

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002

FINAL REPORT/ EXECUTIVE SUMMARY OF THE WORK DONE ON THE MAJOR
RESEARCH PROJECT

1. TITLE OF THE PROJECT: (IN STATISTICS DISCIPLINE)

- **Bayesian Inferences on Augmented Strength Reliability Models**

2. NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR:

- **Dr. Navin Chandra**
Principal Investigator, MRP
Assistant Professor
Department of Statistics, Ramanujan School of Mathematical Sciences,
Pondicherry University, Puducherry-60 5 014, India
- Contact: 094866-23476 ; E-mail: nc.stat@gmail.com

3. NAME AND ADDRESS OF THE INSTITUTION:

- Pondicherry University
(A Central University)
B. R. Ambedkar Administrative Building
R. Venkataraman Nagar, Kalapet
Puducherry-605 014, India

4. UGC APPROVAL LETTER NO. AND DATE:

- (1) F.: 42-38/2013 (SR) dated March 12, 2013 (Initial Approval)
- (2) F.: 42-38/2013 (SR) dated July 05, 2016 (Extension Approval)

5. DATE OF IMPLEMENTATION: **April 01st, 2013**

6. TENURE OF THE PROJECT: April 01st, 2013 to March 31st, 2017

7. TOTAL GRANT ALLOCATED: Rs. 10,40,800/- (Ten Lakhs Forty Thousand and Eight Hundred Only)

8. TOTAL GRANT RECEIVED: Rs. 9,73,000/-

9. FINAL EXPENDITURE: Rs. 9,08,562/-

10. TITLE OF THE PROJECT: **Bayesian Inferences on Augmented Strength Reliability Models**

11. OBJECTIVES OF THE PROJECT:

The objectives of the proposed major research project are elaborated below:

- a) The main objective is to derive an augmented strength reliability models of an equipment or system (electrical or electronics or mechanical) for Gamma and inverse Gaussian distributions by assuming that strength of the system's and the stress imposed on it are independent and identically distributed. Also, to validate the derived augmented strength reliability expressions under all three possible cases of augmentation by numerical study.
- b) To develop an augmented strength reliability model of coherent system by considering that system is configured with parallel and series arrangements of their components for some possible cases of augmentation. Also to examine the derived augmented strength reliability expressions by numerical investigations.
- c) Another important glare of the sanctioned research proposal is to develop the Bayes estimators of augmented strength reliability under generalized form of ASP for informative (Gamma and inverted gamma) as well as non-informative (uniform and Jeffrey's) types of prior distributions under symmetric (squared error loss function) as well as asymmetric (Linex loss function).
- d) To develop the Maximum Likelihood Estimators (MLE's) of augmented strength reliability under generalized form of ASP.
- e) To validate the proposed MLE and Bayes estimators of augmented strength reliability by simulated as well as real data sets.
- f) Then to compare the proposed Bayes estimators of augmented strength reliability models with that of the Maximum Likelihood Estimators.
- g) Finally, to draw Bayesian inferences for estimating parameters of augmented strength reliability models under generalized form of ASP based on comprehensive comparison of the derived estimators.

12. WHETHER OBJECTIVES WERE ACHIEVED (GIVE DETAILS):

- Yes, Objectives of the sanctioned project is achieved as may be seen in the Final Report.

13. ACHIEVEMENTS FROM THE PROJECT:

We could have attempted sufficient number of significant contributions in the proposed research project on augmented strength reliability problems. We could published research articles in the peer reviewed reputed journals in the area of proposed work. Our attempts are fruitful and are recent addition to the existing theoretical concepts in Reliability Theory.

14. SUMMARY OF THE FINDINGS (IN 500 WORDS):

An overall observation is made based on the all the findings and results of all such attempts are summarized below.

- i. We proposed an augmentation strategy to enhance the strength reliability of weaker equipments which gets failed in early stage of its life. It is observed from numerical findings in each of the cases of ASP, the strength reliability models performed adequately and effectively for an equipment / system even the under series and parallel set up of configurations for the proposed life distributions (Gamma and inverse Gaussian) as stress-strength model. Therefore, augmentation strategy plan (ASP) may be suggested in enhancing the strength reliability of a system to perform its intended function up to a desired level for some specified duration of time.
- ii. The Bayes estimators of augmented strength reliability performed better for gamma prior in compare to inverted gamma prior under informative set of prior for both gamma and inverse Gaussian life time distributions.
- iii. The Bayes estimators of augmented strength reliability have better reflection under squared error loss function in compare to LINEX loss function.
- iv. It is conjuncture that in some places the Bayes estimators for inverted gamma prior have good results than gamma prior; even we cannot deny using LINEX loss faction.
- v. The attempts made under non-informative is concern, the better inferences are drawn for uniform prior in compare to Jaffrey's prior under squared error loss function.
- vi. In some variation of parameters, Jaffrey's prior are better in compare to uniform for LINEX loss function.
- vii. It has been observed that the absolute bias and mean square errors of the ML and Bayes estimators of augmented strength reliability are gradually decreases while the sample sizes are increases in almost all such attempts. Hence, it may be concluded that the proposed estimators behave consistently.
- viii. In almost all attempts, it is observed that the Bayesian estimator of augmented strength reliability gives better in compare to the performance of ML estimators.

Hence, overall, it may be concluded that Bayes estimators are more capable estimators than ML estimators in obtaining the fruitful inferences for proposed research problems.

15. CONTRIBUTION TO THE SOCIETY (GIVE DETAILS):

Any new thoughts provide new inventions. It is obvious that any fruitful ideas, policy and designing of research problems framed by the scientists or researchers should be

innovative. It should work to the welfare of humanities, because any outcomes of such attempts must benefits to the society. Keeping this view in mind, we have proposed new ideas of augmentation and its applications in the field of engineering science. These models may be applicable when any newly manufactured equipment/system (electrical or electronics) have an impression of early failure while initial stage of its uses (due to weaker strength in new system) or frequent failures occurs in used system (due to degradation of system strength over time). Augmentation strength Plan (ASP) may be suggestive to enhance the strength of a system under such circumstances. In this connection we have developed number of augmenting strength reliability models and then they are validated by different angles in order to establish such augmented strength reliability models to overcome of irrelevant failures. This contribution will be useful for irrelevant failure free operation of a system at its desired level.

16. WHETHER ANY PH.D. ENROLLED / PRODUCED OUT OF THE PROJECT:

- Yes, the project fellow is enrolled for Ph.D. course in the same area of sanctioned project and which covered a part of his Ph.D. thesis.

17. NO. OF PUBLICATIONS OUT OF THE PROJECT (PLEASE ATTACH):

- We have made significant contributions of the attempted research problems and published ten research articles in the reputed refereed national and international journals including conference proceedings. Three articles are under progress for publications.

(PRINCIPAL INVESTIGATOR)
(Seal)

(REGISTRAR)
(Seal)