

PEER REVIEW JOURNAL
FOR
RESEARCH AND READINGS IN
APPLIED STATISTICS

ISSN 2321-0877

SANKHYA VIGNAN

संख्या विज्ञान

NEW SERIES (NSV 13)

JUNE 2017

No. 1

CONTENTS

<u>EDITORIAL</u>		03-04
<u>PEER REVIEW</u>		05-06
<u>MANAGEMENT AND STATISTICS (ARTICLES)</u>		
□ The Mathematical Programming Approach to media scheduling	(A.C.Brahmbhatt)	07-08
□ Data Mining	(Jayesh R. Purohit)	09-19
<u>RESEARCH ARTICLES</u>		
□ Determination of sample size for testing the significant difference among several serial correlation coefficients.	(M. Prankumar and G.V.S.R. Anjaneyulu)	20-27
□ Sample Mean Deviation (d) Control Chart Based on six sigma Initiatives	(Kalpesh R. Tailor)	28-36
□ Econometric View for some operational parameter of GSRTC	(H.M.Dixit, P.M.Parmar and S. N. Jaiswal)	37-42
□ ગુજરાતમાં આરોગ્ય ક્ષેત્રે સામાજિક વપરાશના સૂચકો	(પ્રિતી ડી. રાવત)	43-51
<u>REVIEW ARTICLE</u>		
□ Six Sigma Deployment in higher education Institutions	(Nimisha Shah and N. D. Shah)	52-58
<u>BIOGRAPHY</u>		
□ Abraham De Moivre	(H.D.Budhbhatti)	59-63
<u>SV NEWSLETTERS</u>	K.Muralidharan)	64-65
<u>READERS FORUM</u>	(A. M. Patel)	66-68



Published by
GUJARAT STATISTICAL ASSOCIATION



SANKHYA VIGNAN

संख्या विज्ञान

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

EDITORIAL BOARD

• CHIEF EDITOR •

Dr. B. B. Jani

C/o. Statistics Department,
Gujarat University, Ahmedabad-380 009. (India)
Ph. (R) 27476770,(M) 9824057902
E-mail : bbjani2012@gmail.com

• JOINT EDITOR •

Prin. A. M. Patel

Ph. : (R) 27479287, (M) 9978444161

• JOINT EDITOR •

Dr. Mrs. R. G. Bhatt

Ph. : (R) 26301457, (O) 26304308 (M) 9601753913

E-mail : drrgb@yahoo.co.in

MEMBERS

Dr. M. C. Jaiswal (USA)

Dr. K. S. Rao

Dr. A. C. Brahmhatt

Dr. R. T. Ratani

Dr. C. C. GUJARATI

Dr. P. H. Thaker

Dr. N. M. Patel

Dr. H. D. Budhbhatti

Dr. D. S. Dave (USA)

Dr. V. H. Bajaj

Dr. D. K. Ghosh

Dr. K. Muralidharan

Dr. Hemal B. Pandya

Dr. P. J. Jhala

Dr. B. H. Prajapati

Prof. H. S. Mediwala

EDITORIAL SECRETARY

Dr. Jayesh R. Purohit

(Mantra Consultants)

Resi.: A/202, Parshwa Towers, Opp. Parekh Hospital
Near Shyamal Cross Road, Sattellite, AHMEDABAD-380015
Contact No. : +91 9909900799
e-mail : drjayesh.purohit@gmail.com

EDITORIAL

*“GREATEST VICTORIES ARE THE LEAST NOISY. MANIFESTATION OF THE NEW WORLD
IS NOT PROCLAIMED BY THE BEATS OF DRUMS.”*

-MOTHER

We are extremely happy to present this issue (NSV 13, No. 1, June 2017) just in time. We thank our contributors, evaluators, readers and well wishers for their consistent support which has made it possible.

This issue contains 2 articles, 4 research articles, 1 review article, Biography and other things as usual.

Under the caption **Management and Statistics First Article** is given by **A.C.Brahmbhatt** which discusses briefly mathematical programming approach for media scheduling.

Second Article under this caption is an interesting one discussing briefly about Data Mining. It is furnished by **Jayesh R. Purohit**.

First research article given by **Prankumar M.** and **G.V.S.R.Anjaneyulu** discusses sample size determination under given situations.

Second research article presented by **Kalpesh Tailor** describes mean deviation control chart under six sigma initiatives.

Third research article considers econometric data analysis pertaining to GSRTC. It is furnished by **H.M. Dixit, P.M. Parmar** and **S.N. Jaiswal**.

Fourth research article given by **Priti Ravat** discusses some health indicators for Gujarat State based upon NSS data. (It is given in Gujarati Language)

There is one **review article** discussing briefly about six sigma deployment in higher education. It is presented by **Nimisha Shah** and **N.D.Shah**.

Biography of famous mathematician cum statistician **Abraham De Moivre** is furnished by **H.D.Budhbhatti**.

S. V. News letter section is presented by **K. Muralidharan**.

Readers Forum section is represented by **A. M. Patel**

We are highly indebted to our following referees who have done an excellent job of evaluating the articles / papers submitted for this issue. **(Their names are give one by one in order of their appearance in the journal)**

(1)	Jayesh R. Purohit	(2)	A. C. Brahmbhatt
(3)	D. K. Ghosh	(4)	Hemal B. Pandya
(5)	M. B. Thakar	(6)	P. H. Thakar
(7)	R. G. Bhatt	(8)	Shailesh Teredesai

As usual, 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 and certificate along with the printed copy.

Wishing you pink health and seasons greetings.

Happy Statistics Day (29 June, 2017) to you.

Ahmedabad

Date : 30-06-2017

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
PEER REVIEWED REFREED BI-ANNUAL JOURNAL
ISSN:2321-0877
(Journal of Research and Readings in Applied Statistics)

- Listed at International ISSN Directory, PARIS

Average Circulation Rate : 850

Average Journal Evaluation Score: 7.50 (As on 31 Dec., 2016)



PUBLISHED BY GSA
GUJARAT STATISTICAL ASSOCIATION



FROM EDITOR'S DESK

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

PEER REVIEW PROCESS

- (1) To maintain PEER REVIEW REGISTER giving full details about authors, Refrees, decisions and internal rankings, before printing the Issue
- (2) All research articles published in the **SANKHYA VIGNAN** will undergo full peer review process. It should be clear for authors that the Editor In Chief is responsible for the final decision about the submitted papers; have the right to accept/reject any paper. The Editor In Chief will choose any option from the following to review the submitted papers:
 - a). send the paper to two reviewers, if the results were negative by one reviewer and positive by the other one; then the editor may send the paper for third reviewer or he take immediately the final decision by accepting/rejecting the paper. The Editor In Chief will ask the selected reviewers to present the results within 7 working days, if they were unable to complete the review within the agreed period then the editor have the right to resend the papers for new reviewers using the same procedure. If the Editor In Chief was not able to find suitable reviewers for certain papers then he has the right to accept/reject the paper.
 - b). sends the paper to a selected editorial board member(s) or reviewer.
 - c). the Editor In Chief himself evaluates the paper.
- (3) The authors of the papers/ Articles accepted for publication need to submit a duly signed copyright form within maximum one week of their receiving intimation of acceptance of their paper/ article.
- (4) To give each published issue for evaluation by two external Refrees other than editors) obtain evaluation reports and journal evaluation Score out of 10 points.
- (5) To declare average Journal Evaluation Score on the basis of the scores given by these two Refrees for each published issue.
- (6) To keep all records in perfect order.
- (7) Invite and accept suggestions made by the Refrees for Peer Review.

PEER REVIEW COMMITTEE:

It consists of six members:

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

PAPERS/ MANUSCRIPT EVALUATION CRITERIA

Each submitted manuscript is evaluated on the following basis:

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

GUIDELINES FOR AUTHORS

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

HOW TO SUBMIT

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

Dr. B. B. Jani

Chief Editor, Sankhya Vignan

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

(R) 079-27476770 (M) 9824057902

THE MATHEMATICAL PROGRAMMING APPROACH TO MEDIA SCHEDULING

A. C. BRAHMBHATT*

ABSTRACT

This article refers to the media scheduling activities and gives an indication where mathematical programming techniques can be introduced at different activity levels.

KEYWORDS

LP (Linear Programming), ILP (Integer Linear Programming), NLP (Non-linear Programming), SP (Stochastic Programming), DP (Dynamic Programming)

The marketing of any product or service revolves around designing an ideal mix of four Ps—Product, Price, Promotion and Place. The third P of promotion, in turn, is again a mix of various promotional elements viz. Advertising, Public Relation, Sales Promotion, Publicity etc. In the Advertising decisions at the core is designing a Media-mix or Media Scheduling Plan. Along with other approaches, the Mathematical Programming approach for the purpose has gained considerable importance amongst media planners and researchers.

In the wake of varieties of newer and newer media emerging in the recent time, the decision as to how many insertions to be made in each medium with the minimum cost has become more pertinent for media planners. Herein where the Mathematical programming has gained wider acceptance. A Linear Programming (LP) approach was adopted by researchers wherein the objective function was of maximizing the total rated exposure to the insertions made in various media subject to the cost constraints. Though it helps to arrive at the decision, LP suffers from several limitations. It is based on certain assumptions that are far from reality. For example the assumption that the insertion is a continuous variable is unrealistic.

• Research mentor at PDP, Gandhinagar

(Recd. May '17 / Revd. June '17) email : acbpramukh@hotmail.com

The function of rated exposure is linear is again not much realistic. The cost of media insertion is constant that may not hold true in reality.

The total rated exposure function, more often being non-linear, Non-Linear Programming(NLP) would be more appropriate . Its special case can be solved by The Piecewise Linear Programming when the Rated Exposure function is concave i.e. no increasing return. This is done by splitting the NLP into equivalent LP.

Another approach is based on setting goals of Advertising , which are mainly two- Reach—Total number of people exposed to at least one advertisement related to product in a given time period; and Frequency —Average number of advertisement for the product seen by each member of the target group during the given time period. Goal Programming is based on such goals. It is based on minimizing an objective function that is the weighted sum of the deviations from the set goals.The constraints are Reach and Frequency goals which are established for various market segments in particular time periods and an usual budget constraint. The limitation of the approach is that it is completely dependent on the goals that are set. Also it is using a rounding off procedure to specify the integer number of insertions in different media. In order to do away with this limitation , a more appropriate approach of Integer Linear Programming (ILP) is used.

Most of the limitations encountered in the earlier approaches are taken care of by Little and Lodish* who developed a model called MEDIAC using sales as the criterion for the media schedule adopting the Dynamic Programming approach.

Though the acumen , experience , competitive intelligence and strategic vision of the advertisers play a vital role in media planning and media scheduling decisions, the Mathematical Programming approaches help them refine their decision making process to achieve the higher order goals of advertising viz. Sales and Profit goals.

ACKNOWLEDGEMENT:

I thank the referee for reviewing my article.

REFERENCES:

J.D.C. Little and L.M. Lodish, (1966) 'A media selection model and its optimization by Dynamic Programming,' *Industrial Management Review*, VIII (Fall, 1966) pp.15-24.

DATA MINING

JAYESH R. PUROHIT*

ABSTRACT

This article describes briefly the main features related with data mining. Scope of data mining along with its modus operandi is discussed and an indication is given for profitable applications of data mining.

KEYWORDS

Data Access, Predictions, OLAP (Online Analytical Processing) Data Mining techniques

1. OVERVIEW

Data mining, *the extraction of hidden predictive information from large databases*, is a powerful new technology with great potential to help companies focus on the most important information in their data warehouses. Data mining tools predict future trends and behaviours, allowing businesses to make proactive, knowledge-driven decisions. The automated, prospective analyses offered by data mining move beyond the analyses of past events provided by retrospective tools typical of decision support systems. Data mining tools can answer business questions that traditionally were too time consuming to resolve. They scour databases for hidden patterns, finding predictive information that experts may miss because it lies outside their expectations.

Most companies already collect and refine massive quantities of data. Data mining techniques can be implemented rapidly on existing software and hardware platforms to enhance the value of existing information resources and can be

-
- Mantra Consultants, Ahmedabad, email : drjayesh.purohit@gmail.com
(recd. May '17 / revd. June '17)

integrated with new products and systems as they are brought on-line. When implemented on high performance client/server or parallel processing computers, data mining tools can analyze massive databases to deliver answers to questions such as, “Which clients are most likely to respond to my next promotional mailing, and why?”

This white paper provides an introduction to the basic technologies of data mining. Examples of profitable applications illustrate its relevance to today’s business environment as well as a basic description of how data warehouse architectures can evolve to deliver the value of data mining to end users.

2. THE FOUNDATIONS OF DATA MINING

Data mining techniques are the result of a long process of research and product development. This evolution began when business data was first stored on computers, continued with improvements in data access, and more recently, generated technologies that allow users to navigate through their data in real time. Data mining takes this evolutionary process beyond retrospective data access and navigation to prospective and proactive information delivery. Data mining is ready for application in the business community because it is supported by three technologies that are now sufficiently mature:

- Massive data collection
- Powerful multiprocessor computers
- Data mining algorithms

Commercial databases are growing at unprecedented rates. A recent META Group survey of data warehouse projects found that 19% of respondents are beyond the 50 gigabyte level, while 59% expect to be there by second quarter of 1996.1 In some industries, such as retail, these numbers can be much larger. The accompanying need for improved computational engines can now be met in a cost-effective manner with parallel multiprocessor computer technology. Data mining algorithms embody techniques that have existed for at least 10 years, but have only recently been implemented as mature, reliable, understandable tools that consistently outperform older statistical methods.

In the evolution from business data to business information, each new step has built upon the previous one. For example, dynamic data access is critical for drill-through in data navigation applications, and the ability to store large databases is critical to data mining. From the user's point of view, the four steps listed in **Table 1** were revolutionary because they allowed new business questions to be answered accurately and quickly.

Table 1.

Evolutionary Step	Business Question	Enabling Technologies	Product Providers	Characteristics
Data Collection (1960s)	"What was my total revenue in the last five years?"	Computers, tapes, disks	IBM, CDC	Retrospective, static data delivery
Data Access (1980s)	"What were unit sales in New England last March?"	Relational databases (RDBMS), Structured Query Language (SQL), ODBC	Oracle, Sybase, Informix, IBM, Microsoft	Retrospective, dynamic data delivery at record level
Data Warehousing & Decision Support (1990s)	"What were unit sales in New England last March? Drill down to Boston."	On-line analytic processing (OLAP), multidimensional databases, data warehouses	Pilot, Comshare, Arbor, Cognos, Microstrategy	Retrospective, dynamic data delivery at multiple levels
Data Mining (Emerging Today)	"What's likely to happen to Boston unit sales next month? Why?"	Advanced algorithms, multiprocessor computers, massive databases	Pilot, Lockheed, IBM, SGI, numerous start-ups (nascent industry)	Prospective, proactive information delivery

3. STEPS IN THE EVOLUTION OF DATA MINING

The core components of data mining technology have been under development for decades, in research areas such as statistics, artificial intelligence and machine learning. Today, the maturity of these techniques, coupled with high-performance relational database engines and broad data integration efforts, make these technologies practical for current data warehouse environments.

4. THE SCOPE OF DATA MINING

Data mining derives its name from the similarities between searching for

valuable business information in a large database — for example, finding linked products in gigabytes of store scanner data — and mining a mountain for a vein of valuable ore. Both processes require either sifting through an immense amount of material, or intelligently probing it to find exactly where the value resides. Given databases of sufficient size and quality, data mining technology can generate new business opportunities by providing these capabilities:

- **Automated prediction of trends and behaviours.** Data mining automates the process of finding predictive information in large databases. Questions that traditionally required extensive hands-on analysis can now be answered directly from the data — quickly. A typical example of a predictive problem is targeted marketing. Data mining uses data on past promotional mailings to identify the targets most likely to maximize return on investment in future mailings. Other predictive problems include forecasting bankruptcy and other forms of default, and identifying segments of a population likely to respond similarly to given events.
- **Automated discovery of previously unknown patterns.** Data mining tools sweep through databases and identify previously hidden patterns in one step. An example of pattern discovery is the analysis of retail sales data to identify seemingly unrelated products that are often purchased together. Other pattern discovery problems include detecting fraudulent credit card transactions and identifying anomalous data that could represent data entry keying errors.

Data mining techniques can yield the benefits of automation on existing software and hardware platforms, and can be implemented on new systems as existing platforms are upgraded and new products developed. When data mining tools are implemented on high performance parallel processing systems, they can analyze massive databases in minutes. Faster processing means that users can automatically experiment with more models to understand complex data. High speed makes it practical for users to analyze huge quantities of data. Larger databases, in turn, yield improved predictions.

Databases can be larger in both depth and breadth:

- **More columns.** Analysts must often limit the number of variables they

examine when doing hands-on analysis due to time constraints. Yet variables that are discarded because they seem unimportant may carry information about unknown patterns. High performance data mining allows users to explore the full depth of a database, without preselecting a subset of variables.

- **More rows.** Larger samples yield lower estimation errors and variance, and allow users to make inferences about small but important segments of a population.

A recent Gartner Group Advanced Technology Research Note listed data mining and artificial intelligence at the top of the five key technology areas that “will clearly have a major impact across a wide range of industries within the next 3 to 5 years.”² Gartner also listed parallel architectures and data mining as two of the top 10 new technologies in which companies will invest during the next 5 years. According to a recent Gartner HPC Research Note, “With the rapid advance in data capture, transmission and storage, large-systems users will increasingly need to implement new and innovative ways to mine the after-market value of their vast stores of detail data, employing MPP [massively parallel processing] systems to create new sources of business advantage (0.9 probability).”³

The most commonly used techniques in data mining are:

- **Artificial neural networks:** Non-linear predictive models that learn through training and resemble biological neural networks in structure.
- **Decision trees:** Tree-shaped structures that represent sets of decisions. These decisions generate rules for the classification of a dataset. Specific decision tree methods include Classification and Regression Trees (CART) and Chi Square Automatic Interaction Detection (CHAID).
- **Genetic algorithms:** Optimization techniques that use processes such as genetic combination, mutation, and natural selection in a design based on the concepts of evolution.
- **Nearest neighbour method:** A technique that classifies each record in a dataset based on a combination of the classes of the k record(s) most similar to it in a historical dataset (where $k \geq 1$). Sometimes called the k-nearest

neighbour technique.

- **Rule induction:** The extraction of useful if-then rules from data based on statistical significance.

Many of these technologies have been in use for more than a decade in specialized analysis tools that work with relatively small volumes of data. These capabilities are now evolving to integrate directly with industry-standard data warehouse and OLAP platforms. The appendix to this white paper provides a glossary of data mining terms.

5. HOW DATA MINING WORKS

How exactly is data mining able to tell you important things that you didn't know or what is going to happen next? The technique that is used to perform these feats in data mining is called modelling. Modelling is simply the act of building a model in one situation where you know the answer and then applying it to another situation that you don't. For instance, if you were looking for a sunken Spanish galleon on the high seas the first thing you might do is to research the times when Spanish treasure had been found by others in the past. You might note that these ships often tend to be found off the coast of Bermuda and that there are certain characteristics to the ocean currents, and certain routes that have likely been taken by the ship's captains in that era. You note these similarities and build a model that includes the characteristics that are common to the locations of these sunken treasures. With these models in hand you sail off looking for treasure where your model indicates it most likely might be given a similar situation in the past. Hopefully, if you've got a good model, you find your treasure.

This act of model building is thus something that people have been doing for a long time, certainly before the advent of computers or data mining technology. What happens on computers, however, is not much different than the way people build models. Computers are loaded up with lots of information about a variety of situations where an answer is known and then the data mining software on the computer must run through that data and distill the characteristics of the data that should go into the model. Once the model is built it can then be used in

similar situations where you don't know the answer. For example, say that you are the director of marketing for a telecommunications company and you'd like to acquire some new long distance phone customers. You could just randomly go out and mail coupons to the general population - just as you could randomly sail the seas looking for sunken treasure. In neither case would you achieve the results you desired and of course you have the opportunity to do much better than random - you could use your business experience stored in your database to build a model.

As the marketing director you have access to a lot of information about all of your customers: their age, sex, credit history and long distance calling usage. The good news is that you also have a lot of information about your prospective customers: their age, sex, credit history etc. Your problem is that you don't know the long distance calling usage of these prospects (since they are most likely now customers of your competition). You'd like to concentrate on those prospects who have large amounts of long distance usage. You can accomplish this by building a model. Table 2 illustrates the data used for building a model for new customer prospecting in a data warehouse.

Table 2 - Data Mining for Prospecting

	Customers	Prospects
General information (e.g. demographic data)	Known	Known
Proprietary information (e.g. customer transactions)	Known	Target

The goal in prospecting is to make some calculated guesses about the information in the lower right hand quadrant based on the model that we build going from Customer General Information to Customer Proprietary Information. For instance, a simple model for a telecommunications company might be:

98% of my customers who make more than \$60,000/year spend more than \$80/month on long distance

This model could then be applied to the prospect data to try to tell something about the proprietary information that this telecommunications company does not currently have access to. With this model in hand new customers can be selectively

targeted.

Test marketing is an excellent source of data for this kind of modeling. Mining the results of a test market representing a broad but relatively small sample of prospects can provide a foundation for identifying good prospects in the overall market. Table 3 shows another common scenario for building models: predict what is going to happen in the future.

Table 3 - Data Mining for Predictions

	Yesterday	Today	Tomorrow
Static information and current plans (e.g. demographic data, marketing plans)	Known	Known	Known
Dynamic information (e.g. customer transactions)	Known	Known	Target

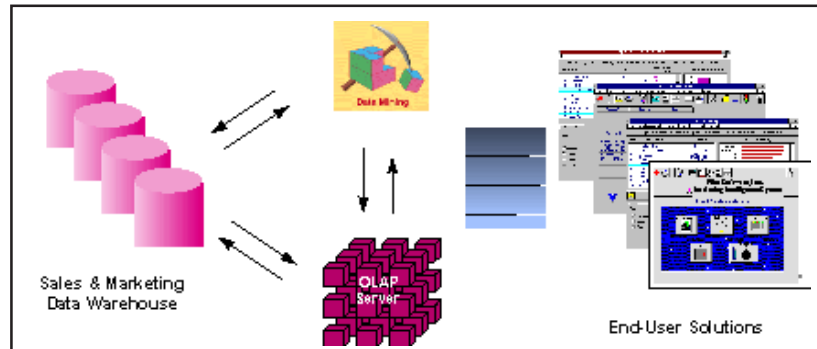
If someone told you that he had a model that could predict customer usage how would you know if he really had a good model? The first thing you might try would be to ask him to apply his model to your customer base - where you already knew the answer. With data mining, the best way to accomplish this is by setting aside some of your data in a vault to isolate it from the mining process. Once the mining is complete, the results can be tested against the data held in the vault to confirm the model's validity. If the model works, its observations should hold for the vaulted data.

6. AN ARCHITECTURE FOR DATA MINING

To best apply these advanced techniques, they must be fully integrated with a data warehouse as well as flexible interactive business analysis tools. Many data mining tools currently operate outside of the warehouse, requiring extra steps for extracting, importing, and analyzing the data. Furthermore, when new insights require operational implementation, integration with the warehouse simplifies the application of results from data mining. The resulting analytic data warehouse can be applied to improve business processes throughout the organization, in areas such as promotional campaign management, fraud detection, new product rollout, and so on. Figure 1 illustrates an architecture for advanced analysis in a large

data warehouse.

Figure 1 - Integrated Data Mining Architecture



The ideal starting point is a data warehouse containing a combination of internal data tracking all customer contact coupled with external market data about competitor activity. Background information on potential customers also provides an excellent basis for prospecting. This warehouse can be implemented in a variety of relational database systems: Sybase, Oracle, Redbrick, and so on, and should be optimized for flexible and fast data access.

An OLAP (On-Line Analytical Processing) server enables a more sophisticated end-user business model to be applied when navigating the data warehouse. The multidimensional structures allow the user to analyze the data as they want to view their business – summarizing by product line, region, and other key perspectives of their business. The Data Mining Server must be integrated with the data warehouse and the OLAP server to embed ROI-focused business analysis directly into this infrastructure. An advanced, process-centric metadata template defines the data mining objectives for specific business issues like campaign management, prospecting, and promotion optimization. Integration with the data warehouse enables operational decisions to be directly implemented and tracked. As the warehouse grows with new decisions and results, the organization can continually mine the best practices and apply them to future decisions.

This design represents a fundamental shift from conventional decision support systems. Rather than simply delivering data to the end user through query and reporting software, the Advanced Analysis Server applies users' business models

directly to the warehouse and returns a proactive analysis of the most relevant information. These results enhance the metadata in the OLAP Server by providing a dynamic metadata layer that represents a distilled view of the data. Reporting, visualization, and other analysis tools can then be applied to plan future actions and confirm the impact of those plans.

7. PROFITABLE APPLICATIONS

A wide range of companies have deployed successful applications of data mining. While early adopters of this technology have tended to be in information-intensive industries such as financial services and direct mail marketing, the technology is applicable to any company looking to leverage a large data warehouse to better manage their customer relationships. Two critical factors for success with data mining are: a large, well-integrated data warehouse and a well-defined understanding of the business process within which data mining is to be applied (such as customer prospecting, retention, campaign management, and so on).

Some successful application areas include:

- A pharmaceutical company can analyze its recent sales force activity and their results to improve targeting of high-value physicians and determine which marketing activities will have the greatest impact in the next few months. The data needs to include competitor market activity as well as information about the local health care systems. The results can be distributed to the sales force via a wide-area network that enables the representatives to review the recommendations from the perspective of the key attributes in the decision process. The ongoing, dynamic analysis of the data warehouse allows best practices from throughout the organization to be applied in specific sales situations.

- A credit card company can leverage its vast warehouse of customer transaction data to identify customers most likely to be interested in a new credit product. Using a small test mailing, the attributes of customers with an affinity for the product can be identified. Recent projects have indicated more than a 20-fold decrease in costs for targeted mailing campaigns over conventional approaches.

- A diversified transportation company with a large direct sales force can apply data mining to identify the best prospects for its services. Using data mining to

analyze its own customer experience, this company can build a unique segmentation identifying the attributes of high-value prospects. Applying this segmentation to a general business database such as those provided by Dun & Bradstreet can yield a prioritized list of prospects by region.

· A large consumer package goods company can apply data mining to improve its sales process to retailers. Data from consumer panels, shipments, and competitor activity can be applied to understand the reasons for brand and store switching. Through this analysis, the manufacturer can select promotional strategies that best reach their target customer segments.

Each of these examples have a clear common ground. They leverage the knowledge about customers implicit in a data warehouse to reduce costs and improve the value of customer relationships. These organizations can now focus their efforts on the most important (profitable) customers and prospects, and design targeted marketing strategies to best reach them.

8. CONCLUSION

Comprehensive data warehouses that integrate operational data with customer, supplier, and market information have resulted in an explosion of information. Competition requires timely and sophisticated analysis on an integrated view of the data. However, there is a growing gap between more powerful storage and retrieval systems and the users' ability to effectively analyze and act on the information they contain. Both relational and OLAP technologies have tremendous capabilities for navigating massive data warehouses, but brute force navigation of data is not enough. A new technological leap is needed to structure and prioritize information for specific end-user problems. The data mining tools can make this leap. Quantifiable business benefits have been proven through the integration of data mining with current information systems, and new products are on the horizon that will bring this integration to an even wider audience of users.

9. ACKNOWLEDGEMENTS

I thank the referee for his review of my article which has helped in its revision.

**DETERMINATION OF SAMPLE SIZE FOR TESTING THE
SIGNIFICANT DEFFERENCE AMONG SEVERAL CORRELATION
COEFFICIENTS**

M. PRAN KUMAR⁽¹⁾, G.V.S.R. ANJANEYULU⁽²⁾

ABSTRACT

Size of sample is determined for the ANOM – type Graphical Method developed by Rao and Pran Kumar (2002) to detect the significant difference among k normal population correlation coefficients by at least a specified amount D for fixed level of significance α and fixed power P in the case of equal sample sizes. Tables of samples sizes are given for $\alpha=0.05, 0.01, P=0.8, 0.9, 0.95, 0.99, D=0.8, 1, 3$ and $k=3(1) 20, 30, 60$.

KEY WORDS

Analysis of means, correlation coefficient, normality, power, sample size.

1. INTRODUCTION

In physical sciences, engineering, medicine, agriculture, life sciences and social sciences, the problem of testing the significant difference among several normal population correlation coefficients arises most frequently. Chi-square test is available in the literature to test the equality of several correlation coefficients. This test is non - graphical and demonstrates only statistical significance of correlation coefficients. Rao and Pran Kumar (2002) developed two graphical procedures, namely “ANOM – type graphical methods for testing the equality of

(1) Senior Faculty in Statistics, Master Minds College of Commerce, Guntur (India)

e-mail: harini.pran@gmail.com

(2) Professor, Department of Statistics, Acharya Nagarjuna University, Nagarjuna Nagar (India)

e-mail: profgvsranu@gmail.com

(rcd. Feb' 17 / rvd. May' 17)

several correlation coefficients” similar to analysis of means (ANOM) introduced by Ott (1967). These methods demonstrate the presence of statistical significance as well as the physical significance of correlation coefficients. Rao and Pran Kumar (2002) used Hotelling’s (1953) z^* transformation in the derivation of decision lines in the case of equal sample sizes. Rao (2005) made a review of papers in the area of analysis of means. Section 2 presents graphical procedure developed by Rao and Pran Kumar (2002) in the case of equal sample sizes.

Sample size determination is immensely very useful for investigators while testing the hypotheses on the basis of random samples drawn from populations. By which the investigator is able to know the number of units to be investigated from a population to test the hypothesis well in advance. It helps the investigator in managing the time and controlling the cost and power of the test.

Nelson (1983) generated tables of sample sizes for the analysis of means necessary of detecting differences among k treatment means differ by at least a specified amount for a fixed level of significance and fixed power. Motivated by Nelson’s (1983) tables of sample sizes, most recently, Pran Kumar and Anjaneyulu (2016 and 2017) derived expressions for sample sizes for two different ANOM-type graphical methods for testing the significant difference among several variances.

In this paper, size of sample is determined for the ANOM-type graphical method developed by Rao and Pran Kumar (2002) to detect the significant difference among k normal population correlation coefficients 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 determination of sample size is carried out using the expression of sizes of samples drawn from normal populations as given in Chow et al.(2008, p.71). Section 3 presents the determination of the expression of sample size. Tables of sample sizes for $\alpha = 0.01, 0.05, P = 0.8, 0.9, 0.95, 0.99, D = 0.8, 1, 2$ and $k = 3 (1) 20, 30, 60$ are given in Section 4.

2. ANOM-TYPE GRAPHICAL METHOD

Let $\{X_{ij}, Y_{ij}\}$, $i = 1, 2, \dots, k$; $j = 1, 2, \dots, n$ be k independent random sample drawn from k bivariate normal populations with correlation coefficients ρ_i ($i = 1, 2, \dots, k$). We wish to test the null hypothesis

$$H_0 : \rho_1 = \rho_2 = \dots = \rho_k = \rho \text{ (unknown)}$$

against the alternative hypothesis that at least one equality does not hold. The ANOM-type graphical method developed by Rao and Pran Kumar (2002) to test H_0 is given in the following steps. This procedure is applicable when the sample size $n > 9$.

1. Calculate r_i the sample correlation coefficients and $z_i = \frac{1}{2} \ln \frac{1+r_i}{1-r_i} \forall i = 1, 2, \dots, k$
2. Calculate \bar{z}^* for all samples and then compute \bar{z}^*

$$\text{where } z_i^* = z_i - \frac{3z_i + r_i}{4(n-1)} \text{ and } \bar{z}^* = \frac{1}{k} \sum_{i=1}^k z_i^*$$

3. Calculate $SE(z_i^* - \bar{z}^*) = \sqrt{\frac{1}{n-1} \left(1 - \frac{1}{k}\right)}$
4. The lower decision line (LDL) and the upper decision line (UDL) for the comparison of each of z_i^* are given by

$$\text{LDL} = \bar{z}^* - Z_{(1-\alpha/2k)} SE(z_i^* - \bar{z}^*) \text{ and } \text{UDL} = \bar{z}^* + Z_{(1-\alpha/2k)} SE(z_i^* - \bar{z}^*)$$

where $Z_{(1-\alpha/2k)}$ is the standard normal variable value for cumulative probability $(1 - \alpha/2k)$.

5. Plot z_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 correlation coefficients are not equal.

3. DETERMINATION OF SIZE OF SAMPLE

The determination of size of sample is carried out in such a way that the test statistic would yield no error conclusion of either accepting H_0 when H_0 is true with a fixed confidence level $(1 - \alpha/2k)$ or rejecting H_0 when H_0 is false with

a fixed power $P = (1 - \beta)$. Using the expression as given in Chow et al.(2008, p.71) to derive the sample size where the samples are taken from normal populations, the size of sample is determined for the method developed by Rao and Pran Kumar (2002) to detect the significant difference between any one of

$$z_l^* = \bar{z}^* - \frac{D}{k-1}, \quad l = 1, 2, \dots, k-1 \quad \text{and} \quad l \neq i.$$

Consider,

$$Z_i = Z_{(1-\alpha/2k)} +$$

where

$$Z_i = \frac{z_i^* - \bar{z}^*}{SE(z_i^* - \bar{z}^*)} \tag{3.1}$$

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

Therefore,

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

For one of significantly different z_i^* from \bar{z}^* , we take $z_i^* - \bar{z}^* = D$

$$\frac{D}{\sqrt{\frac{1}{n-1} \left(1 - \frac{1}{k}\right)}} = Z_{(1-\alpha/2k)} + Z_p \tag{3.2}$$

$$D \sqrt{\frac{k(n-1)}{(k-1)}} = Z_{(1-\alpha/2k)} + Z_p$$

$$\sqrt{\frac{k(n-1)}{(k-1)}} = \frac{Z_{(1-\alpha/2k)} + Z_p}{D}$$

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

$$n - 1 =$$

$$n = 1 + \left(\frac{k-1}{k} \right) \left[\frac{Z_{(1-\alpha/2k)} + Z_p}{D} \right]^2 \quad (3.3)$$

Hence, the derived expression (3.3) is the size of the sample for the method developed by Rao and Pran Kumar (2002) to detect the significant difference of one of z_i^* from \bar{z}^* by at least a specified difference D in the case of equal sample size.

4. TABLES OF SAMPLE SIZES

Using the expression (3.3), the sample sizes computed for fixed $\alpha = 0.01, 0.05, P = 0.8, 0.9, 0.95, 0.99, D = 0.8, 1, 2$ and $k = 3 (1) 20, 30, 60$ are presented in Tables 4.1 through 4.6.

Table 4.1 $\alpha = 0.01 \quad D = 0.8$

$P \backslash k$	0.80	0.90	0.95	0.99
3	16	20	23	30
4	19	23	27	35
5	20	25	29	38
6	22	27	31	40
7	23	28	32	42
8	24	29	33	43
9	24	30	34	44
10	25	30	35	45
11	26	31	36	46
12	26	32	37	47
13	27	32	37	48
14	27	33	38	48
15	27	33	38	49
16	28	33	39	49
17	28	34	39	50
18	28	34	39	50
19	28	34	40	51
20	29	35	40	51
30	31	37	42	54
60	34	40	46	58

Table 4.2 $\alpha = 0.05 \quad D = 0.8$

$P \backslash k$	0.80	0.90	0.95	0.99
3	12	15	18	24
4	14	18	21	28
5	16	20	23	31
6	17	21	25	33
7	18	22	26	35
8	18	23	27	36
9	19	24	28	37
10	20	25	29	38
11	20	25	30	39
12	21	26	30	40
13	21	26	31	40
14	21	27	31	41
15	22	27	32	41
16	22	27	32	42
17	22	28	32	42
18	23	28	33	43
19	23	28	33	43
20	23	29	33	43
30	25	31	36	46
60	28	34	39	50

Table 4.3 $\alpha = 0.01$ $D = 1$

P k	0.80	0.90	0.95	0.99
3	11	13	15	19
4	12	15	17	22
5	13	16	19	24
6	14	17	20	26
7	15	18	21	27
8	15	19	22	28
9	16	19	22	29
10	16	20	23	29
11	17	20	23	30
12	17	21	24	30
13	17	21	24	31
14	18	21	24	31
15	18	21	25	32
16	18	22	25	32
17	18	22	25	32
18	18	22	26	33
19	19	22	26	33
20	19	23	26	33
30	20	24	27	35
60	22	26	30	37

Table 4.4 $\alpha = 0.05$ $D = 1$

P k	0.80	0.90	0.95	0.99
3	8	10	12	16
4	9	12	14	18
5	10	13	15	20
6	11	14	16	22
7	12	15	17	23
8	12	15	18	23
9	13	16	18	24
10	13	16	19	25
11	13	16	19	25
12	14	17	20	26
13	14	17	20	26
14	14	17	20	26
15	14	18	21	27
16	15	18	21	27
17	15	18	21	27
18	15	18	21	28
19	15	18	22	28
20	15	19	22	28
30	16	20	23	30
60	18	22	25	33

Table 4.5 $\alpha = 0.01$ $D = 3$

$P \backslash k$	0.80	0.90	0.95	0.99
3	2	2	3	3
4	2	3	3	3
5	2	3	3	4
6	2	3	3	4
7	3	3	3	4
8	3	3	3	4
9	3	3	3	4
10	3	3	3	4
11	3	3	3	4
12	3	3	4	4
13	3	3	4	4
14	3	3	4	4
15	3	3	4	4
16	3	3	4	4
17	3	3	4	4
18	3	3	4	5
19	3	3	4	5
20	3	3	4	5
30	3	4	4	5
60	3	4	4	5

Table 4.6 $\alpha = 0.05$ $D = 3$

$P \backslash k$	0.80	0.90	0.95	0.99
3	2	2	2	3
4	2	2	2	3
5	2	2	3	3
6	2	2	3	3
7	2	3	3	3
8	2	3	3	3
9	2	3	3	4
10	2	3	3	4
11	2	3	3	4
12	2	3	3	4
13	2	3	3	4
14	2	3	3	4
15	2	3	3	4
16	3	3	3	4
17	3	3	3	4
18	3	3	3	4
19	3	3	3	4
20	3	3	3	4
30	3	3	3	4
60	3	3	4	5

5. CONCLUDING REMARKS

In Tables 4.4, 4.5, and 4.6, the observations (in bold numerals) of sample sizes should be replaced by sample size 10, since the Hotelling's (1953) z^* transformation used in the graphical method developed by Pran Kumar and Rao (1998) follows normality only when the sample size $n > 9$.

From Tables 4.5 and 4.6 it is to conclude that a lowest sample size of 10

is enough to consider for $\alpha \geq 0.01$, $D \geq 3$, $P \leq 0.99$ and

Hence, in general, lower the significance level α , lower the difference D , higher the power P , and more the number of populations k , the higher is the sample size. Higher the significance level α , higher the difference D , lower the power P , and lesser the number of populations k , the lower is the sample size.

6. ACKNOWLEDGEMENT

We thank the referee for his valuable comments and suggestions to revise this paper.

7. REFERENCES

- [1] **Chow, S. Shao, J. and Wang, H.** (2008). "Sample size calculations in Clinical Research". 2nd ed. Chapman and Hall / CRC, *Biostatistics series*, pp. 71.
- [2] **Hotelling, H.** (1953). "New light on the correlation coefficient and its transforms". *Journal of Royal Statistical Society, Series B*, 15, pp. 193-232.
- [3] **Nelson, P. R.** (1983). "A comparison of sample sizes for the analysis of means and the analysis of variance". *Journal of Quality Technology 1*, Vol.15, pp. 33 – 39.
- [4] **Ott, E. R.** (1967). "Analysis of means – a graphical procedure". *Industrial Quality Control*, 24, pp. 101 – 109.
- [5] **Pran Kumar, M. and Anjaneyulu, G. V. S. R.** (2016). "Sample size for testing the homogeneity of several normal population variances". *International Journal in Physical and Applied Sciences*, 03, pp. 34-40.
- [6] **Pran Kumar, M. and Anjaneyulu, G. V. S. R.** (2017). "Sample size determination of ANOM-type graphical method for testing the equality of several variances". *Bulletin of Mathematics and Statistics Research*, 05, (To appear).
- [7] **Rao, C. V.** (2005). "Analysis of Means – a review", *Journal of Quality Technology*, 37, pp. 308 – 315.
- [8] **Rao, C. V. and Pran Kumar, M.** (2002). "ANOM – type graphical methods for testing the equality of several correlation coefficients". *Gujarat Statistical Review 29*, pp. 47-56.

SAMPLE MEAN DEVIATION (d) CONTROL CHART BASED ON SIX SIGMA INITIATIVES

Kalpesh S. Tailor*

ABSTRACT

A control chart is a graphical device for representation of the data for knowing the extent of variations from the expected standard. The technique of control chart was suggested by W.A. Shewhart of Bell Telephone Company based on three sigma limits. M. Harry, the engineer of Motorola has introduced the concept of six sigma in 1980. In six sigma initiatives, it is expected to produce 3.4 or less number of defects per million of opportunities. If the companies practicing Six Sigma initiatives use the control limits suggested by Shewhart, then no point fall outside the control limits because of the improvement in the quality of the process. In this paper an attempt is made to construct a control chart based on six sigma initiatives for sample mean deviation specially designed for the companies applying Six Sigma initiatives in their organization. Suitable Table for standard deviation is also constructed and presented for the engineers for making quick decisions.

KEYWORDS

Process control, Six Sigma, Six Sigma Quality Level.

1. INTRODUCTION

The technique of quality control was developed by W. A. Shewhart (1931). It was based on 3sigma control limits. Mikel Harry (1980), the engineer of Motorola has introduced the concept of six sigma. He developed methods for problem solving that combined formal techniques, particularly relating to

Assistant Professor, Department of Statistics, M.K.Bhavnagar University, Bhavnagar-364001,
Email : kalpesh_tlr@yahoo.co.in. (recd. Jan. ' 17 / revd. April '17)

measurement, to achieve measurable savings in millions of dollars. The companies, which are practicing Six Sigma, are expected to produce 3.4 or less number of defects per million opportunities.

As the level of sigma rises, the level of variation decreases. In order to increase a company's process-sigma level, it should decrease the amount of variation that occurs in its process. The advantage of having less variation gives the company much higher predictability in the process, lowers costs as there is less wastage and rework, better performance and longevity of products and services, and an eventual increase in customers' satisfaction.

R.Radhakrishnan and P.Balamurugan (2010, 2010, and 2016) have developed six sigma based control charts for the number of defectives, exponentially weighted moving average and standard deviation.

V.D.Naik and K.S.Tailor (2015, 2016) have suggested 3σ (3 mean deviation) control limits. On the basis of 3 control limits, they have developed \bar{x} -chart, R-chart, s-chart and d-chart. K.S.Tailor (2016) has also developed moving average and moving range chart under 3 control limits.

Mean deviation is a very good alternative of standard deviation as mean deviation is considered to be the most intuitively and rationally defined measure of dispersion, which is an unbiased estimator of it and has similar property as sample mean has as an estimator of population mean. Thus, in this paper an attempt is made to construct a control chart based on six sigma initiatives for sample mean deviation. Also an empirical study is carried out to make comparisons of three sigma and six sigma control charts based on sample mean deviation.

2. CONCEPTS AND TERMINOLOGIES

A. Upper specification limit (USL)

It is the greatest amount specified by the producer for a process or product to have the acceptable performance.

B. Lower specification limit (LSL)

It is the smallest amount specified by the producer for a process or product

to have the acceptable performance.

C. Tolerance level (TL)

It is the difference between USL and LSL, $TL = USL - LSL$

D. Process capability (Cp)

This is the ratio of tolerance level to six times standard deviation of the process.

$$Cp = (TL / 6\sigma) = (USL - LSL) / 6\sigma$$

E. Standard deviation (σ_{sd}): For many purposes standard deviation is the most useful measure of dispersion of a set of numbers. It is the root mean square value.

F. Quality Control Constant (K_{sd})

The constant is introduced in this paper to determine the control limits based on six sigma initiatives for sample mean deviation.

3. THREE SIGMA CONTROL LIMITS FOR SAMPLE MEAN DEVIATION CHART

Let d be the sample mean deviation, which is defined as,

$$d = \frac{1}{n} \sum_{i=1}^n |x_i - \bar{X}|, \text{ which has following important properties.} \quad (1)$$

d is the unbiased estimator of population mean deviation.

$$\text{i.e. } E(d) = \delta \text{ where } \delta \text{ is the process mean deviation} \quad (2)$$

$$V(d) = \quad (3)$$

$$\text{Hence, S.E.}(d) = \left[\frac{1}{n} \left(\frac{\pi}{2} - 1 \right) \right]^{\frac{1}{2}} \delta \quad (4)$$

Therefore, on the basis of 3σ criteria the control limits of d chart can be represented as follows.

$$\begin{aligned} \text{Central line (C.L)} &= E(d) \\ &= \bar{d} \end{aligned} \quad (5)$$

$$\text{Lower control limit (L.C.L)} = E(d) - 3\sigma_d$$

$$\begin{aligned}
&= \bar{d} - 3 \left[\frac{1}{n} \left(\frac{\pi}{2} - 1 \right) \right]^{\frac{1}{2}} \delta \\
&= \bar{d} - 3 \left[\frac{1}{n} \left(\frac{\pi}{2} - 1 \right) \right]^{\frac{1}{2}} \bar{d} \\
&= \left(1 - 3 \left[\frac{1}{n} \left(\frac{\pi}{2} - 1 \right) \right]^{\frac{1}{2}} \right) \bar{d} \\
&= \left(1 - \frac{2.267}{\sqrt{n}} \right) \bar{d} \tag{6}
\end{aligned}$$

Upper control limit (U.C.L) = E (d) + 3 σ_d

$$\begin{aligned}
&= \bar{d} + 3 \left[\frac{1}{n} \left(\frac{\pi}{2} - 1 \right) \right]^{\frac{1}{2}} \delta \\
&= \bar{d} + 3 \left[\frac{1}{n} \left(\frac{\pi}{2} - 1 \right) \right]^{\frac{1}{2}} \bar{d} \\
&= \left(1 + 3 \left[\frac{1}{n} \left(\frac{\pi}{2} - 1 \right) \right]^{\frac{1}{2}} \right) \bar{d} \\
&= \left(1 + \frac{2.267}{\sqrt{n}} \right) \bar{d} \tag{7}
\end{aligned}$$

4. SIX SIGMA BASED CONTROL LIMITS FOR SAMPLE MEAN DEVIATION CHART

Fix the tolerance level (TL) and process capability (C_p) to determine the process standard deviation (σ_{sd}). Apply the value of in the control limits $\bar{d} \pm K_{sd} \sigma_{sd}$ to get the control limits for the six sigma based control chart for the sample mean deviation. The value of K_{sd} is obtained by using $P(Z \leq K_{sd}) = 1 - \alpha$, where $\alpha_1 = 3.4 \times 10^{-6}$ and Z is a standard normal variate. For a specified TL and C_p of

the process, the value of σ_{sd} is calculated, which is presented in table 2 for various combinations of TL and C_p . Thus, the control limits for six sigma based control chart for sample mean deviation are determined as,

$$CL_{6\sigma} = \bar{d} \tag{8}$$

$$LCL_{6\sigma} = \bar{d} - K_{sd}\sigma_{sd} \tag{9}$$

$$UCL_{6\sigma} = \bar{d} + K_{sd}\sigma_{sd} \tag{10}$$

5. AN EMPIRICAL STUDY FOR SAMPLE MEAN DEVIATION (d) CONTROL CHART AND COMPARISON OF THREE SIGMA LIMITS AGAINST SIX SIGMA INITIATIVES

To illustrate sample mean deviation (d) chart with three sigma and six sigma limits, a data set is taken from E .L. Grant and R. S. Leavenworth (1988) which is given in table 1. Three sigma and six sigma control limits are computed from this data set, and control charts are plotted under these two limits.

Table 1: Data set

Lot	X1	X2	X3	X4	X5	d
1	77	80	78	72	78	2.72
2	76	79	73	74	73	2.16
3	76	77	72	76	74	1.44
4	74	78	75	77	77	1.44
5	80	73	75	76	74	1.96
6	78	81	79	76	76	2.2
7	75	77	75	76	77	0.84
8	79	75	78	77	76	1.52
9	76	75	74	75	75	0.88
10	71	73	71	70	73	4.2
11	72	73	75	74	75	2
12	75	73	76	73	73	1.88
13	75	76	78	79	77	1.52
14	77	77	78	77	76	1.2
15	77	76	77	77	77	1
16	77	77	77	79	79	2

(a) **Three sigma control limits for sample mean deviation (d) chart:**

$$CL = 1.81, LCL = 0 \text{ and } UCL = 3.35$$

(b) **Control limits based on six sigma initiatives for sample mean deviation (d) chart:**

For a given data set $USL = 2.72$, $LSL = 0.84$, $TL = 2.72 - 0.84 = 1.88$ and $C_p = 1.5$

The value of $\sigma_{sd} = 0.2088$, which is found from the table 2, $K_{sd} = 4.831$ which is calculated from $P(Z \leq K_{sd}) = 1 - \alpha$, where $\alpha_1 = 3.4 \times 10^{-6}$. Hence, the control limits based on six sigma initiatives for sample mean deviation chart for a specified TL and K_{sd} are determined as,

$$CL_{6\sigma} = 1.81, LCL_{6\sigma} = 0.8013 \text{ and } UCL_{6\sigma} = 2.8187$$

Table 2: Values of σ_{sd} for a specified C_p and TL

TL \ C _p	1.85	1.86	1.87	1.88	1.89
1.0	0.3083	0.3100	0.3117	0.3133	0.3150
1.1	0.2803	0.2818	0.2833	0.2848	0.2864
1.2	0.2569	0.2583	0.2597	0.2611	0.2625
1.3	0.2372	0.2385	0.2397	0.2410	0.2423
1.4	0.2202	0.2214	0.2226	0.2238	0.2250
1.5	0.2056	0.2067	0.2078	0.2088	0.2100
1.6	0.1927	0.1938	0.1947	0.1958	0.1969
1.7	0.1814	0.1824	0.1833	0.1843	0.1853
1.8	0.1713	0.1722	0.1764	0.1774	0.1783
1.9	0.1623	0.1632	0.1640	0.1649	0.1658
2.0	0.1542	0.1550	0.1558	0.1567	0.1575
2.1	0.1468	0.1476	0.1484	0.1492	0.1500
2.2	0.1401	0.1409	0.1417	0.1424	0.1432
2.3	0.1341	0.1348	0.1355	0.1362	0.1370
2.4	0.1285	0.1292	0.1299	0.1306	0.1313
2.5	0.1233	0.1240	0.1247	0.1253	0.1260

(e) d-charts for data set given in table 1 based on three sigma and six sigma limits:

Figure 1(a): d-chart with 3-sigma

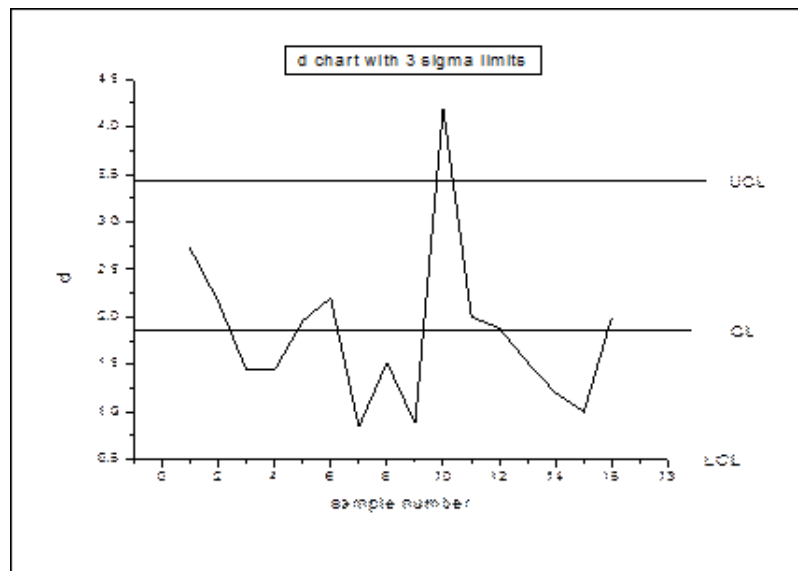
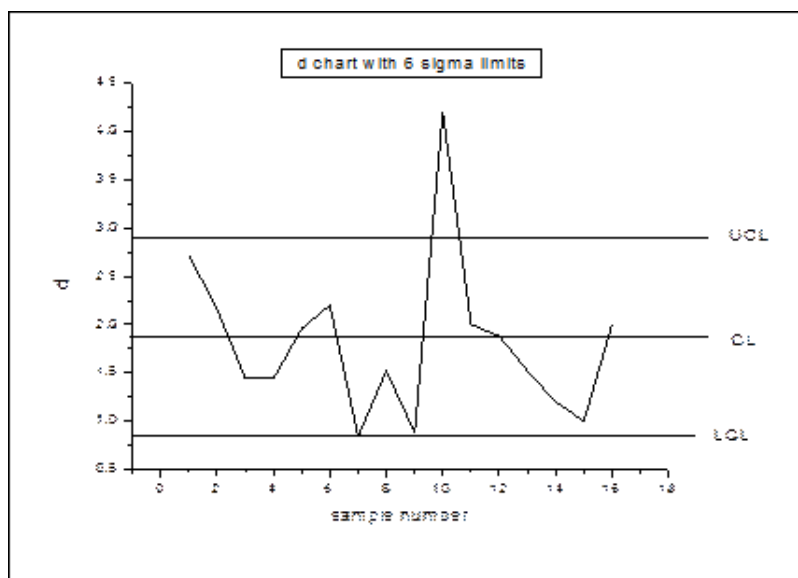


Figure 1(b): d-chart with 6-sigma limits



6. SUMMARY AND CONCLUSION

In this paper, a procedure is given to construct a control chart based on three sigma and six sigma initiatives for sample mean deviation with an illustration. It is found that the process was not in control even when Six Sigma initiatives are adopted. It is very clear from the comparison that when the process is centered with reduced variation many points fall outside the control limits as compared to the 3sigma control limits, which indicate that the process is not in the level it was expected. So a correction in the process is very much required to reduce the variations. The charts suggested in this paper can be very useful for the companies practicing Six Sigma initiatives in their process. These charts will replace the existing Shewhart (1931) control charts in future when all the companies start implementing Six Sigma Initiatives in their organizations.

7. ACKNOWLEDGEMENT

I thank Dr. B .B. Jani sir for his useful suggestions to revise this research paper. I also thank the referee for his comments which has helped in revising thoroughly the earlier draft of this paper.

8. SELECTED REFERENCES

- [1] **D.C. Montgomery (2001):** Introduction to statistical Quality Control (3rd Edition), John Wiley & Sons, Inc., New York,
- [2] **E .L. Grant and R. S. Leavenworth (1988):** Statistical Quality Control, Tata McGraw-Hill Publishing Company Limited, New Delhi
- [3] **K. Muralidharan (2015):** Six Sigma for Organizational Excellence A Statistical Approach, Springer
- [4] **K.S.Tailor(2016):** Moving Average And Moving Range Charts Under The Assumption Of Moderateness And Its 3σ Control Limits, *Sankhya Vignan*, December-2016,No.2, 18-31
- [5] **R. Radhakrishnan, P. Balamurugan(2016):**Construction of control chart based on six sigma initiatives for standard deviation ,*American International Journal of Research in Science, Technology, Engineering & Mathematics*, June- August , pp. 245-248

- [6] **R. Radhakrishnan, P. Balamurugan(2010):**Six Sigma based Control charts for the number of defectives, *Proceedings of the 2010 International Conference on Industrial Engineering and Operations Management (IEOM 2010) organized by Bangladesh Society of Mechanical Engineers, Dhaka, Bangladesh, Jan 9-10, (2010a), 92.*
- [7] **R. Radhakrishnan and P. Balamurugan(2010):**Six Sigma based Exponentially Weighted Moving Average Control Chart, *Indian journal of Science and Technology (IJST)*, Vol.3, No. 10, October, pp. 1052-1055
- [8] **T. L. Allen (2006):** Introduction to Engineering Statistics and Six Sigma, Springer
- [9] **V.S. Athawar and H.S. Lunge (2016):** Comparison of 3-sigma and six-sigma control chart corresponding to X-bar and R-chart to Meet Customer Satisfaction in Banking Sector, *International Journal of Scientific Research*, Vol. 5, Issue-6, pp. 124-129
- [10] **V.D. Naik. and J.M. Desai.(2009):** A Review of Debate on Mean Deviation Versus Standard Deviation and a Comparative Study of Four Estimators (Including Two Proposed Unbiased Estimators) of Mean Deviation of Normal Population, *VNSGU Journal of Science &Technology*, Vol. I, Issue-II, 220-229.
- [11] **V.D. Naik. and J.M. Desai.(2010):** Some more reasons for preferring Mean Deviation over Standard Deviation for drawing inference about first degree dispersion in numerical data, *VNSGU Journal of Science &Technology*, *VNSGU Journal of Science &Technology*, Vol. 2, December-2010
- [12] **V.D. Naik and K.S. Tailor (2015):**On performance of $\bar{\bar{x}}$ and R-charts under the assumption of moderateness rather than normality and with 3δ control limits rather than 3σ control limits, *VNSGU Journal of Science and Technology*, Vol.4, No. 1, 243-255
- [13] **V.D. Naik and K.S. Tailor (2016):** Mean deviation (\bar{d}) based control limits of SQC charts for sample standard deviation(s) and sample mean deviation (d) and their performance analysis under 3 control limits against 3 control limits, *VNSGU Journal of Science and Technology*, (Accepted for Publication).
- [14] **W.A. Shewhart(1931):**Economic Control of Quality of Manufactured Product, New York: Van Nostrand, .

**ECONOMETRIC VIEW FOR SOME OPERATIONAL
PARAMETERS OF GSRTC**

H.M.DIXIT⁽¹⁾, P.M.PARMAR⁽²⁾ & S.N. JAISWAL⁽³⁾

ABSTRACT

Since May 1960, with inception of Gujarat State, GSRTC (Gujarat State Road Transport Corporation) has been trying to provide efficient services at affordable rates to the people. It also always tries to enhance quality and scope of their services against all constraints especially financial and managerial. Therefore it may be necessary to analyse and evaluate operations of such giant service provider. Here an attempt is made to scan some major operational parameters of GSRTC using econometric methods and conclusions are made on the basis of this analysis.

KEY WORDS

Growth Pattern, Routes, Schedules, Earnings

1. INTRODUCTION

The Gujarat State Road Transport Corporation (GSRTC) is functioning with legacy of 56 years as it was formed as a corporation with inception of separate Gujarat State in May 1960. With no prime objective of maximizing profit, GSRTC has been trying to render services to the people against all odds. It also has expanded their services to neighbouring states like Rajasthan, Maharashtra and MP.

GSRTC has proved its indenponsibility by providing alternative mode of

⁽¹⁾ Arts, Commerce and Science College, PILVAI. email : dixithm13@gmail.com

⁽²⁾ H.L. College of Commerce, Ahmedabad. email : parmarm2004@gmail.com

⁽³⁾ R.L. Mehta Science and C.L. Parikh Commerce College, Palanpur.

email : jaiswalsn1964@gmail.com (rcd. May17/rvd. June 17)

transportation for those people who cannot afford air travel and / or reside in remote areas where railway network is not yet reached.

From a beginning with 7 divisions, 76 depots and 7 divisional workshops, it is now expanded to 16 divisions, 126 depots, 226 bus stations, 1554 pick up stands and more than 8000 buses. GSRTC has purchased more than 1500 new buses, including airconditioned, sleeper coaches and volvo buses in 2009. With passage of time GSRTC also provides on line and mobile phone ticket booking facilities. It also provides wi-fi internet services in its volvo buses for free. Unlike its competitors pay-bill and PF system for all employees has been computerized. It renders exemplary services for concessional journey to genuine students and commuters. This also leads to the problems for its financial growth since inception.

In this paper an effort is made to analyse some of the parameters which may be effective and responsible to visualize growth aspects of GSRTC.

2. DATA BASE

Analysis of this paper is carried out on the basis of time series data provided by GSRTC from 1960-61 to 2011-2012.

3. METHODOLOGY

The following multiple regression models are considered for major operational parameters of GSRTC. They are (i) No. of passengers (ii) Gross cost (iii) Earning (iv) No. of routes (v) No. of Schedules. The time component X_i is included in each model where $i = 1, 2, \dots, 51, 52$

- **Model – 1 : Relationship between no. of passengers (P) and earning (E) with progression of time (X_i)**

$$E_{x_i} = \alpha_0 (P_{x_i})^{\alpha_1} \exp (\alpha_2 X_i + u_i)$$

Taking natural logarithm on both the sides –

$$\ln E_{x_i} = \ln \alpha_0 + \alpha_1 \ln P_{x_i} + \alpha_2 X_i + u_{x_i}$$

Here α_0, α_1 and α_2 are the structural parameters of the model and *OLS* estimates of these parameters can be obtained and they can be tested for their

statistical significance.

- **Model – 2 : Relationship between Gr.Cost (C) and Earning (E) with passage of time (X_i)**

$$C_{x_i} = \beta_0 (E_{x_i})^{\beta_1} \cdot \exp(\beta_2 X_i + u_{x_i})$$

Taking natural logarithm on both the sides –

$$\ln C_{x_i} = \ln \beta_0 + \beta_1 \ln E_{x_i} + \beta_2 X_i + u_{x_i}$$

Here β_0, β_1 and β_2 are the structural parameters of the model and OLS estimates of these parameters can be obtained and they can be tested for their statistical significance.

- **Model – 3 : Relationship among no. of passengers (P), No. of routes (R) and No. of schedules (S)**

$$P_{x_i} = \lambda_0 (R_{x_i})^{\lambda_1} \cdot (S_{x_i})^{\lambda_2} \cdot \exp(\lambda_3 X_i + u_{x_i})$$

Here λ_0, λ_1 are the structural parameters of the model and OLS estimates of these parameters can be obtained and they can be tested for their statistical significance.

Taking natural logarithm on both the sides –

$$\ln P_{x_i} = \ln \lambda_0 + \lambda_1 \ln R_{x_i} + \lambda_2 \ln S_{x_i} + \lambda_3 X_i + u_{x_i}$$

Here u_{x_i} denotes error term for all the models.

4. ANALYSIS AND CONCLUSIONS

For the secondary data provided by GSRTC, we consider for our analysis log-log multiple regression models corresponding to certain operational parameters like No. of passengers, Gr. Cost, Earning, No. of routes and No. of schedules in GSRTC.

The parameters α, β and λ are to be estimated under usual assumptions for respective models. This represents three log-log multiple regression models with time as independent variable. These models are listed below in Table 1 as M_1, M_2 and M_3 respectively.

TABLE – 1

Model No.	Independent Variables	Dependent variables
M ₁	No. of passengers	Earnings
M ₂	Earnings	Gr . Cost
M ₃	No. of routes and schedules	No. of Passengers

Once the parameters are estimated for the respective models usual statistical testing can be done for significance.

Table – 2 given below represents regression output with conclusions.

TABLE 2(A)

Model No.	Dependent variable	Constant	Independent variables	
			No. of Passengers	Time
M ₁	Earnings	2.2904 S.E : (0.1701) t : (13.46)**	0.5646 S.E : (0.0206) t : (27.37)**	0.0972 S.E : (0.0009) t : (0106.43)**
		R ² = 0.9985, F = 15991.19, n = 51		

Above model shows statistical significance for the relationship amongst earnings, No. of passengers and time. All partial regression coefficients are found to be significant. The value of R^2 shows that about 99.85% variation is explained by the model. Theoretically there should be positive relationship between No. of passengers and earnings which is justified by the above model as regression coefficient attached to No. of passengers is found to be positive.

TABLE 2 (B)

Model No.	Dependent variable	Constant	Independent variable	
			Earnings	Time
	Gr. Cost	- 0.0893 S.E : (0.2578) t : (-0.346)	1.0134 S.E : (0.0371) t : (27.27) **	0.0012 S.E : (0.0043) t : (0.283)
		R ² = 0.9984, F = 15249.05, n = 51		

Model – 2 indicates that except earnings intercept and time component which is included for trend correction in the model is not found to be significant This

may be due to the fact that after 1996-97 growth rate of Gr. Cost is higher than earnings and high cost operation of GSRTC due to some managerial & non – managerial reasons.

TABLE 2(C)

Model No.	Dependent variable	Constant	Independent variables		
			No. of routes	No. of Schedules	Time
M ₃	No. of passengers	-0.0375	3.7244	-2.9202	-0.0239
		S.E : (0.6494)	S.E : (0.1015)	S.E : (0.1434)	S.E : (0.0033)
		t : (-0.058)	t : (36.66)**	t : (-20.354)**	t : (-7.14)**
R ² = 0.9731, F = 578.34, n = 52					

The above regression output pertaining to No. of passengers, No. of routes and No. of Schedules shows that 97.31% variation is explained by the model. Time component is not found to be significant and surprisingly relationship between No. of passengers and No. of schedules are found to be negative.

5. CONCLUDING REMARKS

We may summarise briefly on the basis of our above analysis.

- (1) The number of passengers exhibit a declining pattern from 1998-99. This may be attributed due to private operators functioning parallel to the GSRTC services. They may be offering relatively cheaper services. It may also due to the fact that the number of routes are decreasing from 2001.
- (2) The number of schedules are decreasing from 2002. This may be due to the fact that many local urban services within city area are gradually curtailed. This also affects the number of passengers and also on the overall earnings of the system.
- (3) It seems that entire system of GSRTC has growth potential. This may lead to increase efficiency and earning pattern of the system, provided that some

6. ACKNOWLEDGEMENTS

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

7. REFERENCES

- [1] **Allen RGD (1990)** Mathematical Analysis for Economics (Chapman and Hill)
- [2] **Damodar Gujarati (1994)** Econometrics (Prentice Hall Co.)
- [3] **Draper and Smith (1992)** Econometrics Analysis (Wiley Int. & Co.)
- [4] GSRTC Annual Reports and Budget Summary from 1960 to 2011-12.
- [5] **James Murphy (1973)** Introductory Econometrics (Richard D. Irwin Inc.)
- [6] **Johnston (1995)** Econometric Methods (John Wiley Co.)
- [7] **Potluri Roa and R.A. Miller (1972)** Applied Econometrics (Prentice Hall Co.)



ગુજરાતમાં આરોગ્ય ક્ષેત્રે સામાજિક વપરાશના અગત્યના સૂચકો

પ્રિતી ડી. રાવત*

સારાંશ (ABSTRACT)

આરોગ્ય વિષયની પસંદગીનો મુખ્ય હેતુ રાજ્યમાં લોકો આરોગ્ય માટેની જુદી જુદી યોજનાઓની વાકેફ વાચ, તેમજ રાજ્યને માટે જુદી જુદી યોજના બનાવવામાં મદદ મળી રહે તે હેતુથી રાષ્ટ્રીય નમુના મોજણીનાં ૭૧મા આવર્તન(જાન્યુ-૨૦૧૪ થી જુન-૨૦૧૪)નાં પરિણામો પરની વચજુલ મુજબ વ્યક્તિઓમાં બીમારીનું પ્રમાણ, માંદગી માટે લીધેલ સારવાર અને તેના પર તેમજ ખર્ચની વિગતો રજૂ કરવામાં આવી છે. જેમાં દવાખાનામાં દાખલ થયેલ હોય તેવા ગ્રામીણ ગુજરાતનાં ૧૪૫૬ અને શહેરી વિસ્તારનાં ૧૪૩૨ કુટુંબોની મોજણી કરવામાં આવી છે. જે અન્વયે તંદુરસ્તી વિષયક કાર્યક્રમો દ્વારા કેવો સુધારો લાવી શકાય તે માટેનું સુચન કરવામાં આવ્યું છે. માંદગી થાય ત્યારે વિવિધ પ્રકારે ભારતીય તબીબી પદ્ધતિ, હોમીયોપેથી અને “યોગ અને નેચરોપેથી” ના વિકલ્પનો સમાવેશ કરવામાં આવ્યો છે. જેમાં માંદગી માટે સારવાર નહીં લેવાનું પ્રમાણ ગ્રામીણ સ્ત્રીઓમાં વધુ જોવા મળેલ છે. આ બાબતે જાગૃતિ કેળવાય તે અનુસારનાં કાર્યક્રમોનું આયોજન કરીને પરિસ્થિતિમાં સુધારો લાવી શકાય. આ માહિતીનો ઉપયોગ રાજ્યમાં આરોગ્યને લઈ ઉદભવતા પ્રશ્નો માટે તેમજ રાજ્યની વિવિધ યોજનાઓના આયોજન માટે મદદ મેળવી શકાય.

KEY WORDS:

ANM - Auxiliary Nurse Midwives

CHC - Community health centre

ASHA - Accredited Social Health Activist

MMU - Mobile Medical Unit

AWW - Anganwadi worker

PAP - Proportion of ailing persons

AYUSH - Ayurved. yunani, unani, sidhdh and homeopathy

PHC - Primary health centre

* આંકડા મદદનીશ, અર્થશાસ્ત્ર અને આંકડાશાસ્ત્ર નિયામકની કચેરી, ગાંધીનગર
(recd. Dec.'16 / recd. April'17)

૧. પૂર્વ ભૂમિકા:

આ અહેવાલ રાષ્ટ્રીય નમુના મોજણીના ૭૧મા આવર્તન (જાન્યુઆરી ૨૦૧૪- જૂન ૨૦૧૪)ની મોજણી સામાજિક વપરાશના વિષય “આરોગ્ય” પર આધારિત છે. આ અહેવાલમાં સદરહુ મોજણીના વિગતવાર પરિણામો પૈકી વયજૂ• મુજબ વ્યક્તિઓમાં બીમારીનું પ્રમાણ, માંદગી માટે મેળવેલ સારવાર અંગેની જાતિવાર વિગતો અને શહેરી અને ગ્રામ્ય વિસ્તારમાં માંદગી - સારવાર માટેના •તા ખર્ચના જાતિ(પુરૂષ/સ્ત્રી)વાર અંદાજોની વિગતો રજૂ કરવાનો પ્રયાસ કરવામાં આવેલ છે.

૨. મોજણીનો મુખ્ય ઉદ્દેશ:

વિવિધ સામાજિક ક્ષેત્રો પૈકી લોકો દ્વારા આરોગ્ય ક્ષેત્રે કરવામાં આવતા વપરાશ અંગેની માહિતી ભેગી કરવા માટે ૭૧મા આવર્તનમાં સામાજિક વપરાશની આ મોજણી હા• ધરવામાં આવી. આ મોજણીમાં વિવિધ ઉંમર - જાતિ ના જુ• માટે માહિતી એકત્રીત કરવામાં આવેલ છે. વધુમાં, સરકાર દ્વારા પૂરી પાડવામાં આવતી આરોગ્ય સેવાઓ કેટલી હદ સુધી ઉપયોગી છે તે સંદર્ભમાં પણ આ મોજણીમાં માહિતી એકત્ર કરવામાં આવેલ છે. તબીબી સારવાર આપવા માટે સરકારી દવાખાના ત• જુદા જુદા (નીચલા) સ્તરની જાહેર આરોગ્ય સંસ્થાઓનો કેટલો ઉપયોગ •ય છે તેમજ જાહેર અને ખાનગી ક્ષેત્રોમાં સારવાર માટે •તા ખર્ચની વિગતો પણ આ મોજણીમાં એકત્ર કરવામાં આવેલ છે.

આ આવર્તનમાં સારવારના પ્રકારની માહિતી ભેગી કરવામાં આવી છે જેમાં, ભારતીય દવાની પદ્ધતિઓ આયુર્વેદ, યોગ, યુનાની અને સિધ્ધનો પણ સમાવેશ કરવામાં આવેલ છે.

Source:- Key indicators of Social Consumption in India - Health (January-June 2014)

૩. મોજણીમાં ઉપયોગમાં લીધેલ પૂછપરછ માટેનું પત્રક:

૩.૧ ૭૧મા આવર્તનની મોજણીનો સમયગાળો જાન્યુઆરી ૨૦૧૪ • જૂન ૨૦૧૪ હતો. જેમાં નમૂનાના કુટુંબો પાસે• જરૂરી માહિતી એકત્રિત કરવામાં આવી હતી. જેમાં, ઘરગથુ લક્ષણો અને વસ્તીવિષયક વિગતો અંગેની નીચે મુજબની માહિતી એકત્રિત કરવામાં આવી.

- છેલ્લા ૩૬૫ દિવસ દરમિયાન તબીબી સંસ્થાઓમાં સારવાર મેળવી હોય અને તેના માટે ઉદભવેલ ખર્ચની વિગતો,
- છેલ્લા ૧૫ દિવસ દરમિયાન કુટુંબના સભ્યોની બિમારીની વિગતો અને છેલ્લા ૧૫ દિવસ દરમિયાન સભ્યની સારવાર દરમિયાન ઉદભવેલ ખર્ચ (તબીબી સંસ્થામાં દાખલ •યેલ ન હોય તો પણ),
- મોજણીની તારીખના દિવસે ૬૦ વર્ષ કે તે• વધુ ઉંમરની વ્યક્તિની તબિયત અને તેની આર્થિક

સ્વતંત્રતાની વિગતો, અને

- છેલ્લા ૩૬૫ દિવસ દરમિયાન ૧૫ બી ૪૯ વર્ષની મહિલાઓમાં પ્રસૂતિ પહેલા અને પછીની સંભાળની વિગતો.

૩.૨ આવરી લીધેલ વિસ્તાર અને ક્ષેત્ર:

૩.૨.૧ નમુનાનું કદ

- (૧) પ્રાથમિક એકમ આ સર્વેમાં ગ્રામ્ય ગુજરાત માટે ૧૮૨ ગામોની મોજણી કરવામાં આવી જ્યારે શહેરમાં ૧૮૦ બ્લોકની મોજણી કરવામાં આવી હતી.
- (૨) દ્વિતીય એકમ ઘરનું સ્તરીકરણ નીચેના અધારે કરવામાં આવ્યું હતું.
છેલ્લા ૩૬૫ દિવસમાં, (૧) ઓછામાં ઓછું ૧ વર્ષની નાનું બાળક અને (૨) કુટુંબમાં ઓછામાં ઓછી એક વ્યક્તિ (ભૂતપૂર્વ બિમારીગ્રસ્ત સભ્યના સમાવેશ સાથે) દવાખાનામાં દાખલ થયેલ હોય તેવા ગ્રામીણ ગુજરાતનાં ૧૪૫૬ અને શહેરી વિસ્તારનાં ૧૪૩૨ કુટુંબોની મોજણી કરવામાં આવી.
- (૩) આ મોજણીનો સમયગાળો ૬ મહિના (જાન્યુઆરી બી જૂન ૨૦૧૪)નો હતો.

કોષ્ટક ૩.૧: મોજણી કરાયેલ ગ્રામ્ય/ બ્લોક, કુટુંબ અને વ્યક્તિ દીઠ સંખ્યા

	મોજણી થયેલ પ્રથમ સ્તરીય એકમની સંખ્યા (ગ્રામ્ય/બ્લોક)		મોજણી કરાયેલ સંખ્યા					
			કુટુંબો			વ્યક્તિઓ		
	ગ્રામ્ય	શહેરી	ગ્રામ્ય	શહેરી	કુલ	ગ્રામ્ય	શહેરી	કુલ
(૧)	(૨)	(૩)	(૪)	(૫)	(૬)	(૭)	(૮)	(૯)
ગુજરાત	૧૮૨	૧૮૦	૧૪૫૬ (૫૦%)	૧૪૩૨ (૫૦%)	૨૮૮ (૧૦૦%)	૮૦૮૨ (૫૩%)	૭૧૨૯ (૪૭%)	૧૫૨૧૧ (૧૦૦%)
ભારત	૪૫૭૭	૩૭૨૦	૩૬૪૮૦ (૫૫%)	૨૯૪૫૨ (૪૫%)	૬૫૯૩૨ (૧૦૦%)	૧૮૯૫૭૩ (૫૭%)	૧૪૩૫૩૧ (૪૩%)	૩૩૩૧૦૪ (૧૦૦%)

() કૌંસમાં આપેલ સંખ્યા ટકાવારી દર્શાવે છે.

૪. બીમાર વ્યક્તિ નું પ્રમાણ અને આરોગ્ય:

૪.૧ “બીમાર વ્યક્તિઓનું પ્રમાણ” એટલે કે, (PAP) ૧૫ દિવસ દરમિયાન દર હજારે બીમાર

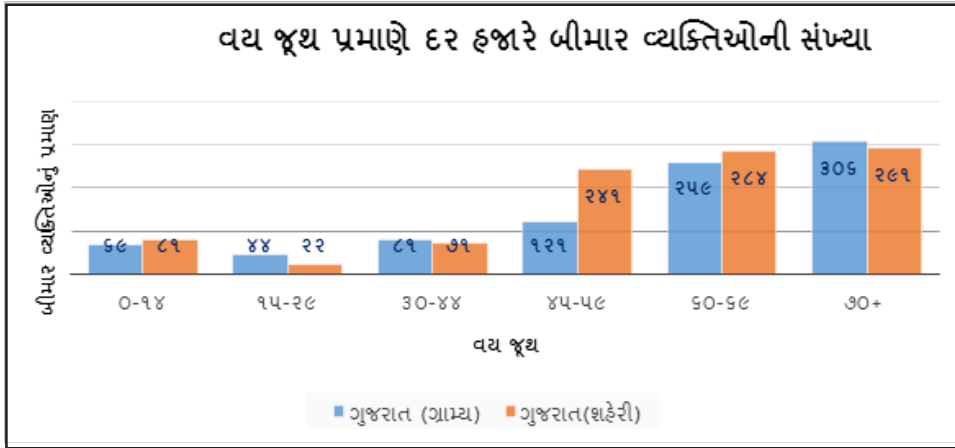
વ્યક્તીની સંખ્યા તે રીતે માપવામાં આવે છે.

૪.૧.૧ નીચેનું પત્રક (PAP)ની વિગતો એટલે કે, ૧૫ દિવસનાં સંદર્ભગાળા દરમિયાન બીમારીના દરના અંદાજો આપે છે.

કોષ્ટક ૪.૧ : ૧૫ દિવસના સંદર્ભગાળા દરમિયાન વય જૂથ પ્રમાણે દર હજારે બીમાર વ્યક્તિઓની સંખ્યા(PAP)

		વય જૂથ પ્રમાણે બીમાર વ્યક્તિઓનું પ્રમાણ(PAP)						
વય જૂથ		૦-૧૪	૧૫-૨૯	૩૦-૪૪	૪૫-૫૯	૬૦-૬૯	૭૦+	તમામ
(૧)	(૨)	(૩)	(૪)	(૫)	(૬)	(૭)	(૮)	(૯)
ગુજરાત	ગ્રામ્ય	૬૯	૪૪	૮૧	૧૨૧	૨૫૯	૪૩૮	૯૨
	શહેરી	૮૧	૨૨	૭૧	૨૪૧	૨૮૪	૨૯૧	૧૦૩
ભારત	ગ્રામ્ય	૬૭	૪૬	૭૭	૧૩૫	૨૫૯	૩૦૬	૮૯
	શહેરી	૮૧	૪૮	૯૮	૨૦૬	૩૫૫	૩૭૩	૧૧૮

ઉપરની માહિતી નીચે પ્રમાણે આલેખિત કરાઈ છે.



૪.૧.૨ ઉપરના કોષ્ટક અને આલેખ પરથી જોઈ શકાય છે કે, ૪૪ વર્ષની વય પછી બીમાર વ્યક્તિઓનાં પ્રમાણમાં ક્રમશઃ નોંધપાત્ર વધારો જોવા મળે છે અને તેમાં પણ શહેરી વિસ્તારમાં ૩૦-૪૪ વયજૂથની સામે ૪૫-૫૯ના વયજૂથમાં બીમાર વ્યક્તિનું પ્રમાણ દર હજારે ૭૧ થી વધીને ૨૪૧ જોવા મળે છે જે ૩.૪ ગણાનો નોંધપાત્ર વધારો દર્શાવે છે. જે અન્વયે ચોક્કસ વયજૂથને ધ્યાને લઈ તેઓ માટેના આરોગ્ય અને તંદુરસ્તી વિષયક બાબતોને લગતા તેમજ તંદુરસ્તી તરફ લઈ જતી રોજિંદી જીવન શૈલીને લગતા કાર્યક્રમો રજૂ કરીને તે દ્વારા આ બાબતે સુધારો લાવી શકાય.

૪.૨ માંદગીની સારવાર

બીમાર વ્યક્તિ જુદા જુદા પ્રકારે સારવાર મેળવે છે જેમ કે, એલોપૌલી, હોમીયોપેલી વગેરે. ઘણીવાર બીમારી માટે કોઈ પણ પ્રકારની તબીબી સારવાર લેવામાં આવતી નથી. આ સર્વેમાં સમાવેશ કરેલ ભારતીય તબીબી પદ્ધતિ (આયુર્વેદ, યુનાની અને સિધ્ધ), હોમીયોપેલી અને “યોગ અને નેચરોપેલી”ના વિકલ્પનો નીચેના કોષ્ટકમાં અન્ય સારવારમાં સમાવેશ કરવામાં આવ્યો છે. નીચેના પત્રકમાં જુદા જુદા પ્રકારે મેળવેલ બીમારીની સારવારનો દર દર્શાવેલ છે.

કોષ્ટક ૪.૨: જાતિ વાર માંદગી માટે જુદા જુદા પ્રકારે મેળવેલ સારવારની ટકાવારીની વિગત
માંદગી માટે મેળવેલ સારવારની ટકાવારી

		પુરુષ			સ્ત્રી		
		એક પણ નહિ	એલોપૌલી	અન્ય	એક પણ નહિ	એલોપૌલી	અન્ય
(૧)	(૨)	(૩)	(૪)	(૫)	(૬)	(૭)	(૮)
ગુજરાત	ગ્રામ્ય	૧૮.૭	૭૩.૮	૬.૬	૨૧.૫	૭૫.૦	૩.૪
	શહેરી	૧૧.૧	૮૮.૧	૦.૮	૧૧.૩	૮૭.૮	૦.૮
ભારત	ગ્રામ્ય	૪.૧	૮૦.૬	૫.૩	૪.૦	૮૮.૭	૭.૩
	શહેરી	૨.૮	૮૦.૪	૬.૮	૨.૫	૮૧.૦	૬.૫

૪.૨.૧ ઉપરના કોષ્ટકની માહિતી પરથી જણાય છે કે, એલોપૌલી દ્વારા સારવાર લેવા તરફ લોકોનું પ્રમાણ વધુ છે. ગુજરાતના શહેરી ક્ષેત્રોમાં પુરુષ અને સ્ત્રી બંનેમાં લગભગ ૧% ની આસપાસ સારવાર તરીકે AYUSH (આયુર્વેદ, યોગ, નેચરોપેલી, યુનાની, સિધ્ધા અને હોમીયોપેલી)નો ઉપયોગ થાય છે, જ્યારે આ બાબતે ગ્રામ્ય મહિલાઓની ટકાવારી ૩.૪% અને પુરુષોની ટકાવારી ૬.૬% છે. જે સામાન્યતઃ ગ્રામ્ય વિસ્તારોમાં આયુર્વેદ અથવા દેશી દવા વાપરવાની આદતનું સૂચન કરે છે.

વધુમાં, ગુજરાતમાં માંદગી માટે સારવાર નહીં લેવાનો દર રાષ્ટ્રીય કક્ષાના દર કરતા ઊંચો છે. રાજ્યમાં માંદગી દરમિયાન સારવાર નહીં લેવાનું પ્રમાણ પુરુષો કરતાં સ્ત્રીઓમાં અને ખાસ કરીને ગ્રામ્ય સ્ત્રીઓમાં વધારે જોવા મળે છે. શહેરી વિસ્તારમાં ૧૧.૧% પુરુષો અને ૧૧.૩% સ્ત્રીઓએ માંદગી દરમિયાન સારવાર ના લીધી હોવાનું જણાવેલ છે, જેની સામે ગ્રામ્ય વિસ્તારમાં ૧૮.૭% પુરુષો અને ૨૧.૫% સ્ત્રીઓ માંદગી દરમિયાન સારવાર ન લીધી હોવાનું જણાવેલ છે, જે પ્રમાણમાં વધારે ગણી શકાય. પારંપરિક રીતે સામાન્ય સંજોગોમાં સ્ત્રીઓમાં પોતાની માંદગીમાં ચલાવી લેવાની અને દવા વગર મટી જશે તેવા પ્રકારની વિચારસરણી/ભાવના આ માટે કારણરૂપ હોઈ શકે છે.

આ સંજોગોમાં લાંબે ગાળે આ વલણને કારણે સ્ત્રીઓની તંદુરસ્તી પર વિપરીત અસર ઉભી ન થાય

તે હેતુથી ખાસ કરીને ગ્રામ્ય વિસ્તારોમાં સ્ત્રીઓની તંદુરસ્તી અને બિમારીમાં સારવાર લેવા બાબતે જાગૃતિ કેળવાય તે માટેના કાર્યક્રમો કરવાની આ દિશામાં સંશોધન અધિકારી સુધારો લાવી શકાય.

૪.૨.૨ માંદગીની સારવાર ક્યાં લીધેલ છે

આ માટેની વિગતોમાં સરકારી દવાખાના, ખાનગી દવાખાના, પ્રાથમિક આરોગ્ય કેન્દ્ર, સામુદાયિક આરોગ્ય કેન્દ્ર, મોબાઇલ મેડિકલ યુનિટ અને રાજ્ય સરકાર મદદ કરતી હોય તેવી ESI હોસ્પિટલ અને ડિસ્પેન્સરીનો સમાવેશ કરવામાં આવેલ છે. નીચેનું કોષ્ટક જાતિવાર અને ક્ષેત્રવાર માંદગીની સારવાર ક્યાં લેવામાં આવી છે તેની વિગતો દર્શાવે છે.

કોષ્ટક ૪.૩: દર હજારે બીમારીની સારવાર માટે લીધેલી સંભાળનું સ્તર

		વ્યક્તિઓ			
		પ્રાથમિક આરોગ્ય કેન્દ્ર, આરોગ્ય પેટા કેન્દ્ર કે અન્ય*	પબ્લીક હોસ્પિટલ	ખાનગી તબીબ/ ક્લીનિક/ હોસ્પિટલ	કુલ
(૧)	(૨)	(૩)	(૪)	(૫)	(૬)
ગુજરાત	ગ્રામ્ય	૧૩૨	૧૦૫	૭૬૩	૧૦૦૦
	શહેરી	૪૪	૧૦૬	૮૫૧	૧૦૦૦
ભારત	ગ્રામ્ય	૧૧૫	૧૬૮	૭૧૭	૧૦૦૦
	શહેરી	૩૯	૧૭૩	૭૮૮	૧૦૦૦

* ANM, ASHA, AWW, ડિસ્પેન્સરી, CHC, MMU સાથે

૪.૨.૩ ઉપરોક્ત કોષ્ટક પરથી જોઈ શકાય છે કે, ગુજરાતનાં શહેરી વિસ્તારમાં ૭૬% વ્યક્તિઓએ ખાનગી તબીબી સુવિધા દ્વારા સારવાર મેળવેલ છે જ્યારે ગ્રામ્ય વિસ્તારમાં ૮૫% વ્યક્તિઓએ ખાનગી તબીબી સુવિધા દ્વારા સારવાર મેળવેલ છે. ગ્રામ્ય કક્ષાએ ઉપલબ્ધ CHC અને PHCની સુવિધાઓનાં ઉપયોગને પરિણામે જાહેર તબીબી સેવાઓમાં સારવાર લેવાનું પ્રમાણ શહેર કરતાં ગ્રામ્ય વિસ્તારમાં વધુ જોવા મળે છે.

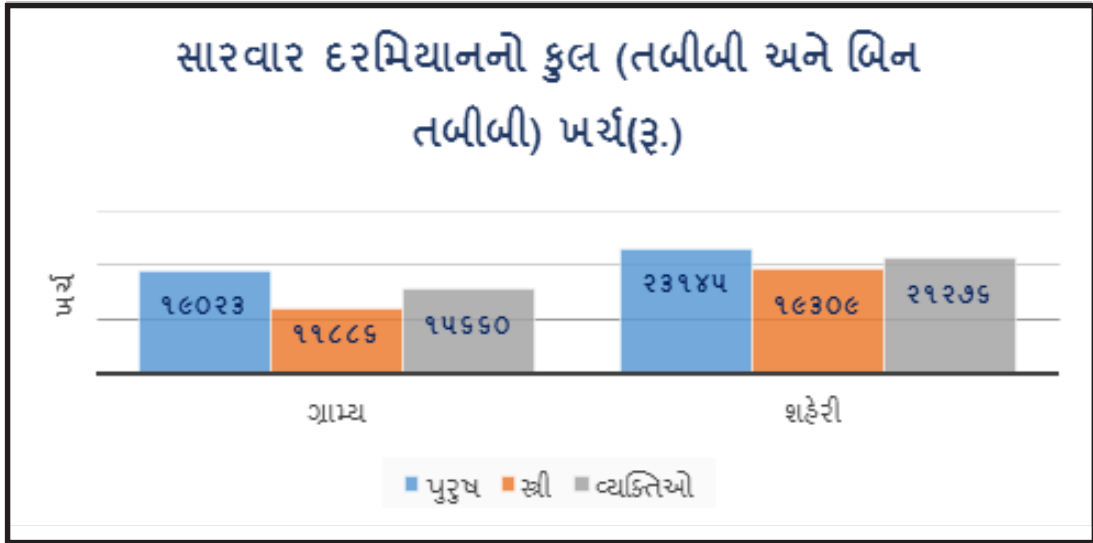
૪.૩ તબીબી સારવાર માટે થયેલા ખર્ચના અંદાજો

નીચેનાં કોષ્ટકમાં શહેરી અને ગ્રામ્ય ક્ષેત્રોમાં તબીબી સારવાર માટે દવાખાનામાં દાખલ થયાના સંદર્ભમાં થયેલ સરેરાશ ખર્ચ (તબીબી અને બીન તબીબી અલગ રીતે) આપેલ છે.

કોષ્ટક ૪.૪: સારવાર માટે દવાખાનામાં દાખલ થયેલ કિસ્સામાં (બાળજન્મ સિવાય) સામાન્ય તબીબી ખર્ચ અને બિન તબીબી ખર્ચ

		કેસ દીઠ સારવાર પર ●યેલ સામાન્ય કુલ તબીબી ખર્ચ(રૂ.માં)								
		દવાખાનામાં દાખલ દરમિયાન સામાન્ય તબીબી ખર્ચ			દવાખાનામાં દાખલ ●વાના સંદર્ભમાં ●યેલ અન્ય ખર્ચ			કુલ ખર્ચ		
		પુરુષ	સ્ત્રી	એકંદર	પુરુષ	સ્ત્રી	એકંદર	પુરુષ	સ્ત્રી	એકંદર
(૧)	(૨)	(૩)	(૪)	(૫)	(૬)	(૭)	(૮)	(૯)	(૧૦)	(૧૧)
ગુજરાત	ગ્રામ્ય	૧૭૫૭૬	૧૦૬૧૮	૧૪૨૮૮	૧૪૪૭	૧૨૬૭	૧૩૬૨	૧૮૦૨૩	૧૧૮૮૬	૧૫૬૬૦
	શહેરી	૨૧૮૫૪	૧૮૨૬૨	૨૦૧૫૫	૧૧૮૧	૧૦૪૭	૧૧૨૧	૨૩૧૪૫	૧૮૩૦૮	૨૧૨૭૬
ભારત	ગ્રામ્ય	૧૭૫૨૮	૧૨૨૮૫	૧૪૮૩૫	૨૧૮૮	૧૮૪૧	૨૦૨૧	૧૮૭૨૭	૧૪૧૩૬	૧૬૮૫૬
	શહેરી	૨૮૧૬૫	૨૦૭૫૪	૨૪૪૩૬	૨૨૮૬	૧૭૫૭	૨૦૧૮	૩૦૪૫૦	૨૨૫૧૧	૨૬૪૫૫

ઉપરની માહિતી નીચે પ્રમાણે આલેખિત કરી છે.



૪.૩.૧ ઉપરોક્ત કોષ્ટક અને આલેખની વિગતો જોતા જણાય છે કે, દવાખાનામાં રોકાણ દરમિયાન સારવાર અને અન્ય માટે ●યેલ ખર્ચ ગ્રામ્ય વિસ્તારની સરખામણીમાં શહેરી વિસ્તારમાં લગભગ ૩૬% જેટલો વધારે છે.જે સ્ત્રીઓમાં ૬૨% જેટલો વધારે અને પુરૂષોમાં ૨૨% જેટલો વધારે છે.વધુમાં એ પણ જોવા મળે છે કે, ગ્રામ્ય અને શહેરી બંને વિસ્તારમાં પુરૂષો માટે સારવારમાં ●યેલ ખર્ચ કરતાં સ્ત્રીઓમાં સારવાર માટે ●યેલ ખર્ચ ઓછો ●યેલ હોવાનું જોવા મળે છે.

કોષ્ટક ૪.૫: દવાખાનામાં દાખલ થયેલ વ્યક્તિ(બાળજન્મ સિવાય) પર ખર્ચ કરાયેલ નાણાંનો મુખ્ય સ્ત્રોત - દર હજારે

		દર હજાર કુટુંબે નોંધાવેલ દવાકીય ખર્ચ પરનો નાણાકીય સ્ત્રોત					
		કૌટુંબીક આવક/ બચત	ઉછીની લીધેલી રકમ	ભૌતિક મિલકતોનું વેચાણ	મિત્રો/સંબંધીઓ તરફની યોગદાન	અન્ય	કુલ
(૧)	(૨)	(૩)	(૪)	(૫)	(૬)	(૭)	(૮)
ગુજરાત	ગ્રામ્ય	૮૬૭	૫૧	૪	૬૧	૧૨	૧૦૦૦
	શહેરી	૮૦૪	૪૧	૧	૪૧	૧૦	૧૦૦૦
ભારત	ગ્રામ્ય	૬૭૮	૨૪૮	૮	૫૪	૭	૧૦૦૦
	શહેરી	૭૪૮	૧૮૨	૪	૫૦	૧૩	૧૦૦૦

૪.૩.૨ ઉપરના કોષ્ટકની વિગતો જોતા,ગુજરાતના ગ્રામ્ય વિસ્તારમાં ૮૭% જેટલા કુટુંબો અને શહેરી વિસ્તારમાં ૮૦% જેટલા કુટુંબો માંદગીની સારવાર માટે પોતાની કૌટુંબીક આવક/બચતમાંની ખર્ચ કરી શકે છે, જ્યારે હજુ પણ ગ્રામ્ય વિસ્તારમાં ૧૩% કુટુંબો આવા ખર્ચ માટે અન્ય સ્ત્રોત એટલે કે, મિત્રો/સંબંધીઓ પાસેની રકમ ઉછીની લઈને ખર્ચ કરવો પડે છે. આ સંજોગોમાં માન્ય પ્રધાનમંત્રીશ્રી દ્વારા જાહેર કરવામાં આવેલ આમ આદમી વીમા યોજના અને તેના જેવી યોજનાઓનો લાભ લઈ માંદગી દરમિયાન સારવારના ●તા મોટા ખર્ચને પહોંચી વળવામાં મદદ મેળવી શકાય.

૫. તારણો અને ભલામણો

- ૪૪ વર્ષની વય પછી બીમાર વ્યક્તિઓનાં પ્રમાણમાં કમશ: નોંધપાત્ર વધારો જોવા મળે છે અને તેમાં પણ શહેરી વિસ્તારમાં ૩૦-૪૪ વયજૂની સામે ૪૫-૫૯ના વયજૂમાં બીમાર વ્યક્તિનું પ્રમાણ દર હજારે ૭૧ ની વધીને ૨૪૧ જોવા મળે છે જે ૩.૪ ગણો નોંધપાત્ર વધારો દર્શાવે છે.આ અન્વયે

ચોક્કસ વયજુને દયાનમાં લઈને તે માટેની આરોગ્ય અને તંદુરસ્તી વિષયક બાબતોને લગતા તેમજ તંદુરસ્તી તરફ લઈ જતી રોજંદી જીવન શૈલીને લગતા કાર્યક્રમોના આયોજન દ્વારા આ બાબતે સુધારો લાવી શકાય.

- વધુમાં,ગુજરાતમાં માંદગી માટે સારવાર નહીં લેવાનો દર રાષ્ટ્રીય કક્ષાના દર કરતા ઉંચો છે. રાજ્યમાં માંદગી દરમિયાન સારવાર નહીં લેવાનું પ્રમાણ પુરૂષો કરતાં સ્ત્રીઓમાં અને ખાસ કરીને ગ્રામ્ય સ્ત્રીઓમાં વધારે જોવા મળે છે.ઉદાસીનતા માટેનું આ એક સ્વાભાવિક લક્ષણ છે,જે હાનીકારક ગણી શકાય.
- શહેરી વિસ્તારમાં ૧૧.૧% પુરૂષો અને ૧૧.૩% સ્ત્રીઓએ માંદગી દરમિયાન સારવાર ન લીધી હોવાનું જાણવા મળે છે. જેની સામે ગ્રામ્ય વિસ્તારમાં ૧૮.૭% પુરૂષો અને ૨૧.૫% સ્ત્રીઓ માંદગી દરમિયાન સારવાર ન લીધી હોવાનું જણાવેલ છે,જે પ્રમાણમાં વધારે ગણી શકાય.

પારંપરિક રીતે સામાન્ય સંજોગોમાં સ્ત્રીઓમાં પોતાની માંદગીમાં ચલાવી લેવાની અને દવા વગર મટી જશે તેવા પ્રકારની વિચારસરણી/ભાવના આ માટે કારણરૂપ હોઈ શકે, આ સંજોગોમાં લાંબે ગાળે આવા વલાણને પરિણામે સ્ત્રીઓની તંદુરસ્તી પર વિપરીત અસર ઉભી ન કરે તે હેતુની ખાસ કરીને ગ્રામ્ય વિસ્તારોમાં સ્ત્રીઓની તંદુરસ્તી અને બિમારીમાં સારવાર લેવા બાબતે જાગૃતિ કેળવાય તે માટેના કાર્યક્રમોનું આયોજન કરવાની આ દિશામાં સુધારો લાવી શકાય.

- ગુજરાતનાં ગ્રામીણ વિસ્તારમાં દવાખાનામાં દાખલ દરમિયાન કેસ દીઠ સામાન્ય તબીબી ખર્ચ રૂ. ૧૪,૨૮૮ તો અન્ય ખર્ચ રૂ. ૧,૩૬૨ છે.જ્યારે શહેરી વિસ્તાર માટે આ જ ખર્ચ રૂ. ૨૦, ૧૫૫ અને રૂ.૧,૧૨૧ છે. (કોષ્ટક ૪.૪)
- ગુજરાતના ગ્રામ્ય વિસ્તારમાં ૮૭% જેટલા કુટુંબો અને શહેરી વિસ્તારમાં ૮૦% જેટલા કુટુંબો માંદગીની સારવાર માટે પોતાની કૌટુંબીક આવક/બચતમાંની ખર્ચ કરી શકે છે, જ્યારે હજુ પણ ગ્રામ્ય વિસ્તારમાં ૧૩% કુટુંબોએ આવા ખર્ચ માટે અન્ય સ્ત્રોત એટલે કે, મિત્રો/સંબંધીઓ પાસેની રકમ ઉછીની લઈને આવો ખર્ચ કરવો પડે છે.આ સંજોગોમાં માન્ય પ્રધાનમંત્રીશ્રી દ્વારા જાહેર કરવામાં આવેલ આમ આદમી વીમા યોજના અને તેના જેવી યોજનાઓનો લાભ લઈ માંદગી દરમિયાન સારવારના મોટા ખર્ચને પહોંચી વળવામાં મદદ મેળવી શકાય.

૬. આભાર વિધિ

આ લેખન માટે પરામર્શક તરીકે આવેલા સૂચનો માટે તેમનો આભાર માનુ છું.લેખ તૈયાર કરવા માટેનું પ્રોત્સાહન તેમજ માર્ગદર્શન આપવા માટે અમારી કચેરીના નિયામકશ્રી એસ. કે. હુદા, સંયુક્ત નિયામકશ્રી આર. આર. પંડ્યા, નાયબ નિયામકશ્રી આર. એ. મહેતા તો સંશોધન અધિકારીશ્રી એમ. એમ. રાઠવા સાહેબનો આભાર માનુ છું.

SIX SIGMA DEPLOYMENT IN HIGHER EDUCATION INSTITUTIONS

Nimisha Shah⁽¹⁾, N.D.Shah⁽²⁾

ABSTRACT

Higher Education Institutions are facing rigorous competition for sustainability regarding low graduation rates, less attendance, and low employability in commerce field. Most studies in the field of higher education focused on students as customers and always interested to study the satisfaction or dissatisfaction with their output and the quality provided to them in the terms of course designed by the institute itself. Six Sigma is uniquely driven by close understanding of customer needs, disciplined use of facts, data and statistical analysis, improving and reinventing business process. Six Sigma is a management philosophy focused on eliminating mistakes, waste and rework. In six sigma organizations, the employees are systematically trained and has a martial arts convention for naming many of its professional roles like Champions, Master Black Belt (MBB), Black Belt (BB), Green Belt (GB) and Team Leaders(TM) based on their knowledge and experience to apply statistical tools and techniques. This paper attempts to understand the deployment of Six Sigma methodology in Higher Education Institutions.

KEY WORDS

Six Sigma, MBB, BB, GB, TM

1. INTRODUCTION

Once upon a time education sector was considered as a stable, traditional

Assistant Professor Head (Statistics Department), Faculty of commerce (GLSIC), GLS University, Ahmedabad 380008 (India) Email: nimisha.shah@glsuniversity.ac.in

Prof and Head Statistics Department, Prin. M.C.Shah Commerce college, Ahemdabad 380009, Email: neeldeepcommerce@yahoo.com

This paper was presented at two days national conference organized by H.L. College of Commerce and A.G Teachers College – CTE Ahmedabad, Gujarat.

(recd. April' 17 / rvd. May' 17)

sector of economy. In the era of globalization, education system has gone through major remarkable changes. Nowadays higher education has become a commercial and profitable industry and became a marketable product. These institutes have their objectives to market their

educational products, in other words different courses and services to the students so that they can be good citizens of the country. Day by day the competition from various institutions and universities is mounting up. Every higher education institution (HEI) is concerned to give the best quality performance to sustain in the market and put efforts to become a top class institution. The most important factor of any educational Institute is to provide the quality education to students and that way they can fulfill their goal to sustain in the market. The word 'Quality' is referred to key element of an organization which is working in multiple areas. In the world of information technology development in socio-economic situations and growth of knowledge and technocrat demanding customers, quality is not at all desirable strategy but it becomes a survival strategy. Higher education Institutions (HEIs) contribute to develop society and nation by growing well educated and skilled students. Some of the important quality improvements methodologies are examined in the context of higher education are Total quality management (TQM), Quality Function Development (QFD), Six Sigma, ISO 9001 and the Malcolm Baldrige National Quality Award. The objective of this paper is to study six sigma deployment in higher education institution to improve the quality and service provided by the higher education institutions.

2. SIX SIGMA - EDUCATION INSTITUTIONS

Six Sigma is a continuous modern quality improvement philosophy which provides improvements for the products, services and profits in many organizations. Six sigma is a process, 6 standard deviations each may be fitted between the mean and the upper and lower specification limits. Six Sigma is a data driven concept for reducing defects, waste and quality problems in organization. Firstly, it believes in teamwork, which is inherently with the activities in education. It is often used to measure the 'goodness' or quality of a product. Six Sigma methodology mainly

focus on the following objectives in higher education institutions.

- Basic requirements and expectations of students in the form of goals.
- Develop the process to achieve these goals.
- Applying data analysis to minimize the variation in the process.
- Driving rapid and sustainable improvement to educational process.

3. PERSPECTIVES OF SIX SIGMA

Two main perspectives of Six Sigma are

- Statistical view point
- Business view point.

3.1 Statistical View Point:

When statistical view point in Six Sigma is discussed it is noteworthy observation that, it is originated from statistics and statisticians. Six Sigma is a statistical probabilistic and quantitative method.[2]. Statistically Six Sigma is defined as having less than 3.4 defects per million opportunities or success rate of 99.99967% where Six Sigma is a term used to represent the process variation[1]. If the organization works at 3 Sigma level that is 66800 defects per million opportunities or success rate is 93.45%.

Table -1 Six Sigma Defects Scale

SIGMA	DPMO (Defects Per Million Opportunity)	COST OF POOR QUALITY	LEVEL
6σ	3.4	< 10%	WORLD CLASS
5σ	233	10 % - 15 %	WORLD CLASS
4σ	6210	15 % - 20 %	AVERAGE
3σ	66807	20% - 30 %	AVERAGE
2σ	308537	30% - 40 %	POOR
1σ	690000	> 40%	POOR

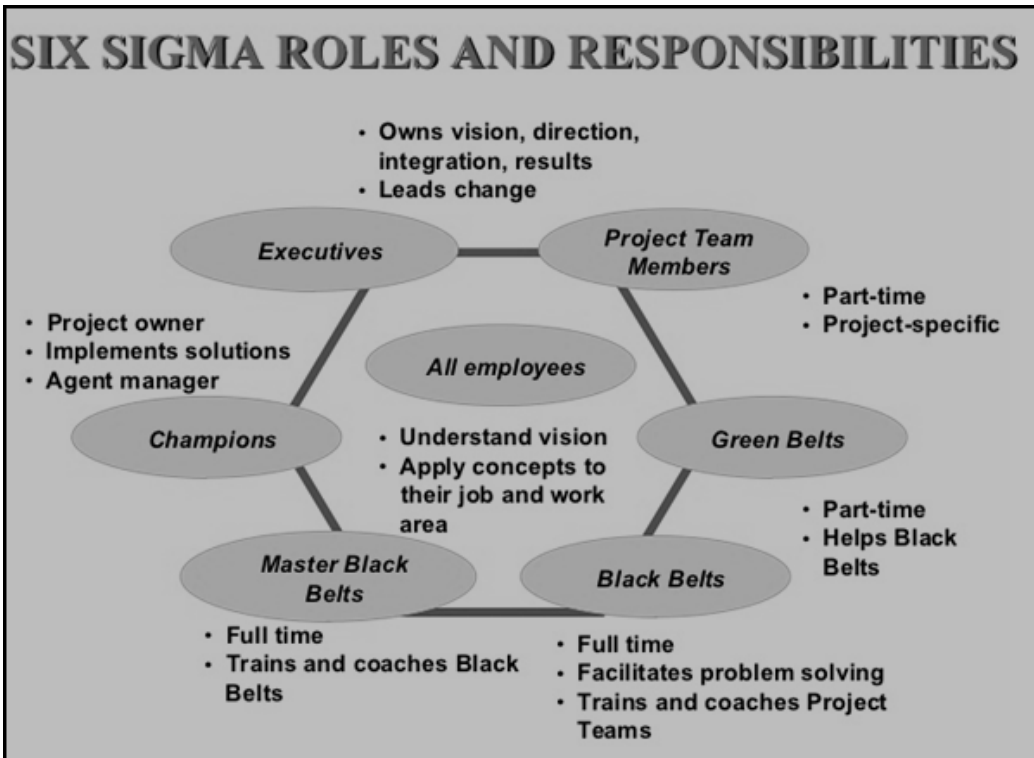
3.2 BUSINESS VIEW POINT

In this global business world Six Sigma is defined as a **business strategy**

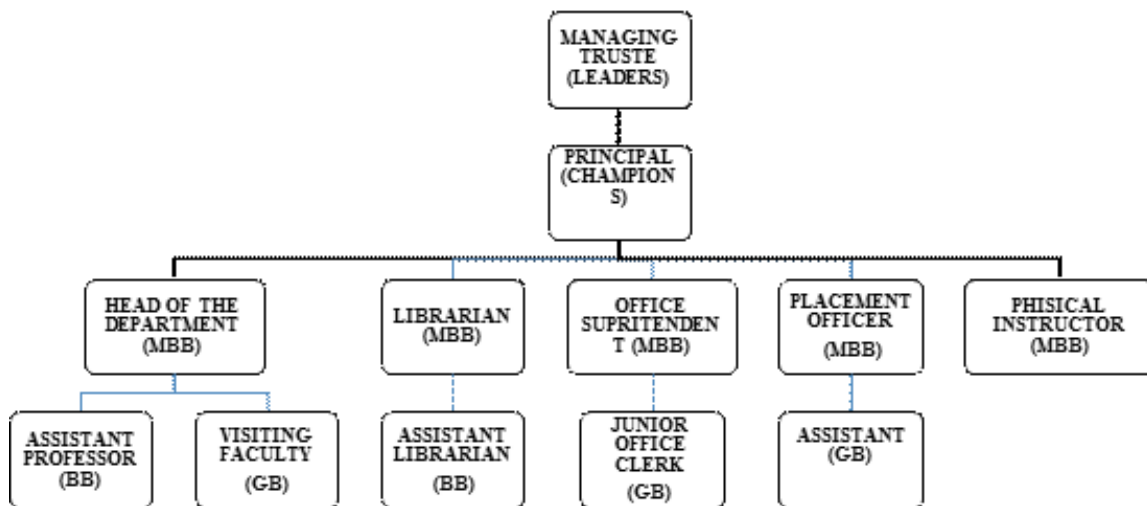
used to improve profitability and efficiency to meet with the customer's expectations [1]. The Six sigma methodology was first applied to the manufacturing and gradually followed by areas like Marketing, purchasing, Service, Administrative and many more. Most of the organization where to articulate benefit of Six Sigma presented in financial return by connecting process with cost savings.

The Six Sigma can be defined as $Y = f(x)$, where Y denotes the product or service that has to be improved and 'x' denotes a set of factors that influence Y. 'f' is defined as the function that shows the relationship between 'Y' and 'x'. Generally quality professionals have focused on output of the process (Y) to improve the process. But to improve process and reduce defects, Six Sigma focuses on 'x' rather than 'Y'. Ultimately the influencing factors are precisely so improved to produce not only a defect-free product, but a completely different and superior one.

For the effective management of any organization it needs several key positions to develop the mechanism of the organization. Any organization decide to apply six sigma concept as quality improvement strategy, the organization has to train its employees or hire sigma leaders, team leaders and facilitators of six sigma methodology. Six Sigma is uniquely driven by close understanding of customer needs, disciplined use of facts, data and statistical analysis, improving and reinventing business process. Six Sigma is a management philosophy focused on eliminating mistakes, waste and rework. It is often used as a scale for levels of 'goodness' or quality. Six Sigma professionals exist at every level – each with a different role to play while implementations and roles may vary. In six sigma organizations, the employees are systematically trained and has a martial arts convention for naming many of its professional roles like Champions, Master Black Belt (MBB), Black Belt (BB), Green Belt (GB) based on their knowledge and experience to apply statistical tools and techniques. [3]



Proposed six sigma structure in Education Institutions



4. COMPARISON OF SIX SIGMA INDUSTRIES V/S INSTITUTIONS

SIX SIGMA PROFESSIONALS IN INDUSTRIES	SIX SIGMA PROFESSIONALS IN INSTITUTES
<p>Leadership group council/ Executives</p> <ol style="list-style-type: none"> 1. Senior Managers/ owners of the company who plan and execute Six Sigma plan. 2. They target to their goal, aim to achieve Six Sigma in a planned way. 	<p>Governing body/ Board of members</p> <ol style="list-style-type: none"> 1. Members of Management/ Trustee Committee /Chairman 2. Take decision to adapt Six Sigma. 3. Vision for future progress.
<p>Project sponsors and Champions</p> <ol style="list-style-type: none"> 1. A well experience senior managewho form team of black belts and allot six sigma projects. 2. Bridge between leadership council and black belts. 3. Review the progress of their project frequently and its sustainability. 	<p>Principal/Head of institute</p> <ol style="list-style-type: none"> 1. Sets up a goal for improving project 2. Finds resources and infrastructure for the team. 3. Ensure the activity done by the team and coordinate with the management.
<p>Six Sigma coach (Master Black Belts)</p> <ol style="list-style-type: none"> 1. Responsible for coaching/mentoring/ training Black Belts and Green Belts. 2. Helping the Six Sigma leader and Champions to keep the initiative on track. 3. He acts as a mentor and a trainer 4. Highly experienced and successful professionals. 	<p>Head of departments (HODs)</p> <ol style="list-style-type: none"> 1. Communicate with principal and management. 2. Deals with resistance within department to implement Six Sigma. 3. Help to resolve team and other conflicts 4. Developer of curriculum/ syllabus.
<p>Project leader (Black Belts)</p> <ol style="list-style-type: none"> 1. Full-time professional who acts as a team leader on Six Sigma projects and accepts primary responsibility. 2. Provide training in tools to Green Belts and team members. 3. Responsible for on time performance and meeting goals. 	<p>Assistant Professors</p> <ol style="list-style-type: none"> 1. Reviews/revises/clarifies according to the particular subject. 2. Works with team members like visiting faculties/ seniors students. 3. Motivate, guide and mentor the team.
<p>Green Belts</p> <ol style="list-style-type: none"> 1. Assist in data collection, computer data input, analysis of data using the software, and preparation of reports for management. 2. Communicate with champion, MBBs, BBs 3. Leads small projects 	<p>Visiting faculties/students' committee</p> <ol style="list-style-type: none"> 1. Carries out instructions for data collection and analysis 2. Carries out assignments. 3. Assist black belts/Assistant professors 4. Learns new data-driven ways to manage the operation.

5. CONCLUSIONS

Six Sigma is a data driven methodology and a benchmark that increases benefit and helps the higher education institute to provide best service through a quality process and that way institute can produce world class students which ensure its success. Furthermore, an attempt is made to study comparative relationship between this popular industrial methodology and its scope of study in an academic environment.

6. ACKNOWLEDGEMENT

We thank the referee for reviewing our paper which has helped in revising the earlier draft of the paper.

7. REFERENCES

- [1] *Antony, J., Banuelas, R., 2002. Key ingredients for the effective implementation of six sigma program. Measuring Business Excellence 6 (4), 20–27.*
- [2] *Hahn, G.H., Hill, W., Hoerl, R.W., Zinkgraf, S.A., 1999. The impact of six sigma improvement: a glimpse into the future of statistics. The American Statistician 53, 1–8.*
- [3] *P.Ramasubramanian, D. (August 2012). Six Sigma in Educational Institutions. International Journal of Engineering Practical Research , Volume 1, Issue 11-5.*



BIOGRAPHY

ABRAHAM DE MOIVRE*

H.D.BUDHBHATTI**



Abraham de Moivre was born in Vitry-le-François in Champagne on May 26, 1667. His father, Daniel de Moivre, was a surgeon who believed in the value of education. Though Abraham de Moivre's parents were Protestant, he first attended Christian Brothers' Catholic school in Vitry, which was unusually tolerant given religious tensions in France at the time. When he was eleven, his parents sent him to the Protestant Academy at Sedan, where he spent four years studying Greek under Jacques du Rondel.

In 1682 the Protestant Academy at Sedan was suppressed, and de Moivre enrolled to study logic at Saumur for two years. Although mathematics was not part of his course work, de Moivre read several works on mathematics on his own including *Elémens des mathématiques* by Jean Prestet and a short treatise on games of chance, *De Ratiociniis in Ludo Aleae*, by Christiaan Huygens. In 1684, de Moivre moved to Paris to study physics, and for the first time had formal mathematics training with private lessons from Jacques Ozanam.

Religious persecution in France became severe when King Louis XIV issued the Edict of Fontainebleau in 1685, which revoked the Edict of Nantes, that had given substantial rights to French Protestants. It forbade Protestant worship and required that all children be baptized by Catholic priests. De Moivre was sent to the Prieure de Saint-Martin, a school that the authorities

* Adopted from wikipedia (the free encyclopedia). We express our sense of gratitude for this assistance.

** Ex. CSO, Head, Statistics Dept. GSRTC, Ahmedabad.
(recd. April'17 / revd. June'17)

sent Protestant children for indoctrination into Catholicism.

It is unclear when de Moivre left the Prieure de Saint-Martin and moved to England, since the records of the Prieure de Saint-Martin indicate that he left the school in 1688, but de Moivre and his brother presented themselves as Huguenots admitted to the Savoy Church in London on August 28, 1687.

By the time he arrived in London, de Moivre was a competent mathematician with a good knowledge of many of the standard texts. To make a living, de Moivre became a private tutor of mathematics, visiting his pupils or teaching in the coffee houses of London. De Moivre continued his studies of mathematics after visiting the Earl of Devonshire and seeing Newton's recent book, *Principia Mathematica*. Looking through the book, he realized that it was far deeper than the books that he had studied previously, and he became determined to read and understand it.

According to a possibly apocryphal story, Newton, in the later years of his life, used to refer people posing mathematical questions to him to de Moivre, saying, "**He knows all these things better than I do.**"

By 1692, de Moivre became friends with **Edmond Halley** and soon after with **Isaac Newton** himself. In 1695, Halley communicated de Moivre's first mathematics paper, which arose from his study of fluxions in the *Principia Mathematica*, to the Royal Society. This paper was published in the *Philosophical Transactions* that same year. Shortly after publishing this paper, de Moivre also generalized Newton's noteworthy **binomial theorem** into the **multinomial theorem**. The Royal Society became apprised of this method in 1697, and it made de Moivre a member two months later.

After de Moivre had been accepted, Halley encouraged him to turn his attention to astronomy. In 1705, de Moivre discovered, intuitively, that "the centripetal force of any planet is directly related to its distance from the centre of the forces and reciprocally related to the product of the diameter of the evolute and the cube of the perpendicular on the tangent." In other words, if a planet, M, follows an elliptical orbit around a focus F and has a point P where PM is tangent to the curve and FPM is a right angle so that FP is the perpendicular to the tangent, then the centripetal force at point P is proportional to $FM/[R*(FP)^3]$ where R is the radius of the curvature at M. The mathematician Johann Bernoulli proved this formula in 1710.

Despite these successes, de Moivre was unable to obtain an appointment to a chair of mathematics at any university, which would have released him from his dependence on time-consuming tutoring that burdened him more than it did most other mathematicians of the time. At least a part of the reason was a bias against his French origins.

In November 1697 he was elected a **Fellow of the Royal Society** and in 1712 was appointed to a commission set up by the society, alongside MM. Arbuthnot, Hill, Halley, Jones, Machin, Burnet, Robarts, Bonet, Aston, and Taylor to review the claims of Newton and Leibniz as to who discovered calculus. The full details of the controversy can be found in the Leibniz and Newton calculus controversy article.

Throughout his life de Moivre remained poor. It is reported that he was a regular customer of old Slaughter's Coffee House, St. Martin's Lane at Cranbourn Street, where he earned a little money from playing chess.

De Moivre continued studying the fields of probability and mathematics until his death in 1754 and several additional papers were published after his death. As he grew older, he became increasingly lethargic and needed longer sleeping hours. A common, though disputable, claim is that he noted he was sleeping an extra 15 minutes each night and correctly calculated the date of his death as the day when the sleep time reached 24 hours, November 27, 1754. On that day he did in fact die, in London and his body was buried at St Martin-in-the-Fields, although his body was later moved.

De Moivre pioneered the development of analytic geometry and the theory of probability by expanding upon the work of his predecessors, particularly Christiaan Huygens and several members of the Bernoulli family. He also produced the second textbook on probability theory, **The Doctrine of Chances: a method of calculating the probabilities of events in play.** (The first book about games of chance, *Liber de ludo aleae* (On Casting the Die), was written by Girolamo Cardano in the 1560s, but it was not published until 1663.) This book came out in four editions, 1711 in Latin, and in English in 1718, 1738, and 1756. In the later editions of his book, de Moivre included his unpublished result of 1733, which is the first statement of an approximation to the binomial distribution in terms of what we now call the **normal or Gaussian function.** This was the first method of finding the probability of the occurrence of an

error of a given size when that error is expressed in terms of the variability of the distribution as a unit, and the first identification of the calculation of probable error. In addition, he applied these theories to gambling problems and actuarial tables.

An expression commonly found in probability is $n!$ but before the days of calculators calculating $n!$ for a large n was time consuming. In 1733 de Moivre proposed the formula for estimating a factorial as $n! \approx c \cdot e^{-n} \cdot n^{n+\frac{1}{2}}$. He obtained an approximate expression for the constant c but it was James Stirling who found that c was $\sqrt{2\pi}$.

De Moivre also published an article called "**Annuities upon Lives**" in which he revealed the normal distribution of the mortality rate over a person's age. From this he produced a simple formula for approximating the revenue produced by annual payments based on a person's age. This is similar to the types of formulas used by insurance companies today.

Some results on the Poisson distribution were first introduced by de Moivre in *De Mensura Sortis seu; de Probabilitate Eventuum in Ludis a Casu Fortuito Pendentibus* in *Philosophical Transactions of the Royal Society*, p. 219. As a result, some authors have argued that the Poisson distribution should bear the name of de Moivre.

Abraham de Moivre is also known for the **de Moivre's formula**, a formula that links complex numbers and trigonometry and for his work on the normal distribution and probability theory. De Moivre wrote a book on **probability theory**. *The Doctrine of Chances*, said to have been prized by gamblers. De Moivre first discovered **Binet's formula**, the closed form expression for **Fibonacci numbers** linking the n th power of the golden ratio ϕ to the n th Fibonacci number. He also was the first to postulate the **central limit theorem**, a cornerstone of probability theory.

Euler had proved de Moivre's formula for any real n using Euler's formula, which makes the proof quite straightforward. This formula is important because it relates complex numbers and trigonometry. Additionally, this formula allows the derivation of useful expressions for $\cos(nx)$ and $\sin(nx)$ in terms of $\cos(x)$ and $\sin(x)$.

REFERENCES

- [1] **Abraham De Moivre (November 12, 1733)** "Approximatio ad summam terminorum binomii $(a+b)^n$ in seriem expansi" (self-published pamphlet), 7 pages.
English translation: A. De Moivre, *The Doctrine of Chances ...*, 2nd ed. (London, England: H. Woodfall, 1738), pp. 235-243.
- [2] **Bellhouse, David R. (2011)**. Abraham De Moivre: Setting the Stage for Classical Probability and Its Applications. London: Taylor & Francis. p. 99.
- [3] **Cajori, Florian (1991)**. History of Mathematics (5 ed.). American Mathematical Society. p. 229.
- [4] **Coughlin, Raymond F.; Zitarelli, David E. (1984)**. The ascent of mathematics. McGraw-Hill. p. 437.
- [5] **H. J. R. Murray, 1913**. History of Chess. Oxford University Press: p 846.
- [6] **Hald, Anders, Abraham de Moivre, and Bruce McClintock**. "A. de Moivre:'De Mensura Sortis' or'On the Measurement of Chance'." International Statistical Review/Revue Internationale de Statistique (1984): 229-262
- [7] **Johnson, N.L., Kotz, S., Kemp, A.W. (1993)** Univariate Discrete distributions (2nd edition). Wiley. ISBN 0-471-54897-9, p157
- [8] **Pearson, Karl**. "Historical note on the origin of the normal curve of errors". Biometrika. 16: 402–404. doi:10.1093/biomet/16.3-4.402.
- [9] **Schneider, I., 2005**, "The doctrine of chances" in Grattan-Guinness, I., ed., *Landmark Writings in Western Mathematics*. Elsevier: pp 105–20
- [10] **Smith, David Eugene (1959)**, *A Source Book in Mathematics*, Volume 3, Courier Dover Publications, p. 444
- [11] **Stigler, Stephen M.** "Poisson on the Poisson distribution." *Statistics & Probability Letters* 1.1 (1982): 33-35.
- [12] **Tanton, James Stuart (2005)**. *Encyclopedia of Mathematics*. Infobase Publishing. p. 122.
"Library and Archive Catalogue". The Royal Society. Retrieved 3 October 2010.

Activities

1. National Conference on “Recent Advancements in Statistics and their Applications to Society” (NCRASS) during 23-25 March, 2017 at S. P. Pune University, Pune.
2. Annual conference of ISPS 2017 at Bharathiar University, Coimbatore.
3. National Conference On Statistics and Optimization Techniques (NCSOT) in Conjunction with 2nd Convention of Indian Association for Reliability and Statistics (CIARS-2017) Organized By Department of Statistics (UGC – GDA Scheme)M.D. University, Rohtak-124001 (Haryana). Date: FEBRUARY 11-13, 2017. Website: www.mdurohtak.ac.in.
4. International Conference on Interdisciplinary Research and 8th International Conference on Quality, Reliability Engineering, Infocom Technology and Business Operations, was scheduled to be held during Feb 8-10th 2017 at Amity University Greater Noida. Web site: www.amity.edu/jiricqrit2017.

* **Statistics Day Celebration**

As usual on 29th June 2017, **Statistics Day** will be celebrated at all places in India. This time the focal theme is “**Administrative Statistics**”.

M Sc BDA – Big Data Analytics

(A joint venture by **St. Xavier’s College** and **TCS – Tata Consultancy Services**)

Eligibility:

First Class in UG with BSc (Mathematics, Statistics), BCA, BA (Economics)

Duration:

2 years (4th semester internship), Intake: 30 seats, Fees: Rs.40,000/-

Class timing: 10.00 am – 4.30 pm

Apply: sxca.edu.in

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

POST GRADUATE DIPLOMA IN ACTUARIAL SCIENCES (PGDAS)



GUJARAT UNIVERSITY

About the Actuarial Profession:

An actuary is a business professional who deals with the financial impact of risk and uncertainty. They provide expert assessments of financial security systems, with a focus on their complexity, their mathematics, and their mechanisms. They mathematically evaluate the likelihood of events and quantify the contingent outcomes in order to minimize losses associated with uncertain undesirable events.

Every area of business is subject to risks so an actuarial career offers many employment options, including banking, insurance, healthcare, pensions, investment and also non-financial areas.

Objectives:

This one year program lays the foundation of the core Mathematical, Statistical and Financial principles which will enable the participants to have a solid foundation in actuarial sciences. They will be equipped to take up advanced and specialist courses of actuarial sciences later on depending on their interest and choice. This course will also be helpful to students who want to pursue careers in Actuarial Science/Financial Risk Management/Financial Engineering abroad.

Number of seats:

30

Duration of the Program:

1 year (Two Semesters)

Course Fees:

Rs. 25,000/- per semester

Minimum Eligibility:

A candidate must hold a graduate/post graduate degree with a minimum of 10+2+3 years of formal education in B.Sc. (Mathematics / Statistics), B.E., B.Com, BBA. Candidates who are in the final year of the above courses, are also eligible to apply provided they complete their formal education as specified above.

The admission will be on merit basis and if the number of applications exceeds more than two times the number of seats, an entrance test may be conducted, if required. The University may conduct personal interviews if decided by the admission committee.

Contact: Department of Mathematics, University School of Sciences,
Gujarat University, Ahmedabad - 380009, India
Tel: 079-26301154 Email: maths-gujuni@hotmail.com

[1] Dr. M. M. Bhatt (MUMBAI)

Good efforts have been made to keep the quality of SV. The editorial Board committee members are doing their best for SV.

The **SV , NSV 12, Oct.2016, Special Issue** contains 3 articles, 4 research articles/papers, 1 technical note, 1 Biography with others sections.

My observation / evaluation of the **SV , NSV 12, Oct.2016, Special Issue**

(a) Articles:

1. Jayesh Purohit would have define / given “What is the meaning of Data”. From my experience , it has been noted the educated people mix-up the meaning of Data & Information, for them both are the same /interchangeable.
2. In “Conjoint Analysis” a research mentor A.C.Brahmbhatt mentioned a good number of examples. Along with these examples, he would have explained the versatile statistical techniques under conjoint analysis, in little more depth.

(b) Research Articles / Papers: All research papers are quality papers !

1. The research article / paper on “Simultaneous selection ...” by Rajesh Kumar is a perfect research paper. In his paper a live case study of AICRP on sugarcane has been discussed. The procedure, theory, data collection method, multi-location trails in other zones, conclusion and the acknowledgements are presented perfectly.
2. D. K. Ghosh & Ms. Sangeeta have done good job in writing the paper on “On Balance....”. They would have taken live examples along with their theoretical article so that in their conclusion they would have strongly suggested the importance of BIBD and pair wise block designs.
3. “A study for Pre-Harvest.....” research paper by M.B.Thaker and his co-authors is also a quality paper. In this paper: (a) Introduction (b) Literature

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

review – Data on different weather variables (c) Study area- Geography & climate of Gandhinagar has been discussed (d) Research methodology (very important) (e) Tabulation (f) Result oriented discussion (f) Conclusion (g) Acknowledgement, are presented very well. I feel the authors would have taken global view of other regions of India, so that better comparison would have been made.

4. H. M. Dixit and his co-authors have taken a good research paper on “Trend Models...”, considering GSRTC – one of the largest public service provider in road transportations of Gujarat State. The methodology and Analysis of the GSRTC is studied with all possible variables and presented the result with its conclusion very well. Even the projection based on data analysis is also valuable. But the authors would have explained theoretical methods in detail.

(c) Technical Note:

“A review of Quality Management” a technical article by Neeta is considered as a good note of the current issue. She tries to highlight how to measure the quality of services with respect to customer satisfaction. Ms. Neeta would have mentioned the reason for using “Kruskal-Wallis H test which is an extension the Wilcoxon Rank-Sum test for non parametric test. She would have presented her results in a tabulation.

(d) Biography:

H. D. Budhbhatti has described a biography of Walter A. Shewhart, the father of SQC nicely. Detail historical facts are very well mentioned. The author would have mentioned more highlights on SQC used in most of the industrial operations. On the whole it is a good biography.

[2] G.V.S.R. Anjaneyulu (GUNTUR)

Sankhya Vignan : a peer review journal is a nice academic and research journal. This journal has been giving equal role and importance to all such as-editorial, peer review by learned colleagues, research articles of all levels, review articles which vividly explain the contributions of several researchers budding researchers, biography of the great personalities to inspire everyone,

book review which is a significant feature of this journal giving useful information to the readers and finally SV News letter and also Readers Forum a conference for all the researchers.

I appreciate the efforts of the editorial board and the experts who are moulding the journal to a great contribution. Quality of work is a never ending phenomena.

It is a PDA cycle : P-Plan, D-Do, S-Study, A-Act.

Therefore the editorial board continuously implements the PDSA cycle for continuous quality improvements of the publication of this journal.

[3] Dr. G. S. Bhimani (RAJKOT)

Sankhya Vignan journal new series volume (NSV) is being published since last 12 years. I have found this journal as a catalytic agent for the growth potential of statistical research work. It includes theoretical as well as applied research articles in many areas of statistical research. The best thing is that it encourages research workers and practitioners to bring out their ideas on this platform. All articles are referred and reviewed without any bias. This process is very quick. Also journal issues are published regularly and nowadays also digital as well as print copies are sent to the authors with their offprints followed by a certificate of publication. I have been working at many places in different categorical works and I really appreciate this spriti of work. Sankhya Vignan team is to be congratulated for such an auspicious academic work. I express my hearty congratulations to the whole team. My best wishes for still more further rapid growth in future.



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
Institutional Member (for 3 years)	₹ 2,000/-	US \$ 500
Life Member	₹ 1,500/-	US \$ 300
Ordinary Member (p.a.)	₹ 500/-	US \$ 50

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

Executive Committee

President	:	Dr. (Mrs.) R. G. Bhatt
Vice President	:	Dr. N. D. Shah Dr. D. K. Ghosh
Secretary	:	Dr. Chirag J. Trivedi
Joint Secretary	:	Dr. R. D. Patel
Treasurer	:	Dr. (Mrs.) C. D. Bhavsar

Members

Dr. Mrs. R. G. Bhatt (Editor : GSR)	Dr. B. B. Jani (Editor : Sankhya Vignan)
Dr. Rakesh Srivastav	Dr. Parag B. Shah
Dr. Ashok Shanubhogue	Dr. H. D. Budhbhatti
Dr. Arati Rajguru	Dr. A. J. Patel
Dr. Mayuri Pandya	Dr. Rajashree Mengore

Co-opted Members

Dr. J. B. Shah	Dr. Mrs. Kavita Dave
-----------------------	-----------------------------

Invited Members

Dr. Arnar Laha	Prof. (Smt.) Subha Rani
-----------------------	--------------------------------

ABRAHAM DE MOIVRE*



Abraham de Moivre was born at Vitry-Le-Francois in champagne (France) on May 26, 1667. He was a french mathematician. He expired on Nov. 27, 1754 at the age of 87 years in London.

He had done very inspiring and pioneering works in mathematics as well as in statistics. He is very wellknown for **De Moivre's Theorem, De Moivre Laplace Limit Theorem.**

He first discovered **Binet's formula**, the closed form expression for **Fibonacci Numbers** linking the n^{th} power of the golden ration ϕ to the n^{th} Fibonacci number. He was first to postulate the **central limit theorem** in probability theory.

His Alma Mater was at Academy of saumur college d'Harcourt (France). He extended Newton's Biomial theorem to **Multinomial Theorem.**

The very famous expression in mathematics given by $n! \approx \sqrt{2\pi} \cdot e^{-n} \cdot n^{n+\frac{1}{2}}$ was **first given by him.** He influenced **Sir Isaac Newton, Edmond Halley, James Stirling** etc.

He was made **Fellow of the Royal Society (FRS)** in 1712.

*(Brief Biographical sketch is given inside the journal)

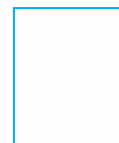
This page is specially donated by Prof. Shailesh Teredesai (Ex. Head), Statistics Dept., S. M. Patel Insitute of Commerce, GLS, Ahmedabad-380 009.

Printed Matter

(Journal of GSA, Ahmedabad)

To,

BOOK-POST



From :

Gujarat Statistical Association,

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