education of new generations.

SERVQUAL MODEL: This model is generally used in service industry and various fields like banking, education etc. This model is has been given by Parsuraman's, Zeithaml, and Berry (1985). After many times modification now five factors are very important in this model- like Tangibility, Assurance, Reliability, Responsiveness and Empathy.

2. OBJECTIVES OF THE STUDY

This study is intended with reference to the following Objectives.

1. To examine the relationship between service quality dimensions (tangibility, responsiveness, reliability, assurance, empathy and overall service quality) and student satisfaction.
2. To identify the prominent factors, which may be attributed to student's satisfaction
3. To do a comparative study of the leading commerce colleges of theUniversity of Gujarat as regards to their quality management adopting.
4. To study about college quality improvement in infrastructure for higher education and also to study quality improvement in commerce and engineering colleges.

3. LITERATURE REVIEW

The aim of the literature review is to ensure for those issues which are relevant to the aims and objectives of the research identified and further for the field work for research.

Wan Sulaiman, Wan Rafaei, Dzulkifli, & Wan Samhanin (2013) have examined that Lack of education will also be lack of confidence.

Firdaus (2006) has lead to discussion about two models HEdPERF and

SERVPERF the conceptual and operational concerns associated with the generic measures of service quality. These are attempted to compare and contrast empirically the HEdPERF scale against two alternatives namely the SERVPERF and the merged HEdPERF-SERVPERF scales.

Becket (2008) has described a review of current quality management practices within HEIs. Here there is a different model for application in higher education. He has explained the above quality in different dimensions and suggested that all the models do not fit in higher Education.

4. METHODOLOGY

Design of the study

The descriptive research design has been employed for the present study. The research design attempts to understand quality management practice in Higher Education in different commerce and Engineering institutes.

Sampling Frame

The samples for the study are selected from different disciplines such as commerce and engineering. Data collected from the students of Lokmanya Colleges of commerce, H.L. College of commerce and J.G. College of commerce and in engineering institutes like silver oak engineering and Sal engineering institutes. Stratified random sampling method was used under proportional allocation for our study. Based upon the sample selected Kruskal-Wallis non parametric tests are carried for this study.

Hypothesis

- There is no significant difference in college quality and infrastructure.
- There is no significant difference in college quality for Granted and self finance colleges.

Kruskal-Wallis Test

The **Kruskal-Wallis H test** is a non-parametric test which is used in place of a one-way ANOVA. Essentially it is an extension of the Wilcoxon Rank-Sum test for more than two independent samples. Although, as explained in Assumptions for ANOVA, one-way ANOVA is usually quite robust, there are many situations where the assumptions are sufficiently violated and so the Kruskal-Wallis test becomes quite useful.

The Kruskal-Wallis Test can be briefly described as under

A popular nonparametric test to compare outcomes among more than two

independent groups is the Kruskal Wallis test. The Kruskal Wallis test is used to compare medians among k comparison groups (k > 2) and is sometimes described as an ANOVA with the data replaced by their ranks. The null and research hypotheses for the Kruskal Wallis nonparametric test are stated as under:

H_0: The k population medians are equal versus

H_1: The k population medians are not all equal

The procedure for the test involves pooling the observations from the k samples into one combined sample, keeping track of which sample each observation comes from, and then ranking lowest to highest from 1 to N, where $N = n_1+n_2 + ...+ n_k$. Test Statistic for the Kruskal Wallis Test

The test statistic for the Kruskal Wallis test is denoted by H and is defined as follows:

$$H = \left(\frac{12}{N(N+1)} \sum_{j=1}^{k} \frac{R_j^{\,2}}{n_j} \right) - 3(N+1) \quad ,$$

Where k=the number of comparison groups, N= the total sample size, n_j is the sample size in the j^{th} group and R_j is the sum of the ranks in the j^{th} group.

For testing the Tangible variables for this study based upon SERVQUAL Model, the Tangible variables occurring in the questionnaire are as under

Tangible Variables

Q_11_A_1_Your college campus is up to date with all amenities
Q_11_A_2_The classroom is clean and comfortable for study.
Q_11_A_3_Library Facility is really good
Q_11__A_4_Do you find library and books facilities to be adequate in your college?
Q_11__A_5_Canteen provides healthy snacks and beverages
Q_11__A_6_Staffs are well dressed up and well performed and well equipped
Q_11_A_7_Proper Physical education facilities are available
Q_11_A_8_Easily available transport facilities for your college

Test Statistics	
	Response
Chi-Square	212.831
df	7
Prob.	2.1907

Testing

$H_{o:}$ All questions have got equal agreement.

$H_{1:}$ At least one question has got different response.

A Non parametric test Kruskal- Wallis is performed. The test statistics is

$$H: \frac{12}{N(N+1)}\left(\sum_{i=1}^{K}\frac{1}{n1}\left(Ri-\frac{n(N+1)}{2}\right)^2\right)$$

$H \sim \chi^2$ (k-1)

R_i : sum of ranks for i^{th} group (question)

n_i: no of responses for i^{th} group (question)

N: $\sum_{i=1}^{k} n_i$ = (the total sample size)

K: no of groups (question)

If test is significant (i.e. p value $<$ 0.05) then a multiple comparison test is performed to observe for the significant difference. A pair wise comparison is performed by using critical difference formula.

$$|\overline{Ri}-\overline{Rj}| \geq 1.96\sqrt{\frac{N(N+1)}{12}\left(\frac{1}{ni}+\frac{1}{nj}\right)}$$

Critical Values of the ÷^{2} Distribution

n_j is the sample size in the j^{th} group and R_j is the sum of the ranks in the j^{th} group.

Decision Rule: Reject H_0 if H$\geq$ critical value

(I.e. If P value <= 0.05 Reject $H_{0:}$)

Each of the above questions has one of the five answers (Liker Scale) which can be mentioned as under.

1) Strongly disagree, 2) Disagree, 3) Neutral 4) Agree, and 5) Strongly Agree

The continuous improvement in different colleges using Tangible Dimension in Servqual model is the same, irrespective of, the type of the college, location of the colleges and subject taught there. Which means that there is different situation in each and every college, So null Hypothesis cannot be accepted.

Assurance Variables

Q_11__B_1_Has a wide subject knowledge, gives varied and timely lectures. Maintains students interest during lectures
Q_11__B_2_The faculty is an expert in their subjects, so I receive sufficient advice and support with my studies.
Q_11_B_3_Faculty provided very good information related to subject and general
Q_11_B_4_Faculty also takes interest in cultural activities
Q_11_B_5_Faculty are innovative and also teach Students how to be polite.
Q_11_B_6_The faculty has the knowledge to answer your questions; friendly, and I am able to contact staff when I need to
Q_11_B_7_Faculty behavior is very good; they give Special sessions for the weak students. Also, help to improve the communication skills of the students.
Q_11_B_8_The atmosphere in college is safe for the student. Faculty monitors to the student and gives good advice if the student is not on the track.
Q_11_B_9_Personnel at the college inspires confidence
Q_11_B_10_Personnels at the college are polite
Q_11_B_11_Faculty provides service at the time they promised

Each of the above questions has one of the five answers as explained above.

Test Statistics	
Chi- Square	130.956
df	10
Prob.	2.98115

Using the formula as explained earlier we applied the test and make conclusions. The continuous improvements in different colleges using Assurance Dimension in Servqual model is the same, irrespective of, the type of the college, location of the colleges and subjects taught to them. That means there is different situation in each and every college. So null Hypothesis cannot be accepted

5. CONCLUDING REMARKS

In this SERVQUAL Model Tangible variables are the eight questions related to each infrastructure each and every question explains the requirement of colleges and improvement in infrastructure, eventhough different institute has different demand. The continuous improvement in different colleges using Tangible Dimension in Servqual model is the same, irrespective of, the type of the college, location of the

colleges and subject taught there. Which means that there is different situation in each and every college, So null Hypothesis cannot be accepted.

In this SERVQUAL Model Assurance variables are the eleven questions related to staff and students understanding as to how they help students and solve their problems. Eventhough the different institutes have different demand. The continuous improvement in different colleges using Assurance Dimension in SERVQUAL model is the same, irrespective of, the type of the college, location of the colleges and subjects taught there, which means that there is different situation in each and every college and hence null Hypothesis cannot be accepted.

6. ACKNOWLEDGEMENT

I am highly indebted to the referee for the comments and suggestions that helped me in revising the earlier draft of this paper.

7. SELECTED REFERENCES

[1] **Alnser, S.A., Mahmoud, K. and Almsafir (2014)** Service Quality Dimensions and Students Satisfaction. *Journal of Advanced Social Research,* Vol.4 no.6. June 2014, pp.01-17.

[**2**] **Amran, R.,Ahmadreza,S., & Muhammed, J.I.(2012)** Perception of Service Quality in Higher Education: Perspective of Iranian students in Malaysian Universities. *International Journal of academic Research in,* pp.10-25.

[3] **Basheer,A,A.-A., & Ahmad Salih,M.A.(2012)** Assessing the Relationship between Higher Education Service Quality Dimensions and Student Satisfaction. *Australian Journal of Basic and Applied Sciences,* pp. 156-164.

[4] **Becker,N.(2008)** Higher Education and Social Change. *Springer,* pp. 381-393.

[5] **Firdaus, A.(2006)** Measuring service quality in higher education: HEdPERF versus SERVPERF. *Marketing Intelligence & Planing,* 31-47.

[6] **MNGopalan(2014)** TQM in Education. *Sankhya Vignan (NSV 10-1)* pp.19-31

[7] **Nigavekar, A.(2003)** Higher Education in India. New Delhi 110002: published by the Secretary, UGC.

[8] **Rizwan, A.,& Syed, I.A.(2012)** Implementing TQM practice in Pakistani Higher Education Institutions. Pak.j.eng.technol.sci., pp.1-26.

BIOGRAPHY

WALTER A. SHEWHART*

H.D.BUDHBHATTI**

Walter Andrew Shewhart (pronounced like Shoe-heart) was born at New Canton, Illinois, USA on 11, March 1891 to Anton and Esta Barney Shewhart. He was an American Physicist, engineer and statistician.

He attended the University of Illinois at Urbana-champaign before being awarded his docterate in Physics from the University of California, Berkeley in 1917.

He married Edna Elizabeth Hart, daughter of William Nathaniel and Iscabelle on August 1914 in Pike Count, Illinois.

Eventhough being a physicist and engineer, he had developed tremendous interests in the statistical basics and ideologies. This led him to be a very significant pioneering work related to industrial engineering and he brought revolution by his work related to **Statistical Quality Control Charts Technique.**

Somethimes he is also regarded as the father of SQC and also related to shewhart cycle.

Work on industrial quality

Bell Telephone's engineers had been working to improve the reliability of their **transmission systems**. In order to impress government regulators of this natural monopoly with the high quality of their service, Shewhart's first assignment was to improve the voice clarity of the carbon transmitters in the company's telephone handsets. Later he applied his statistical methods to the final installation of central station switching systems, then to factory production. When Dr. Shewhart joined the **Western Electric Company** Inspection Engineering Department at the **Hawthorne Works** in 1918, **industrial quality** was limited to inspecting finished products and removing defective items. That all changed on May 16, 1924. Dr. Shewhart's boss, George D. Edwards, recalled: "Dr. Shewhart prepared a little memorandum only about a page in length. About a third of that page was given over to a simple diagram

* This article is adapted by net collection from wikipedia (the free encyclopedia). We express our gratitude for this assistance.

** Ex. CSO, Head, Statistics Dept., GSRTC, Ahmedabad.

(rcd. July '16 / rvd. Sept. '16)

which we would all recognize today as a schematic **control chart.** That diagram, and the short text which preceded and followed it, set forth all of the essential principles

and considerations which are involved in what we know today as process quality control." Shewhart's work pointed out the importance of reducing variation in a manufacturing process and the understanding that continual process-adjustment in reaction to non-conformance actually increased variation and degraded quality.

Shewhart framed the problem in terms of assignable-cause and chance-cause variation and introduced the control chart as a tool for distinguishing between the two. Shewhart stressed that bringing a production process into a state of statistical control, where there is only chance-cause variation, and keeping it in control, is necessary to predict future output and to manage a process economically. Dr. Shewhart created the basis for the control chart and the concept of a state of statistical control by carefully designed experiments. While Dr. Shewhart drew from pure mathematical statistical theories, he understood data from physical processes never produce a "normal distribution curve" (a Gaussian distribution, also commonly called a "bell curve"). He discovered that observed variation in manufacturing data did not always behave the same way as data in nature (Brownian motion of particles). Dr. Shewhart concluded that while every process displays variation, some processes display controlled variation that is natural to the process, while others display uncontrolled variation that is not present in the process causal system at all times.

Shewhart worked to advance the thinking at Bell Telephone Laboratories from their foundation in 1925 until his retirement in 1956, publishing a series of papers in the Bell System Technical Journal.

His work was summarized in his book **Economic Control of Quality of Manufactured Product (1931).**

Shewhart’s charts were adopted by the American Society for Testing and Materials (ASTM) in 1933 and advocated to improve production during World War II in American War Standards Z1.1-1941, Z1.2-1941 and Z1.3-1942.

Later work

From the late 1930s onwards, Shewhart's interests expanded out from industrial quality to wider concerns in **science and statistical inference**. The title of his second book, Statistical Method from the Viewpoint of Quality Control (1939), asks the audacious question: What can statistical practice, and science in general, learn from the experience of industrial quality control?

Shewhart's approach to **statistics** was radically different from that of many of his contemporaries. He possessed a strong **operationalist** outlook, largely absorbed

from the writings of **pragmatist** philosopher **Clarence Irving Lewis,** and this influenced his statistical practice. In particular, he had read Lewis' Mind and the World Order many times. Though he lectured in England in 1932 under the sponsorship of **Karl Pearson** (another committed operationalist) his ideas attracted little enthusiasm within the English statistical tradition. **The British Standards** nominally based on his work, in fact, diverge on serious philosophical and methodological issues from his practice.

His more conventional work led him to formulate the statistical idea of **tolerance intervals** and to propose his data presentation rules, which are listed below:

1. Data have no meaning apart from their context.
2. Data contain both signal and noise. To be able to extract information, one must separate the signal from the noise within the data.

Walter Shewhart visited India in 1947–1948 under the sponsorship of **P.C.Mahalanobis** of the **Indian Statistical Institute.** He toured the country, held conferences and stimulated interest in statistical quality control among Indian industrialists.

He died at Troy Hills, New Jersey in 1967.

Influence

In 1938 his work came to the attention of **physicists W. Edwards Deming and Raymond T. Birge.** The two had been deeply intrigued by the issue of measurement error in science and had published a landmark paper in Reviews of Modern Physics in 1934. On reading of Shewhart's insights, they wrote to the journal to wholly recast their approach in the terms that Shewhart advocated.

The encounter began a long collaboration between Shewhart and Deming that involved work on productivity during World War II and Deming's championing of Shewhart's ideas in Japan from 1950 onwards. Deming developed some of Shewhart's methodological proposals around **scientific inference** and named his synthesis the Shewhart cycle.

Achievements and honours

In his obituary for the American Statistical Association, Deming wrote of Shewhart:

"As a man, he was gentle, genteel, never ruffled, never off his dignity. He knew disappointment and frustration, through failure of many writers in mathematical statistics to understand his point of view."

He was founding editor of the Wiley Series in Mathematical Statistics, a role that he maintained for twenty years, always championing freedom of speech and confident to publish views at variance with his own.

His honours included

- Founding member, fellow and president of the **Institute of Mathematical Statistics;**
- Founding member, first honorary member and first **Shewhart Medalist of the American Society for Quality;**
- Fellow and **President of the American Statistical Association;**
- Fellow of the **International Statistical Institute;**
- Honorary fellow of the **Royal Statistical Society;**
- Holley medal of the **American Society of Mechanical Engineers;**
- Honorary Doctor of Science, **Indian Statistical Institute, Calcutta.**
- Control chart
- **Common cause and special cause (statistics)**
- Analytic and enumerative statistical studies

Selected References

[1] **Bayart, D. (2001)** Walter Andrew Shewhart, Statisticians of the Centuries (ed. C. C. Heyde and E. Seneta) pp. 398–401. New York: Springer.

[2] **2005**, "Economic control of quality of manufactured product" in Grattan-Guinness, I., ed., Landmark Writings in Western Mathematics. Elsevier: 926-35.

[3] **Fagen, M D, ed. (1975)** A History of Engineering and Science in the Bell System: The Early Years (1875–1925).

[4] **ed. (1978)** A History of Engineering and Science in the Bell System: National Service in War and Peace (1925–1975) *ISBN 0-932764-00-2*

[5] **Wheeler, Donald J. (1999).** Understanding Variation: The Key to Managing Chaos, 2nd ed. SPC Press, Inc. *ISBN 0-945320-53-1.*

[6] **Shewhart, Walter A[ndrew]. (1917).** A study of the accelerated motion of small drops through a viscous medium. Lancaster, PA: Press of the New Era Printing Company. pp. 433

[7] **Shewhart, Walter A[ndrew]. (1931).** Economic control of quality of manufactured product. New York: D. Van Nostrand Company. pp. 501 p. ISBN 0-87389-076-0. LCCN 31032090. OCLC 1045408. LCC TS155. S47.

[8] **Shewhart, Walter A[ndrew]. (1939).** Statistical method from the viewpoint of quality control. *(W. Edwards Deming). Washington, D.C.,* The Graduate School, the Department of Agriculture. pp. 155 p. ISBN 0-486-65232-7. LCCN 40004774. OCLC 1249225. LCC HA33 .S45.

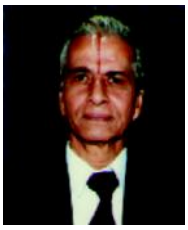
[9] **W. Edwards Deming (1967)** "Walter A. Shawhart, 1891-1967", American Statistician 21:39-40

ACKNOWLEDGEMTNS

I thank the referee for his review of this article.

SV NEWS LETTER

- K. Muralidharan*



May 14, 1935
- June 30, 2016

Professor M.N.Gopalan, a very senior academician and one of the most learned person has expired recently. He was senior most member of the editorial board of ***Sankhya Vignan***.

His brief biographical sketch is represented below for the information to our readers.

Professor M.N.Gopalan, Ph.D.

FIE, FIIE, FIETE, FIPE, FORSI, FSSI, FIPE, FISPS, FUWAI, FIASS

Ex-Professor : IIT Mumbai (1960-1995)

Professor Emeritus : SJCE, Mysure (1995-2000)

Visiting Professor : ISTE, Delhi (2002-2004)

Life-time Achievement Award : ORSI, Delhi (2007)

Professor M.N.Gopalan holds a Ph.D. Degree from IIT Madras. He was associated with IIT Bombay for 35 years from 1960 to 1995. During this period, he guided 23 Ph.D. Scholars, besides guiding a number of M.Tech., M.Sc., and B.Tech. students in the fields of Quality and Reliability Engineering and Operations Research. He has to his credit more than 270 research papers, published in various national and international journals devoted to **Quality and Reliability Engineering and Operations Research.**

Professor Gopalan was the Convenor of the inter-disciplinary postgraduate programme in Reliability Engineering at IIT Bombay for nearly a decade (till his retirement in May 1995) and was instrumental in starting the programme in 1984.

Professor Gopalan has organized a number of conferences, at national level, in the fields of Operations Research, Quality and Reliability Engineering. Besides, he has conducted several short-term programmes and courses in these areas for the benefit of persons from industries and engineering colleges int he country.

Professor Gopalan is a life-fellow and life-member of several professional bodies in the country & also the Editor / Assoicate Editor / Member of the Editorial Boards of technical journals published by some of these professional bodies.

Professor Gopalan is the recipient of the 'Life-time Achievement Award' of the Operational Research Society of India (ORSI) offered to him during its

* Professor and Head, Dept. of Statistics, The M.S.University, Vadodara 390002

Annual Convention held at Delhi in 2007 in recognition of his contributions to the field during the past four and half decades.

Professor Gopalan was associated with Sri Jaya Chamarajendra College of Engineering, Mysore as Professor Emeritus from 1995 to 2000. From August 1995 to July 1997, he was Emeritus Fellow of the All India Council for Technical Education (AICTE) and from March 1998 to March 2000, he was Emeritus Fellow of the University Grants Commission (UGC) India. He was ISTE Visiting Professor during 2002-04. He was AICTE Visiting Professor at SDM Institute for Management Development, Mysore, during 2003-04. He had been offered the post again during 2005-06.

Professor Gopalan's name is mentioned in the **who-in-the-world directories** published by various international bodies and has been honoured with a number of prizes and medals in recognition of his contributions to society, during the past 50 years.

Professor Gopalan has, to his credit, a number of books written in Kannada and English language. Besides, he has published several articles in these languages in various news papers, magazines & journals. He has received several honours from various organisations devoted to art, culture and literature for his contributions to literature. Life is to build a strong and dynamic society, free from social evils, such as, illiteracy, ill-health and ignorance. He is keen on moulding the youth to imkplement his life's ambition.

AWARDS

1. Gramina Buddi Jivigala Balaga, K.R.Nagar, Mysure Dist. **'Suvarna Karnataka Seva Prashasti' (2010)**
2. Gramina Buddi Jivigala Balage, K.R.Nagar, Mysure Dist. K.S.Na.Nenapina **'Prema Kavi Puraskrara' (2010)**
3. Karnataka Muktaka Sahitya Academy Trust, Mysure '**Certificate of Appreciation (Education)' (2010)**
4. Suddi Spota and Samskrithika Prathishtana, Mysure '**Sir M.Visvesvaraya Award' (2011)**
5. Mysure Sahithya & Samskrithika Prathishtana, Mysure **'Sahithya Sindu' (2012)**
6. Sadhbavana Foundation, Bengaluru **'Rajiv Gandhi Sadbhavana Award (Education)' (2012)**
7. Himalaya Foundation & Anantha Publications, Mysure **'Vidya Bhushana Award' (2013)**

8. Bharatiya Samskruthika Vikasa Vedike, Mysure **'Sarthaka Seva Bhushan Award' (2013)**
9. Simrana Youth Foundation, Mysure **'Life-time Achievement Award' (2014)**
10. Himalaya Foundation, Mysure **'Vidyaranya Award' (2014)**
11. Dept. of Welfare of Senior Citizens, Gok, Mysore **'Life-time Achievement Award.' (2014)**
12. Gi. Sham.Pa Sahithya Vedike, Mandya **'Kuvempur Vishwamanava Award' (2015)**
13. Sneha Sinchana Trust (R), Mysure **'Shikshaka Seva Ratna Award' (2015)**
14. Divya Jyothi Kala & Sahithya Vedike, Mandya, Karnataka **'Dr. APJ Abdul Kalam Seva Award' (2016)**

Prof. gopalan has also done very significant work by publishing 7 reputed research articles relating to Upnishad, Bhagvadgita, Bhagvat etc. He had very keen desire to get D.Lit. degree on the basis of this work. Unfortunately he could not survive more and passed away in his very artical health conditons. He was a very noble soul and worked for his whole life after his devotion to his specific areas.

We very rarely, come across such a pious ddignitory in life who remain exemplary for our routines. We all pray to God that his soul may rest in place.

Let Noble Ideas Reach Us From Different Parts of the Universe. (RIGVEDA)

SOME CONFERENCES

- Sixth International Science Congress (ISC-2016) will be held on 8-9, December 2016 at Hutatma Rajguru Mahavidyalaya Rajgurunagar, Pune, Maharashtra. Contact : www.hrmrajgurunagar.com
- 49th Annual Convention of ORSI will take pleace at Birla Institute of Management Technology, knowledge Park-II, Greater Noida, New Delhi, during 12-14 December 2016.
- National Seminar on "Quality of Education and Problems in Higher Education: was held at HLCC during 30 Sept. to 1 Oct. 2013.

Indian Society for Probability and Statistics

It was in August 1978, CSIR had awarded a grant to Prof. G. Sankaranarayanan of the Department of Statistics, Annamalai University, Annamalainagar for conducting a national Symposium on Queues, Inventories and Reliability. Many eminent scholars and researchers in Probability, Statistics and Stochastic Process had gathered at the feet of Lord Nataraja, Chidambaram. They mooted the idea of having similar gatherings of like minded people regularly, may be under the aegis of a society. Initially the topics of interest suggested were Probability and Stochastic Processes.

A core group met once again in S.V. University, Tirupati early in 1980 at the feet of Lord Venkateswara. Prof. M.P. Sastry of S.V. University, Prof. S.K. Srinivasan, of I.I.T., Madras and another enthusiast Prof. M.N. Gopalan of I.I.T. Bombay joined the group. All those present decided to name the Society as Indian Society for Theory of Probability and its Applications (ISTPA). The scope of Society now included Statistics and Stochastic Processes. Draft constitution was drawn up during a subsequent Conference at I.I.T. Bombay, in 1980 formly calling the society as Indian Society for Probability and Statistics (ISPS).

ISPS now conduct annual meetings every year. ISPS also conduct and support many other activities including seminars and workshops. The society has now more than thousand life members. Currently, the President of the society is Prof. P. Rajasekhar Reddy of S. V. University, Tirupati and the Secretary is Prof. K. Muralidharan of the department of Statistics, The Maharaja Sayajirao University of Baroda, Vadodara. The new members can register their membership online, and the web site is www.isps.org. The XXXVI annual conference of 2016 will be conducted by Department of Statistics and Operations Research of Aligarh University, Aligarh. All members are requested to see the above web site for all ISPS activities, competitions, journals and conference/seminar related informations.

Some of the conference related lectures, awards and competitions are given below:

Endowment Lectures:

1. Prof. P. V. Sukhatme Endowment lecture
2. Prof. Y. C. Narasimhalu Endowment lecture
3. Dr. A. M. Mathai Endowment lecture

ISPS eminent statistician's awards:

1. Fellowship of ISPS
2. Distinguished Statistician Award
3. Dr.C.R.Rao Life time Achievement Award

Prizes and Awards for students :

1. Dr. C. R. Rao gold medal for first Best Research paper

2. Dr. A. M. Mathai prize money (case award of Rs. 10,000/-) for second best Research paper
3. Dr. M. N. Gopalan prize money (case award of Rs. 2,500/-) for third best Research paper
4. Dr. B. K. Kale prize money prize money (case award of Rs. 1,500/-) for fourth best Research paper
5. Dr. A. R. Kamat award for best PhD thesis (Rs. 60,000/-)

ISPS-IISA MSc student Project competition, 2016

Title : Study of efficiency of various pollution control measures
Eligibility : A team of three students studying in MSc/MTech Statistics/Biostatistics/ Industrial Statistics/Actuarial Statistics.
Submission : Soft copy and hard copy.

The last date of submission of entries is 15 October 2016. For more information's on competitions and prizes, kindly contact the following address:

Prof. K. Muralidharan
Secretary, ISPS, Department of Statistics, Faculty of Science
The Maharaja Sayajirao University of Baroda, Vadodara-390002.
Email: lmv_murali@yahoo.com, muralikustat@gmail.com
Phone: (0) 0265-2794269, (MO) 09879596190.

XXXVI Annual conference if ISPS 2016

Topi : Statistical inference, sampling and Optimization Techniques & Related Areas (ISSAC-2016)
Venue : Department of Statistics& Operations Research, Aligarh University, Aligarh, India
Date : 17-19, December, 2016

ISPS Journal: ISPS in collaboration with Springer has started publishing the journal from 2016. The first issue was published in the month of May. For more details one may visit:

Web site: www.isps.org.in

READERS FORUM

A. M. PATEL*

- **P. H. VAKHARIA**

  I am LM of GSA since its inception. I very much appreciate the tradition of statistics dept., Gujarat University. My pranams to all my Gurus. S V journal is a regular publication since last 12 years. I shall be highly pleased if it receives Peer Review Status in future. My best wishes to the S V team for their efforts.

- **V. H. BAJAJ**

  S V Journal is definitely devoted to different areas of applied statistics. Since 2005, all the articles are Peer Reviewed by experts. In my view SV has maintained its standard for quality of its work. In my opinion SV must get Peer Review status. My best luck to the SV team.

- **A. C. BRAHMBHATT**

  I have been appointed in the Peer Review Committee of SV. The entire process of review system is open and unbiased. Even my articles were revised - I very much appreciate this fact. Last issue contained a very good article on Mahalanobis D^2 statistics which inspires to learn more about certain things like multidimensional scaling. I am connected with 9 editorial boards of reputable journals in different capacities. I firmly admit that SV has maintained its standard. My best wishes for a nice teamwork ahead.

- **M. M. BHATT**

  I feel proud to be LM of GSA since 1993. I am always very keen to receive SV journal. Efforts made by SV team in its publication are praiseworthy. I believe that articles connected with IT and computer algorithms and applications should be published in the journal with positive mind. I am sure that the quality of SV journal will be maintained in next future also.

- **P. J. JHALA**

  I have a feeling that SV journal may further be elivated if more and more topics in the fields of national economy like dynamics of population, social and economic development, labour force participation, mortality and morbidity, fertility and family planning, level of living etc. can be incorporated in its contents in future. Slight more attention is also required to be paid while going through

* Rtd. Principal, H. K. Commerce College, Ahmedabad and Ex. Secretary, Gujarat Vidyasabha and Brahmachari Wadi Trust, Ahmedabad.

editing and printing stages towards some printing errors. Worthy attempt. Keep it up.

- **P. H. THAKER**

  While refereeing SV June 2015 issue, I have some specific comments.

  (1) Article on EPQ in Inventory considers many unrealistic assumptions.

  (2) Another article for OLIM under varying demand also has similar features. The quoted example gives some numerical values taken hypothetically. Note that each such case in always associated with econometric application.

  (3) Article for power consumption pattern makes assumption about log-linear regression model. How far it is justifiable ?

  (4) Biography of any statistican must be accompanied by author's own contribution also. In general this issue, as Peer Reviewed makes a worthy attempt.

- **D. K. GHOSH**

  I have reviewed June 2016 issue as suggested. I have some specific comments.

  (1) Names of authors should be on the first page.

  (2) Details of revison etc can be furnished with the article.

  (3) Names of referees should be given in the printed journal

  (4) Articles in Pure and Applied field should be on 50-50% basis.

  This journal carries very good impression and it is useful for young research workers.

  I am extremely happy to be associated with SV team.

- **RAKESH SHREEVASTAV**

  GSA is publishing SV since 2005 in the form of NSV. Its main effective portion is Biography of statistician inside and on the last page of the journal. There is a considerable variety for the materials submitted for publication and review work is also done unbiasedly, as I know one of my paper was also reviewed and then I revised. This journal has definitely good future as Peer Review journal and it is giving encouragement to teachers and research workers. My best wishes to the team.

- **HEMAL PANDYA**

  On the whole SV published by GSA is a very useful peer reviewed journal with ISSN in the field of Applied Statistics and provides noteworthy contribution for the researchers in the field. It provides a sound platform for the academicians and practitioners for publication of their research work. I am confident that SV can certainly reach to new heights by the efforts made by SV team. My congrats and best wishes.

Gujarat Statistical Association

Established : 1969

[Registered under Public Trust Act of 1950 (Bombay)]

R. No. E2502 A'bad-1974

The objective of the association is primarily to promote statistical ideas in pure and applied fields in the form of study, teaching and research in statistics.

The membership of GSA consists of Life / Institutional / ordinary members.

Membership	Fees	
	In India	Abroad
Insitutional Member (for 3 years)	₹ 2,000/-	US $ 500
Life Member	₹ 1,500/-	US $ 300
Ordinary Member (p.a.)	₹ 500/-	US $ 50

Annual Subscription for Gujarat Stastistical Review / Sankhya Vignan for individuals, Institutions and library is ₹ 500 (in India), US $ 50 (Abroad)

WALTER A. SHEWHART

Walter Andrew Shewhart was born on March 18, 1891 at New Canton, Illinois, USA and he died on March 11, 1967 at Troy Hills, New Jersey, USA. He was an American Physicist, engineer and statistician. He is sometimes known as the father of **Statistical Quality Control (SQC)** and also related to the **Shewhart Cycle**. His pioneering works at the Bell Telephone Laboratories from 1925 to 1956 brought him on the world map making revolutionary changes in the industrial engineering system. Shewhart's charts were adopted by the American Society for Testing and Materials (ASTM) in 1933 and advocated to improve production during second world war in American war standards.

His honours included the following :

(1) Founding member, fellow and president of **Institute of Mathematical Statistics.**
(2) First Schewart Medalist of the **American Society for Quality.**
(3) Fellow and president of **the American Statistical Association.**
(4) Fellow of the **International Statistical Institute.**
(5) Hon. Fellow of the **Royal Statistical Society.**
(6) Holley medal of the **American Society of Mechanical Engineers.**
(7) Honorary Doctor of science from **ISI, Calcutta etc.**

***(Brief Biographical sketch is given inside the journal)**

This page is specially donated by Prof. Shailesh Teredesai (Ex. Head), Statistics Dept., S. M. Patel Insitute of Commerce, GLS, Ahmedabad-380 009.

Printed Matter **BOOK-POST**
(Journal of GSA, Ahmedabad)
To,

From :
Gujarat Statistical Association,
C/o. Statistics Dept. Gujarat University, Ahmedabad-380 009. (INDIA)