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CONTENTS

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

EDITORIAL BOARD

EDITORIAL

"CONCENTRATE ALL YOUR THOUGHTS UPON THE WORK AT HAND.
THE SUN'S RAYS DO NOT TURN UNTIL BROUGHT TO A FOCUS."
-ALEXANDER GRAHAM BELL

We feel very happy and delighted to present this issue (NSV 13, December 2017, No. 2) to our readers. We express our sincere thanks to our contributors, evaluators, readers and well wishers for their consistent support which has helped us in achieving our goal.

This issue contains **in all five research articles, one article, one note, biography and other items** as usual.

Under the caption of **Management And Statistics first article** is a very lucid presentation on sample size determination during research work. This is presented by **A.C.Brahmbhatt.** Next one in this section is a **Research Article** on brief discussion for dairy industry in India presenting its actual scenario. This research work is discussed by **Jayesh R. Purohit, Shankarsinh R. Rana and Payalba S. Rana.**

Environmental protection is the need of the day. A **note** is presented by **Mansi Patel**, regarding canadian experience for solid waste disposal schemes.

There are **four other research articles** in the journal.

First Research Article is given by **Prankumar M. and G.V.S.R. Anjaneyulu** which discusses a comparison for sample size determination under given conditions.

Second Research Article is for design of experiment for robustness of BIBD under given situations. This work is carried out by **Pratima U. Srivastava and A. J. Patel**

Third Research Article is on information flow in a supply change management for Indian and U.S. Consumer awarness. This work is carried out by **D.S.Dave, James E. Stoddard and J. Dottson.**

Fourth Research Article is presented by **Rakesh Pandya.** It is regarding fertility trend as a comparative study for western districts of Gujarat state.

Biography of the famours english statistician. **Frank Yates** is present by **H.D. Budhbhatti.**

S. V. News Letter gives some useful information. It is presented by **K. Muralidharan.**

Readers Forum expresses some views and it is presented by **A. M. Patel**

We are highly indebted to our following referees who have done excellent job of evaluation for the articles / papers submitted in this issue.

(Their names are given one by one in order of appearance of articles in the journal)

(1)	**Jayesh R. Purohit**	**(2)**	**D. S. Dave**
(3)	**Shailesh Teredesai**	**(4)**	**M. B. Thakar**
(5)	**R. G. Bhatt**	**(6)**	**A. C. Brahmbhatt**
(7)	**P. P. Prajapati**	**(8)**	**H. M. Dixit**

Digital Copy of this issue will be sent to all our readers whose email ID are with us. Printed copy will follow soon. Our contributors will be given offprints of their published article along with the printed copy and certificate.

Wishing you good health and seasons greetings.

Editorial board expresses our best wishes for the coming New Year 2018.

Ahmedabad

Date : 31-12-2017

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.

SANKHYA VIGNAN

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10. References should be mentioned in APA Referencing Format.

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MANAGEMENT AND STATISTICS
ARTICLE

SAMPLE SIZE ESTIMATIION - A CRUCIAL DECISION

A. C. BRAHMBHATT*

ABSTRACT

This article deals with some specific features that occur when samples are selected for any research study. There are different approaches at different places and it really becomes a crucial decision about sample size selection.

Key Words

Confidence Level, Response Rate, Incidence Rate SEM

• • •

In a descriptive study after having designed the questionnaire , in order to to reach out the respondents the researcher has to adopt a sampling process . The sampling process comprises of the various phases such as defining the target audience, design the sampling frame, defining the sampling unit, deciding the geographical extent, choosing the sampling method and estimating the sample size.

Though this last phase of estimating the sample size is very crucial , the researchers sometimes are found adopting a very casual approach about it. They choose the figures like 500, 600 or some other multiple of 100 as their sample size and when asked about its reasoning they have lame explanations like 'the other researchers had chosen such figures' or 'my supervisor suggested it' etc. In several Ph.D. studies also, you will find the researchers choosing such figures as their sample size.If you have to give a Birthday gift or Marriage gift to your friends you may choose such auspicious figures but in a scientific study undertaken by you what is sacrosanct about such figure as sample size that has no logical reasoning.

* Research Mentor, PDPU, Gandhinagar. (rec. Dec.'17 / rvd. Dec.'17)

There are several misconceptions prevailing about the sample size, say for example the notion of small sample and large sample. How do you define smallness or largeness of the sample size? Strictly statistically speaking $n > 30$ is considered to be the large sample but in real world situation , even in a pilot study , we are choosing minimum 50 respondents as sample respondents. Suppose one selects sample of 500 or even more and calls it a large sample , but when he compares it with the size of the aggregate (N), which might be 5 lakh or even more, the sample size of 500 is only 0.1% of the total-how can you say it is large?

Secondly , the researchers do leverage from the large size of the sample in terms of the reduced standard error(as standard error is standard deviation /square root of n) but at the same time it inflates the cost of sampling. Therefore one has to think as to how to deal with this cost-precision trade–off. These sorts of paradoxes have led the researchers to explore the approaches like Confidence Level Approach wherein the researcher defines his tolerable margin of error or degree of precision say plus–minus 100 of the true mean and his confidence level say 95% ,that leaves only 5% risk of the true population parameter being outside the defined margin of error. This confidence level-based formula are available for both -for estimating means and proportions. The sample size so obtained can also be revised in the light of the population size-N , if it is known and finite.

The sample size formula are also available in any standard text book of Statistics for stratified random sampling with disproportionate allocation, with proportional allocation and also with optimum allocation where the cost per interview in a particular stratum and the standard deviation of that stratum are also embedded in the formula.

When the response rate is known and also the incidence rate (it refers to the rate of occurrence or percentage of respondents eligible to participate in the study) is known , the initial sample size chosen has to be much bigger as to ultimately provide the required size dictated by the formula.. For example, in a household survey the response rate is 60% and those heads of families in the age group 30-60 years are considered to be eligible as respondents in the survey

and according to census data , there are 75% of such respondents, and suppose the sample size worked out by the Confidence Level Approach formula is 351, then the initial size of the sample has to be : 351/0.6*0.75 i.e. 780.

Sample size also depends on what type data analytical technique the researcher wants to employ. For example the Chi-square analysis requires the minimum sample size of 50. In Multiple Regression Analysis –it is more the merrier. In Factor Analysis , some thumb rule is generated by the researcher like Throndike like n = squareof k+50 where k is the number of variables. If you have 10 variables, you require minimum sample size of 150 to run the Factor Analysis.For Structural Equation Modeling(SEM), with 5 or fewer constructs, each with more than 3 measured variables and communalities of at least 0.5 should be estimated with sample sizes of at least 200. When there are more than 5 constructs, with several constructs being measured with fewer than 3 indicators, and there are multiple low(less than 0.5) communalities, the sample size should be at least 400. **

The sample size estimation decision is crucial and should be seriously arrived at by the researchers.

Acknowledgements

I thank the referee for reviewing my article. I also thank the editor for inviting me to write a article in this section on "Management And Statistics."

Reference

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MANAGEMENT AND STATISTICS
RESEARCH ARTICLE

INDIAN DAIRY INDUSTRY- PRESENT AND FUTURE SCENARIO

Jayesh R. Purohit[(1)], Shankarsinh R. Rana[(2)], Payalba S. Rana[(3)]

ABSTRACT

This paper carries out an exhaustive study pertaining to Dairy industry in India. It describes the present situation, opportunities and problems for thsi industry. It is a known fact that the industry is lucrative however it also has shortcomings and constraints. A vision for year 2030 is indicated briefly for presenting future scenario.

Key Words

FAO, FSMA, FSSAI, Vision

1. Introduction

India is set to become world's most populated country by 2030 with around 1.53 billion people and 19 %+ of world's population by the same time. India, with current approximately 18% of world population which is growing with the rate of 1.3% annually, has only 7.3% of global arable land faces a huge challenge ahead for its agricultural sector to feed these extra mouths. This task becomes more challenging against climate change and tightening natural resource constraints (water and soil foot print) and reducing cultivable land in wake of magnums unplanned urbanisation. There is clearly a massive challenge facing the Indian

(1) Mantra Consultants, Ahmedabad, Gujarat State
email : drjayesh.purohit@gmail.com
(2) Principal, Arts and Commerce College, Kalol, Gujarat State and Chirman, Madhur Dairy, Sector 25, 'ઙ' Road, Gandhinagar
(3) Research Student. (rcd. Nov.'17 / rvd. Dec.'17)

industry. With global populations set to rise from 7 billion today, to 8 billion by 2030 and 9 billion by 2050, opportunities for Indian food producers to respond to this growing market place are considerable.

FAO (Food & Agriculture Organization) has analysed global dairy trends as far as 2050. Their analysis predicts that as incomes rises, people generally prefer to spend a higher share of their food budget on animal protein, so meat and dairy consumption tends to grow faster than that of food crops. As a result, the past three decades have seen buoyant growth in the consumption of livestock products, especially in newly industrialising countries and emerging markets. Post white revolution Indian dairy industry has shown a constant growth in milk production as well as in per capita milk availability. That is 51.4 million tons in 1990 to about 127 million tons in 2011-12 and 291 gm/day respectively. Few reports suggest that with current growth rate of approx. 3%-4% it is thought to grow to 185 million tons and become a $24 billion (Rs 144000 Crore) organised industry by 2020 and $140 billion (Rs 840000 Crore) including unorganised sector.

However, research considers the same production levels by 2022-23 only. Even such volumes could only be attained if the system wakes up and begin to act fast on the new context being suggested by us by focussing on farmer's groups, societies and associations rather than individuals. Based on extrapolations of mega Indian economic story and analysis of domestic growth, India will shoot ahead of Japan in mid 2030's to become the world's third biggest economy. Consequently, a huge surge in GDP and PPP is expected. Reflecting in enhanced protein consumption in form of dairy products in India. During next few years till 2030 the demand of dairy products is expected to grow at a rate of 9%-12% and industry at a rate of 4-5%. Clearly Indian industry will struggle to maintain 100% self-sufficiency due to huge local demand, between 160 to 170 Million Tonnes of milk at would be required by 2030. The industry will have to overhaul to meet ends.

With the potential to accommodate imports with home produced dairy products Indian industry will present to be a very lucrative market. Net area sown has not grown in proportion to the rate of growth of population. There could be

marked decline in the area allocated for pastures and animal grazing from 7 % to 6% by 2020 and with the increased pressure of urbanization and modified land bills it could further reduce to below 5 % by 2030.

The land for green fodder production will only grow from 5 to 6 % by 2030, if strong measures to induce contract farming or focus on commercial fodder production by corporate for captive or group usage are not taken up. The compound feed market is also underserved and the installed capacity is only 10 % of the expected total demand of around 60 million MT per annum at current levels.

A lot of investments need to be directed towards building this capacity as well as to incentivise and subsidise cattle feed manufacturers to set up mineral mix plants also. This will ensure better nutrition to the animal over and above the feed for health. The current deficit for green fodder, dry fodder and concentrates have a deficit of 63% ,24 % and 76% (2010 data) respectively which means that even at today's demand level for milk production there is a need to double up the land for fodder growing and pastures feed lots for dairy. There has been large gap in production of medicines and vaccines for animal industry.

A robust plan to raise the current home delivered AI (Artificial Insemination) levels for animal breeding from around 20 % to 80% needs to be implemented. Farmers in interior are perceptually not ready to accept AI as a technique for their animal breeding. It puts more pressure on the system to develop large scale capacity building programs at community levels over and above looking out for establishing bull breeding farms or semen production. Male calves and stray bulls of poor pedigree are considered to be the biggest impediment to the sustainability of the Indian dairy industry. Both of these categories put a lot of pressure on limited resources therefore some pragmatic solution by using latest technologies like sexed semen and injection based sterilisation could be evaluated and implemented.

The same problems could also be better handled through a community led approach rather than an individual farmer focus. From 2009 to 2014 the middle class in Africa grew by 3 times from 120 to 330 million and by 6 times from 500 million to 3.2 billion. This trend has yet to bloom fully and these booming

economy and expanding cash rich middle class, would mean a lucrative and very incentivising market. This would make India a hotspot of globally competitive and compliant dairy destination.

Dairy Industry would witness further consolidation of organised dairy structure to an impressive 35% by that time. Post 2020's industry will see increased dominance and importance of "A" class global brands and emergence of "private labels" meaning Indian dairy industry would be under pressure to become globally competitive at all stages of the supply chain. Customer maturity along with FSSAI (Food Safety & Standards Authority of India) norms and adaptations of newer versions of food quality norms like FSMA (Food Safety Modernization Act) would coerce industry to improve efficiency and effectiveness and where possible benchmark their performance.

2030 will see the apotheosis of long sighted dream of becoming a global giant in international dairy market with Indian companies positioning themselves in hall of fame global dairy arena. In 2030, it would be rather a surprise to not to see mega dairy brands like Fonterra, Avonmore, Campina, Alra etc. when you walk in to a store even in a Tier 2 and 3 level cities and towns.

The research has brought out a 5I model consisting of Identification, Inventorization, Integration, Institutionalization and Investment as a mantra for developing a national level strategy to meet the humongous demand of milk and milk products through sustainable dairying in India through community mobilization.

2. Dairy Industry: Vision - 2030

Rationale

"Mass production is production by masses" has been the mantra behind Indian context of agricultural development and a strong conviction of Mahatma Gandhi. Since independence most of our policies for agriculture sector have been an outcome of this context. Dairy comes under fragmented industry as per the definition of uber guru on strategy Michael Porter, which means local requirements

have to be met through local supplies as the production is scattered and available locally.

The strategy for dairy development till date lies with decentralising the production and centralising the processing and marketing. In this model with individual focus to a farmer or even a village level society, scaling is difficult. The only strategy to counter this state is by building economies of scale at all levels of business by developing a critical mass. Indian dairy production comes majorly from small and marginal farmers with an average animal holding of 2-4 animals. Barring very few areas in the country where dairy is not considered as the main occupation at household level, it may be perceived as a pocket money business for the homemaker or pass-time activity for the elderly at home.

The farmer also keeps a major part of nutritional milk for his family at home. Cost of production is imputed as the input to animals are either assortment of agriculture residues or by grazing at community owned pastures land. In such cases though a religious commitment to animal is visible but business wisdom to grow the business is missing or in other words in the whole model sustainability is missing. In this vision document we propose to set a new context while reimagining dairying in India. The research shows that now only a radical change in our national policy making could bring about the required growth in milk production by 2030 for supply to meet demand. It requires a scale orientation and development of critical mass at all levels of the value chain for cost effective interventions and investments.

The industry does not have time to pursue uninterested farmer with an indifferent generation "Y" to identify himself with the animal rearing. However much better result at a faster pace could be achieved by focussing on existing dairy communities in the form of societies or associations or by developing dairy clusters of various stakeholders in the dairy value chain.

A progressive community not only brings in scale to the business but also brings in necessary commitment to grow and build a professional model attractive enough for young generation to become part of it. In the later part of the research

we will offer a blue print of an implementation plan to further support our vision statement. Let us try to prove it empirically.

3. Looking beyond the Horizon: Opportunities

- Total milk production in India may touch 216 Million Metric ton by 2030 with a per capita consumption of around 390 ml at an estimated population of 1.53 billion.
- Packaged milk, to grow from $7.76 billion to $32.9 billion by 2030, with 8% annual growth.
- 73% milk sold by 2030 would be branded, against 31 % at present. Sweets and savoury snacks will be second largest category at an estimated $16.39 billion by 2030 from $1.28 billion in 2010, clocking a 13% growth annually.
- India's per capita GDP is expected to leap 320% in the next 20 years, with a parallel increase in overall food consumption by 4% per annum from INR 11 lakh crore in 2010 to INR 22.5 lakh crore in 2030.
- Agricultural output (at farm-gate prices) could grow from INR 12.69 lakh crore in 2011 to INR 29.28 lakh crore by 2030.
- Processing could grow from INR 1.1 lakh crore in 2011 to INR 5.65 lakh crore by 2030. Food exports could rise from INR 1.4 lakh crore in 2011 to INR 7.72 lakh crore by 2030.
- India world's biggest producer of mango, banana, papaya, milk, spices, sesame, and castor oil-seed in 2010.
- With improvements, farmers could aspire four times better income, reducing gap with national average income in 20 years.
- Agricultural GDP grew at the rate of approx. 3% between 1980 and 2012. India becomes third largest agricultural producer by value (closely behind China and the United States).
- India spending more on high value foods. Consumption shifting from plant to animal-based protein.

- Agricultural productivity grew over the last decade, with a qualitative shift from basic food grains to high value agriculture like fruits and vegetables.
- Between 2000 and 2010, high value produce moved from forming 38% to 45% of total produce by weight.
- High value foods like soya bean, potato, mango, banana, and poultry grew 4 times faster than like rice and wheat.
- There was a 4.35 times increase in total agriculture outlay from the 10th Five Year Plan to the 11th Five Year Plan.
- Agricultural outlay in Percentage to increase from 5.2% in the 10th FYP to 5.6% in the 11th FYP. Highest proportion allocated to agriculture in the last 20 years.
- Consumers could benefit from better milk supply to match per capita consumption. Having access to safe and healthy milk at affordable prices.
- Packaged food segment to grow 9% annually to become Rs 6 lakh crore industry by 2030. Packed milk, sweet and savoury snacks and processed poultry, to dominate.
- Branding to enhance realization of packaged foods by up to 30% by 2030.
- India has a huge potential in Animal medicines market. With current levels of around Rs 2000 Crores this is just around 2 % of world's market share even after having largest animal population in the world. With high growth rate of cross bred animals in the country as well as current alarm against Indian dairy products in certain countries due to F&M the demand of medicines and vaccines may be on the rise. The current rate of growth is about 10 % on YoY.
- BRIC Report by Goldman Sachs predicts India's third largest economy by 2032, ranking just after the US and China.
- Animal nutritional product market is close to Rs 800 crore with around 20 % YoY growth.

4. Focus Areas

- To improve productivity in large pool of animals so as to meet large demands of milk and milk products
- To promote indigenous animals for A2 milk as well as on chemical free and organic milk to meet future demands

- To improve capacity utilization of existing capacities by making value added products
- To develop critical mass for economies of scale both through community projects and by supporting setting up of large dairy farms

5. Challenge Areas

Small farmer market puts pressure on distribution costs, especially vaccines requiring cold chain. On the other side, trade exerts pressure on margins due to the dispersed market. Affordability is a big issue at individual farmer level at the last mile and thus the end result is unregulated competition at both quality and price levels for all markets of farm input at rural India.

- Availability of green fodder for the animals
- To keep unproductive and low quality animals away from accessing the high value natural resources as well as from reproducing more of their likes.
- Developing a mass scale extension services for dairying in a fragmented scenario as well as for developing a large pool of trainers for dairy industry.
- To develop an appropriate distribution and pricing policy for milk from
- Indian descript cows
- To set up common service centre for milking, natural/AI, silage, hydroponics, biogas, processing (SPV), capacity building for CMP, health and nutrition, effluent treatment plant, packaging recycle units, community dairy waste treatment for milk collection and chilling centre.
- To create opportunities of higher ROI (Return On Investment) in the industry by wise product mix selection.

6. Concluding Remarks

Dairy industry will show exponential growth in time to come. The influencers attached with this industry will earn much more than past and will get more & more benefits from the Government by the way of various schemes and subsidies.

7. Acknowledgements

Authors express their deep sense of gratitude to the referee for reviewing this paper which has helped in its revison.

MANAGEMENT AND STATISTICS
NOTE

CANADIAN EXPERIENCE OF SOLID WASTE DESPOSAL SCHEMES FOR ENVIRONMENTAL PROTECTION

Mansi Patel*

ABSTRACT

This paper deals with a brief study for the solid waste management schemes as used in Canadian States. It is also compared with German Dual System experience. Further modifications are suggested which may be helpful for environmental protection in Canada.

KEY WORDS

Blue Box System, Recycling, Green Dot, Extended Producer Responsibility (EPR),OWDA

1. WASTE BLUES : CURBSIDE RECYCLING REASSESSED

In the article by David Menzies, he critically reviewed Ontario's Blue Box system which was initiated in 1985. In the initial years of its introduction, it gained an enthusiastic response from politicians, environmentalists, soda industry and the public. However, it faced a lot of criticism from the environmentalists and the municipal officials in the later years.

Since its introduction, the Blue Box emerged as the favourite method of disposing waste for the urbanites because they can just dump their waste proudly in those blue boxes that say **'We Recycle'**. **Studies suggested that only 30% of the recyclable items were recycled whereas remaining 70% ended up either in landfill sites or as litter.**

* P. G. Student (M. Engg.) CarletonUniveristy, Ottawa, Canada
Email : patelmansi1412@gmail.com (rcd. Nov.' 17 / Dec.'17)

Following these consequences enforced the environmentalists and consultants to end up stating the Blue Box system as just a business strategy and terrible drain of resources. The soft drinks companies were targeted for using Aluminium cans and Polyethylene Terephthalate (PET) containers rather than using refillable glass bottles. It was not much later when John Jackson of the Citizen's Network proposed the idea of deposit-return system for all beverage containers. However, the soft drink industry did not get along with the user-pay system claiming the refillable bottles causing more harm to the environment than the recyclable bottles and cans. Valiante of General Science Works noted that when the soft-drink companies criticized refillable bottles, they contradicted the usage of tens of millions of the same bottles over Europe, Southeast Asia, Mexico and South America. Moreover, Eva Ligeti, the environmental commissioner of Ontario found that while the soft-drinks firm in Ontario are obliged to sell 30% of their products in refillable bottles, the real figure was less than 2%. In addition to this, the shopping patterns of people of Ontario and North America affected the usage of refillable PET bottles. However, the recovering and reusing rate of beer bottles can set as a perfect example for the soft-drink industry. Not to forget the zero contribution of Liquor Control Board of Ontario (LCBO) towards the Blue Box program although these boxes being over stuffed by the glass bottles purchased at LCBO. Hence, in the end one can only find the feasible solution if various industries and companies are ready to contribute towards the environmentalism.

2. GERMANY DUAL SYSTEM : GREEN DOT

Der Grüne Punkt – Duales System Deutschland GmbH (DSD) was founded in 1990 as the first dual system, providing nationwide collection of used sales packages and obtaining raw materials from them for the closed-cycle economy. Today Green Dot is a leading provider of take-back systems.

The Green Dot is a protected trademark of DSD, its task being the collection, sorting and recycling of used sales packaging. It is financed by trade and industry manufacturers and distributors. Also, the payment is based entirely on the material

used and the weight of packaging. It indicates to the end consumer that the manufacturer of this packaging has fulfilled the requirements of the Packaging Ordinance. Apart from Germany, this system is being successfully implemented in 25 European countries and 6 other countries. Sorted waste such as aluminum and tinplate are melted down and processed into new aluminum or tinplate cans. There are basically two types of collection systems in this Dual system: (1) **Kerbside system** with the yellow bag or the yellow bin for collecting lightweight packaging at home and (2) **Drop-off system** in which the consumer can use containers for recyclables (ex. Glass and paper packaging) collection placed near the home. About 92% of consumers think it is a good practice to collect recyclables. Here, separate collection of packaging recyclables from residual waste by the consumer is a pre-condition for efficient recycling as the unsorted waste would greatly reduce the quality of the sorted recyclables and significantly increase recycling costs. Studies suggest that 94% of consumers separate packaging of plastic or metal from residual waste. There are five waste categories in total: **(a) packaging waste from glass and paper, (b)** so-called **lightweight packaging of plastic, (c) aluminum, tinplate and composites, (d)** as well as **residual waste and (e) bio-waste.** Individual collection containers are available for each of these five categories. Moreover, CD's and DVD's needs to be separated for recycling because they consist of valuable plastic. **Not to forget that separation by color is especially important for the recycling of glass.**

Thus, DSD and other such organizations can contribute significantly to the conservation of environmental resources and limiting greenhouse gas emissions.

3. TRANSITIONING ONTARIO'S BLUE BOX TO EXTENDED PRODUCER RESPONSIBILITY (EPR)

Since more than a decade, Ontario's Waste Diversion Act 2002 (WDA) works as a **"shared responsibility"** which says that the producers whose products result in paper products and packaging (PPP) must fund 50% of net municipal recycling costs of delivering Blue Box PPP recycling. This will in turn result as a support

towards Blue Box system.

The recent introduction to Resource Recovery and Circular Economy Act with the same concept of EPR, will shift the obligation for delivering Blue Box recycling from Ontario municipalities to producers. For the success of EPR, some of the prerequisites such as Seamless transition to full EPR, Minimization of disruption to management of municipal and private sector capital assets i.e. to allow a smooth transition, avoiding the disruption of existing municipal contracts and to ensure a continued open and competitive market, etc. should be attained. In addition to this, strong arrangement of capitals are needed to process PPP.

It was noted that majorly the private companies were involved in collection of the Blue Box PPP. The term of the contract are defined by the municipalities and are generally of 7 years for collection contract and 10 years for processing contract. Here, the most efficient way of transition to full EPR is said to be when the producers or the manufacturers understand their responsibility to deliver PPP collection either to the municipalities or to the private companies using their contract with them and furthermore recycling the same with an existing municipal contract. The transition from shared to full producer responsibility will ultimately lead to an increase in producer self-determinacy, to determine and manage private and municipal sector assets and most importantly the household collection without any sort of interruption.

The above proposed approach transitioning from shared responsibility to EPR for PPP would need a thorough study and simultaneous participation of producers and Ontario municipalities.

4. OTTAWA LAGGING ON WASTE DIVERSION

Recently in September 2017, a new report by the group Waste Watch Ottawa (WWO) stated that Ottawa is actually lagging behind other Ontario municipalities when it comes to diverting residential waste from landfills. On comparing with all the major cities, Ottawa has the least diversion rate.

It was a critical blow when Ottawa disconnected itself from a deal with Plasco

Energy Group which produced electricity from waste. According to WWO, Ottawa diverted 42.5% of its residential waste in 2015, the provincial average being 47.7%. As per the studies by Duncan Bury of WWO, 50% of Ottawa residents are not using their green bins, and 25 per cent do not use the recycling program at all. In addition to this, the city of Ottawa lacks in recycling and green bin promotion and education than do all other large municipalities in Ontario.

For getting the highrise on board, Ottawa needs to look for more successful solutions. Apart from this certain measures like municipalities having a dedicated staff who can work hand in hand with building managers, superintendents, condo boards and rental tenant associations should be encouraged. Moreover, it is found that the residential diversion rates are higher than industrial, commercial and institutional sector, which point out towards the only effective solution being the participation of municipalities.

5. ACKNOWLEDGEMENTS

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RESEARCH ARTICLE

A COMPARISON BETWEEN SAMPLE SIZES FOR ANOM-TYPE GRAPHICAL METHODS FOR TESTING THE SIGNIFICANT DIFFERENCE AMONG SEVERAL VARIANCES

M. Pran Kumar and G.V.S.R. Anjaneyulu

ABSTRACT

A comparison is done between the sample size derived by Pran Kumar and Anjaneyulu (2016) for an ANOM – type graphical method developed by Rao and Harikrishna (1997) and the sample size derived by Pran Kumar and Anjaneyulu (2017) for another ANOM – type graphical method developed by and Pran Kumar and Rao (1998) to detect the significance of one of the population variance among k normal population variances from their grand average by at least a specified amount 'd' for fixed level of significance α *and fixed power P in the case of equal sample sizes. The specified amount* Δ *in the sample size given by Pran Kumar and Anjaneyulu (2016) and the specified amount D in the sample size given by Pran Kumar and Anjaneyulu (2017) are derived in terms of the common amount 'd' for comparison. The tables of comparison of sample sizes are given particularly for one of the significant variance taken as unity among k variances from their grand average and for* α = 0.01, 0.05, P = 0.8, 0.9, 0.95, 0.99, d = 1, 3, 5 *and* k = 3(1) 20, 30, 60. *The comparison reveals that the sample size derived by Pran Kumar and Anjaneyulu (2017) for the method developed by Pran Kumar and Rao (1998) is less than that of the sample size derived by Pran Kumar and Anjaneyulu (2016) for the method developed Rao and Harikrishna (1997).*

***Key words*:** *Analysis of means, cube root transformation, log-transformation, normality, power.*

* M. Pran Kumar and G. V. S. R. Anjaneyulu, Department of Statistics, Acharya Nagarjuna University GUNTUR – 522510, A.P., India. harini.pran@gmail.com, & profgvsranu@gmail.com
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1. Introduction

The problem of testing the significant difference among k normal population variances occurs very often in many areas such as life sciences, physical sciences, engineering, medicine agriculture and social sciences. Several test procedures were developed by many authors in the literature for testing the significant difference among k normal population variances. Rao and Harikrishna (1997) developed a graphical method, namely "A graphical method for testing the equality of several variances" similar to analysis of means (ANOM) introduced by Ott (1967). Rao and Harikrishna (1997) used cube root transformation of chi-square to normal of Wilson and Hilferty (1931) in the derivation of decision lines. Using log - transformation of Bartlett and Kendall (1946) in the derivation of decision lines, Pran Kumar and Rao (1998) developed another graphical method, namely "ANOM – type graphical method for testing the equality of several normal population variances". Rao (2005) made a review of papers in the area of analysis of means.

In the problems of testing of hypotheses by random sampling, determination of size of sample is the most important primary task. Sample size determination is very helpful for the investigator to decide the number of units to be investigated from a population to test the hypothesis. By which he can control the cost, time and power of the test. Motivated by Nelson's (1983) tables of sample sizes, recently, Pran Kumar and Anjaneyulu (2016) derived an expression of the sample size for the ANOM-type graphical method developed by Rao and Harikrishna (1997) to detect the significant difference among k normal population variances by at least a specified amount Δ. Most recently, another expression of sample size was derived by Pran Kumar and Anjaneyulu (2017) for the graphical method developed by Pran kumar and Rao (1998) to detect the significant difference among k normal population variances by at least a specified amount D. Both sizes of samples were derived in the case of equal sample sizes for fixed level of significance and fixed power P using the expression as given in Chow et al.(2008, p.71) to determine sample sizes where the samples were taken from normal populations.

In this paper, a comparison is made between the sample size derived by Pran

Kumar and Anjaneyulu (2016) for the method developed by Rao and Harikrishna (1997) and another sample size derived by Pran Kumar and Anjaneyulu (2017) for the method developed by Pran kumar and Rao (1998). The comparison is carried out to detect the significance of one of the population variance among k normal population variances from their grand average by at least a specified amount d for fixed level of significance α and fixed power P in the case of equal sample sizes.

Section 2 presents the brief description of graphical methods developed by Rao and Harikrishna (1997) and Pran Kumar and Rao (1998) in the case of equal sample sizes. Also, it presents the sample sizes derived by Pran Kumar and Anjaneyulu (2016, 2017) for the above respective methods. In Section 3, the specified significant difference amount in the sample size given by Pran Kumar and Anjaneyulu (2016) and the specified significant difference amount D in the sample size given by Pran Kumar and Anjaneyulu (2017) are derived in terms of the common amount d for comparison. The tables of comparison of sample sizes are given particularly for one of the significant variance taken as unity among k variances from their grand average and for α = 0.01, 0.05, P = 0.8, 0.9, 0.95, 0.99, d = 1, 3, 5 and k = 3(1) 20, 30, 60 in Section 4.

$\{X_{ij}\}, i = 1,2,...,k; j = 1,2,...,n$

2. ANOM-Type Graphical Methods and Sample Sizes

Let be k independent random sample drawn from k normal populations $N(\mu_i, \sigma_i^2)$. We wish to test the null hypothesis

$H_0 : \sigma_1^2 = \sigma_2^2 = ... = \sigma_k^2 = \sigma^2 (unknown)$

against the alternative hypothesis that at least one equality does not hold.

The graphical method developed by Rao and Harikrishna (1997) to test H_o in the case of equal sample sizes consists of the lower decision line (LDL) and the upper decision line (UDL) for the comparison of each t_i are given by

LDL = $\bar{t} - Z_{(1-\alpha/2k)} S.E.(t_i - \bar{t})$

UDL = $\bar{t} + Z_{(1-\alpha/2k)} S.E.(t_i - \bar{t})$

Where $t_i = S_i^{2/3} / A$, $A = \frac{9n-11}{9(n-1)^2}$, $\bar{t} = \frac{1}{k}\sum_{i=1}^{k} t_i$

$$SE(t_i - \bar{t}) = \bar{t}\sqrt{\frac{C(k-1)}{k}}, \quad C = \frac{18(n-1)}{(9n-11)^2}$$

S_i^2 are the sample variances for all $i = 1, 2, ..., k$ and is the standard normal variable value for the cumulative probability $(1 - \alpha/2k)$. By plotting t_i against the respective decision lines if any one of the points plotted lies outside the respective decision lines, H_o is rejected and conclude that the population variances are significantly different. This method is applicable when the sample size n>3.

The sample size derived by Pran Kumar and Anjaneyulu (2016) for the method developed by Rao and Harikrishna (1997) to detect the significant difference of any one of from unity by at least a specified difference Δ in the case of equal sample size for a fixed power P is given as follows

(2.1)

Where $Z = Z_{(1-\alpha/2k)} + Z_p$

$Z_{(1-\alpha/2k)}$ and Z_P are the values of standard normal variate values for the cumulative probabilities of $(1 - \alpha/2k)$ and power P respectively and = for one of t_i.

Another graphical method developed by Pran Kumar and Rao (1998) to test H_0 in the case of equal sample sizes contains the lower decision line (LDL) and the upper decision line (UDL) for the comparison of each of t_i' are given by

LDL =

UDL = $\bar{t}' + Z_{(1-\alpha/2k)} S.E.(t_i' - \bar{t}')$

where = *ln* and $\bar{t}' = \frac{1}{k}\sum_{i=1}^{k} t_i'$

$SE(t_i' - \bar{t}') = \sqrt{\frac{2}{n-1}(1-\frac{1}{k})}$

By plotting t_i' against the respective decision lines if any one of the points plotted lies outside the respective decision lines, H_0 is rejected and conclude that the population variances are significantly different. This method is applicable when the sample size $n > 10$.

Another sample size derived by Pran Kumar and Anjaneyulu (2017) for the method developed by Pran Kumar and Rao (1998) to detect the significant difference between any one of and by at least a specified difference D in the case of equal sample size for a fixed power P is given as follows

(2.2)

where $D = t_i' - \bar{t}'$ for one of t_i'.

$n_2 = 1 + 2(1-1/k)\left[\frac{Z_{(1-\alpha/2k)} + Z_p}{D}\right]^2$

3. Derivation of Expressions for and *d* in Sample Sizes in Terms of the Common Amount *'d'* for Comparison

Since, the significant difference amount taken in the sample size derived by Pran Kumar and Anjaneyulu (2016) as given in (2.1) is different from that of the significant difference amount D in the sample size derived by Pran Kumar and Anjaneyulu (2017) as given in (2.2) then, the two amounts and D are derived in terms of the common significant difference amount d for making comparison between the sample sizes. The derivations are carried out on the basis of the following considerations:

, the sample variances as the estimators of their respective σ_i^2, the normal population variances for all i =1, 2, …, k and

$\bar{S}^2 = \frac{1}{k}\sum_{i=1}^{k} S_i^2$, the grand mean of all sample variances is the estimator of equal

variance σ^2 of all k normal populations in the case of equal sample sizes.

While testing H_0 , let us suppose that H_0 is rejected when it is actually false with a fixed level of significance α and power P on the basis of the evidence that there is a significant difference between one of the sample variance and the grand mean $\bar{S}^2$ by an amount d .

For this, we assume that one of the sample variance $S_i^2 = S^2$ (for some i) is significantly lesser than $\bar{S}^2$ by an amount d i.e., $S^2 = \bar{S}^2 - d$ and all the remaining k-1 sample variances are equal as $S_j^2 = S^2 + d/(1-1/k) \wedge j \neq i.$

3.1 Derivation of Δ in Terms of the Amount *d*

Based on the above information the amount taken in the sample size given in (2.1) is derived in terms of the amount d by considering one of

(3.1.1)

and the remaining k-1 statistics are equal as

$$t_j = \left\{S^2 + d/(1-1/k)\right\}^{1/3} \Big/ A \ \wedge j \neq i, \tag{3.1.2}$$

in the graphical method developed by Rao and Harikrishna (1997).

By using (3.1.1) and (3.1.2) in $\bar{t}$ in the graphical method, we obtain

$$\bar{t} = \frac{1}{k}\sum_{i=1}^{k} t_i = \frac{1}{Ak}\left[\left(S^2\right)^{1/3} + (k-1)\left\{S^2 + d/(1-1/k)\right\}^{1/3}\right] \tag{3.1.3}$$

Since, Δ = for one of t_i. By substituting (3.1.1) and (3.1.3) in Δ, we have

=

$$= \frac{k\left(S^2\right)^{1/3}}{\left(S^2\right)^{1/3} + (k-1)\left\{S^2 + d/(1-1/k)\right\}^{1/3}} - 1 \tag{3.1.4}$$

3.2 Derivation of D in Terms of the Amount d

Similarly the amount D taken in the sample size given in (2.2) is derived by considering one of

$$t_i' = lnS^2 \tag{3.2.1}$$

and the remaining k-1 statistics are equal as

$$t_j' = ln\left\{S^2 + d/(1-1/k)\right\} \wedge j \neq i, \tag{3.2.2}$$

in the graphical method developed by Pran Kumar and Rao (1998).

By using (3.2.1) and (3.2.2) in $\bar{t}'$ in the graphical method, we obtain

(3.2.3)

Since, $D = t_i' - \bar{t}'$ for one of t_i' .

By substituting (3.2.1) and (3.2.3) in D, we have

$$D = ln\left[S^2\left\{S^2 + d/(1-1/k)\right\}^{k-1}\right]^{1/k}$$

$$\bar{t}' = \frac{1}{k}\sum_{i=1}^{k} t_i' = ln\left[S^2\left\{S^2 + d/(1-1/k)\right\}^{k-1}\right]^{1/k} = ln\left\{S^2 \Big/ \left[S^2\left\{S^2 + d/(1-1/k)\right\}^{k-1}\right]^{1/k}\right\} \tag{3.2.4}$$

4. Tables of Comparison of Sample Sizes

The computed sizes for the sample size n_1 derived by Pran Kumar and Anjaneyulu (2016) for the method developed by Rao and Harikrishna (1997) given in (2.1) and the sample size n_2 derived by Pran Kumar and Anjaneyulu (2017) for the method developed by Pran Kumar and Rao (1998) given in (2.2) and their comparison $n_1 - n_2$ for α = 0.01, 0.05, P = 0.8, 0.9, 0.95, 0.99, d = 5, 3, 1 and k = 3(1) 20, 30, 60 are presented in Tables 4.1 through 4.6. The expressions Δ given in (3.1.4) and D given in (3. 2.4) are used in the computations of and n_2 respectively by taking one of the significant sample variance as unity i.e., $S^2 = 1$.

Table. 4.1 $\alpha = 0.01 \quad d = 5$

P	0.8			0.9			0.95			0.99		
k		n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$
3	14	**10,**11	3	17	13	4	20	15	5	26	19	7
4	15	11	4	19	13	6	22	15	7	28	19	9
5	16	11	5	20	13	7	23	15	8	30	20	10
6	17	11	6	21	13	8	24	16	8	31	20	11
7	18	11	7	22	14	8	25	16	9	32	20	12
8	18	11	7	22	14	8	26	16	10	33	20	13
9	19	12	7	23	14	9	26	16	10	34	21	13
10	19	12	7	23	14	9	27	16	11	34	21	13
11	19	12	7	23	14	9	27	16	11	35	21	14
12	20	12	8	24	14	10	27	17	10	35	21	14
13	20	12	8	24	15	9	28	17	11	35	21	14
14	20	12	8	24	15	9	28	17	11	36	21	15
15	20	12	8	25	15	10	28	17	11	36	22	14
16	21	12	9	25	15	10	29	17	12	36	22	14
17	21	12	9	25	15	10	29	17	12	37	22	15
18	21	13	8	25	15	10	29	17	12	37	22	15
19	21	13	8	25	15	10	29	17	12	37	22	15
20	21	13	8	26	15	11	29	17	12	37	22	15
30	23	13	10	27	16	11	31	18	13	39	23	16
60	25	14	11	29	17	12	33	19	14	42	24	18

Table. 4.2 $\alpha = 0.01 \quad d = 3$

P	0.8			0.9			0.95			0.99		
k		n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$
3	20	16	4	25	19	6	29	23	6	37	30	7
4	22	16	6	27	20	7	32	23	9	41	30	11
5	24	17	7	29	21	8	33	24	9	43	31	12
6	25	17	8	30	21	9	35	25	10	45	32	13
7	26	18	8	31	22	9	36	25	11	47	32	15
8	26	18	8	32	22	10	37	26	11	48	33	15
9	27	18	9	33	22	11	38	26	12	49	33	16
10	28	19	9	33	23	10	39	26	13	50	34	16
11	28	19	9	34	23	11	39	26	13	50	34	16
12	28	19	9	34	23	11	40	27	13	51	34	17
13	29	19	10	35	23	12	40	27	13	52	35	17
14	29	19	10	35	24	11	41	27	14	52	35	17
15	30	20	10	36	24	12	41	27	14	53	35	18
16	30	20	10	36	24	12	42	28	14	53	35	18
17	30	20	10	36	24	12	42	28	14	53	35	18
18	30	20	10	37	24	13	42	28	14	54	36	18
19	31	20	11	37	24	13	43	28	15	54	36	18
20	31	20	11	37	25	12	43	28	15	55	36	19
30	33	21	12	39	26	13	45	29	16	57	37	20
60	36	23	13	42	27	15	48	31	17	61	40	21

Table. 4.3 $\alpha = 0.01 \quad d = 1$

P	0.8			0.9			0.95			0.99		
k		n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$
3	59	52	7	73	65	8	85	76	9	112	100	12
4	66	56	10	81	70	11	95	82	13	125	107	18
5	71	60	11	87	74	13	102	86	16	133	113	20
6	75	62	13	92	77	15	107	90	17	140	117	23
7	78	64	14	95	79	16	111	92	19	144	120	24
8	80	66	14	98	81	17	115	94	21	148	122	26
9	83	68	15	101	83	18	117	96	21	152	125	27
10	84	69	15	103	84	19	120	98	22	155	127	28
11	86	70	16	105	86	19	122	99	23	157	128	29
12	88	71	17	107	87	20	124	101	23	159	130	29
13	89	72	17	108	88	20	125	102	23	161	131	30
14	90	73	17	109	89	20	127	103	24	163	132	31
15	91	74	17	111	90	21	128	104	24	165	134	31
16	92	75	17	112	91	21	130	105	25	166	135	31
17	93	75	18	113	91	22	131	106	25	168	136	32
18	94	76	18	114	92	22	132	107	25	169	137	32
19	95	76	19	115	93	22	133	107	26	170	137	33
20	96	77	19	116	93	23	134	108	26	171	138	33
30	102	81	21	122	98	24	141	113	28	180	144	36
60	111	89	22	133	106	27	152	122	30	193	154	39

Table. 4.4 $\alpha = 0.05 \quad d = 5$

P	0.8			0.9			0.95			0.99		
k		n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$
3	11	**8,**11	0	13	**10,**11	2	16	12	4	21	16	5
4	12	**8**,11	1	15	**10,**11	4	18	12	6	23	16	7
5	13	**8,**11	2	16	**10,**11	5	19	12	7	25	16	9
6	13	**9,**11	2	17	11	6	20	13	7	26	17	9
7	14	**9,**11	3	17	11	6	20	13	7	27	17	10
8	14	**9,**11	3	18	11	7	21	13	8	28	17	11
9	15	**9,**11	4	18	11	7	22	13	9	28	17	11
10	15	**9,**11	4	19	12	7	22	13	9	29	18	11
11	16	**9,**11	5	19	12	7	22	14	8	29	18	11
12	16	**10,**11	5	19	12	7	23	14	9	30	18	12
13	16	**10,**11	5	20	12	8	23	14	9	30	18	12
14	16	**10,**11	5	20	12	8	23	14	9	30	18	12
15	17	**10,**11	6	20	12	8	24	14	10	31	18	13
16	17	**10,**11	6	20	12	8	24	14	10	31	18	13
17	17	**10,**11	6	21	12	9	24	14	10	31	19	12
18	17	**10,**11	6	21	12	9	24	14	10	32	19	13
19	17	**10,**11	6	21	13	8	25	15	10	32	19	13
20	17	**10,**11	6	21	13	8	25	15	10	32	19	13
30	19	11	8	23	13	10	26	15	11	34	20	14
60	20	12	8	25	14	11	29	17	12	36	21	15

n_1

Table. 4.5 $\alpha = 0.05 \quad d = 3$

P	0.8			0.9			0.95			0.99		
k		n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$
3	15	12	3	19	15	4	23	18	5	30	24	6
4	17	12	5	21	16	5	25	19	6	34	25	9
5	18	13	5	23	16	7	27	19	8	36	26	10
6	19	13	6	24	17	7	28	20	8	37	26	11
7	20	14	6	25	17	8	29	20	9	39	27	12
8	21	14	7	26	18	8	30	21	9	40	27	13
9	21	14	7	26	18	8	31	21	10	41	28	13
10	22	15	7	27	18	9	32	21	11	42	28	14
11	22	15	7	27	19	8	32	22	10	42	29	13
12	23	15	8	28	19	9	33	22	11	43	29	14
13	23	15	8	28	19	9	33	22	11	44	29	15
14	23	16	7	29	19	10	34	23	11	44	29	15
15	24	16	8	29	19	10	34	23	11	45	30	15
16	24	16	8	29	20	9	35	23	12	45	30	15
17	24	16	8	30	20	10	35	23	12	45	30	15
18	25	16	9	30	20	10	35	23	12	46	30	16
19	25	16	9	30	20	10	35	23	12	46	30	16
20	25	16	9	31	20	11	36	24	12	47	31	16
30	27	17	10	33	21	12	38	25	13	49	32	17
60	30	19	11	36	23	13	41	27	14	53	34	19

Table. 4.6 $\alpha = 0.05 \quad d = 1$

P	0.8			0.9			0.95			0.99		
k		n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$	n_1	n_2	$n_1 - n_2$
3	43	38	5	56	49	7	67	59	8	91	81	10
4	50	42	8	63	54	9	75	65	10	102	87	15
5	54	45	9	68	58	10	81	69	12	109	92	17
6	57	48	9	72	60	12	86	72	14	115	96	19
7	60	50	10	76	63	13	90	74	16	120	99	21
8	62	51	11	78	64	14	93	76	17	124	102	22
9	64	53	11	81	66	15	95	78	17	127	104	23
10	66	54	12	83	68	15	98	80	18	129	106	23
11	68	55	13	84	69	15	100	81	19	132	108	24
12	69	56	13	86	70	16	101	83	18	134	109	25
13	70	57	13	87	71	16	103	84	19	136	110	26
14	71	58	13	89	72	17	105	85	20	138	112	26
15	72	59	13	90	73	17	106	86	20	139	113	26
16	73	59	14	91	74	17	107	87	20	141	114	27
17	74	60	14	92	74	18	108	87	21	142	115	27
18	75	61	14	93	75	18	109	88	21	143	116	27
19	76	61	15	94	76	18	110	89	21	145	117	28
20	77	62	15	95	76	19	111	90	21	146	118	28
30	82	66	16	101	81	20	118	95	23	154	124	30
60	92	73	19	112	89	23	130	104	26	167	134	33

5. Concluding Remarks

Since, the method developed by Pran Kumar and Rao (1998) is applied only when the sample size is more than 10, in the computation of n_2 in Tables. 4.1 and 4.4 the sample size values less than or equal to 10 (in bold numerals) are to be replaced by the minimum sample size 11.

The comparison reveals that the sample size for the method developed by Pran Kumar and Rao (1998) requires less number of units than that of Rao and Harikrishna (1997) for a fixed power and therefore, the method developed by Pran Kumar and Rao (1998) leads to minimize the cost and time than that of the method developed by Rao and Harikrishna (1997).

Hence, it is recommended that the method developed by Pran Kumar and Rao (1998) is better applied when the sample size is more than ten whereas the method developed by Rao and Harikrishna (1997) is applied when the sample size ranges from four to ten to test the significant difference among several normal population variances.

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RESEARCH ARTICLE

ROBUSTNESS OF BALANCED INCOMPLETE BLOCK DESIGN WITH REPEATED BLOCKS AGAINST MISSING OF THREE BLOCKS INVOLVING REPEATED BLOCKS

Prathima U. Srivastava[1] and A. J. Patel[2]

ABSTRACT

This paper deals with the problem of finding the robustness of of Balanced Incomplete Block design with repeated blocks against missing of three blocks involving repeated blocks. We have obtained A-efficiency for different cases. We have also derived the general structure of C-matrix. It is observed that BIB design with repeated blocks is fairly robust against the missing of three blocks involving repeated blocks. Finally it is also concluded after investigation that as the number of common treatment increases the efficiency of residual design decreases.

KEYWORDS

A-efficiency, Balanced Incomplete Block Design with repeated blocks, Robustness

1. INTRODUCTION

Balanced incomplete block design with repeated blocks always became interesting phenomena for many statisticians. Foody, W. and A. Hedayat (1977) worked on the theory and application of BIB design with repeated blocks. They described importance and main application of BIB Designs with repeated blocks in Experimental Design and in Controlled Sampling. Ghosh, D.K., Shrivastava S.B. (2001) also described about class of BIB designs with repeated blocks. Hanani, H. (1961) talked about the existence and construction of balanced incomplete block

(1) Government Commerce College, Naroda, email : pratisriv8@gmail.com

(2) R. H. Patel Arts & Commerce College, Nava Vadaj. email : ashvinjpatel@gmail.com

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designs. Whittnghill.D.C.III, (1989) shown that Balanced incomplete block design is fairly robust against the single observation. The required condition with properties, method of construction and usefulness of BIBDR are described in Hedayat and Li (1979), Hedayat and Hwang (1984),

Parker (1963) and Seiden (1963) focused on adverse part. They had given proof that there does not exist any Balanced incomplete block design with repeated blocks having parameters v= 2x+2,b= 4x+2 and k= x+1 (where x is any odd or even positive integer) . Wynn (1977) discussed about the construction and application of BIB design with parameters: v=8, b=56, k =3 and b* = 24.

Recently, Sharma R.(2004) published thesis had derived Balanced Incomplete block design with repeated blocks through different methods of construction. He Constructed Balanced Incomplete Block Designs with Repeated Blocks using

(a) Mutually Orthogonal Latin Squares
(b) Method of Block Section and Initial
(c) Using a series of Steiner's Triple System and [S 11: v = (6t+3), b= (3t+1) (2t+1),
r = (3t+1) , k=3 , ë =1]
(d) Using Two-fold Triple System with parameters.
[S 22: v = 6t + 4 , b = 2 (2t+1) (3t+2), r= 6t+3 , k=3 , ë =2]
(e) Using series of Balanced Incomplete Block design with parameters v, b= 2r, r = v-1, k and ë
(f) Using the Block Intersection of BIB design of the series v = 4 t - 1 = b, r = 2 t - 1 = k, ë = t – 1
(g) Using some more BIB Design with Repeated Block obtained by using Different Method.

In present investigation we have tried to find robustness of BIB design with repeated blocks for the missing of three blocks where missing blocks involve at least two repeated blocks. We have considered a balanced incomplete block design with repeated blocks D having Parameters v, b, r, k, ë. For the construction of BIB design with repeated blocks we have referred Sharma, R.(2004) published

thesis.

2. PRELIMINARY RESULT

We will use the following lemma by Mukerjee and Kageyama (1990), to evaluate the eigenvalues of C-matrix. Here, Js×t is the s × t matrix, whose elements are all unity. Hereafter J denotes such a matrix of approximate size.

$$A = \begin{pmatrix} a_1 I_{S_1} + b_{11} J_{S_1 S_1} & b_{12} J_{S_1 S_2} & \dots & b_{1u} J_{S_1 S_u} \\ b_{21} J_{S_3 S_1} & a_2 I_{S_2} + b_{22} J_{S_2 S_2} & \dots & b_{2u} J_{S2 S_2} \\ | & | & \dots & | \\ b_{u1} J_{S_u S_1} & b_{u2} J_{S_u S_u} & \dots & a_u I_{S_u} + b_{uu} J_{S_u S_u} \end{pmatrix}$$

Where $s = s_1 + s_2 + \dots + s_u$ and the u × u matrix B = (bij) is symmetric. Then the eigenvalues of A are ai with multiplicity s_i - 1, (1 ≤ i < u) and μ_1^*, μ_2^*, $\dots \mu_u^*$ where μ_1^*, μ_2^*, $\dots \mu_u^*$ are the eigenvalues of Δ = Da + $DS^{½}$, $BDs^{½}$, Da = diag (a_1, a_2, ... a_u) Ds = diag (s_1, s_2, ... s_u).

3. ROBUSTNESS OF BALANCE INCOMPLETE BLOCK DESIGN WITH REPEATED BLOCKS AGAINST MISSING OR UNAVAILABILITY OF THREE BLOCKS.

It is proved that BIBD with repeated blocks are fairly robust against unavailability of two missing blocks involving both repeated as well as non-repeated blocks. We are going to check the robustness of BIBD with repeated blocks against three missing blocks involving blocks which are repeated. We have considered two cases.

Case (i) Involving two same blocks

There are two sub cases

(a) Two same blocks which are repeated twice and one block which is non-Repeated are lost with zero common treatment

(b) Two same blocks and one block which is also repeated but distinct are lost with zero common treatment

Case (ii) Three same blocks which are repeated are lost.

We will discuss one by one both the cases.

Case (i) (a) Two same blocks which are repeated twice and one block which is non-repeated are lost with zero common treatment

Let us consider a BIB design D with repeated blocks d with parameters v, b, r, k, ë. Let C matrix of the design D is given by C=è (Iv - 1/vEvv).where è = ëv/k is the non-zero eigen value of C matrix of design D with multiplicity (v-1). Let three blocks are lost in which two are same block and one is non-repeated. Call this design as a residual design D*.

We assume that a residual design D* is a connected design. Let the blocks be bi , b_j and b_l. Let there be zero common treatment between three lost blocks i.e. ç (bi)"bj)"b_l) =0. Each treatment which are present in two same blocks will be replicated (r-2) times and those treatment which are present in one non-repeated lost block will be replicated (r-1) times. All remaining treatment will be replicated r times in design.

Let C* be the information matrix of design D*.For this design D*, the diagonal element of C* matrix are as follows,

$C_{ii}= \frac{(r-2)(k-1)}{k}$ where *i* denotes those treatments which are present in two repeated lost blocks.

$C_{jj}= \frac{(r-1)(k-1)}{k}$ where *j* denotes those treatments which are present in one non-Repeated lost block.

$C_{ll}= \frac{r(k-1)}{k}$ where *l* denotes the remaining treatments.

In the residual design D*, the pair of treatment occurs together as below

λ_1 = ë -2, for those treatments which are common in all the three lost blocks.

λ_2 = ë-1, for those treatments which are present in all three lost blocks but distinct

λ_3 = ë, for remaining treatments.

Non zero eigenvalues of C* matrix with their corresponding multiplicities are

1) $\frac{\lambda v}{k}$ with multiplicity (v-2k+1)

2) $\frac{\lambda v-k}{k}$ with multiplicity (k-1)

3) $\frac{\lambda v-2k}{k}$ with multiplicity (k-1)

THEOREM 1 Balance incomplete block designs having repeated blocks and with parameters v, b, r, k, ë is fairly robust against the unavailability of three blocks, where two blocks are same i.e repeated blocks and one is non-repeated block and number of common treatment between them is zero, provided the efficiency is given by

$$e = \frac{(v-1)(\lambda v-k)(\lambda v-2k)}{(\lambda v-k)(\lambda v-2k)(v-2k+1)+\lambda v(k-1)(2\lambda v-3k)}$$

PROOF: Without loss of generality if three blocks are lost from design D where all blocks non-repeated and number of common treatment between them is one.

C* matrix of residual design is given by

$$kC^* = \begin{pmatrix} (\lambda v-2k)I_k-(\lambda-2)J_{kk} & -\lambda J_{kk} & -\lambda J_{(v-2k)k} \\ -\lambda J_{kk} & (\lambda v-k)I_k-(\lambda-1)J_{kk} & -\lambda J_{(v-2k)k} \\ -\lambda J_{(v-2k)k} & -\lambda J_{(v-2k)k} & \lambda v I_{(v-2k)}-v^{-1}J_{(v-2k)(v-2k)} \end{pmatrix}$$

Non-zero eigenvalues of C* matrix with their corresponding multiplicities are

1) $\frac{\lambda v}{k}$ with multiplicity (v-2k+1)

2) $\frac{\lambda v-k}{k}$ with multiplicity (k-1)

3) $\frac{\lambda v-2k}{k}$ with multiplicity (k-1)

Further the overall efficiency e is defined mathematically as e $=\frac{\phi_1}{\phi_2}$

ϕ_1= Sum of reciprocal of eigen values of C-matrix of Design D

ϕ_2= Sum of reciprocal of eigen values of C*-matrix of Design D*

That is $\phi_1 = \frac{k(v-1)}{\lambda v}$ $\phi_2 = \frac{k(v-2k+1)}{\lambda v} + \frac{k(k-1)}{(\lambda v-k)} + \frac{k(k-1)}{(\lambda v-2k)}$

Hence, e $= \frac{\frac{k(v-1)}{\lambda v}}{\frac{k(v-2k+1)}{\lambda v}+\frac{k(k-1)}{(\lambda v-k)}+\frac{k(k-1)}{(\lambda v-2k)}}$

After simplification we get A-efficiency as

e $= \frac{(v-1)(\lambda v-k)(\lambda v-2k)}{(\lambda v-k)(\lambda v-2k)(v-2k+1)+\lambda v(k-1)(2\lambda v-3k)}$

EXAMPLE: 1 Let D represent the BIB design having repeated blocks with parameter v=12, b=33, r=11, k=4, ë=3. Design D is given by,

0 1 2 3	0 2 5 8	0 3 10 11	**1** **5** **6** **7**	1 2 5 8	1 5 9 10	1 5 9 10	2 3 6 9	**3** **4** **8** **10**	**3** **4** **8** **10**	4 5 6 11	0 1 4 7	0 2 10 11	0 4 5 9	0 7 8 9	1 3 4 7	1 6 8 11	1 6 8 11	2 4 9 11	2 4 9 11	3 5 7 11	3 5 7 11	7 8 9 10

0 1 10 11	0 3 6 9	0 4 6 8	1 2 4 7	1 3 6 9	2 3 5 8	2 6 7 10	2 6 7 10	4 5 6 10	7 8 9 11

Three blocks are lost where (3 4 8 10) are repeated twice and (1 5 6 7) is non- repeated. Here two blocks are same and one block is different and the number of common treatment between them is zero.

C* matrix of residual design D* is

$$4C^* = \begin{bmatrix}
30 & -3 & -3 & -3 & -3 & -2 & -2 & -2 & -3 & -3 & -3 & -3 \\
-3 & 33 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 \\
-3 & -3 & 33 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 \\
-3 & -3 & -3 & 27 & -1 & -3 & -3 & -3 & -1 & -3 & -1 & -3 \\
-3 & -3 & -3 & -1 & 27 & -3 & -3 & -3 & -1 & -3 & -1 & -3 \\
-2 & -3 & -3 & -3 & -3 & 30 & -2 & -2 & -3 & -3 & -3 & -3 \\
-2 & -3 & -3 & -3 & -3 & -2 & 30 & -2 & -3 & -3 & -3 & -3 \\
-2 & -3 & -3 & -3 & -3 & -2 & -2 & 30 & -3 & -3 & -3 & -3 \\
-3 & -3 & -3 & -1 & -1 & -3 & -3 & -3 & 27 & -3 & -1 & -3 \\
-3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & 33 & -3 & -3 \\
-3 & -3 & -3 & -1 & -1 & -3 & -3 & -3 & -1 & -3 & 27 & -3 \\
-3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & -3 & 33
\end{bmatrix}$$

1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	6	6
2	2	2	2	3	3	3	4	5	3	4	5	6	4	5	6	5	6	7	6	7	7	7
3	4	6	6	4	5	6	7	7	4	5	7	7	5	6	7	6	7	7	6	7	7	7

Non- zero eigenvalues of C* matrix with their corresponding multiplicities are

1) 9 with multiplicity 5

2) 8 with multiplicity 3

3) 7 with multiplicity 3

A-efficiency= e = **0.8993**

EXAMPLE: 2 Let D represent the BIB design having repeated blocks with parameter v=7, b=28, r=12, k=3, ë=4. Design D is given by,

$3C^* =$

24	-4	-4	-4	-4	-4	-4
-4	20	-2	-4	-2	-4	-4
-4	-2	20	-4	-2	-4	-4
-4	-4	-4	22	-4	-3	-3
-4	-2	-2	-4	20	-4	-4
-4	-4	-4	-3	-4	22	-3
-4	-4	-4	-3	-4	-3	22

Non-zero eigenvalues of C* matrix with their corresponding multiplicities are

1) 28/3 with multiplicity 2
2) 25/3 with multiplicity 2
3) 22/3 with multiplicity 2

A-efficiency= e = **0.8843**

EXAMPLE: 3 Let D represent the BIB design having repeated blocks with parameter v=7, b=35, r=15, k=3, ë=5. Design D is given by,

1 2 4	**1 2 4**	1 2 4	2 3 5	2 3 5	2 3 5	2 3 7	2 3 7	2 6 7	2 6 7	2 6 7	1 3 4	1 3 4	1 3 7	1 3 7	1 3 7	1 5 6	1 5 6	1 5 6	1 5 7	1 5 7	1 2 6

1 2 6	3 4 6	3 4 6	3 4 6	2 4 5	2 4 5	4 5 7	4 5 7	4 5 7	**3 5 6**	3 5 6	4 6 7	4 6 7

Three blocks containing (1 2 4), (1 2 4) and (3 5 6) are lost. Where (1 2 4) is repeated thrice and block (3 5 6) is repeated twice and the number of common treatment between them is zero.

C* matrix of residual design D* is

$3C^* =$

26	-3	-5	-3	-5	-5	-5
-3	26	-5	-3	-5	-5	-5
-5	-5	28	-5	-4	-4	-5
-3	-3	-5	26	-5	-5	-5
-5	-5	-4	-5	28	-4	-5
-5	-5	-4	-5	-4	28	-5
-5	-5	-5	-5	-5	-5	30

Non-zero eigenvalues of C* matrix with their corresponding multiplicities are

1) 35/3 with multiplicity 2
2) 32/3 with multiplicity 2
3) 29/3 with multiplicity 2

A-efficiency= e = **0.9089**

NOTE: Case (i) (a) and (b) both are same and therefore their C* matrix, eigenvalues of C* matrix and their multiplicities are also same. Example: 3 provides base for Case (i) (b)

Case (ii) Three same blocks which are repeated are lost.

Let us consider a BIB design D with repeated blocks d with parameters v, b, r, k, ë. Let C matrix of the design D is given by C=è (Iv - 1/vEvv).where è = ëv/k is the non zero eigen value of C matrix of design D with multiplicity (v-1). Let us suppose that three blocks are lost and all are same. Call this design as a residual design D*. We assume that a residual design D* is a connected design. Let the blocks be bi , bj and b_l. let there be k treatments which are common between three lost blocks i.e.

ç(bi)"bj)"b_l) = k. Each treatment which is present in the three lost blocks will be replicated (r-3) times. All remaining treatment will be replicated r times in design.

Let C* be the information matrix of design D*.For this design D*, the diagonal element of C* matrix are as follows,

$C_{ii} = \frac{(r-3)(k-1)}{k}$ where i denotes those treatments which are

common in all the three lost blocks.

$C_{jj}= \frac{r(k-1)}{k}$ where j denotes the remaining treatments.

In the residual design D*, the pair of treatment occurs together as below

λ_1 = ë -3, for those treatments which are common in all the three lost blocks.

λ_2 = ë, for remaining treatments.

The C* matrix of the given design can be written as

$$kC^* = \begin{pmatrix} (\lambda v - 3k)I_k - (\lambda - 3)J_{kk} & -\lambda J_{k(v-k)} \\ -\lambda J_{(v-k)k} & \lambda v I_{(v-k)} - v^{-1} J_{(v-k)(v-k)} \end{pmatrix}$$

Non-zero eigenvalues of C* matrix with their corresponding multiplicities are

1) $\frac{\lambda v}{k}$ with multiplicity (v-k)

2) $\frac{\lambda v - 3k}{k}$ with multiplicity (k-1)

THEOREM 2 Balance incomplete block designs having repeated blocks and with parameters v, b, r, k, ë is fairly robust against the unavailability of three blocks, where all three blocks are the same and number of common treatment between them is k, provided the efficiency is given by

$$e = \frac{(v-1)(\lambda v - 3k)}{\lambda v(k-1) + (v-k)(\lambda v - 3k)}$$

PROOF: Without loss of generality if three blocks are lost from design D where all blocks non-repeated and number of common treatment between them is one.

C* matrix of residual design is given by,

$$kC^* = \begin{pmatrix} (\lambda v - 3k)I_k - (\lambda - 3)J_{kk} & -\lambda J_{k(v-k)} \\ -\lambda J_{(v-k)k} & \lambda v I_{(v-k)} - v^{-1} J_{(v-k)(v-k)} \end{pmatrix}$$

Non-zero eigenvalues of C* matrix with their corresponding multiplicities are

1) $\frac{\lambda v}{k}$ with multiplicity (v-k)

2) with multiplicity (k-1)

Further the overall efficiency (e) is defined mathematically as e =

That is $$\phi_2 = \frac{k(v-k)}{\lambda v} + \frac{k(k-1)}{(\lambda v - 3k)}$$

Hence, $$e = \frac{\frac{k(v-1)}{\lambda v}}{\frac{k(v-k)}{\lambda v} + \frac{k(k-1)}{(\lambda v - 3k)}}$$

After simplification we get A-efficiency as

$$e = \frac{(v-1)(\lambda v - 3k)}{\lambda v(k-1) + (v-k)(\lambda v - 3k}$$

EXAMPLE: 4 Let D represent the BIB design having repeated blocks with parameter v=7, b=35, r=15, k=3, ë=5. Design D is given by,

1	1	1	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	2
2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	5	5	5	6
4	4	4	5	5	5	7	7	7	7	4	4	7	7	7	6	6	7	7	6	7	7	6

1	3	3	3	2	2	4	4	4	3	3	4	4
2	4	4	4	4	4	5	5	5	5	5	6	6
6	6	6	6	5	5	7	7	7	6	6	7	7

Three blocks containing (1 2 4), (1 2 4) and (1 2 4) are lost. Where (1 2 4) is repeated thrice and the number of common treatments between them is k=3.

3C* =

24	-2	-5	-2	-5	-5	-5
-2	24	-5	-2	-5	-5	-5
-5	-5	30	-5	-5	-5	-5
-2	-2	-5	24	-5	-5	-5
-5	-5	-5	-5	30	-5	-5
-5	-5	-5	-5	-5	30	-5
-5	-5	-5	-5	-5	-5	30

Non zero eigenvalues of C* matrix with their corresponding multiplicities are

1) 35/3 with multiplicity 4

2) 26/3 with multiplicity 2

A-efficiency = e = **0.8965**

4. GENERAL STRUCTURE OF C-MATRIX OF RESIDUAL DESIGN FOR THE MISSING OF SAME BLOCKS

For one missing block of balanced incomplete block design with repeated blocks the C-matrix of residual design and corresponding eigen value with its multiplicity is obtained by Bhatt P.(2008) as below.

$$kC^* = \begin{pmatrix} (\lambda v - k)I_k - (\lambda - 1)J_{kk} & -\lambda J_{k(v-k)} \\ -\lambda J_{(v-k)k} & \lambda v I_{(v-k)} - v^{-1} J_{(v-k)(v-k)} \end{pmatrix}$$

Non-zero eigenvalues of C* matrix with their corresponding multiplicities are

1) $\frac{\lambda v}{k}$ with multiplicity (v-k)

2) $\frac{\lambda v - k}{k}$ with multiplicity (k-1)

and for missing of two same blocks of balanced incomplete block design with repeated blocks, the C-matrix of residual design and corresponding eigen value with its multiplicity was obtained by Bhatt P.(2008) as below

$$kC^* = \begin{pmatrix} (\lambda v - 2k)I_k - (\lambda - 2)J_{kk} & -\lambda J_{k(v-k)} \\ -\lambda J_{(v-k)k} & \lambda v I_{(v-k)} - v^{-1} J_{(v-k)(v-k)} \end{pmatrix}$$

Non-zero eigenvalues of C* matrix with their corresponding multiplicities are

3) $\frac{\lambda v}{k}$ with multiplicity (v-k)

4) $\frac{\lambda v - k}{k}$ with multiplicity (k-1)

Similarly, for the case of missing of three same blocks we have obtained C-matrix of residual design and corresponding eigen value with its multiplicity which is given as

$$kC^* = \begin{pmatrix} (\lambda v - 3k)I_k - (\lambda - 3)J_{kk} & -\lambda J_{k(v-k)} \\ -\lambda J_{(v-k)k} & \lambda v I_{(v-k)} - v^{-1} J_{(v-k)(v-k)} \end{pmatrix}$$

Non-zero eigenvalues of C* matrix with their corresponding multiplicities are

5) $\frac{\lambda v}{k}$ with multiplicity (v-k)

6) $\frac{\lambda v - k}{k}$ with multiplicity (k-1)

So, in general the structure of C-matrix of residual design for the missing of ì same blocks can be written as

$$kC^* = \begin{pmatrix} (\lambda v - \mu k)I_k - (\lambda - \mu)J_{kk} & -\lambda J_{k(v-k)} \\ -\lambda J_{(v-k)k} & \lambda v I_{(v-k)} - v^{-1} J_{(v-k)(v-k)} \end{pmatrix}$$

Non-zero eigenvalues of C* matrix with their corresponding multiplicities are

1) $\frac{\lambda v}{k}$ with multiplicity (v-k)

2) $\frac{\lambda v - k}{k}$ with multiplicity (k-1)

Where ì= number of missing blocks which are the same

THEOREM 3 Balance incomplete block designs having repeated blocks and with parameters v, b, r, k, ë is fairly robust against the unavailability of blocks, where all blocks are the same then number of common treatments between them is k, provided that the efficiency is given by

$$e = \frac{(v-1)(\lambda v - 3k)}{\lambda v(k-1) + (v-k)(\lambda v - 3k)}$$

PROOF: Without loss of generality, in general the structure of C-matrix of residual design for the missing of same blocks can be written as

$$kC^* = \begin{pmatrix} (\lambda v - \mu k)I_k - (\lambda - \mu)J_{kk} & -\lambda J_{k(v-k)} \\ -\lambda J_{(v-k)k} & \lambda v I_{(v-k)} - v^{-1} J_{(v-k)(v-k)} \end{pmatrix}$$

Non zero eigenvalues of C* matrix with their corresponding multiplicities are

1) $\frac{\lambda v}{k}$ with multiplicity (v-k)

2) $\frac{\lambda v-k}{k}$ with multiplicity (k-1)

That is $\phi_1 = \frac{k(v-1)}{\lambda v}$ $\phi_2 = \frac{k(v-k)}{\lambda v} + \frac{k(k-1)}{(\lambda v - \mu k)}$

Hence, $e = \frac{\frac{k(v-1)}{\lambda v}}{\frac{k(v-k)}{\lambda v} + \frac{k(k-1)}{(\lambda v - \mu k)}}$

After simplification we get A-efficiency as

$$e = \frac{(v-1)(\lambda v - \mu k)}{\lambda v(k-1) + (v-k)(\lambda v - \mu k)}$$

5. CONCLUSION

We have considered a BIB design with repeated blocks as D and D* which are considered as its residual design. From our above analysis we conclude the following:

(a) If three blocks are lost from a BIBD with repeated blocks involving atleast two repeated blocks, the efficiency factor depends upon the common number of treatments between three lost blocks and the type of the blocks lost which can be clearly concluded from the table given below

	Overall A-efficiency	
BIBD with repeated blocks	Two repeated blocks with (zero common treatment)	Three repeated blocks (k common treatment)
v=7, b=35, r=15, k=3, λ=5.	**0.9089**	**0.8965**

(b) From our analysis we may conclude that for missing of three blocks involving all repeated blocks or atleast two repeated blocks, the A-efficiency decreases as the number of common treatments increases.

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RESEARCH ARTICLE

A PRELIMINARY STUDY OF INDIAN AND U.S. CONSUMER AWARENESS OF INFORMATION FLOW IN A SUPPLY CHAIN

Dinesh S. Dave[1], James E. Stoddard[2] and Michael J. Dotson[3]

ABSTRACT

Supply chain management is viewed as one of the most critical functions in an organization. It has been gaining significant visibility due to the effect of globalization as many organizations operate their business functions with their partners globally. The objective of supply chain management is to provide better competitive advantage by improving organizational performance and enhance customer satisfaction. Each participating organization in the chain of supply gain the potential benefit of earning optimal profit. Supply chain encompasses three flows: information flow, materials flow, and financial flow. The objective of this study is to examine the awareness of consumers about information flow in supply chain management. Through the application of multivariate discriminant analysis, the paper investigates the awareness of both Indian and U. S. consumers regarding information flow in supply chain management.

KEY WORDS

SCM, Discriminant Analysis, Consumer Awareness

(1) Chair and Professor, Computer Information System and Supply Change Management. John A. Walker College of Business. Appalachian State University, BOONE, North Carolina, 28608 (USA).email : daveds@appstate.edu

(2) Chair and Professor, Dept. of Marketing, J.A. Walker College of Business, Applachian State University, BOONE, North Carolina, 28608 (USA).
email : stoddardje@appstate.edu

(3) Michael J. Dotson**, Formerly Professor, Dept. of Marketing, J.A. Walker College of Business, Applachian State University, BOONE, North Carolina, 28608 (USA).

** We fell very sorry to inform that Dr. Michael J. Dotson passed away on August 8th 2017. We are deeply saddened by our loss. He was a great friend and a colleague. Dr. Dotson will have a special place in our hearts.

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1. INTRODUCTION

Supply chain management (SCM) can be explained as the coordination of all activities starting with raw materials and ending with a satisfied customer and it is viewed as one of the most important functions in an organization. A supply chain potentially includes suppliers, manufacturers, distributors, wholesalers and retailers working cooperatively to deliver products and services to consumers. SCM has been gaining significant visibility due to the influence of globalization as many organizations continuously engage their business functions with their partners globally. Some of these supply partners could be global organizations. In today's environment, companies are operating in a global supply chain network. A study by Vitasek (2013) explained supply chain management as encompassing the planning and management of all activities involved in sourcing and procurement, conversion, and logistics management activities.

Supply chain includes coordination and collaboration with partners or suppliers, intermediary organizations, third-party service providers, and consumers (Beamon, 1998; Sumchi-Levi et al., 2008; Blackstone, 2013). Supply chain management offers the opportunity to capture the synergy of intra- and inter-company integration and management and deals with total business excellence and relationships with other members of the supply chain (Lambert and Cooper, 2000). One of the goals of supply chain management is to provide better competitive advantages by improving organizational performance and enhancing customer satisfaction. Each participating organization in the chain of supply can receive the benefit of earning optimal profit (Sahin and Robinson, 2002). Also, the objectives of supply chain management can include the enhancement of responsiveness and flexibility to customers; lower cost, reducing cycle time, maximizing access to inventory and capacity utilization. The objective of supply chain management is to manage three flows: information flow, material flow, and financial flow. The objective of this study is to compare the awareness of information flow of consumers in the United States and India.

According to Stadtler (2005), supply chain management is the task of

integrating organizational units along a supply chain and coordinating materials, information, and financial flows in order to satisfy customer demands with the objective of improving competitiveness of the supply chain as a whole. Cooper, et al. (1997) suggested that supply chain management includes the two directional flow of products and information**.** Supply chain relationships lead to increased information flows, reduced uncertainty, and a more profitable supply chain (Fiala, 2005). Rai et al. (2006) suggested that an integrated information technology infrastructure enables firms to develop a higher-order capability of supply chain process integration. This capability enables firms to split information flows from physical flows, and to share information with their supply chain partners in order to create information-based approaches for superior demand planning, for staging and movement of physical products, and for streamlining voluminous and complex financial work processes.

Rodriguez-Diaz and Espino-Rodriguez (2006) stated the benefits of the development of relational capabilities which include an information process and a knowledge process. These processes refer to the superior ability to obtain any type of information necessary to the present and future functioning of the network, integrating it and making it effective in maximizing the competitiveness of companies in the network. Thus, supply chain affiliations can lead to relational learning which can occur between companies with a high degree of cooperation via both formal and informal information transfer. Dyer and Singh (1998) have suggested that the sharing of knowledge and resources by firms are more likely to generate relational rents. Patnayakuni et al. (2006) concluded that tangible and intangible resources invested in supply chain partnerships enable information flow integration between a focal firm and its partners for supply chain coordination. Zhou and Benton (2007) suggested that effective information sharing and effective supply chain practice are necessary to achieve improvement in supply chain performance. Further, Kaipia (2009) contended that "planning nervousness" can be diminished by stabilizing planning and by synchronizing information sharing with upstream and downstream members of the supply chain to ensure that

decisions are based upon the most current available data.

Ruel et al. (2013) traced the stages of information flow in a supply chain through the development of an innovation. Their results illustrated the difficulty of managing information flows during the implementation of its supply chain by a new organization. Costantino et al., (2015) demonstrated that a slow information sharing approach is successful in restricting the bullwhip effect and inventory variance throughout the supply chain.

Hofstede's model suggests important cultural differences between India and the United States. These differences are identified by Hofstede and his colleagues and can be found at The Hofstede Center (2016). The primary differences between the Indian culture and that of the United States involves the dimensions of power-distance (India = 77, U.S. = 40), individualism (India = 48 U.S. = 91), long term orientation (India = 51, U.S. = 26) and indulgence (India = 26, U.S = 68). Compared to the United States, India scores high on the power-distance dimension. This suggests that Indian culture places a greater emphasis on societal hierarchy and a top-down structure in society and its organizations. India is also more collectivist which may induce its consumers to be more susceptible to social influence. Therefore, via social influence, information dissemination throughout India's culture is likely to me more rapid. The proposition advanced in this paper is that these cultural differences will be manifested in each society's consumer awareness of supply chain information flows. Ultimately, the notion is that consumer awareness of supply chain flows will impact their perceptions of the value added by a supply chain and how a supply chain can advance competitive differentiation.

The objective of this study is to examine the awareness of consumers about information flow in supply chain management. Through the application of multivariate discriminant analysis, the paper investigates the awareness of both Indian and U. S. consumers regarding information flow in supply chain management.

2. RESEARCH METHOD

An electronic survey was constructed to collect the data assessing consumer awareness of information flow in the supply chain. Consumers were asked to imagine a retailer that they regularly buy from when responding to the survey questions. The survey was broken into several sections but the only data being reported in this paper is related to supply chain activities (supply chain management), specifically information flow.

Consumer awareness of information flow was measured by five questions associated with the flow of information measured on a 5-point awareness scale anchored by (1) "Not at all aware" to (5) "Completely aware." These questions included "Obtaining Customer Information", "Promotion", "Obtaining Competitor Information", "Estimating Sales", and "Choosing Information Technology". Finally, respondents were asked demographic questions.

The total number of usable surveys was 285. One hundred and forty-two (49.8%) from the U.S. sample and one hundred and fifty-three (50.2%) from the India sample. Demographically in terms of age, the two samples were different. For example, the India sample's average age was 25.1 years as compared to the average age of the U.S. sample of 38.4 years (p-value = 0.000). Additionally, India sample had more males (77% males versus 23% females) and the U.S sample had more females (59% females versus 41% males) ($\div^2 = 38.32$, df = 1, p = .000). The U.S. sample had statistically higher number of years of SCM experience (4.1 years) as compared to the India sample (0.5 year). This could be because the U.S. sample consists of respondents with higher age than the India sample.

3. RESULTS AND CONCLUSION

In order to compare the awareness of information flow for U.S. sample and the India sample, multivariate discriminant analysis was performed. The results of this analysis are presented in Table 1.

Table 1 Discriminant Analysis Univariate F-Ratios				
Information Flow	Country	Mean (Standard Deviation)	F*	Sig.
Obtaining Customer Information	U.S.	3.79 (1.597)	2.709	0.101
	India	4.08 (1.427)		
Promotion	U.S.	4.18 (1.581)	11.782	0.001**
	India	4.78 (1.400)		
Obtaining Competitor Information	U.S.	3.54 (1.691)	17.588	0.000**
	India	4.32 (1.437)		
Estimating Sales	U.S.	3.54 (1.704)	2.635	0.106
	India	3.85 (1.526)		
Choosing Information Technology	U.S.	3.27 (1.621)	24.978	0.000**
	India	4.20 (1.513)		
*df = 1, 283 **Statistically significant Null hypothesis of no multivariate differences between U.S. and India on awareness of information flows is rejected. Wilkes $\lambda = 0.882$, $\chi^2 = 35.208$, df = 5, p = .000				

The review of Table 1 suggests that the information flows of *promotion, obtaining competitor information,* and *choosing information technology* are statistically significant between India and the U.S. The results suggest that consumers in India are more aware of these supply chain information flows than their U.S. counterparts.

The analyses did not yield significant differences in consumer awareness of the information flows "obtaining customer information" and "estimating sales" for the two samples. However, the responses were in the same direction as those that reached statistical significance.

Consumer awareness of information flow within a supply chain may impact their purchase intentions. Future research needs to consider whether the differences in consumer awareness of supply chain information flow between India and the U.S. manifests itself in terms of the perceived benefits consumers are receiving from the supply chain. If increased consumer awareness of information flow is related to increased perceived benefits being delivered by a supply chain, consumer purchase intentions are likely to increase.

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RESEARCH ARTICLE

TREND IN FERTILITY - A COMPARATIVE STUDY OF WESTERN STATES AND DISTRICTS WITHIN GUJARAT

Rakesh Pandya*

ABSTRACT

In this study Birth rates and Total Fertility Rate for 2003 to 2015 for Gujarat and for western states of India are considered for analysis. Data in this study are based on Sample Registration System (SRS) reports provided by Registrar General of India. Comparisons are made with 2015 final data of Western States. The birth rate of Gujarat State has decreased substantially from 17.1 births per 1,000 population in 1971 to 20.4 births per 1,000 population in 2015, which is less than the national average. Total Fertility rate has decreased significantly from 5.6 in 1971 to 2.3 in 2015. Growth models are used for projections of CBR and TFR up to year 2021. The Birth rate of Gujarat is projected to decrease by 18.3 and the TFR is likely to decline by near to 2.0 by the year 2021.

Keywords : Birth Rates, Total Fertility Rates, Vital Statistics, Replacement Rate.

1. INTRODUCTION

The demographic scenario in the country has been undergoing a change since the inception of SRS; however, the profile and rate of change is not uniform across all the States/UTs. Overall, the crude birth rate in the country has come down from 36.9 per one thousand population in 1971 to 21.8 in 2015, whereas the crude death rate has declined from 14.9 to a low of 7.1 during the same period. The infant mortality rate, which is an important indicator of the health status of the

* Directorate of Economics and Statistics, Gujarat State, Gandhinagar, India
email : id.sapdes@gujarat.govt.in. (rcd. Oct'17 / rvd. Nov.'17)

country, has registered a significant decline from 129 per one thousand live births in 1971 to 35 in 2015. The total fertility rate of the country has declined from 5.2 in 1971 to 2.3 in 2015.

The comparative study of regional states has become an important area of research for a number of reasons. Given the regional disparities in India, a study of western states become important if some of its parts need to be develop in a balanced way. Also, a study of states throws up successful experiments and examples which can be replicated or adapted by other states. And, finally a comparative study can be useful for inducing some healthy competition across the western states of India and for districts within Gujarat State.

In this paper we compare the results from the raw and refined analysis. Here we draw comparisons across western states with all India figures on their progress on health indicators. To make the comparisons easier and to interpret effectively, we make two separate indices (Birth and Fertility), each of which is widely used and publicly available variables that are available across states. We conclude the paper with policy implications and scope for further research.

The Sample Registration System (SRS) is the largest demographic survey in the country provides annual estimates of fertility as well as mortality indicators at the State and National level.

The demographic scenario of Gujarat is very similar to that of India. In the year 2015, the birth rate of the State was 20.4 compared to 20.8 in India as a whole. In the urban areas of the State, the birth rate is substantially higher than the national average whereas in the rural areas, it is marginally lower. On the other hand, the death rate in the State is lower than the national average in both rural and urban areas whereas infant mortality rate in the State is very similar to that prevails in India as a whole according to the Sample Registration System.

The population of the State continues to be young characterized by a high young dependency because of the above average birth rate. At the same time, the decrease in the death rate suggests that an increasing number of people are surviving to old ages thereby increasing the old dependency. The projected

population of the State suggests a young dependency ratio of 419 dependents (people aged less than 15 years) and an old dependency ratio of 130 dependents (people aged 60 years and above) per 1000 persons in the age group 15-59 years leading to total dependency ratio of 549 for the year 2011. The dependency ratio is projected to decrease marginally to 529 by the year 2016.Gujarat has remarkable achievement in demographic transition over the last few decades. The fertility and mortality levels in the state have declined marginally. According to 2011 Census, Gujarat state is having 6.04 crore population with a decadal growth rate of 19.28as against 17.68 percent of India.

2. METHODOLOGY

This is an analysis of secondary data to study the trend and pattern of population change in Gujarat vis-à-vis other western states; to understand the variation in fertility transition; and identify major reasons for such a variation in the state.

The present study is based on the secondary sources of data drawn mainly from Census, SRS, CRS reports and Socio-Economic Review of Gujarat State. For projections, various growth models are fitted on a time series data of CBR and TFR by using SPSS software.

Population Growth in Western States of India:

The major demographic indicators such as mortality, fertility and migration plays a major role in population change. These components are also directly and indirectly associated with socio-economic development of a region. Gujarat has done a lot of exercise under Family Welfare programme to bring down considerable reduction in fertility rate. The population growth has considerably decline in the western states, however, the pace of reduction is slower in rural are as compared to the urban area. Reduction in population growth is higher in neighboring states like Maharashtra and Rajasthan. Table-1 presents the levels and trends in population growth across the western states.

Table-1 : Population and Decennial Growth Rates of Western States and All-India 1961-2011 (Population in lakh)

Year	India		Gujarat		Rajasthan		Maharashtra		Madhya Pradesh		Goa	
	Popu.	Dece. G.R.	Popu	Dece. G.R.	Popu.	Dece. G.R.	Popu.	Dece. G.R.	Popu.	Dece. G.R.	Popu	Dece. G.R.
1961	4392	21.64	206	26.88	202	26.20	396	23.60	324	24.73	-	7.77
1971	5482	24.80	267	29.39	258	27.83	504	27.45	417	29.28	-	34.77
1981	6833	24.66	341	27.67	343	32.97	628	24.54	522	27.16	-	26.74
1991	8434	23.86	413	21.19	440	28.44	789	25.73	662	27.64	11.70	16.08
2001	10287	21.54	507	22.66	565	28.41	969	22.73	603	24.26	13.48	15.21
2011	12106	17.68	604	19.28	685	21.30	1124	16.00	726	20.35	14.59	8.20

Source: Sample Registration System, Statistical Report (Registrar General, India).

As per the data, the population growth rate of Gujarat varies since 1961 census with both positive and negative variations from one census to another. The population rise in 1971 census and then decline up to 1991 and again increases in 2001 census. There was a significant fall in the population during 1981 to 1991 mainly due to policy based programmes from Family Planning and Health department of the state. Historically, at the end of these periods (2011), the population growth rate of Gujarat has been lower than the Rajasthan and Madhya Pradesh. As observed from the data, from 1961to 1971, the growth rate has increased sharply in India as well as in Gujarat, Maharashtra and Madhya Pradesh. Further the growth rate had significantly come down after 1971 in all western states. Maharashtra over took the western states in reducing the growth rate till 2011 census except Goa.

3. Growth Variations within Districts of Gujarat

The fluctuations in the growth rate of Gujarat has been seen mainly due to its geographical location and demographic profile across the districts. As per SRS area division, Kachchh district in Dry Area has shown significant rise in growth rate in last 5 decades. South Eastern districts have also shown rise in growth rate. Whereas on other hand in last 5 decades most of the districts in Saurashtra region

have shown significant decline in growth rate. All the districts of Plain Northern region also exhibits declining trend, among them the Mahesana district showed significant decline in last 5 decades.

Fertility Levels and Differentials

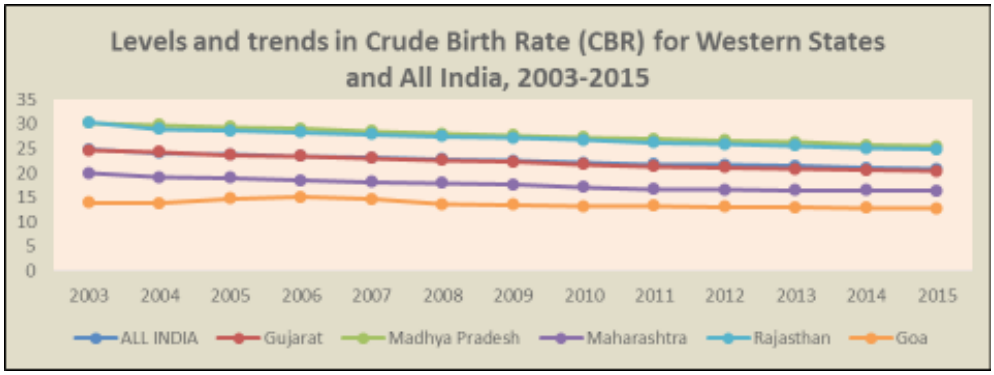
Crude Birth Rate at National Level

The crude birth rate (CBR) at all India level had declined from 36.9 in 1971 to 33.9 in 1981, registering a fall of about 8 per cent. During 1991-2015, the decline has been about 29.49 per cent from 29.5 to 20.8. During 2015 Uttar Pradesh has reported the highest CBR (26.7) while Goa the lowest (12.7). The rural-urban differential has also narrowed over these years. However, the CBR has continued to be higher in rural areas compared to urban areas in the last three decades. Figure 3 represents the levels and trends in Crude Birth Rate (CBR) in Gujarat including western states and All-India.

According to SRS 2015 data, the CBR in the state is 20.4 (22.4 in rural and 18.0 in urban areas) which is lower than the national average (20.8). With regard to comparison of Crude Birth Rate (CBR) in western states, Maharashtra stands in a better position (16.3) than in Gujarat (20.4), Rajasthan (24.8) and Madhya Pradesh (25.5) except a smaller state Goa (12.7) during 2015.

Table-2: Crude Birth Rate (CBR) for Western States and All India, 2003 to 2015

India/States	Crude Birth Rate												
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ALL INDIA	**24.8**	**24.1**	**23.8**	**23.5**	**23.1**	**22.8**	**22.5**	**22.1**	**21.8**	**21.6**	**21.4**	**21.0**	**20.8**
Gujarat	24.6	24.3	23.7	23.5	23.0	22.6	22.3	21.8	21.3	21.1	20.8	20.6	20.4
Madhya Pradesh	30.2	29.8	29.4	29.1	28.5	28.0	27.7	27.3	26.9	26.6	26.3	25.7	25.5
Maharashtra	19.9	19.1	19.0	18.5	18.1	17.9	17.6	17.1	16.7	16.6	16.5	16.5	16.3
Rajasthan	30.3	29.0	28.6	28.3	27.9	27.5	27.2	26.7	26.2	25.9	25.6	25.0	24.8
Goa	13.9	13.8	14.8	15.1	14.7	13.6	13.5	13.2	13.3	13.1	13.0	12.9	12.7



Crude Birth Rate At State Level

The Crude Birth Rate (CBR) has been declining in Gujarat since the early 1970s. When we looks into the levels and trends of Gujarat's CBR in the past, it shows that the CBR which remains relatively stable at a higher level of about 40 or more in the sixties and seventies, it has substantially declined since 1971and reached a level of about 29.6 in 1990 and in last decade it significantly reduced to 20.4 in 2015 which is less than the national average of 20.8. This is mainly due to various effective steps, policy building and programmes taken by the Health and Family Welfare Department of the state over the period. However, the Crude Birth Rate (CBR) is marginally higher in rural areas (22.4) than in urban areas(18.0) of the state.

Whereas as per the available CRS-2013 report, the CBR of the state was 20.8, in urban areas birth rate (32.14) reported is almost 2.58 times to that of rural areas (12.41), which is mainly, due to lower estimates of vital events than the actual or due to the fact that SRS estimates of vital events are based on the usual residence with events registered at the place of occurrence irrespective of the place of residence under CRS. The districts having higher CBR than the state average are The Dangs (31.4), Banaskantha (27.8), Sabarkantha (25.9), Dohad (25.8), Panchmahals (25.2), Patan (25.2), Kachchh (23.8), Kheda (23.0), Bhavnagar (22.8), Rajkot (22.2), Surendra nagar (21.6) and Mehsana (21.1).

Methodology for Projection of CBR in Gujarat State

The Birth rate projections of Gujarat from 2016 to 2021 are made by using curve estimation. In curve estimation Linear, Logarithmic and Exponential Growth curves have been fitted on the data. By using SPSS software we find different values of R, R^2 etc for above mention models to check the validity of the models and provided in model summary table given below.

Model Summary and Parameter Estimates

Equation	Model Summary					Parameter Estimates	
	R^2	F	df1	df2	Sig.	Constant	b1
Linear	0.966	1236.7	1	43	0	918.95	-0.447
Logarithmic	0.967	1263.4	1	43	0	6793.66	-890.4
Exponential	0.983	2562.8	1	43	0	34.24	-0.016

The forecasted values of Birth Rate are as follows.

Table –3: ANNUAL FORECAST OF BIRTH RATES IN GUJARAT

Sr. No	Year	Forecasted Value based on models		
		Linear	Logarithmic	Exponential
1	2016	18.55202	18.58861	19.76426
2	2017	18.10539	18.14704	19.46015
3	2018	17.65877	17.70569	19.16072
4	2019	17.21214	17.26457	18.8659
5	2020	16.76551	16.82366	18.57562
6	2021	16.31888	16.38296	18.2898

Here we can see that R^2 for Exponential model is higher than the other two models. Moreover the decreasing pattern of forecasted values given by Exponential model seems to be more practical than the rest of the models. Based on fitting of Exponential model the forecasted birth rate can come down to 18.3 by the end of the year 2021.

Fertility Transition Scenario

Total Fertility Rate at National Level

During 2007-2015, there has been a decline of 0.4 points in TFR at the National level. The corresponding decline in rural and urban TFRs has been to the extent of 0.4 and 0.2 points respectively. At present, a rural woman (having a TFR of 2.8) at the National level would have about one child more than an urban woman

(having a TFR of 1.9), on average.

Total Fertility Rate (TFR) for the country has decreased to 2.3 during 2015. During 2015, Bihar has reported the highest TFR (3.2) while Tamil Nadu and West-Bengal have recorded the lowest (1.7). It is noteworthy that the replacement level TFR, viz 2.1, has been attained by Andhra Pradesh (1.7), Delhi (1.7), Himachal Pradesh (1.7), Karnataka (1.8), Kerala (1.8), Maharashtra (1.8), Jammu & Kashmir (1.9), Punjab (1.7), Tamil Nadu (1.6), West Bengal (1.6) and Odisha (2.0).

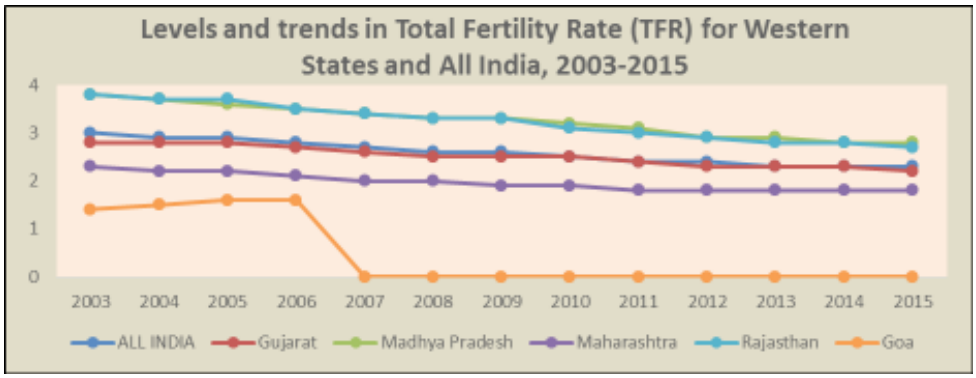
Gujarat has experienced considerable reduction in fertility, but lagging behind the western state of Maharashtra. According to 2015 SRS data presented in Table 4, fertility in Gujarat is still 0.1 point away from replacement level (Total Fertility Rate of 2.1). While the observed fertility level in Gujarat (2.2) is one point lower than the all India average (TFR of 2.3) but is quite higher than Maharashtra (1.8) and lower than Madhya Pradesh (2.8) and Rajasthan (2.7). The rural fertility rates are marginally higher than the urban fertility in all the states across India. As mentioned earlier among western states in India, Maharashtra is the first and only state to achieve the replacement level of fertility among bigger states.

Contrary to other western states in India, Madhya Pradesh seems to have lagged behind in fertility transition. This study looks into the progress of fertility transition over the last three decades in Gujarat in comparison with other western states. It also tries to provide reasons for slow progress of the state in fertility reduction as compared to other states in the region.

According to the Sample Registration System-2015, the total fertility rate of Gujarat is 2.2 whereas, other western states particularly Maharashtra has achieved replacement level fertility by 2006 but Madhya Pradesh and Rajasthan also have not achieved the replacement level fertility of 2.1. Gujarat is far behind its neighbouring state Maharashtra in total fertility rates.

Table–4:Total Fertility Rate (TFR) for Western States and All India, 2003 to 2015

All India/ States	Total Fertility Rate												
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ALL INDIA	**3.0**	**2.9**	**2.9**	**2.8**	**2.7**	**2.6**	**2.6**	**2.5**	**2.4**	**2.4**	**2.3**	**2.3**	**2.3**
Gujarat	2.8	2.8	2.8	2.7	2.6	2.5	2.5	2.5	2.4	2.3	2.3	2.3	2.2
Madhya Pradesh	3.8	3.7	3.6	3.5	3.4	3.3	3.3	3.2	3.1	2.9	2.9	2.8	2.8
Maharashtra	2.3	2.2	2.2	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.8	1.8	1.8
Rajasthan	3.8	3.7	3.7	3.5	3.4	3.3	3.3	3.1	3.0	2.9	2.8	2.8	2.7
Goa	1.4	1.5	1.6	1.6	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A	N.A



Note: TFR of Goa is not available from the yea 2007

Family Planning Scenario in the State

Acceptance of family planning is the major strategy to limit the family size. It also determines the economic condition of a family and broadly tells about the socio-economic development of the society. In India, the official family planning programme started in the 1952. However, it could not achieve its goal as expected; the TFR is far more than 2 in many states of the country. But Gujarat had a unique history of early start to the family planning programme. Due to remarkable achievement, Gujarat is at present having a better record of health and family welfare programmes as compared to other states.

In 2015-16, 98.5 per cent of the deliveries were institutional including

Government as well as private hospitals. The percentage of institutional deliveries in urban areas is higher than in rural areas.

Total Fertility Rate at State Level

As far as district-wide variation of total fertility rate (TFR) in Gujarat is concerned, most of the northern districts of the state have high fertility above replacement level (2.1). High fertility in the northern districts was prevalent in the earlier decades as well. The coastal and southern districts, on the contrary, also yet not have achieved replacement level fertility. The fertility transition has been reduced in the south resulting in widening the fertility gap between northern and southern districts.

Policy based efforts are made by Gujarat and witnessed a fairly rapid decline in fertility during the nineties, despite slow progress in socio-economic development. The total fertility rate has declined significantly from 4.3 in 1981 to 2.2 in 2015 backed by improved level of female literacy. In addition, the favourable implementation of women's empowerment programme, higher rate of participation of women in labour market was also considered conducive for the fertility decline in Gujarat. The total Fertility projections of Gujarat from 2016 to 2021 are made.

5. Methodology for prediction of TFR in Gujarat

METHOD-1

As a first step, growth in total fertility rate for Gujarat has been estimated using different growth curves. Out of different growth models, few best fitted models are presented below.

In this method the total Fertility projections of Gujarat from 2016 to 2021 are made by using curve estimation. In curve estimation we have used Linear, Logarithmic and Exponential Growth curve using SPSS.

Model Summary and Parameter Estimates

Dependent Variable: **TFR-Gujarat**

Equation	Model Summary					Parameter Estimates	
	R^2	F	df1	df2	Sig.	Constant	b1
Linear	0.932	272.01	1	20	0	144.19	-0.07
Logarithmic	0.933	277.52	1	20	0	1073.26	-140.8
Exponential	0.971	667.22	1	20	0	41.28	-0.02

Table – 5: Annual Forecast of total fertility rate of GUJARAT based on models

Sr. No.	Year	Forecasted value based on models		
		Linear	Logarithmic	Exponential
1	2016	1.95214	1.95629	2.15108
2	2017	1.88158	1.88647	2.10829
3	2018	1.81103	1.81668	2.06634
4	2019	1.74048	1.74692	2.02523
5	2020	1.66992	1.67721	1.98494
6	2021	1.59937	1.60752	1.94544

Here we can see that for Exponential is higher than the rest of the models. Moreover the decreasing pattern of forecasted values given by Exponential seems to be more practical than the rest of the models. So by using Exponential model the forecasted total fertility rate can come down nearer to 2.0 by the end of the year 2021 in Gujarat.

METHOD-2

In this method time series data of Total Fertility Rate (TFR), Female Literacy Rate (FLR), Per Capita Income, Child Mortality Rate (CMR) and Family Planning methods is taken to discuss the multivariate model. Here TFR is considered as dependent variable and others are taken as independent variables and causal relationship between two variables where one variable is hypothesized to depend on the other is calculated.

The results of Correlation coefficients are given in following table

	TFR	*FLR*	*CMR*	*Per Capita Income*	*STERILIZATION*	*I.U.D*
TFR	1					
FLR	-0.93883	1				
CMR	0.996797	-0.93492	1			
Per Capita Income	-0.70785	0.82936	-0.68426	1		
STER	-0.87174	0.764884	-0.84768	0.685061322	1	
IUD	-0.95583	0.928712	-0.93861	0.779352583	0.880095	1

From the above table we can see that there is significant positive correlation between TFR and CMR. We can say that as Child mortality increases, total fertility rate also increases. Further there is significant negative correlation between TFR and Family Planning methods, which says that TFR decreases as use of Family Planning methods increases among people. When we compare total fertility rate with income, it comes out with a negative correlation, which says that as per capita income increases the fertility rate decreases.

Model Fitting:

Here we have tried to present a simplified version of two variables and three variable linear regression models.

Total Fertility Rate is considered as dependent variable and Child Mortality Rate and Family Planning methods as an independent variable.

Since the correlation between TFR and CMR and Family Planning Methods is very significant and their p-values are also significant, other variables therefore excluded from the final regression model. The model summary is provided in the following table.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.9989
R Square	0.9970
Adjusted R Square	0.9974
Standard Error	0.0470
Observations	22

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	17.54614919	5.848716	2647.8160	5.43388E-24
Residual	18	0.039759898	0.002209		
Total	21	17.58590909			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	2.436720686	0.128253	18.99	2.33194E-13	2.167271	2.706169
CMR	0.050111042	0.001986	25.24	1.68176E-15	0.045939	0.054283
STERI	-0.000830854	0.000353	-2.35	0.03	-0.001572	-8.94725E-05
IUD	-0.000639153	0.000180	-3.55	0.00	-0.00102	-0.000262

MODEL

TFR = 2.4367 + 0.0501(CMR) - 0.0008(STER) - 0.0006(IUD)

In the above model the F-statistic significance is less than 5% which enable us to accept that the model is statistically significant and can be fit.

6. Concluding Remarks

Ø The CBR of the state was comparatively stable at higher level in the past (40 or more) and by decade to decade it has been drastically declining and as per SRS 2015 data, the CBR had reached to 20.4, whereas, the Natural Growth Rate gained by 14.6 in the state due to widening the gap between CBR and CDR.

Ø After considerable progress in the field of health and related activities, Maharashtra comes out to be well known performer over the last several decades that due to a variety of historic, social and economic reasons. While Gujarat has yet not successfully achieved the replacement level of fertility (2.1) from the projected year. During the eighties and nineties, the state has experienced a considerable reduction in fertility, but lower in scale and slower in pace as compared to other western states.

Ø The analysis identifies some of the structural determinants of the delay in childbearing and decline in fertility rates and it highlights two set of factors

that have contributed to current fertility trends: (i) higher education and employment of women, and changes in patterns of family formation; and (ii) shifting values of younger women towards a less traditional role of women within family and society. Women with paid jobs, with higher education and income, and who are not married have lower births than other women. In addition, fertility is positively associated with child mortality and negatively associated with female education and per capita income.

- Ø Various explanations have been offered for the successful fertility decline in Gujarat. Female literacy, agrarian reforms, matrilineal customs, better health and educational facilities, government involvement in sponsored welfare measures and political consciousness are believed to be the main reasons for the rapid and unusual demographic transition in Gujarat.
- Ø Fertility levels were lower among districts with better social settings or stronger family planning programs than among those with poorer settings or weaker programs; they were lowest in the presence of both good social settings and strong programs. At 2.2, Gujarat is now just 0.1 points away from reaching replacement levels. Fertility is declining rapidly, including among the poor and illiterate. At these rates, Gujarat will achieve its demographic transition and reach replacement level earliest by 2017. After that conscious role of maintaining replacement fertility will be on priority.
- Ø However, the replacement level of fertility in Northern Gujarat is still lagging behind due to its socio-economic and cultural factors. Few districts in Northern Gujarat have high fertility, which impacts the overall achievement of the state. The tribal and backward districts have not only high fertility but also have poor socio-economic indicators such as agricultural productivity due to the semi-arid areas and lack of proper irrigation.
- Ø The entire area of southern Gujarat was under Maharashtra state and till today a majority of the people from this area are highly influenced by its tradition and culture. At the same time, these districts belong to a historical region that had been part of the former Maharashtra state. These districts are part of a larger high fertility zone that extend toward the northern region of Maharashtra.
- Ø Most of the family from tribal and backward area are opposed to using of

contraceptive methods due to religious beliefs. This shows its effect on overall performance of fertility decline and other developmental aspects in the state. As a result, the districts of Panchmahals, Godhra, Narmada, The Dangs, Dohad, Sabarkantha and Banaskantha of Gujarat have higher fertility rate as compared to the other districts in the state.

- Ø However, in southern Gujarat and Central region especially those districts which are most urbanized the fertility has substantially decline not only because of high literacy and other non-traditional culture but also due to its developmental growth.
- Ø To maintain the pace of decline, Health and Family Planning Department should improve or revise the existing family planning programmes and introduce new effective programmes in future. Most of the developmental indicators, generally attributed for decline in fertility including female literacy, have yet to reach the threshold level in the backward districts of the State. Therefore, effective steps should be taken to establish better health and other infrastructural facilities in such backward areas. The concerned central and state government department should initiate appropriate programmes for the development of the people residing in interior villages and backward areas.

7. Acknowledgements :

I thank the referee for reviewing this research article, which has helped me in its revision.

8. References:

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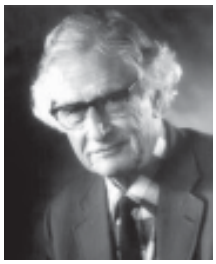
[7] Commissionerate of Health Services, Government of Gujarat.

BIOGRAPHY

FRANK YATES*

H. D. BUDHBHATTI**



Frank Yates was one of the pioneers of 20th century statistics. He was born on 12th May 1902, Manchester, England.

Frank Yates's mother was Edith Wright and his father was Percy Yates. Percy was a seed merchant as was Edith's father. Edith and Percy Yates had five children, with Frank being the eldest with four younger sisters. His interest in mathematics came early.

An uncle's gift of a table of five-figure logarithm led to the young, precocious Yates becoming interested in mathematics.

He was educated at Wadham House, a private school where the mathematics master was both an excellent mathematician and teacher who encouraged Frank into this direction. He obtained a scholarship to Clifton College in 1916. Four years later he was awarded a scholarship to study at St. John's College, Cambrdige. He graduated with First Class Honours in 1924 after doing very well at university but never looking like the outstanding scholar that he later became.

After two years teaching mathematics in secondary schools, he decided that he wanted to pat his mathematical skills to more practical use, and anyway he was tired of trying to teach people who did not want to learn, so he joined the Gold Coast Survey as mathematical advisor.

Here began a deep appreciation of Gaussian least squares, and a lifelong love of the slide rule and other aids to efficient, well organized and accurate

* Adapted from wikipedia (the free encyclopedia).
We express our sincere thanks and gratitude for this assistance.

** Ex. CSO, Head, Statistics Dept., GSRTC, Ahmedabad
(rcd. Nov.'17 / rvd. Dec.'17

arithmetic.

By chance Yates met R. A. Fisher and after applying to him for a post, he was appointed assistant statistician at Rothamsted Experimental Station in August 1931. When Fisher was appointed to a chair in University College London in 1933, Yates become Head of Statistics at Rothamsted. He held this post until he retired in 1968. During the ten years from 1958 until his retirement he was aldo deputy director of Rothamsted. Yates worked on experimental design, often collaborating with Fisher. Together they proved a longstanding conjecture on 6x6 Latin squares in 1934. Yates introduced the 'continuity correction' in 1934 and published an extremely important volume of statistical tables jointly with Fisher in 1936. Also in 1936 he published work on incomplete block designs which proved very influential in designing biological experiments. Yates' monograph on factorial design published in 1937 was another improtant publication. In a paper in the Proceedings of the Cambridge Philosophical Society in 1939, Yates discussed the Behrens-Fisher test of the significance of the difference of means of pairs of sample independently drawn from normal populations in which the variances are not assumed to be equal. Wilks writes that Yates indicates :-

During World war II he studied food supplies and application of fertilisers to improve crops. This was an important contribution to the war effort and led directly to the government implementing specific policies on imports. He applied his experimental design techniques to a wide range of problems such as control of pests. After 1945 he was to continue to apply his statistical techniques to problems of human nutrition.

Yates published a major paper on Systematic sampling in the Philosophical Transactions of the Royal Society in 1948. Wolfowitz writes that Yates :-

... discussed various results dealing with one-dimensional systematic sampling. No fully reliable estimate of the sampling error can be obtained from the observations themselves, except that, under certain circumstances, the sum of sets of terms taken alternately positve and negative provides a reasonably

satisfactory estimate (which is usually an overestimate). The method of "partial systematic samples", based on short sections of completely enumerated sequences, is proposed for estimating the systematic sampling error.

In 1949 Yates was appointed to the United Nations Commission on Statistical Sampling and published Sampling Methods for Censuses and Surveys.

... a work which did much to establish sound principles and technical terminology.

A survey Yates wrote in 1951 on the design of experiments Quelques developpements modernes dans la planification des experiences discussed topics such as : factorial experiments, including a discussion of the weighing problems; the theory of confounding in factorial experiemnts; fractional replications; split plot designs; balanced and partially balanced incomplete block designs; lattices; lattice squares; and quasi-Latin squares.

Yates became an enthusiastic user of computers writing :- According to him..

... to be a good theoretical statistician one must also compute, and must therefore have the best computing aids.

In 1954 he purchased a computer to assist with the statistical analysis to the data at Rothamsted. He was one of the people who were influential in establishing the British Computer Society, and he was president of the Society in 1960-61. In his Presidential Address Yate's pointed out that, as well as making the impossible possible, computers provided speed, thoroughness and a fairly complete mechanisation of techniques for work which would previously have been done by hand. The last of these, Yates suggested, is particularly important for specialist such as biologists. He went on to say that the reluctance of statistician to use computers was vanishing and they were carrying out computations which were previosuly impossible, or almost impossibly time consuming to do by conventional methods. Yates remarked that most of the calculations which were possible by hand calculation were still being done that way, probably because no code had been written and made available. He

encouraged people to write code to solve standard statistical problems, and emphasised that it should be code which was machine independent.

Yates was an extremely good Departmental Head. In the address at his memorial service his style in this role was talked about :-

Frank Yates' method of managing his department was a remarkable one, in that it was totally invisible. There were almost no rules, apart from that which insisted that no scientific apper left the department without being read, and usually greatly improved, by him.

After he retired, he became Senior Research Fellow at Imperical College, London. There he did some lectuing for the first time in his carrer.

The Royal Society of London, to which he was elected in 1948, awarded him their Royal Medal in 1966 in :-

...recognition of his profound and far-reaching contributions to the statistical methods of experimental biology.

He was also a member of the Royal Statistical Society and received their Guy medal in 1960. He was president of the Society in 1967-68. Frank Yates died on 17 June 1994 in Harpenden, England after living for 92 years and noteworthy work in the field of Statistics.

Franks Yates received the following honous :

(1) Fellow of the Royal Society (1948)

(2) BMC morning speaker (1955)

(3) RSS Guy Model in Gold (1960)

(4) Royal Society Royal Medal (1966)

Selected References :

• The design and analysis of factorial experiemtns. Technical Communication no. 35 of the Commonwealth Bureau of Soils (1937) (alternatively attributed to the Imperial Bureau of Soil Science)

• Statistical tables for biological, agricultural and medical research (1938, coauthor R.A.Fisher) sixth edition

• Sampling methods for censuses and surveys (1949)

• Computer programs GENFAC, RGSP, Fitquan.

SV NEWS LETTER

K. Muralidharan*

Activities

* During these days, there are many academic programmes for conferences, seminars, workshops etc. We mention some of such programmes under the heading of **ACTIVITIES** as under

ACTIVITIES

- International conference on Energing Innovations in Statistics and Operations Research (EISOR 2018)
  Date : Dec. 27-30, 2018
  Place : Dept. of Statistics, M. D. University, ROHTAK-124001
  Contact : sc_malik@rediffmail.com
- Advancing Frontiners in Operation Research towards a sustainable world.
  Dated : Dec. 21-23, 2017, Kolkata
  (In collaboration with Heritage Institute of Technology)
- 54th Econometrics Conference, 2018
  Dated : March 7-9, 2018
  Place : Shri Mata Vaishnodevi University, Katra, Jammu
  Contact : Dr. Pabitrakumar Jena
  email : 54thties@gmail.com
- Biostatistics Conference of India
  Dated : Dec. 28-30, 2017
  Place : IISA, HICC, Hyderabad
  Contact : iisa2017@intindstat.org
- International conference on Theory and Applications of Statistics and Information Sciences (TASIS - 2018)
  Dated : Jan 5-7, 2018
  Place : Coimbatore
  Contact : tasis2018@gmail.com

* Prof. and Head, Department of Statistics,
M. S. University, Vadodara 390 002

- International Conference at Nirma University, (NIPICON 2018)
  Date : Jan. 23-25, 2018
  Contact : registration@nipicon.org
- International Conference on Recent trends in O.R.
  Date : 28-30 December
  Place : IIT, Roorakee
  Contact : drmadhujain.math.litr@gmail.com
- (IISA 2017) International Indian Statistical Association Conference
  Date : Dec. 28-30, 2017
  Place : Hyderabad
  Contact : iisa2017@intindst.org
- (ICSTC 2017)
  The International Conference for 21st Century
  Dated : Dec. 14-16, 2017
  Place : Dept. of Statistics, University of Kerala, Trivendram
  Contact : icstc2017@gmail.com
- National Conference on Statistics for Huminities and Social Sciences - Recent Trends and Advances
  Dated : Jan 15-18, 2018
  Place : University of Lifelong Learning (University of Rajasthan, Jaipur)
  Contact : 65jayantsingh@gmail.com

READERS FORUM

A. M. PATEL*

* **D. S. Dave (USA)**

Sankhya Vignan is now a peer review journal for research and readings in applied statistics. It is published regularly since last 13 years. During recent days, a special section of 'Management and Statistics' is started which establishes a link between management people with researchers in statistis subject. I would welcome more articles, project reports, surveys etc in this journal.

More emphasis should be thrusted for application areas which is a need of the day.

I express my best wishes to the team for their efforts. Please keep it up.

* **Dr. P. Prajapati (Ahmedabad)**

I read with interest the issues of S V Journal sometimes. I had contributed also by means of my own work as well as for peer review. This Journal is useful for theoreticians as well as practicians.

I feel that the journal should be made quarterly and there can be different issues clubed together in respective quarters e.g. One quarter may be devoted only for projects / survey work, another only for theoretical papers etc. I suggest more emphasis for applications.

Team SV is working with Zeal, spirit and hardwork under the guidance of chief editor, Dr. B. B. Jani. This is a journal with merits as all the articles are refered unbiasedly. I express my congratulations to the whole team.

* **Dr. V. H Bajaj (Aurangabad)**

Dedicated efforts by the team doing SV Journal activities have brought fame and success. To run an academic journal under different constraints is a difficult task. Personally I wish that SV should now be published on quarterly basis from the next year. Balancing must be maintained between theoretical and application oriented articles. Some new topics for study can be discussed under classroom notes. etc.

My best wishes for further work ahead.

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

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Note : For any querries you may please contact (1) Dr. B. B. Jani, e-mail : bbjani2012@gmail.com; (2) Dr. J. R. Purohit, jrjayesh.purohit@gmail.com

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
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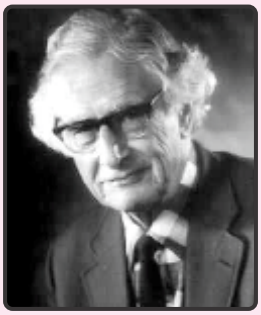
Life Member	₹ 1,500/-	US $ 300
Ordinary Member (p.a.)	₹ 500/-	US $ 50

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

FRANK YATES*



Frank Yates was born in Manchester, England on 12th May 1902. He was an English Statistician cum mathematician. He passed away on 17th June 1994 at the age of 92 years in Harpenden, England. He was educated at St. John's College, Cambridge. He obtained his graduation with First class Honours in 1924.

Frank was considered to be **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 Yate's algorithm and the balanced imcompele block design. He **became an enthusiast of electronic computers.** In 1954 he obtained an Eliott 401 for Rothamsted and contributed to the initial development of statistical computing. He is remembered for his notable contributions like Yate's analysis, Yate's correction for continuity, Fisher-Yates Shuffle, systematic sampling, factorial designs etc. He was honoured by the following **(1) Fellow of Royal Society** (FRS) *1948), **(2) BMC morning speaker** (1955) **(3) RSS Guy medal in Gold** (1960), **(4) Royal society roayl medal** (1966)

He became president of Royal Statistical Society in 1967-68.

***(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.

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