INTERNATIONAL JOURNAL OF RESEARCH IN COMPUTER APPLICATION & MANAGEMENT

IJRCM

A Monthly Double-Blind Peer Reviewed (Refereed/Juried) Open Access International e-Journal - Included in the International Serial Directories

Indexed & Listed at:

Ulrich's Periodicals Directory ©, ProQuest, U.S.A., EBSCO Publishing, U.S.A., Cabell's Directories of Publishing Opportunities, U.S.A.,

Open J-Gage, India [link of the same is duly available at Inflibnet of University Grants Commission (U.G.C.)],

Index Copernicus Publishers Panel, Poland with IC Value of 5.09 & number of libraries all around the world.

Circulated all over the world & Google has verified that scholars of more than 4255 Cities in 176 countries/territories are visiting our journal on regular basis.

Ground Floor, Building No. 1041-C-1, Devi Bhawan Bazar, JAGADHRI – 135 003, Yamunanagar, Haryana, INDIA

http://ijrcm.org.in/

CONTENTS

CALL FOR MANUSCRIPTS

We invite unpublished novel, original, empirical and high quality research work pertaining to recent developments & practices in the areas of Computer Science & Applications; Commerce; Business; Finance; Marketing; Human Resource Management; General Management; Banking; Economics; Tourism Administration & Management; Education; Law; Library & Information Science; Defence & Strategic Studies; Electronic Science; Corporate Governance; Industrial Relations; and emerging paradigms in allied subjects like Accounting; Accounting Information Systems; Accounting Theory & Practice; Auditing; Behavioral Accounting; Behavioral Economics; Corporate Finance; Cost Accounting; Econometrics; Economic Development; Economic History; Financial Institutions & Markets; Financial Services; Fiscal Policy; Government & Non Profit Accounting; Industrial Organization; International Economics & Trade; International Finance; Macro Economics; Micro Economics; Rural Economics; Co-operation; Demography: Development Planning; Development Studies; Applied Economics; Development Economics; Business Economics; Monetary Policy; Public Policy Economics; Real Estate; Regional Economics; Political Science; Continuing Education; Labour Welfare; Philosophy; Psychology; Sociology; Tax Accounting; Advertising & Promotion Management; Management Information Systems (MIS); Business Law; Public Responsibility & Ethics; Communication; Direct Marketing; E-Commerce; Global Business; Health Care Administration; Labour Relations & Human Resource Management; Marketing Research; Marketing Theory & Applications; Non-Profit Organizations; Office Administration/Management; Operations Research/Statistics; Organizational Behavior & Theory; Organizational Development; Production/Operations; International Relations; Human Rights & Duties; Public Administration; Population Studies; Purchasing/Materials Management; Retailing; Sales/Selling; Services; Small Business Entrepreneurship; Strategic Management Policy; Technology/Innovation; Tourism & Hospitality; Transportation Distribution; Algorithms; Artificial Intelligence; Compilers & Translation; Computer Aided Design (CAD); Computer Aided Manufacturing; Computer Graphics; Computer Organization & Architecture; Database Structures & Systems; Discrete Structures; Internet; Management Information Systems; Modeling & Simulation; Neural Systems/Neural Networks; Numerical Analysis/Scientific Computing; Object Oriented Programming; Operating Systems; Programming Languages; Robotics; Symbolic & Formal Logic; Web Design and emerging paradigms in allied subjects.

Anybody can submit the **soft copy** of unpublished novel; original; empirical and high quality **research work/manuscript** ***anytime*** in ***M.S. Word format*** after preparing the same as per our **GUIDELINES FOR SUBMISSION**; at our email address i.e. infoijrcm@gmail.com or online by clicking the link **online submission** as given on our website (***FOR ONLINE SUBMISSION, CLICK HERE***).

GUIDELINES FOR SUBMISSION OF MANUSCRIPT

1. **COVERING LETTER FOR SUBMISSION:**

DATED: _____________

THE EDITOR

IJRCM

Subject: **SUBMISSION OF MANUSCRIPT IN THE AREA OF _______________________.**

(e.g. Finance/Mkt./HRM/General Mgt./Engineering/Economics/Computer/IT/ Education/Psychology/Law/Math/other, please specify)

DEAR SIR/MADAM

Please find my submission of manuscript entitled '____' for possible publication in one of your journals.

I hereby affirm that the contents of this manuscript are original. Furthermore, it has neither been published elsewhere in any language fully or partly, nor is it under review for publication elsewhere.

I affirm that all the co-authors of this manuscript have seen the submitted version of the manuscript and have agreed to their inclusion of names as co-authors.

Also, if my/our manuscript is accepted, I agree to comply with the formalities as given on the website of the journal. The Journal has discretion to publish our contribution in any of its journals.

NAME OF CORRESPONDING AUTHOR :
Designation :
Institution/College/University with full address & Pin Code :
Residential address with Pin Code :
Mobile Number (s) with country ISD code :
Is WhatsApp or Viber active on your above noted Mobile Number (Yes/No) :
Landline Number (s) with country ISD code :
E-mail Address :
Alternate E-mail Address :
Nationality :

NOTES:

a) The whole manuscript has to be in ***ONE MS WORD FILE*** only, which will start from the covering letter, inside the manuscript. ***pdf. version is liable to be rejected without any consideration***.

b) The sender is required to mention the following in the **SUBJECT COLUMN of the mail**:

New Manuscript for Review in the area of (e.g. Finance/Marketing/HRM/General Mgt./Engineering/Economics/Computer/IT/ Education/Psychology/Law/Math/other, please specify)

c) There is no need to give any text in the body of mail, except the cases where the author wishes to give any **specific message** w.r.t. to the manuscript.

d) The total size of the file containing the manuscript is expected to be below **1000 KB**.

e) **Abstract alone will not be considered for review** and the author is required to submit the **complete manuscript** in the first instance.

f) ***The journal gives acknowledgement w.r.t. the receipt of every email within twenty four hours*** and in case of non-receipt of acknowledgment from the journal, w.r.t. the submission of manuscript, within two days of submission, the corresponding author is required to demand for the same by sending a separate mail to the journal.

g) The author (s) name or details should not appear anywhere on the body of the manuscript, except the covering letter and the cover page of the manuscript, in the manner as mentioned in the guidelines.

2. **MANUSCRIPT TITLE**: The title of the paper should be **bold typed**, **centered** and **fully capitalised**.

3. **AUTHOR NAME (S) & AFFILIATIONS**: Author (s) **name**, **designation**, **affiliation** (s), **address**, **mobile/landline number** (s), and **email/alternate email address** should be given underneath the title.

4. **ACKNOWLEDGMENTS**: Acknowledgements can be given to reviewers, guides, funding institutions, etc., if any.

5. **ABSTRACT**: Abstract should be in **fully italicized text**, ranging between **150** to **300 words**. The abstract must be informative and explain the background, aims, methods, results & conclusion in a **SINGLE PARA**. ***Abbreviations must be mentioned in full***.

6. **KEYWORDS**: Abstract must be followed by a list of keywords, subject to the maximum of **five**. These should be arranged in alphabetic order separated by commas and full stop at the end. All words of the keywords, including the first one should be in small letters, except special words e.g. name of the Countries, abbreviations.

7. **JEL CODE**: Provide the appropriate Journal of Economic Literature Classification System code (s). JEL codes are available at www.aeaweb.org/econlit/jelCodes.php, however, mentioning JEL Code is not mandatory.

8. **MANUSCRIPT**: Manuscript must be in ***BRITISH ENGLISH*** prepared on a standard A4 size ***PORTRAIT SETTING PAPER***. *It should be free from any errors i.e.* ***grammatical, spelling*** *or* ***punctuation.*** *It must be thoroughly edited at your end*.

9. **HEADINGS**: All the headings must be bold-faced, aligned left and fully capitalised. Leave a blank line before each heading.

10. **SUB-HEADINGS**: All the sub-headings must be bold-faced, aligned left and fully capitalised.

11. **MAIN TEXT**:

THE MAIN TEXT SHOULD FOLLOW THE FOLLOWING SEQUENCE:

INTRODUCTION
REVIEW OF LITERATURE
NEED/IMPORTANCE OF THE STUDY
STATEMENT OF THE PROBLEM
OBJECTIVES
HYPOTHESIS (ES)
RESEARCH METHODOLOGY
RESULTS & DISCUSSION
FINDINGS
RECOMMENDATIONS/SUGGESTIONS
CONCLUSIONS
LIMITATIONS
SCOPE FOR FURTHER RESEARCH
REFERENCES
APPENDIX/ANNEXURE

The manuscript should preferably range from ***2000 to 5000 WORDS***.

12. **FIGURES & TABLES**: These should be simple, crystal **CLEAR**, **centered**, **separately numbered** & self explained, and **titles must be above the table/figure**. **Sources of data should be mentioned below the table/figure**. *It should be ensured that the tables/figures are referred to from the main text*.

13. **EQUATIONS/FORMULAE**: These should be consecutively numbered in parenthesis, horizontally centered with equation/formulae number placed at the right. The equation editor provided with standard versions of Microsoft Word should be utilised. If any other equation editor is utilised, author must confirm that these equations may be viewed and edited in versions of Microsoft Office that does not have the editor.

14. **ACRONYMS**: These should not be used in the abstract. The use of acronyms is elsewhere is acceptable. Acronyms should be defined on its first use in each section: Reserve Bank of India (RBI). Acronyms should be redefined on first use in subsequent sections.

15. **REFERENCES**: The list of all references should be alphabetically arranged. ***The author (s) should mention only the actually utilised references in the preparation of manuscript*** and they are supposed to follow Harvard Style of Referencing. **Also check to make sure that everything that you are including in the reference section is duly cited in the paper**. The author (s) are supposed to follow the references as per the following:

- All works cited in the text (including sources for tables and figures) should be listed alphabetically.
- Use (**ed.**) for one editor, and (**ed.s)** for multiple editors.
- When listing two or more works by one author, use --- (20xx), such as after Kohl (1997), use --- (2001), etc, in chronologically ascending order.
- Indicate (opening and closing) page numbers for articles in journals and for chapters in books.
- The title of books and journals should be in italics. Double quotation marks are used for titles of journal articles, book chapters, dissertations, reports, working papers, unpublished material, etc.
- For titles in a language other than English, provide an English translation in parenthesis.
- ***Headers, footers, endnotes*** *and* ***footnotes*** *should* ***not be used*** *in the document.* However, **you can mention short notes to elucidate some specific point**, which may be placed in number orders after the references.

PLEASE USE THE FOLLOWING FOR STYLE AND PUNCTUATION IN REFERENCES:

BOOKS

- Bowersox, Donald J., Closs, David J., (1996), "Logistical Management." Tata McGraw, Hill, New Delhi.
- Hunker, H.L. and A.J. Wright (1963), "Factors of Industrial Location in Ohio" Ohio State University, Nigeria.

CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

JOURNAL AND OTHER ARTICLES

- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

CONFERENCE PAPERS

- Garg, Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–23

UNPUBLISHED DISSERTATIONS

- Kumar S. (2011): "Customer Value: A Comparative Study of Rural and Urban Customers," Thesis, Kurukshetra University, Kurukshetra.

ONLINE RESOURCES

- Always indicate the date that the source was accessed, as online resources are frequently updated or removed.

WEBSITES

- Garg, Bhavet (2011): Towards a New Gas Policy, Political Weekly, Viewed on January 01, 2012 http://epw.in/user/viewabstract.jsp

THE STOCHASTIC MODELLING AND RELIABILITY ANALYSIS OF A BEER BOTTLE FILLING PLANT IN AN INDUSTRY

NEHA KUMARI
RESEARCH SCHOLAR
DEPARTMENT OF STATISTICS
UNIVERSITY OF JAMMU
JAMMU

PAWAN KUMAR
ASSOCIATE PROFESSOR
DEPARTMENT OF STATISTICS
UNIVERSITY OF JAMMU
JAMMU

ABSTRACT

A model of Beer Bottle Filling Plant is developed for its stochastic analysis by personally visiting factory situated at District Samba in State Jammu and Kashmir. The said filling plant consists of five units- Conveyer belt, Filler, Crowner, Pasteurizer and Labeling Machine. Conveyer Belt is in series with other four units. The other four units are in parallel form but Filler machine is unified with crowner machine such that if any one of the two units fail, the other are kept in standby mode. After random period of time, if repair of failed unit is not completed then other units are kept in standby mode. If one unit is already in repair and within this period some other unit also fails then the whole system is put under emergency repair in order to make system ready as early as possible. A single repair facility is always available with the system to repair a failed unit. All the failure time distributions are taken to be negative exponential and all the repair time distributions are taken as arbitrary.

KEYWORDS
Reliability; Availability; Busy period; Expected number of Repairs; Profit Analysis; Graphical study of Model.

1. INTRODUCTION

Although a lot of work has been done in the field of reliability by formulating and analyzing various kinds of system models, but most of the work done is of hypothetical nature and is not of much practical utility. Singh, S.K. and G. Nair Sheeba [10] have analyzed stone crushing system used in iron ore mines. Kumar Pawan and Bharti Ankush [7] formulated and carried out reliability analysis of a battery production system in an industry. Gupta and Ramkishan[5] developed a model pertaining to electric power, inverter and generator and obtained various reliability measures. Gupta and Shivakar [6] carried out the analysis w.r.t. reliability characteristics of a cloth manufacturing system model. Gupta,Varshney and Sharma[3] obtained various measures of system effectiveness of a milk powder making system in dairy plant. Besides these Malik et. al. [8,9] formulated and analyzed a system model of concrete mixture plant with preventive maintenance and also carried out a study on the comparison of various reliability characteristics of Haryana textile units. Sharma and Panigrahi [12], Arora and Kumar [1] have also studied the industrial system models with real existing situations.

For the purpose of analyzing real existing system, a model of beer bottle filling plant is developed for its stochastic analysis by personally visiting the plant situated in Samba district of state J&K.

The given plant consists of five units of varying nature. The working of different units of the system is described as follows:

1. **CONVEYOR BELT:** The conveyor belt conveys bottles from one machine to another one.
2. **FILLER MACHINE:** The bottle is pressed against the filling head and the evacuation valve of filler machine is opened, thereafter bottle is evacuated. By additional opening of preparatory valve, CO_2 is fed into the bottle and through second evacuation, the residual air is removed from it. Thereafter the beer valve opens and the beer flows along the wall into the bottle. The filling end is reached when the beer has reached the return pipe then beer and return valves are closed. The filler pressure, temperature and dosage of beverage quantity are preset.
3. **CROWNER MACHINE:** After filling, the bottles are directed to the crowner machine. It is necessary to fill the bottles as quickly as possible and subsequently to seal them immediately. For this purpose, the filler machine is unified with crowner machine. In the crowner machine, the first closure phase crown corks on bottles and second closure phase puts pressure on bottle to close rings of crown corks. Then the bottles are put on a slat conveyor belt.
4. **PASTEURIZER:** From slat conveyor belt, the bottles enter in pasteurizer. Pasteurizer is the best method of securing the shelf life of beverage. During pasteurization, the bottles, standing on conveyor belt, are fed slowly through the tunnel pasteurizer and at the same time warmed up by spraying on them warm and hot water of fixed temperature, then pasteurized and subsequently cooled down again.
5. **LABELING MACHINE:** After the pasteurization, the bottles are put forward to labeling machine by slat conveyor belt. The labeling machine has gluing pallets which roll against the gluing roller and are equipped there with a thin adhesive film. Each gluing pallet rolls against the label magazine and picks up one label at a time. The label is caught by gripping finger at the gripped cylinder and the glued backside facing outwards is transferred onto the bottle and brushed on.

Using the regenerative point technique the following important reliability characteristics of interest are obtained:

a) Transition probabilities and mean sojourn times.
b) Reliability and Mean time to system failure.
c) Point wise and steady-state availabilities of the system.
d) Expected up time of the system.
e) Expected busy time of the repairman during (0, t] and in the steady-state.
f) Expected number of repairs by repairman during (0, t] and in the steady-state.
g) Net expected profit incurred by the system during (0, t] and in the steady-state.

2. SYSTEM DESCRIPTION AND ASSUMPTIONS

a) The system consists of five non-identical units. Initially all the units are operative.
b) Conveyer Belt is arranged in series with other four units. The other four units are in parallel form but Filler machine is unified with crowner machine such that if any one of the two units fails, the other are kept in standby mode.
c) If repair of failed unit is not completed then after random period of time other units are kept in standby mode.

d) If one unit is already in repair and the other unit also fails within this period then the whole system is put under emergency repair in order to make system ready as early as possible.
e) A single repair facility is always available with the system to repair a failed unit.
f) A repaired unit is as good as new and is immediately reconnected to the system.
g) All the failure time distributions are taken to be negative exponential.
h) All the repair time distributions are taken as arbitrary.

3. NOTATIONS AND SYMBOLS

λ : Constant failure rate of another unit when one unit is already failed.
λ_1 : Constant rate with which the system is in down state.
α : Failure rate of unit **CB** (conveyer belt).
$G(.)$: C.d.f. of emergency repair time.
$G_1(.)$: C.d.f. of repair time of unit **CB.**
$\beta_i\ (i = 1,2)$: Failure rate of unit **F/C** respectively.
$\gamma_i\ (i = 1,2$: Failure rate of unit **P/L** respectively.
$H_i(.)\ (i = 1,2)$: C.d.f. of repair time of unit **F/C** respectively.
$F_i(.)\ (i = 1,2)$: C.d.f. of repair time of unit **P/L** respectively.
$m_i (i = 1,2)$: mean repair time of unit **F/C** respectively.
$n_i (i = 1,2)$: mean repair time of unit **P/L** respectively.
k_i/k : mean repair time of **CB/** emergency repair.

Symbols for the states of the system

$CB_0/CB_s/CB_r$: Conveyer belt is operative/ in standby mode/ under repair.
$F_0/F_s/F_r$: Filler machine is operative/ in standby mode/ under repair.
$C_0/C_s/C_r$: Crowner machine is operative/ in standby mode/ under repair.
$P_0/P_s/P_r$: Pasteurizer is operative/ in standby mode/ under repair.
$L_0/L_s/L_r$: Labeling machine is operative/ in standby mode/ under repair.
Emergency Repair : system is put under emergency repair, when any two units of the system are failed.

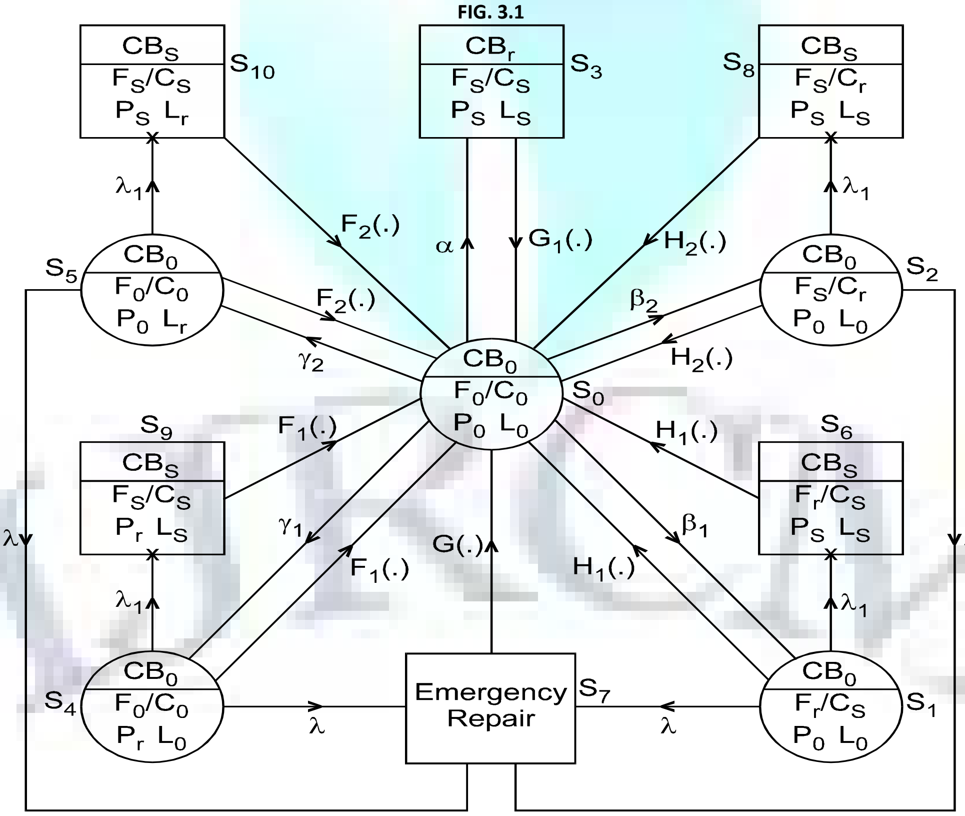
With the help of the above symbols, the possible states of the system are:

$S_0 = [CB_0, F_0, C_0, P_0, L_0]$, $S_1 = [CB_0, F_r, C_s, P_0, L_0]$
$S_2 = [CB_0, F_s, C_r, P_0, L_0]$, $S_3 = [CB_r, F_s, C_s, P_s, L_s]$
$S_4 = [CB_0, F_0, C_0, P_r, L_0]$, $S_5 = [CB_0, F_0, C_0, P_0, L_r]$
$S_6 = [CB_s, F_r, C_s, P_s, L_s]$, $S_7 = [\text{Emergency repair}]$
$S_8 = [CB_s, F_s, C_r, P_s, L_s]$, $S_9 = [CB_s, F_s, C_s, P_r, L_s]$
$S_{10} = [CB_s, F_s, C_s, P_s, L_r]$

The transition diagram along with all transitions is shown in Fig. 3.1.

TRANSITION DIAGRAM

FIG. 3.1



4. TRANSITION PROBABILITIES AND SOJOURN TIMES

Let $T_0(\equiv 0), T_1, T_2$ .... denotes the regenerative epochs and X_n denotes the state visited at epoch T_{n^+} i.e just after the transition at T_n. Then $\{X_n, T_n\}$ constitute a Markov-Renewal process with state space E, set of regenerative states and

$Q_{ij}(t) = P[X_{n+1} = j, T_{n+1} - T_n \leq t | X_n = i]$

is the semi Markov kernel over E.

(a) Thus steady state transition probabilities can be obtained as follows:

$p_{ij} = \lim_{t\to\infty} Q_{ij}(t)$

So that,

$p_{01} = \frac{\beta_1}{(\alpha+\beta_1+\beta_2+\gamma_1+\gamma_2)}$ $\quad$ $p_{02} == \frac{\beta_2}{(\alpha+\beta_1+\beta_2+\gamma_1+\gamma_2)}$

$p_{03} = \frac{\alpha}{(\alpha+\beta_1+\beta_2+\gamma_1+\gamma_2)}$ $\quad$ $p_{04} = \frac{\gamma_1}{(\alpha+\beta_1+\beta_2+\gamma_1+\gamma_2)}$

$p_{05} = \frac{\gamma_2}{(\alpha+\beta_1+\beta_2+\gamma_1+\gamma_2)}$ $\quad$ $p_{10} = \tilde{H}_1(\lambda+\lambda_1)$

$p_{10}^{(6)} = \frac{\lambda_1}{(\lambda+\lambda_1)}[1-\tilde{H}_1(\lambda+\lambda_1)]$ $\quad$ $p_{17} = \frac{\lambda}{(\lambda+\lambda_1)}[1-\tilde{H}_1(\lambda+\lambda_1)]$

$p_{20} = \tilde{H}_2(\lambda+\lambda_1)$ $\quad$ $p_{20}^{(8)} = \frac{\lambda_1}{(\lambda+\lambda_1)}[1-\tilde{H}_2(\lambda+\lambda_1)]$

$p_{27} = \frac{\lambda}{(\lambda+\lambda_1)}[1-\tilde{H}_2(\lambda+\lambda_1)]$ $\quad$ $p_{40} = \tilde{F}_1(\lambda+\lambda_1)$

$p_{40}^{(9)} = \frac{\lambda_1}{(\lambda+\lambda_1)}[1-\tilde{F}_1(\lambda+\lambda_1)]$ $\quad$ $p_{47} = \frac{\lambda}{(\lambda+\lambda_1)}[1-\tilde{F}_1(\lambda+\lambda_1)]$

$p_{50} = \tilde{F}_2(\lambda+\lambda_1)$ $\quad$ $p_{50}^{(10)} = \frac{\lambda_1}{(\lambda+\lambda_1)}[1-\tilde{F}_2(\lambda+\lambda_1)]$

$p_{57} = \frac{\lambda}{(\lambda+\lambda_1)}[1-\tilde{F}_2(\lambda+\lambda_1)]$ **(1-17)**

It can be easily seen that the following results hold good:

$p_{01}+p_{02}+p_{03}+p_{04}+p_{05} = 1$ $\quad$ $p_{10}+p_{10}^{(6)}+p_{17} = 1$

$p_{20}+p_{20}^{(8)}+p_{27} = 1$ $\quad$ $p_{40}+p_{40}^{(9)}+p_{47} = 1$

$p_{50}+p_{50}^{(10)}+p_{57} = 1$

$p_{30} = p_{60} = p_{70} = p_{80} = p_{90} = p_{10,0} = 1$ **(18-23)**

(b) Mean sojourn times:

The mean sojourn time in state S_i denoted by Ψ_i is defined as the expected time taken by the system in state S_i before transiting to any other state. To obtain mean sojourn time Ψ_i, in state S_i, we observe that as long as the system is in state S_i, there is no transition from S_i to any other state. If T_i denotes the sojourn time in state S_i then mean sojourn time Ψ_i in state S_i is:

$\Psi_i = E[T_i] = \int P(T_i > t)dt$ **(24)**

Thus

$\Psi_0 = \int e^{-(\alpha+\beta_1+\beta_2+\gamma_1+\gamma_2)t}\,dt = \frac{1}{(\alpha+\beta_1+\beta_2+\gamma_1+\gamma_2)}$

$\Psi_1 = \int e^{-(\lambda+\lambda_1)t}\,\overline{H}_1(t)dt = \frac{1}{(\lambda+\lambda_1)}[1-\tilde{H}_1(\lambda+\lambda_1)]$

$\Psi_2 = \int e^{-(\lambda+\lambda_1)t}\,\overline{H}_2(t)dt = \frac{1}{(\lambda+\lambda_1)}[1-\tilde{H}_2(\lambda+\lambda_1)]$

$\Psi_3 = \int \overline{G}_1(t)dt = k_1$

$\Psi_4 = \int e^{-(\lambda+\lambda_1)t}\,\overline{F}_1(t)dt = \frac{1}{(\lambda+\lambda_1)}[1-\tilde{F}_1(\lambda+\lambda_1)]$

$\Psi_5 = \int e^{-(\lambda+\lambda_1)t}\,\overline{F}_2(t)dt = \frac{1}{(\lambda+\lambda_1)}[1-\tilde{F}_2(\lambda+\lambda_1)]$

$\Psi_6 = \int \overline{H}_1(t)dt = m_1$

$\Psi_7 = \int \overline{G}(t)dt = k$

$\Psi_8 = \int \overline{H}_2(t)dt = m_2$

$\Psi_9 = \int \overline{F}_1(t)dt = n_1$

$\Psi_{10} = \int \overline{F}_2(t)dt = n_2$ **(25-35)**

5. ANALYSIS OF RELIABILITY AND MTSF

Let the random variable T_i be the time to system failure when system starts up from state $S_i \in E_i$, the the reliability of the system is given by

$R_i(t) = P[T_i > t]$

To determine, $R_i(t)$ we regard the failed states $(S_3, S_6, S_7, S_8, S_9, S_{10})$ of the system as absorbing. Using the simple probabilistic arguments, one can easily develop the recurrence relations among $R_i(t)$; i = 0, 1, 2, 4, 5. Taking the Laplace Transforms of these relations and simplifying the resulting set of algebraic equations for, $R_0^*(s)$ after omitting the arguments 's' for brevity, we get

$R_0^*(s) = N_1(s)/D_1(s)$ **(36)**

where,

$N_1(s) = (Z_0^* + q_{01}^* Z_1^* + q_{02}^* Z_2^* + q_{04}^* Z_4^* + q_{05}^* Z_5^*)$

and

$D_1(s) = [1 - (q_{01}^* q_{10}^* + q_{02}^* q_{20}^* + q_{04}^* q_{40}^* + q_{05}^* q_{50}^*)]$

where, $Z_0^*, Z_1^*, Z_2^*, Z_4^*, Z_5^*$ are the Laplace transforms of

$Z_0(t) = e^{-(\alpha+\beta_1+\beta_2+\gamma_1+\gamma_2)t}$, $\quad$ $Z_1(t) = e^{-(\lambda+\lambda_1)t}\,\overline{H}_1(t)$, $\quad$ $Z_2(t) = e^{-(\lambda+\lambda_1)t}\,\overline{H}_2(t)$

$Z_4(t) = e^{-(\lambda+\lambda_1)t}\,\overline{F}_1(t)$, $\quad$ $Z_5(t) = e^{-(\lambda+\lambda_1)t}\,\overline{F}_2(t)$

Taking inverse Laplace Transform of **(36),** we get reliability of the system.

To get MTSF, we use the well-known formula

$E(T_0) = \int R_0(t)dt = \lim_{s\to 0} R_0^*(s) = N_1(0)/D_1(0)$ **(37)**

where,

$N_1(0) = (\Psi_0 + p_{01}\Psi_1 + p_{02}\Psi_2 + p_{04}\Psi_4 + p_{05}\Psi_5)$

and

$D_1(0) = [1 - (p_{01}p_{10} + p_{02}p_{20} + p_{04}p_{40} + p_{05}p_{50})]$

Here we use the relations $q_{ij}^*(0) = p_{ij}$ and $\lim_{s\to 0} Z_i^*(s) = \int Z_i(t)dt = \Psi_i$.

6. AVAILABILITY ANALYSIS

Define $A_i(t)$ as the probability that the system is up at epoch't' when it initially started from regenerative state $S_i \in E_i$. Using the definition of $A_i(t)$ and probabilistic concepts, the recurrence relations among $A_i(t)$ where i = 0, 1, 2, 3, 4, 5, 7 can easily be developed.

Using the technique of L.T., the value of $A_0(t)$ in terms of its L.T. is as follows:

$A_0^*(s) = N_2(s)/D_2(s)$ **(38)**

where,

$N_2(s) = (Z_0^* + q_{01}^* Z_1^* + q_{02}^* Z_2^* + q_{04}^* Z_4^* + q_{05}^* Z_5^*)$ **(39)**

and

$D_2(s) = 1 - [q_{01}^*(q_{10}^* + q_{10}^{(6)*} + q_{17}^*q_{70}^*) + q_{02}^*(q_{20}^* + q_{20}^{(8)*} + q_{27}^*q_{70}^*) + q_{03}^*q_{30}^* + q_{04}^*(q_{40}^* + q_{40}^{(9)*} + q_{47}^*q_{70}^*) + q_{05}^*(q_{50}^* + q_{50}^{(10)*} + q_{57}^*q_{70}^*)]$ **(40)**

The steady state availability of the system, i.e probability that in the long run the system will be up, is given by

$A_0 = \lim_{t\to\infty} A_0(t) = \lim_{s\to 0} s\,A_0^*(s) = \lim_{s\to 0} \frac{sN_2(s)}{D_2(s)} = \lim_{s\to 0} N_2(s) \lim_{s\to 0} \frac{s}{D_2(s)}$

As $s \to 0$, the above equation becomes indeterminate form.

Hence on using L'Hospital's rule, A_0 becomes

$A_0 = N_2(0)/D_2'(0)$ **(41)**

where,

$N_2(0) = (\Psi_0 + p_{01}\Psi_1 + p_{02}\Psi_2 + p_{04}\Psi_4 + p_{05}\Psi_5)$ **(42)**

and

$D_2'(0) = \Psi_0 + p_{01}\Psi_1 + p_{02}\Psi_2 + p_{03}k_1 + p_{04}\Psi_4 + p_{05}\Psi_5 + Ak$ **(43)**

where, $A = p_{01}p_{17} + p_{02}p_{27} + p_{04}p_{47} + p_{05}p_{57}$

The expected up time of the system during $(0, t]$ is given by

$\mu_{up}(t) = \int_0^t A_0(u)\,du$

So that,

$\mu_{up}^*(s) = A_0^*(s)/s.$ **(44)**

7. BUSY PERIOD ANALYSIS

Define $B_i(t)$ as the probability that the system having started from regenerative state $S_i \in E$ at time $t = 0$, is under repair at time $'t'$ due to failure of the unit. Using the definition of $B_i(t)$ and probabilistic concepts, the recurrence relations among $B_i(t)$ where i = 0, 1, 2, 3, 4, 5, 7 can easily be developed.

Using the technique of L.T., the value of $B_0(t)$ in terms of its L.T. is as follows:

$B_0^*(s) = N_3(s)/D_2(s)$ **(45)**

where,

$N_3(s) = (q_{01}^*Z_1^* + q_{02}^*Z_2^* + q_{03}^*Z_3^* + q_{04}^*Z_4^* + q_{05}^*Z_5^*) + (q_{01}^*q_{17}^* + q_{02}^*q_{27}^* + q_{04}^*q_{47}^* + q_{05}^*q_{57}^*)Z_7^*$ **(46)**

In steady state, the probability that the repairman will be busy is given by

$B_0 = \lim_{t\to\infty} B_0(t) = \lim_{s\to 0} s\,B_0^*(s) = N_3(0)/D_2'(0)$ **(47)**

also as $s \to 0$, $q_{ij}^*(s)/_{s=0} = q_{ij}^*(0) = p_{ij}$ and $\lim_{s\to 0} Z_i^*(s) = \int Z_i(t)dt = \Psi_i$

where,

$N_3(0) = (p_{01}\Psi_1 + p_{02}\Psi_2 + p_{03}k_1 + p_{04}\Psi_4 + p_{05}\Psi_5) + (p_{01}p_{17} + p_{02}p_{27} + p_{04}p_{47} + p_{05}p_{57})k$ **(48)**

The expected busy period of the repairman during (0, t] is given by

$\mu_b(t) = \int_0^t B_0(u)\,du$

So that,

$\mu_b^*(s) = B_0^*(s)/s.$ **(49)**

8. EXPECTED NUMBER OF REPAIRS

Let us define $V_i(t)$ as the expected number of repairs of the failed units during the time interval $(0, t]$ when the system initially starts from regenerative state S_i.Using the definition of $V_i(t)$ and probabilistic concepts, the recurrence relations among $V_i(t)$ where i = 0, 1, 2, 3, 4, 5, 7 can easily be developed.

Using the technique of L.S.T., the solution for $\tilde{V}_0(s)$ is given by

$\tilde{V}_0(s) = N_4(s)/D_4(s)$ **(50)**

where,

$N_4(s) = \tilde{Q}_{01}(\tilde{Q}_{10} + \tilde{Q}_{10}^{(6)} + \tilde{Q}_{17}\tilde{Q}_{70}) + \tilde{Q}_{02}(\tilde{Q}_{20} + \tilde{Q}_{20}^{(8)} + \tilde{Q}_{27}\tilde{Q}_{70}) + \tilde{Q}_{03}\tilde{Q}_{30} + \tilde{Q}_{04}(\tilde{Q}_{40} + \tilde{Q}_{40}^{(9)} + \tilde{Q}_{47}\tilde{Q}_{70}) + \tilde{Q}_{05}(\tilde{Q}_{50} + \tilde{Q}_{50}^{(10)} + \tilde{Q}_{57}\tilde{Q}_{70})$ **(51)**

$D_4(s)$ can be written on replacing q_{ij}^* by $\tilde{Q}_{ij}$ in $D_2(s)$ given by $(\mathbf{40})$

In the steady state, the expected number of repairs per unit time is given by

$V_0 = \lim_{t\to\infty}\left[\frac{V_0(t)}{t}\right] = \lim_{s\to 0} s\,\tilde{V}_0(s) = N_4(0)/D_2'(0)$

where,

$N_4(0) = p_{01}(p_{10} + p_{10}^{(6)} + p_{17}p_{70}) + p_{02}(p_{20} + p_{20}^{(8)} + p_{27}p_{70}) + p_{03}p_{30} + p_{04}(p_{40} + p_{40}^{(9)} + p_{47}p_{70}) + p_{05}(p_{50} + p_{50}^{(10)} + p_{57}p_{70})$ **(52)**

9. PROFIT FUNCTION ANALYSIS

Two profit functions $P_1(t)$and $P_2(t)$ can easily be obtained for the system model under study with the help of characteristics obtained earlier. The expected total profits incurred during $(0, t]$ are:

$P_1(t) =$ Expected total revenue in (0, t]− Expected total expenditure in (0, t]

$= K_0\mu_{up}(t) - K_1\mu_b(t)$ **(53)**

Similarly,

$P_2(t) = K_0\mu_{up}(t) - K_2V_0(t)$ **(54)**

where,

K_0 is revenue per unit up time.

K_1 is the cost per unit time for which repair man is busy in repair of the failed unit.

K_2 is per unit repair cost.

The expected total profits per unit time, in steady state, is

$P_1 = \lim_{t\to\infty}[P_1(t)/t] = \lim_{s\to 0} s^2P_1^*(s)$

$P_2 = \lim_{t\to\infty}[P_2(t)/t] = \lim_{s\to 0} s^2P_2^*(s)$

So that,

$P_1 = K_0A_0 - K_1B_0$ **(55)**

and

$P_2 = K_0A_0 - K_2V_0$ **(56)**

10. PARTICULAR CASE

If the repair time distributions are taken as negative exponential i.e.

$G(t) = 1 - e^{-\eta t}$ $\quad G_1(t) = 1 - e^{-\alpha_1 t}$

$H_i(t) = 1 - e^{-\theta_i t}$ $\quad F_i(t) = 1 - e^{-\mu_i t}$ where, $(i = 1,2)$

Then the variations in transition probabilities and mean sojourn times are as follows:

$p_{10} = \frac{\theta_1}{(\lambda+\lambda_1+\theta_1)}$ $\quad p_{10}^{(6)} = \frac{\lambda_1}{(\lambda+\lambda_1+\theta_1)}$ $\quad p_{17} = \frac{\lambda}{(\lambda+\lambda_1+\theta_1)}$

$p_{20} = \frac{\theta_2}{(\lambda+\lambda_1+\theta_2)}$ $\quad p_{20}^{(8)} = \frac{\lambda_1}{(\lambda+\lambda_1+\theta_2)}$ $\quad p_{27} = \frac{\lambda}{(\lambda+\lambda_1+\theta_2)}$

$p_{40} = \frac{\mu_1}{(\lambda+\lambda_1+\mu_1)}$ $\quad p_{40}^{(9)} = \frac{\lambda_1}{(\lambda+\lambda_1+\mu_1)}$ $\quad p_{17} = \frac{\lambda}{(\lambda+\lambda_1+\mu_1)}$

$p_{50} = \frac{\mu_2}{(\lambda+\lambda_1+\mu_5)}$ $\quad p_{40}^{(10)} = \frac{\lambda_1}{(\lambda+\lambda_1+\mu_2)}$ $\quad p_{57} = \frac{\lambda}{(\lambda+\lambda_1+\mu_2)}$

$\Psi_1 = \frac{1}{(\lambda+\lambda_1+\theta_1)}$ $\quad \Psi_2 = \frac{1}{(\lambda+\lambda_1+\theta_2)}$ $\quad \Psi_3 = \frac{1}{\alpha_1}$

$\Psi_4 = \frac{1}{(\lambda+\lambda_1+\mu_1)}$ $\quad \Psi_5 = \frac{1}{(\lambda+\lambda_1+\mu_2)}$ $\quad \Psi_6 = \frac{1}{\theta_1}$

$\Psi_7 = \frac{1}{\eta}$ $\quad \Psi_8 = \frac{1}{\theta_2}$ $\quad \Psi_9 = \frac{1}{\mu_1}$

$\Psi_{10} = \frac{1}{\mu_2}$

11. GRAPHICAL STUDY OF THE SYSTEM MODEL

For more concrete study of system behavior, we plot MTSF and Profit functions with respect to β_1 (failure rate of Filler machine) for different values of θ_1(repair rate of Filler machine).

Fig. 2 shows the variations in MTSF in respect of β_1 for different values of θ_1 as 0.25, 0.50 and 0.75 while the other parameters are fixed as $\lambda = 0.30$, $\lambda_1 = 0.10$, $\gamma_1 = 0.03$, $\gamma_2 = 0.03$, $\alpha = 0.20$, $\alpha_1 = 0.30$, $\beta_2 = 0.05$, $\eta = 0.04$, $\mu_1 = 0.02$, $\mu_2 = 0.02$, $\theta_2 = 0.05$. It is observed from the graph that MTSF decreases with the increase in the failure parameter β_1 and for higher values of θ_1, the MTSF is higher i.e., the repair facility has a better understanding of failure phenomenon resulting in longer lifetime of the system.

Fig. 3 represents the change in profit function P_1 and P_2 w.r.t. β_1 for different values of θ_1 as 0.25, 0.50 and 0.75 while the other parameters are fixed as $\lambda = 0.30, \lambda_1 = 0.10, \gamma_1 = 0.03, \gamma_2 = 0.03, \alpha = 0.20, \alpha_1 = 0.30, \beta_2 = 0.05, \eta = 0.04, \mu_1 = 0.02, \mu_2 = 0.02, \theta_2 = 0.05, K_0 = 1000, K_1 = 300, K_2 = 250$. From the graph it is seen that both profit functions decrease with the increase in failure rate β_1 and increase with the increase in θ_1. It is also observed that profit function P_2 is always higher as compared to profit function P_1 for fixed values of β_1 and θ_1. Thus the better understanding of failure phenomenon by the repairman results in better system performance.

12. CONCLUDING REMARKS

A model of Beer Bottle Filling Plant consisting of five units is developed and analyzed with respect to various reliability characteristics for its stochastic analysis by personally visiting the factory situated at District Samba in State Jammu and Kashmir. All the failure time distributions are taken to be negative exponential. All the repair time distributions are taken as arbitrary. The graphical study of some of the reliability characteristics has also been carried out.

FIG. 2

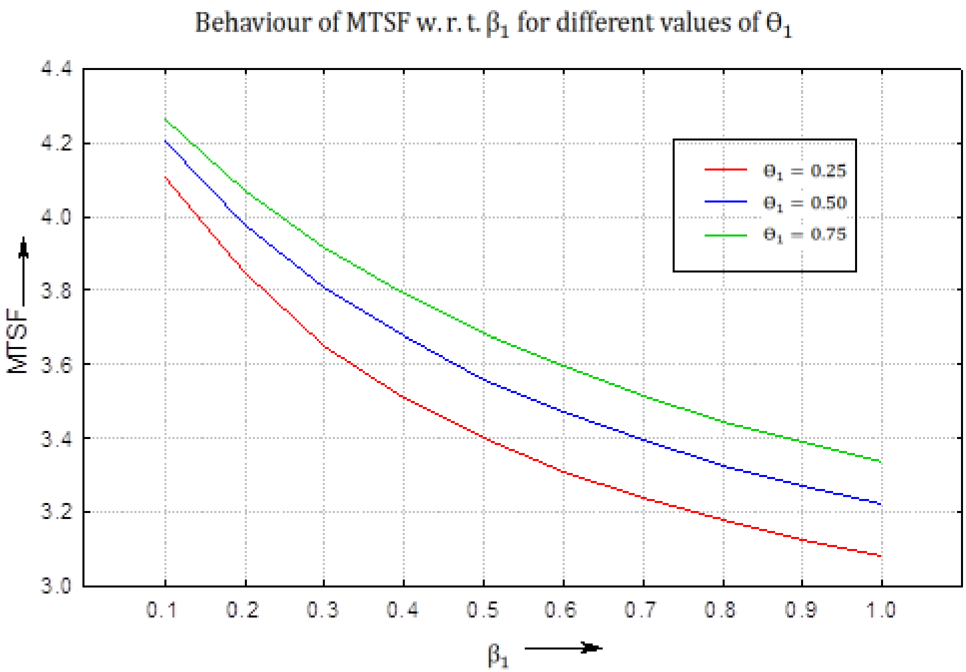
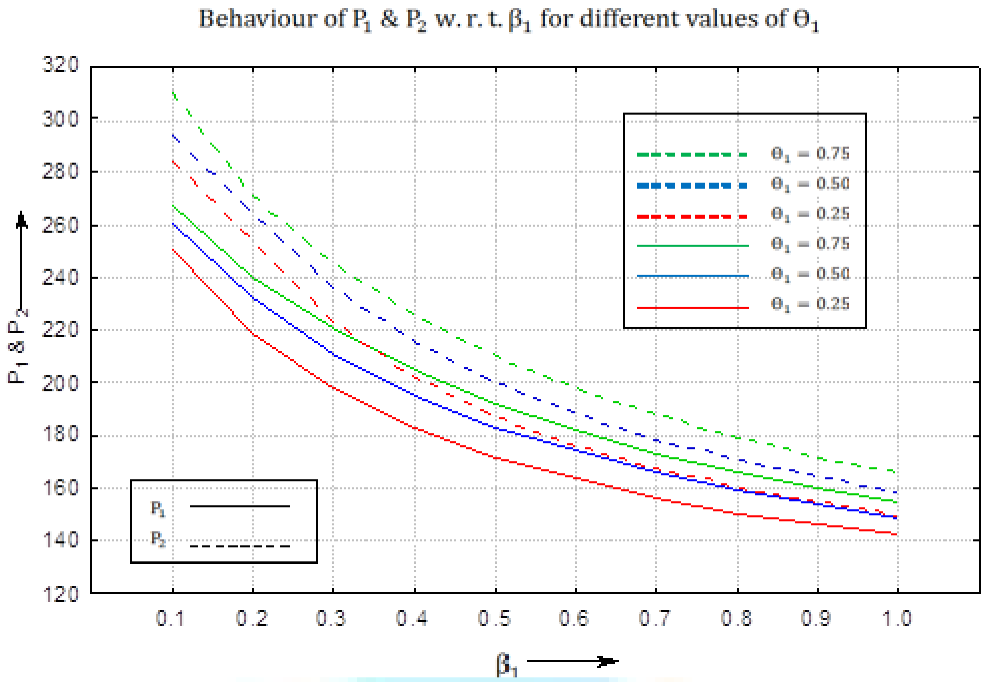


FIG. 3



REFERENCES

1. Arora, N. and D. Kumar (2000); System analysis and maintenance management for the coal handling system in a paper plant. *Int. J.Manag.Syst*., 16, pp 137-156.
2. Gupta, R., C.P. Bajaj and S.M. Sinha (1986); Cost benefit analysis of a multicomponent standby system with inspection and slow switch. *Microelectron Reliab*., Vol. 26, No. 5, pp. 879-882.
3. Gupta, R., G. Varshney and V. Sharma(2010); The stochastic modelling and analysis of milk powder making system in dairy plant, *Aligarh J. Statistics,* Vol. 30, pp.1-13.
4. Gupta, R. and P. Kumar (2002); Analysis of Two Unit Series Subsystem with Standby System Model, *Gujarat Statistical Review*, Vol. 29, No. 1-2, pp 87-100.
5. Gupta, R and Ramkishan(1998); Stochastic Analysis of a system model pertaining to electric power, inverter and generator, *Bulletin of Pure and Applies Sciences*, Vol. 17E, No.1, pp 95-102
6. Gupta, R and Shivakar(2003); Analysis of a Stochastic model of a cloth weaving system, *IAPQR,* Vol. 28 No.1,pp 83-99
7. Kumar, Pawan and Bharti, Ankush(2012);The stochastic modelling and reliability analysis of a Battery production system in an Industry, *International Journal of research in Commerce, IT and Management*, Vol.2, Issue 4, pp 98-102.
8. Malik et. al. (2014); stochastic modelling of a concrete mixture plant with preventive maintenance, *Application and Applied Mathematics*, vol.9, Issue 1, pp. 13-27.
9. Malik et. al. (2013); A comparative analysis of Haryana textile units, *International Journal of Human Resource Development and Management*, Vol. 3, No. 1, pp. 15-31.
10. Singh,S.K. and G. Nair Sheeba (1995); Stochastic modelling and analysis of stone crushing system used in iron ore mines, *Journal of Ravishankar University*, 8, 101-104.
11. Singh, S.K. and S. P. Singh (2002); The configurational modelling and analysis of wire rod mild system, *Aligarh J. Statist*., 22, 43-62.
12. Sharma, V. and S.C. Panigrahi (1990); Reliability evaluation of communication system considering a multi-state model, *Microelectron Reliab*., 30, 701-704.

REQUEST FOR FEEDBACK

Dear Readers

At the very outset, International Journal of Research in Computer Application & Management (IJRCM) acknowledges & appreciates your efforts in showing interest in our present issue under your kind perusal.

I would like to request you tosupply your critical comments and suggestions about the material published in this issue as well as on the journal as a whole, on our E-mail**infoijrcm@gmail.com** for further improvements in the interest of research.

If youhave any queries please feel free to contact us on our E-mail **infoijrcm@gmail.com**.

I am sure that your feedback and deliberations would make future issues better – a result of our joint effort.

Looking forward an appropriate consideration.

With sincere regards

Thanking you profoundly

Academically yours

Sd/-
Co-ordinator

DISCLAIMER

ABOUT THE JOURNAL

In this age of Commerce, Economics, Computer, I.T. & Management and cut throat competition, a group of intellectuals felt the need to have some platform, where young and budding managers and academicians could express their views and discuss the problems among their peers. This journal was conceived with this noble intention in view. This journal has been introduced to give an opportunity for expressing refined and innovative ideas in this field. It is our humble endeavour to provide a springboard to the upcoming specialists and give a chance to know about the latest in the sphere of research and knowledge. We have taken a small step and we hope that with the active co-operation of like-minded scholars, we shall be able to serve the society with our humble efforts.

Our Other Journals