

**ISBN: 978-81-953571-3-0**

**PROCEEDINGS  
OF  
ARC 2021  
XV INTERNATIONAL CONFERENCE ON APPLIED  
RESEARCH IN ENGINEERING AND MANAGEMENT  
SCIENCES**

**13<sup>th</sup> August, – 2021**

**EVENT ORGANISERS**



**Edited By**

**Dr. K. Ravichandran  
Professor (Former)  
New York Institute of Technology**



**ACADEMIC RESEARCH CONFERENCES**

PROCEEDINGS OF

*ARC 2021*

*XV INTERNATIONAL CONFERENCE ON APPLIED RESEARCH IN ENGINEERING AND  
MANAGEMENT SCIENCES*

**Edited By**

**Dr. K. Ravichandran**  
**Professor (Former)**  
**New York Institute of Technology**

**Organized by:**



**Academic Research Conferences. India.**



**Dr. Ravichandran Krishnamoorthy,**  
*Professor (Former), School of Management,  
New York Institute of Technology,  
Abu Dhabi Campus, UAE*



## **Inaugural Address**

An astute and result oriented professional with over 22 years of extensive experience in operations, business development, academics and institution building. Received the Award for “Outstanding Contribution towards Education 2016 & 17” from World Sustainability Council at DUBAI. Also due to his contribution to the field of finance, he was appointed as a consultant for Abu Dhabi Stock exchange and also he is on a research project in developing an Education application for Arpuda app private limited. He Received championship Award From WSIS ( UN forum) for his two sustainable development projects. Currently he launched the portal for Women Entrepreneurship development in Chennai. Currently employed as Professor and Director of Experiential Learning, New York Institute of Technology, Abu Dhabi Campus, UAE.

He holds the Post-doctoral fellowship from University Kebangsaan Malaysia and Ph.D. in Finance from the University of Madras, India. His area of expertise is primarily with corporate finance and conducts focused research in the Behavioral finance and company analysis. He has co- authored several text books in Finance which are mainly focused on Indian markets. He made intellectual contributions that impact on the academic community in the area of corporate and Behavioural finance through papers published in competitive journals in this domain space (Finance India, Journal of investment, Money and Banking, International Journal of Economics and Finance...). He has also made contributions through service to the academic community, as recognition of his scholarship, through her inclusion as a reviewer and/or discussant for several academic conferences and also acting as an Editor of an International Journal. His research in the field of finance also resulted in contribution to teaching and learning by way of the receipt of a NYIT ISRC grant award. His Intellectual contributions have furthered higher education initiatives through his continued collaborative experiential education work with students into the annual Corporate Challenge Competition. His Intellectual contributions, by way of faculty-mentored student research projects were presented by students at International conferences and also got published International journals. So far he has published 25 international journal publications, 12 Books of which 4 are text books and participated in 25 international conferences worldwide.

**Dr. Easwaramoorthy Rangaswamy,**  
*B.Com, M.Com, M.B.A, M.Phil (International Business),  
P.G.D.C.A, D.A.C.S.A, Ph.D (Management)  
Principal & Provost,  
Amity Global Institute, Singapore*



## **Chief Guest**

Dr. Easwaramoorthy Rangaswamy, Principal & Provost of Amity Global Institute, Singapore is one of the distinguished management professional. He holds a PhD in Management and also has degrees in Master of Business Administration, Master of Commerce, Master of Philosophy in International Business, Post-Graduate Diploma in Computer Applications, Diploma in Advanced Client Server Applications, Bachelor of Commerce and Specialist Diploma in Applied Learning and Teaching from Republic Polytechnic, Singapore. He is also Associate Fellow of the Higher Education Academy, United Kingdom.

He has taught for University of Northampton, Anglia Ruskin University, University of London, London School of Economics, UK; Victoria University, Australia and Bharathiar University & Visveswararajah Technological University, India. He is also a Member of Panel of International Experts for IMD Executive Opinion Survey 2015, 2016, 2019, 2020 which have been published in IMD World Competitiveness Yearbook. Various awards and accolades received are as follows,

- Recipient of the “Best Teacher Award” for Master of Business Administration, Queen Mary University of London, United Kingdom in Amity Global Institute, Singapore on 17 August 2019
- Recipient of with Singapore Business Review: International Business Award for Innovative Initiative in Education - "Learner-Centered Holistic Approach that fosters Deep Learning" by Singapore Business Review, Singapore on 11 July 2019
- Recipient of the “Outstanding Teacher Award” for Doctor of Business Administration, University of Northampton, United Kingdom in Amity Global Institute, Singapore on 15 August 2018
- Top Runner up for Accountity – Adaptive Application with an Iterative Algorithm in Reimagine Education Awards 2017 organised by QS and Wharton School, University of Pennsylvania, USA, December 2017
- International Education Award for Outstanding Contribution to International Education by ASIC, United Kingdom on September 20, 2017
- Shortlisted for Bett Asia Global Citizen Award at Bett Asia Leadership Summit, November 2016.
- Recipient of the MTC Global Award for Excellence as “Distinguished Teacher -



2015" by Management Teacher Consortium (MTC)

- Recipient of the "Award for 12 Most Influential Business Professors Under 40" by Singapore Business Review Oct/Nov 2014, Singapore
- Recognised as an "Honored Member" in 2011-2012 Edition of The Stanford Who's Who Black Book
- Recipient of "Star Award" for the year 2001-02 for the outstanding performance in ISO 9001:2000 activities of Coimbatore Institute of Management And Technology, Coimbatore, India

With more than 20 years of experience, he has been a dedicated lecturer to students at undergraduate, master's and doctorate level respectively in business management subjects with consistent high teaching ratings from students over 48 different countries. His students have become World Top Scorer in the subjects namely Principles of Marketing, Human Resource Management, Organisational Behaviour: An Interdisciplinary Approach for University of London, London School of Economics programmes. His students have attained Distinction in MBA programmes of Queen Mary University of London, Anglia Ruskin University and University of Northampton, UK. He has also produced 9 university rank holders during 4 years of teaching in India.

Overall, he has achieved a high ranking for educational leadership, lecturing, teaching, and curriculum design and research initiatives. He is more of a student-centred teacher, who strives to move his students from surface to deep learning. He ensures that the students' confidence level is built and motivates them to achieve excellence. His belief and practice is more related to the "Transmission" and "Nurturing" type, when it is referred to the TPI framework. Blended with the teaching qualities, he is also good at Institution Building achieving success in educational leadership.

**Dr. Arockiasamy Soosaimanickam,**  
*Acting Dean, Associate Professor,  
The University of Nizwa, OMAN*



## **Invited Guest Speaker**

Dr. Arockiasamy is currently an Acting Dean of College of Economics Management and Information Systems, University of Nizwa, Sultanate of Oman. He is also serving as a member of various Committees at University of Nizwa, such as University Academic Council, Executive Board for Academic Affairs, Institutional Standard Assessment Steering Committee, and Foundation Program Board etc. He is also a Chair of Executive Board and College Board of the College of Economics, Management and Information Systems, University of Nizwa. In total, he has 29+ years of experience in Teaching and Research in India and Sultanate of Oman, which includes 12 years of Teaching and Administrative experience at University of Nizwa. Dr. Arockiasamy obtained his Master's degree from Bharathidasan University, MPhil and PhD in Computer Science from Bharathiar University, India. His main expertise and research interests are in the field of Image Processing and Data Mining. He is also involved in various Research Projects inside and outside Oman. He is a recognized 'PhD supervisor' of several Universities in India and abroad. Three Research Scholars have already completed their PhD in Computer science under his supervision. He has published over 50 Research papers in International / National Journals and conferences to his credit. Dr. Arockiasamy was serving as a Chief Editor of an in-house magazine named "Voice of CEMIS" at University of Nizwa. He has been invited as a keynote speaker in various International / National conferences in India and abroad as well. He is an External Reviewer of various National / International Journals. He has been acting as an External Examiner for evaluating PhD thesis for many Universities in India. Dr. Arockiasamy was a popular writer in a well-established Tamil Newspaper 'Daily Thanthi' for more than 8 years. A full page article on popular computer related topics titled "Computer Jaalam" was published for the benefit of many people. He has written more than 400 articles from March 2004 to December 2010. Dr. Arockiasamy joined the Faculty of University of Nizwa in 2007. Prior to his current position, he worked at a College affiliated to Bharathiar University since 1990. He was a HoD and Director, Department of Computer Science and Applications for 18 years in a reputed institution in India. He was also a Chairman of Computer Society of India, Coimbatore Chapter during the year 2006-07 and also a recipient of Chapter

**Patron Award for the year 2011 during CSI annual convention. He is also a recipient of a prestigious award, “Best Professor in Information Technology” by Asian Education Leadership Awards on 25th September 2012 at Dubai. This award is for his contributions in Teaching, Research and Community Services. He is also a recipient of “Distinguished Leader in Science” Award, by Higher Education Leadership Award (HELA), Venus International Foundation on 6th January 2018 at the Hotel Le Meridian, Chennai. Recently, he has received an award, “Fabulous Global Education Leader” by World Education Congress on 4th July, at Hotel TajLand Ends, Mumbai. This award is for his contributions in the field of Education in different capacity.**

**Dr. Latha Krishnadas Mazumder**  
*Khawarizmi International College,  
Faculty of Business Administration  
Abu Dhabi , UAE*



## **Invited Guest Speaker**

A consummate academician passionate about the potential and impact of Business Administration, Quality Management, Strategic Management, HR and OD. Innovative teacher devoted to education and learning for the under graduate, Post Graduate level. Committed towards helping students develop their full potential in their studies. Comprehensive blend of hands-on industry exposure and as an Academician for 25 years, recognized for structuring and implementing innovative teaching methodologies to generate undivided commitment & dedication among the students. Diligent and resourceful with excellent communication skills. Consistently mentor, coach and collaborate with students, parents and the teaching fraternity to build a cohesive environment that maximizes student learning, academic performance and social growth. Remained as a dedicated partner to university programs and outreach events that helps promote learning and support the student community, and also was a research guide for PhD students and exhibited commitment towards research and analysis.

**Dr. Kabaly P Subramanian PhD,  
MCMi (UK)**

*Management Teacher, Researcher, Trainer and  
Consultant, Senior Faculty,  
Arab Open University, Muscat, Sultanate of OMAN*



## **Invited Guest Speaker**

**Academic Position:** Assistant Professor and Head of Innovation and Entrepreneurship Initiative **Present Affiliation:** Arab Open University, Muscat, Sultanate of Oman **Other Affiliation:** Adjunct Professor, VIT University, India  
**Qualifications:** MBA (Marketing), M. Ed, M.Phil. (Management), PhD (Management)  
**Post Graduate Program in Digital Business from** Columbia Business School and MIT, US (2020) **Professional Accreditation:** SLET, India (in Management) -University Grants Commission, 1999 **Attended Professional Development Programs of** IIM (Kozhikode), IIM (Bangalore), Oxford University (UK), Columbia Business School (US), MIT (US), Open University (UK), UCSI University (Malaysia) **Academic Experience:** 21 Years  
**Countries Visited:** India, US, UK, Oman, UAE, Kuwait, Malaysia, Georgia and Lebanon. He is also founder and Principal Consultant of Rakansas Business Consulting and Training (P) Ltd- a specialist Strategy and Innovation Consulting firm, Business Associate of Franchise India, New Delhi and Partner of Franchise-Fresh & Fresh, Fish Mart India (P) Ltd, Bangalore.

**Dr. Sheetal Sharma ,**  
*Professor & Dean,*  
*VIT Bhopal University, MP, INDIA*



## **Invited Guest Speaker**

**Dr. Sheetal Sharma, An academic Professional with background in Architecture and Urban Planning. Seeking to build on strong academic teaching and research skills gained through qualifications and Enormous Professional Work along with studies consisting 23+ years of independent architectural consultancy projects. Currently posted as Dean/Professor in School Of Architecture, VIT University, Bhopal, a leading academic institution of international reputation based in India. Ambition is to eventually have broad-based academic career including teaching, research, and management responsibilities. She did her B Arch with a Gold Medal from Amravati University, and Post Graduation in Urban Development Planning from MANIT in 2010 and also Ph.D in Environment Planning from MANIT in 2015. She has won many International Awards, have chaired many International conferences in DUBAI, CANADA, SINGPORE , PARIS, EDINURGH ETC , many Best paper Awards at International Level , Best Educationist Award, 4 Gold medals in different streams and published more than 35 International and National papers with many Book chapters.**

**Ts. Dr. MD. Jakir Hossen**  
*Department of Robotics and Automation,  
Multimedia University, MALAYSIA*



## **Invited Guest Speaker**

**A committed senior lecturer with over 15 years of experience at leading Malaysian academic institutions teaching students from various social and cultural backgrounds and possessing excellent research, administrative roles, collaboration and services along with constructive and effective teaching and learning methods that promote a stimulating learning environment. Able to work in a managerial role or as part of team and having the proven ability to successfully work to tight schedules and deadlines. Currently looking for suitable academic opportunities in universities or research institutions to lead and overcome the challenges of Industrial Revolution 4.0.**

**Dr. Osamah Ibrahim Khalaf,**  
*Associate Professor,*  
*Al-Nahrain University, IRAQ*



## **Invited Guest Speaker**

**Dr. Osamah Ibrahim Khalaf is a Senior Engineering and Telecommunications Lecturer in the School of IT. He has 15 years of university-level teaching experience in computer science and network technology.**

**He have a strong CV and had many articles published (ISI/Thomson Reuters) and also presented at numerous conferences. He hold a patent and have received several medals and awards for his work and research.**

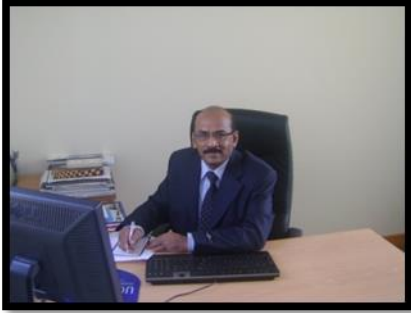
**He has good skills in software engineering including experience with: .Net, SQL development, database management, mobile applications design, mobile techniques, Java development, android development, IOS mobile development, Cloud system, website design.**

**Personal Strengths: Highly self-motivated team player who can work independently with minimum supervision, strong leadership skills, and outgoing personality.**

**He is also guest editor in many Scopus and SCI index journals also an Editor in chief in many journals.**



## FOREWORD



**Dr. K. PrakashVel,  
Professor,  
University of Wollongong in Dubai.**

It gives me immense pleasure in writing a foreword to the 'ARC 2021 XV INTERNATIONAL CONFERENCE ON APPLIED RESEARCH IN ENGINEERING AND MANAGEMENT SCIENCES.

ARC is a forerunner in creating and exchanging knowledge in the field of Business Management featuring major developments in the global economy and markets. They have been successful in organizing conferences to exchange skills and acumen on theory and practice on current and emerging management principles, ideas, concepts and research methods facilitating analysis among academicians, scholars and students, both at the post graduate and doctoral levels. I strongly believe that the conference would not only inspire the delegates participating from different parts of the World, but also further add to the existing literature in different research domains in business management.

I am positive that the one day International Conference would be beneficial to the participants. I extend my sincere wishes for a successful conference.

**Dr. K. PrakashVel**

## FOREWORD



**Gantasala V. Prabhakar, Ph.D**

**Professor & Assistant Dean,  
School of Management  
New York Institute of Technology,  
Abu Dhabi Campus, UAE**

Knowledge stems from extensive research undertaken by the multitude of experts in academia and the corporate. It then becomes quintessential that research-based findings that contribute to extant knowledge must be shared. One of the integral elements of Nonaka and Takeuchi's SECI model is Knowledge Sharing. I have believed that bringing researchers from across the globe working in their domains of expertise on a common platform is in the direction of creating strong Communities of Practice. Academic Research Publishers has set a benchmark in organizing these congregations of knowledge and research pools and presenting opportunities for knowledge sharing and in turn fuelling possibilities of knowledge creation. ARC has successfully over the years provided the base to present, discuss and enhance research developments in each of the management functions.

ARC has also garnered increasing patronage of participants who represent all the major continents and that in itself has been very inspiring and satisfying for me to be a part of their success. The conferences organized have seen an overwhelming response from global experts and is a testimony of the credentials that ARC embodies and has stood for.

It is my privilege to applaud their vision, their efforts and to be part of **ARC 2021 XV INTERNATIONAL CONFERENCE ON APPLIED RESEARCH IN ENGINEERING AND MANAGEMENT SCIENCES**. Given the calibre of the participants and the values that are enshrined by conferences organized by ARC, I am very assured that the two day conference will be a resounding success and will draw appreciation and support from all associated with this noble endeavour.

**Gantasala V. Prabhakar, Ph.D**

## FOREWORD



**Dr. R. Krishna**  
Group Director,  
Don Bosco Group of Institutions  
Bangalore.

It is with immense pleasure that I write this Foreword for the the Proceedings of the **ARC 2021 XV INTERNATIONAL CONFERENCE ON APPLIED RESEARCH IN ENGINEERING AND MANAGEMENT SCIENCES**, organised by the Academic Research Conferences/Publishers, Abu Dhabi, UAE.

I am informed that the responses are overwhelming from all corners in the form of quality research papers submitted for review/approval for presentation during the conference. I am sure, the Proceedings of the conference will serve as an excellent reference book to the Management teachers the world over. I trust also that this conference will be an impetus to stimulate further study and research in all the areas.

Wishing Godspeed in all the endeavours.

**Dr. R. Krishna.**

ARC 2021

**XV INTERNATIONAL CONFERENCE ON APPLIED RESEARCH IN ENGINEERING AND  
MANAGEMENT SCIENCES**

**ADVISORY BOARD MEMBERS**

- Dr. Ariyarathna Jayamaha**, University of Kelaiya, Sri Lanka  
**Dr. Srimantoorao. S. Appadoo**, University of Manitoba, Canada  
**Dr. G. Anantha Padmanaban**, India  
**Dr. Sandeep Ojha**, Salalah, Sultanate of Oman  
**Dr. R. Amudha**, Karunya University, Coimbatore  
**Dr. R. Krishna**, Don Bosco Group of Institutions, Bangalore  
**Dr. Rupa Gunaseelan**, BSMED, India  
**Dr. Yuvraj Gajpal**, University of Manitoba, Canada  
**Dr. Preethi Keerthi DSouza**, Mangalore University, India  
**Dr. Ritwij Bhowmik**, IIT Kanpur, India  
**Dr. C. Vadivel**, Bharathiar University Arts & Science College, India  
**Dr. Arasu Rangaswami**, Professor & Principal, Madras University, India  
**Dr. Latha Krishnadas**, Professor, Al khawarziehmi College, UAE  
**Dr. Sheetal Sharma**, Professor & Dean, VIT Bhopal University, MP, INDIA  
**Ts. Dr. MD.Jakir Hossen**, Department of Robotics and Automation, Multimedia University,  
MALAYSIA  
**Dr. R. Dinesh Kumar**, Associate Professor & HOD, Siddhartha Institute of Technology &  
Science, Telangana. India  
**Dr. Kenny Netshiongolwe**, President and Vice Chancellor, SAFFIIT University, Midrand,  
South Africa  
**Dr. Wadmare Siddhant Vasantrao**, Associate Professor, Dr. D.Y. Patil Arts Commerce and  
Science College, Pimpri, Pune. India  
**Dr. Suzan Dsouza**, Assistant Professor, College of Business Administration, American  
University of the Middle East, Kuwait  
**Dr. Samson S Chiru**, North East Christian University, Nagaland, India.  
**Dr. Ranbir Singh**, Associate Professor & HOD, Maharaja Agrasen School of Management,  
Maharaja Agrasen University, Kalujhinda, Baddi District, Solan, Himachal Pradesh. India  
**Dr. Ram Palanisamy**, St. Francis Xavier University, Antigonish, NS, Canada  
**Dr. Praveen K. Das**, University of Louisiana, Lafayette, LA  
**Dr. Adil Hassan Bakheet Khalid**, Sohar University, Sultanate of Oman  
**Dr. Emmanuel Awuor**, Management University of Africa, Nairobi, Kenya  
**Dr. Kazi Nazmul Huda**, Southern University, Bangladesh  
**Dr. Zaroug Osman Bilal**, Salalah, Sultanate of Oman

**Contact Chair**

**Mr. C. Jey Yoganand**  
Director, Indian Operations  
ACRPUB, UAE  
Email: jey@acrpublish.com

Contact us <http://www.arcconferences.com>  
Email: [arc2021@acrpublish.com](mailto:arc2021@acrpublish.com)

**ARC 2021**  
**XV INTERNATIONAL CONFERENCE ON APPLIED RESEARCH IN  
ENGINEERING AND MANAGEMENT SCIENCES**

**DATE: 13<sup>th</sup> August, 2021**

TIME	AGENDA	PLACE
09:00-09:15	<b>REGISTRATION</b>	Online
09:15-09:30	<p style="text-align: center;"><b><u>Conference Inauguration</u></b>  <b><u>Inaugural Address</u></b></p> <p style="text-align: center;"><b>Dr. K. Ravichandran ,</b>  <i>Professor(former) NYIT, Abu Dhabi, UAE &amp; Founder ARC  Conferences</i></p>	Online
09:30-10:00	<p style="text-align: center;"><b><u>Chief Guest Address:</u></b></p> <p style="text-align: center;"><b>Dr. Easwaramoorthy Rangaswamy ,</b>  <i>Principal &amp; Provost, Amity Global Institute, Singapore</i></p>	
10:00-11:15	<p style="text-align: center;"><b><u>Invited Guest Speakers:</u></b></p> <p style="text-align: center;"><b>Dr. Arockiasamy Soosaimanickam,</b>  <i>Acting Dean, Associate Professor,  The University of Nizwa, OMAN</i></p> <p style="text-align: center;"><b>Dr. Kabaly P Subramaniam ,</b>  <i>Senior Faculty, Arab Open University, OMAN</i></p> <p style="text-align: center;"><b>Dr. PSS. Srinivasan,</b>  <i>Principal, KIOT, Salem. INDIA</i></p> <p style="text-align: center;"><b>Dr. Sheetal Sharma ,</b>  <i>Professor &amp; Dean, VIT Bhopal University, MP, INDIA</i></p> <p style="text-align: center;"><b>Ts. Dr. MD.Jakir Hossen</b>  <i>Department of Robotics and Automation, Multimedia  University, MALAYSIA</i></p> <p style="text-align: center;"><b>Dr. Osamah Ibrahim Khalaf,</b>  <i>Associate Professor, Al-Nahrain University, IRAQ</i></p>	Online
11:15-01:00	<b>Technical Session 1 (Management)</b>	Online
11:15-02:00	<b>Technical Session 2 (Engineering)</b>	Online
02:00-03:45	<b>Technical Session 3 (Management)</b>	Online
04:00-04:15	<p style="text-align: center;"><b>Valedictory</b></p> <p style="text-align: center;"><b>Dr. K. Ravichandran</b>  <i>Professor(former) NYIT, Abu Dhabi, UAE &amp;  Founder ARC Conferences</i></p>	Online

*ARC 2021*  
Conference Schedule  
**Room 1 Morning (Management)**

Join Zoom Meeting

<https://zoom.us/j/5457092288?pwd=WjFDUXp6VlBGVDVEZlc2NTRORDJEdzo9>

Meeting ID: 545 709 2288

Passcode: 55555

SESSION 1 CHAIRS

**Dr. Charumathi ,**  
*Professor & HOD, Pondicherry University,*  
*India*

**Dr. Kabaly P Subramaniam ,**  
*Senior Faculty, Arab Open University,*  
*OMAN*

13-08-2021, Friday  
Session 11:15 AM to 01:00 PM

REF. No.	Paper Title & Presenter
1	A Study on Online Shopping Behavior of Rural Consumers in Palakkad Taluk  Author: Dr. S. Kamalasaravanan
2	The Study of the Continuous and Comprehensive Evaluation in the Schools  Author: Mr. Srinivas Rao
3	Influence of Intellectual Capital on Financial Performance; Evidence from Listed Real Estate and Consumer Service PLCs in Sri Lanka  Authors: Dr. N.C Wickramaarachchi and B.K. Nelumika
4	Reforms in Indian Capital Market : An Empirical Analysis  Author: Dr. Sabina Batra
5	“Designing Strategies for Sustainable Livelihood in Peri-Urban Settlement – A Case of Smart City Vadodara”  Authors: Ms. Pooja Shah and Prof. Jagruti Shah
6	Entrepreneurial Readiness of Women Students Studying in Indian Technical Institutions  Authors: Ms. Archana M S, Dr. VijayaKumar and Dr. M S. Shyamasundar
7	Crisis Management Strategies Adopted by Micro and Small Enterprises During the Covid Pandemic  Authors: Dr. S.R.K. Prasad, Dr. John R Raj, Dr. R. Jayanthi and Dr. S. Gokul Kumar

ARC 2021

Conference Schedule

**Room 2 Morning (Engineering)**

Join Zoom Meeting

<https://zoom.us/j/5457092288?pwd=WjFDUXp6VlBGVDVEZlc2NTRORDJEdzo9>

Meeting ID: 545 709 2288

Passcode: 55555

SESSION 2 CHAIRS

**Ts. Dr. MD. Jakir  
Hossen**

*Department of Robotics  
and Automation,  
Multimedia University,  
Malaysia*

**Dr. R. Dinesh Kumar,**  
*Associate Professor &  
HOD, Siddhartha Institute  
of Technology & Science,  
Telangana. India*

**Dr. Kishor V. Bhadane**  
*Associate Professor &  
Head, Electrical  
Engineering, Amrutvahini  
College of Engineering,  
Nasik. India*

13-08-2021, Friday

Session 11:00 AM to 02:00 PM

REF. No.	Paper Title & Presenter
1	A Survey of Extraction Based Approaches on Multi-Documents Authors: Mr. Pavan Kartheek Rachabathuni and Mr. Yunus. SK
2	A Review of Video Stabilization Algorithms Authors: G. Balachandran and Dr. J. Venu Gopala Krishnan
3	Biomedical Application of Iron Oxide Nanoparticles: Hyperthermia Cancer Therapy Authors: Ms. Jayashree K and Dr. Narendra Kumar S
4	Efficient Channel State Information (CSI) Estimation Using Deep Learning Techniques for Future Generation High Speed Networks Author: Ms. Syeda Ayesha Unisa
5	Novel Utilization and Applications of Rice Husk as Green and Sustainable Biomass Authors: Shaik Abdul Vaheed, Sejal Masade and Dr. Madhuri Pydimalla
6	A Review on Chipless RFID Tags Authors: Akhila Madhav, Sumi M and Harikrishnan A
7	Biodiesel: Review on Production Techniques & Raw Material Process Economic Aspects Authors: J. Srinithi, Dr. M. Thirumarimurugan and D. Gokul

8	<p><b>Gesture Controlled AI-Robot Using Kinect</b></p> <p><b>Authors: Jayasurya B, Jino Justin, Kharat Pooja C, Mrutyunjay A Hasaraddi and Dr. T. Kavitha</b></p>
9	<p><b>ECG Watermarking Technique for Telemedicine Applications using Deep Learning</b></p> <p><b>Authors: Busharath PV and Nandakumar Paramparambath</b></p>
10	<p><b>A Novel Approach to MEMS Based Wideband Energy Harvesting for Sensing Applications</b></p> <p><b>Authors: V. Amirtha Raj and Dr. M. Manivannan</b></p>
11	<p><b>Development of Toolkits and Checklists for Design of Public Transport Infrastructure – A Case Study of Raichur and Kalburgi Bus Terminal</b></p> <p><b>Authors: Rohan N Ramaiya and Prof. Jagruti Shah</b></p>
12	<p><b>Stabilization of Soil Using Sewage Sludge as Admixture</b></p> <p><b>Authors: Dr. BindhuLal and Ms. Sukeerti Bansal</b></p>



**ARC 2021**  
**Conference Schedule**  
**Room 1 Afternoon (Management)**

Join Zoom Meeting

<https://zoom.us/j/5457092288?pwd=WjFDUXp6VlBGVDVEZlc2NTRORDJEdzo9>

Meeting ID: 545 709 2288

Passcode: 55555

**SESSION 3 CHAIRS**

**Dr. Rupa Gunaseelan,**  
*Dean, BSMED,  
Bharathiyar University,  
India*

**Dr. K. Ravichandran**  
*Professor (Former), NYIT,  
Abu Dhabi UA*

**Dr. Preethi Keerthi  
Souza,**  
*Assistant Professor,  
Mangalore University  
Mangalore. India*

**13-08-2021, Friday**  
**Session 02:00 PM to 03:45 PM**

REF. No.	Paper Title & Presenter
1	<b>Central Transfers and Fiscal Dependence of States in India – An Analysis of Fiscal Dependency of Assam</b>  Authors: Mr. Santosh Borkakati and Dr. Konthoujam Gyanendra
2	<b>Influence of Small / Niche / Community Banks on the Financial System: An Investigation</b>  Authors: Mr. Joshy Mathew K and Regi Kumar V
3	<b>Factor Influencing the Investors Behavior towards the Selection of Pension Schemes</b>  Authors: Ms. Anita Taneja and Dr. Mahesh Kumar Sarva
4	<b>A Study On Job Satisfaction Of KSRTC Women Conductors In Kerala With Reference to Kollam District</b>  Author: Abin P Jose
5	<b>Invisible Lacunae in Responsible Tourism Management in Kerala</b>  Author: Dr. Satheesh Babu A. T

CONTENTS  
Proceeding of  
ARC – 2021

*XV International Conference on Applied Research in Engineering  
and Management Sciences  
(ICAREMS-2021)*

REF. No.		Page No
1	<b>A Study on Online Shopping Behavior of Rural Consumers in Palakkad Taluk</b>  <i>Author: Dr. S. Kamalasaravanan, Associate Professor, Department of Management Sciences, Hindusthan college of Engineering and Technology, Coimbatore</i>	1-7
2	<b>The Study of the Continuous and Comprehensive Evaluation in the Schools</b>  <i>Author: Mr. Srinivas Rao, Research Scholar, Krishna University, Machillipatnam.</i>	8-17
3	<b>Influence of Intellectual Capital on Financial Performance; Evidence from Listed Real Estate and Consumer Service PLCs in Sri Lanka</b>  <i>Authors: Dr. N.C Wickramaarachchi and B.K. Nelumika, Department of Estate Management and Valuation, Faculty of Management Studies and Commerce, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.</i>	18-30
4	<b>Reforms in Indian Capital Market : An Empirical Analysis</b>  <i>Author: Dr. Sabina Batra, Associate Professor, PG Department of Commerce and Business Administration, Kanya Maha Vidyalaya, Jalandhar.</i>	31-41
5	<b>“Designing Strategies for Sustainable Livelihood in Peri-Urban Settlement – A Case of Smart City Vadodara”</b>  <i>Authors: Ms. Pooja Shah, Infrastructure Engineering and Technology, B.V.M Engineering College, V.V Nagar, Gujarat, India. Prof. Jagruti Shah, Asst. Prof. Structural Engineering Department, B.V.M Engineering College, V.V Nagar, Gujarat, India.</i>	42-54

6	<b>Entrepreneurial Readiness of Women Students Studying in Indian Technical Institutions</b>  <b>Authors:</b> Ms. Archana M S, <i>Department of Higher Education, Government of Karnataka, Bengaluru.</i> Dr. VijayaKumar, <i>Department of Industrial Engineering and Management, R V College of Engineering, Bengaluru.</i> Dr. M S. Shyamasundar, <i>National Assessment and Accreditation Council, Bengaluru.</i>	55-61
7	<b>Crisis Management Strategies Adopted by Micro and Small Enterprises During the Covid Pandemic</b>  <b>Authors:</b> Dr. S.R.K. Prasad, Dr. John R Raj, Dr. R. Jayanthi and Dr. S. Gokul Kumar, <i>Coimbatore Institute of Technology, Coimbatore</i>	62-81
8	<b>Central Transfers and Fiscal Dependence of States in India – An Analysis of Fiscal Dependency of Assam</b>  <b>Authors:</b> Mr. Santosh Borkakati, <i>Research Scholar, Department of Basic Science and Humanities &amp; Social Sciences, National Institute of Technology, Mizoram, India.</i> Dr. Konthoujam Gyanendra Singh, <i>Associate Professor of Economics, Department of Basic Science and Humanities &amp; Social Sciences, National Institute of Technology, Mizoram, India.</i>	82-94
9	<b>Influence of Small / Niche / Community Banks on the Financial System: An Investigation</b>  <b>Authors:</b> Mr. Joshy Mathew K and Regi Kumar V	95-104
10	<b>Factor Influencing the Investors Behavior towards the Selection of Pension Schemes</b>  <b>Authors:</b> Ms. Anita Taneja, <i>Ph.D. Research Scholar, Lovely Professional University, Phagwara, Punjab.</i> Dr. Mahesh Kumar Sarva, <i>Associate Professor, Lovely Professional University, Phagwara, Punjab.</i>	105
11	<b>A Study On Job Satisfaction Of KSRTC Women Conductors In Kerala With Reference to Kollam District</b>  <b>Author:</b> Abin P Jose, <i>Research Scholar, University Of Kerala, Trivandrum</i>	106-115
12	<b>Invisible Lacunae In Responsible Tourism Management In Kerala</b>  <b>Author:</b> Dr. Satheesh Babu A. T, <i>Assistant Professor, Department of Commerce, Govt. Arts College, Trivandrum, Kerala. India</i>	116-124

**ENGINEERING**

1	<b>A Survey of Extraction Based Approaches on Multi-Documents</b>  <b>Authors:</b> Mr. Pavan Kartheek Rachabathuni , Dept. of Computer Science and Engineering Bapatla Engineering College, Bapatla, India. Mr. Yunus. SK, Dept. of Computer Science and Engineering Bapatla Engineering College, Bapatla, India.	1-10
2	<b>A Review of Video Stabilization Algorithms</b>  <b>Authors:</b> G. Balachandran, Research Scholar, Sathyabama Institute Of Science And Technology, Chennai, India. Dr. J. Venu Gopala Krishnan, Professor, Jeppiaar Engineering College, India.	11-19
3	<b>Biomedical Application of Iron Oxide Nanoparticles: Hyperthermia Cancer Therapy</b>  <b>Authors:</b> Ms. Jayashree K and Dr. Narendra Kumar S, Department of Biotechnology, RVCE, Bangalore, Karnataka, India.	20
4	<b>Efficient Channel State Information (CSI) Estimation Using Deep Learning Techniques for Future Generation High Speed Networks</b>  <b>Author:</b> Ms. Syeda Ayesha Unisa	21-30
5	<b>Novel Utilization and Applications of Rice Husk as Green and Sustainable Biomass</b>  <b>Authors:</b> Shaik Abdul Vaheed, Student, Department of Chemical Engineering, CBIT Engineering College, Gandipet, Hyderabad, Telangana. Sejal Masade, Student, Department of Chemical Engineering, CBIT Engineering College, Gandipet, Hyderabad, Telangana. Dr. Madhuri Pydimalla, Assistant Professor, Department of Chemical Engineering, CBIT Engineering College, Gandipet, Hyderabad, Telangana.	31-41
6	<b>A Review on Chipless RFID Tags</b>  <b>Authors:</b> Akhila Madhav, Sumi M and Harikrishnan A, APJ Abdul Kalam Technological University, NSS Engineering College , NSS Nagar, Akathethara, Kerala.	42-49
7	<b>Biodiesel: Review on Production Techniques &amp; Raw Material Process Economic Aspects</b>  <b>Authors:</b> J. Srinithi, Research Scholar, Department of Chemical Engineering, Coimbatore Institute of Technology, Coimbatore. India. Dr. M. Thirumarimurugan, Professor & Head, Department of Chemical Engineering, Coimbatore Institute of Technology, Coimbatore. India. D. Gokul, Student, Department of Chemical Engineering, Kalasalingam Academy of Research and Education.	50-64

8	<b>Gesture Controlled AI-Robot Using Kinect</b>  <b>Authors:</b> Jayasurya B, Jino Justin, Kharat Pooja C, Mrutyunjay A Hasaraddi and Dr. T. Kavitha, <i>Dept. of Electronics and Communication Engineering, AMC Engineering College, Bengaluru, India.</i>	65-78
9	<b>ECG Watermarking Technique for Telemedicine Applications using Deep Learning</b>  <b>Authors:</b> Busharath PV and Nandakumar Paramparambath, <i>Department of Electronics and Communication Engineering, NSS College of Engineering, Palakkad, Kerala, India.</i>	79-99
10	<b>A Novel Approach to MEMS Based Wideband Energy Harvesting for Sensing Applications</b>  <b>Authors:</b> V. Amirtha Raj, <i>Research Scholar, Electronics and Instrumentation Department, Annamalai University, Tamil Nadu, India.</i> <b>Dr. M. Manivannan</b> , <i>Associate Professor, Electronics and Instrumentation Department, Annamalai University, Tamil Nadu, India.</i>	100-106
11	<b>Development of Toolkits and Checklists for Design of Public Transport Infrastructure – A Case Study of Raichur and Kalburgi Bus Terminal</b>  <b>Authors:</b> Rohan N Ramaiya, <i>Infrastructure Engineering and Technology, B.V.M Engineering College, V.V Nagar, Gujarat, India.</i> <b>Prof. Jagruti Shah</b> , <i>Asst. Prof. Structural Engineering Department, B.V.M Engineering College, V.V Nagar, Gujarat, India.</i>	107-117
12	<b>Stabilization of Soil Using Sewage Sludge as Admixture</b>  <b>Authors:</b> Dr. BindhuLal, <i>Professor, Dept. of Civil &amp; Env. Engg. Birla Institute of Technology, Mesra, Ranchi, Jharkhand, India</i> <b>Ms. Sukeerti Bansal</b> , <i>PG student, Dept. of Civil &amp; Env. Engg. Birla Institute of Technology, Mesra, Ranchi, Jharkhand, India</i>	118-130

# A Study on Online Shopping Behavior of Rural Consumers in Palakkad Taluk

**Dr. S. Kamalasaravanan**

Associate Professor,  
Department of Management Sciences,  
Hindusthan college of Engineering and Technology,  
Coimbatore.

## **Abstract**

Online shopping is a recent phenomenon in electronic commerce and its definitely going to be the future of shopping in the world. It is user friendly compare to in store shopping because consumers can just complete his requirements just with a click of mouse without leaving their home. In this study it is to analyse the online shopping behaviour of rural consumers in Palakkad Taluk. With the advancements in the technology and the changing lifestyle, how it effects the rural consumers were analyzed. The attitude of the consumers, factors that influence, satisfaction of the consumers and the problems facing will be analyzed. A sample of 150 respondents was taken into consideration from rural areas.

**Keywords:** Online Shopping, Rural areas, Factors Influencing.

## **INTRODUCTION**

Online shopping is a form of electronic commerce which allows consumers to directly buy goods or services from a seller over the Internet using a web browser. Consumers find a product of interest by visiting the website of the retailer directly or by searching among alternative vendors using a shopping search engine, which displays the same product's availability and pricing at different e-retailers. As of 2020, customers can shop online using a range of different computers and devices, including desktop computers, laptops, tablet computers, Smartphone's, and smart speakers.

## **STATEMENT OF THE PROBLEM**

Internet has created a revolution in the present scenario. With the advancements in the technology the lifestyle of the peoples had changed. Thus it changed the way consumers shop for goods and services and has rapidly evolved into a global event. Increased use of android phones and internet usage

paved the way for online shopping. The internet is increasingly playing a pervasive factor in ecommerce. Over a short period of time there is a tremendous increase in the online market. Most of the peoples depend on Online Shopping for their regular purchases. Consumers can purchase any goods and services anytime at anywhere. Online shopping is user friendly compared to store shopping because consumers can just complete their requirements just with a click of mouse without leaving their home. The massive ecommerce boon has changed the way urban peoples shop. The majority of the peoples are living in villages than cities. So rural market capacity is wider and larger than urban. Most of the people in urban areas depend on online shopping for their purchase because it is more convenient for them shop in their busy living schedule. The present study is an attempt to determine the online buying behaviour of rural consumers in Palakkad Taluk.

## **OBJECTIVES OF THE STUDY**

- ♦ To identify the rural consumer attitude towards online shopping.
- ♦ To analyze the factors influencing online shopping behaviour in rural areas.
- ♦ To analyse the level of satisfaction of rural consumers towards online shopping.
- ♦ To determine the problems faced by the rural consumers through online shopping.

### RESEARCH METHODOLOGY

Descriptive research design is used for the study to understand and describe the online shopping behaviour of rural consumers in Palakkad Taluk. The rural peoples of palakkad taluk are the population of the study. Sample size of this study is 150. Convenience sampling which is a Non probability sampling is used as sampling technique for the study. In this study questionnaire was prepared to collect primary data. The sources of secondary data for this study were collected from journal articles, research papers, internet sources, website, etc... The statistical tools are used for this analysis are Simple Percentage, ANOVA, Chi-Square, Multiple Regression.

### ANALYSIS AND INTERPRETATION

Majority (59.3%) of respondents are females and 40.7 are male. most (45.3%) of the respondents belong to the age group of 22-27 years, 41.3 % belong to 18-22 years, 8.7% belong to 27-32, 7.7% belong to 32-37 years and remaining 2% belongs above 37 years. majority (88%) of the respondents are unmarried and 12% are married. majority (80.7%) of the respondents belongs to nuclear family and 19.3% belong to joint family. majority (79.3%) of the respondents number of family members belonging to 3-5, 11.3 % belonging to 5-7, 5.3% belonging to 2, 2% belonging to 7-10 and 2% are more than

10. majority (58.7%) of the respondents educational qualification is under graduate, 35.3 % are post graduate, 3.3% are diploma and 2.7% qualification is higher secondary. most (49.3%) of the respondents are students, 37.3% are private employees, 6.7% are self-employed, 4% are others and remaining 2.7% are Government employees. most (48.7%) of the respondents having monthly income below 10000, 32.7 % having 10000-25000, 10% having monthly income of 25000-40000 and 8.7% having above 40000.

Chi-square

### Relationship between gender and preference of online shopping

**Null hypothesis  $H_{01}$ :** There is no significant relationship between gender and preference of online shopping.

P value of price, discounts, seasonal sales, more product range, door step delivery, returnability, time saving, accessibility, payment options and exchange facility is greater than 0.05. Hence null hypothesis is accepted. Therefore there is no significant difference in the factor that influences online shopping in rural areas among different age group of respondents.

### SUGGESTION

There is a need to provide internet facility in rural areas. The availability of internet is the major factor

Mostly the online customers are in the age group of 22- 27, others not having much awareness about online shopping. Most of the respondents are students, other peoples are not much aware about this. so for that people should be given awareness

Almost all the customers prefer the cash on delivery mode to make payment for their shopping but some of



the products are not available in cash on delivery option.

Majority peoples use the apps for their purchase so the features should be made easily accessible to all the peoples.

Most of the people prefer online shopping because they are saving money so the low price and discounts are expected by the consumers. More offers should be provided for the best use of online shopping by the rural consumers.

Peoples are more preferring clothing for their purchase they are not much interested in other categories so attract the buyers to get other categories of things too. So the companies should concentrate on attracting other products too.

Companies are not proving return policy for some of the products so that should be given

Marketers should make efforts to build trust in rural consumers by providing good quality of products.

### CONCLUSION

The present technological development with respect to the internet has given platform to a new marketing system. Online shopping is more and more driven by the ICT infrastructure development, online payment systems and the Internet penetration rate in India .Application of technology has unlocked new ways and opportunities that enable for a more convenient lifestyle today. Online shopping makes the life of the people much easier. These changes made the rural peoples to change their buying habits. Just sitting at home all the wanted things will be on your hand that was the reason for the growth of the online companies. The barriers that stop the consumers from indulging in online purchasing are also different for different sets of consumers. This study brought to the fact that most of the online customers

are educated people and students who have a positive perception towards online shopping. Low price offered by online companies motivates the rural customers to buy online and by this they are saving money. Rural consumers are satisfied with this. The goal is not to convert all shoppers to online purchasing, but to show them it's an extraordinary option. Gone were the days when a rural consumer had to go to a nearby town or city to buy a branded product.

### REFERENCES

- JHA, M. (2013). A Study on The Rural Consumer Buying Behaviour In Bihar. *International Journal of Marketing, Financial Services & Management Research* , 175.
- Alamuri Megha Gupta, S. R. (2015). Rural Consumers of E-Retailing in India. *Paridnya - The MIBM Research Journal* , 11-12.
- Chiru, P. R. (2017). Consumer Behaviour in Rural Market: A Study on Buying Behaviour of Rural Consumers in Manipur. *International Journal of Contemporary Research and Review* , 1-2.
- Fenin Samuel. S, K. A. (2016). Online shopping - a strategy need for rural customer. *Journal of Chemical and Pharmaceutical Sciences* , 2082.
- K.Jayaprakash,Dr. N.Balakrishnan, C.Sivaraj. (2016). FACTORS INFLUENCING THE BUYING BEHAVIOUR OF ONLINE RURAL CONSUMER IN POLLACHI. *International Journal of Management and Social Science Research Review* , 2-3.
- Kanwal Gurleen,Varun Nayyar, Ajwinder Dhillon. (2014). A Study on Purchase Behavior of Rural Consumers of Jalandhar. *Journal of Research in Marketing* , 286-287.

- Mohammad Anisur Rahman, M. A. (2018). Consumer buying behavior towards online shopping: An empirical study on Dhaka city, Bangladesh. 2-3.
- Pathan, Z. (2019). Rural Consumer Behavior Towards Online Shopping In Vadodara District. *International Journal of Management, Technology and Engineering* , 1929-1930.
- R.Sureshkumar. (2017). Rural Consumer Attitude Towards Online Shopping: An Empirical Study of Rural Area. *International Journal of Innovative Research in Management Studies*, 3-4.
- Velayudhan, S. K. (2019). Factors influencing online shopping in rural India: A review. 2

**Table showing Demographic of the respondents**

<b>Gender</b>	<b>Frequency</b>	<b>Percentage</b>
Male	61	40.7
Female	89	59.3
Total	150	100.0
<b>Age</b>	<b>Frequency</b>	<b>Percentage</b>
18-22	62	41.3
22-27	68	45.3
27-32	13	8.7
32-37	4	2.7
37 above	3	2.0
Total	150	100.0
<b>Marital status</b>	<b>Frequency</b>	<b>Percentage</b>
Married	18	12.0
Unmarried	132	88.0
Total	150	100.0
<b>Type of family</b>	<b>Frequency</b>	<b>Percentage</b>
Nuclear family	121	80.7
Joint family	29	19.3
Total	150	100.0
<b>No of members in family</b>	<b>Frequency</b>	<b>Percentage</b>
2	8	5.3
3-5	119	79.3
5-7	17	11.3
7-10	3	2.0
Above 10	3	2.0
Total	150	100.0
<b>Educational qualification</b>	<b>Frequency</b>	<b>Percentage</b>
Higher secondary	4	2.7
Diploma	5	3.3
Under Graduate	88	58.7
Post Graduate	53	35.3
Total	150	100.0
<b>Occupation</b>	<b>Frequency</b>	<b>Percentage</b>
Student	74	49.3
Self employed	10	6.7
Government employee	4	2.7
Private employee	56	37.3
Others	6	4.0
Total	150	100.0
<b>Monthly income of family</b>	<b>Frequency</b>	<b>Percentage</b>
Up to 10000	73	48.7
10000- 25000	49	32.7
25000- 40000	15	10.0
Above 40,000	13	8.7
Total	150	100.0

*Source-primary data*

**Gender \* Do you prefer Online shopping for your purchase?**  
**Crosstabulation**

			Do you prefer Online shopping for your purchase?		Total
			yes	no	
Gender	Male	Count	57	4	61
		Expected Count	56.1	4.9	61.0
		% within Gender	93.4%	6.6%	100.0%
	Female	Count	81	8	89
		Expected Count	81.9	7.1	89.0
		% within Gender	91.0%	9.0%	100.0%
Total	Count		138	12	150
	Expected Count		138.0	12.0	150.0
	% within Gender		92.0%	8.0%	100.0%

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.291 <sup>a</sup>	1	.590
Likelihood Ratio	.297	1	.586
Linear-by-Linear Association	.289	1	.591
N of Valid Cases	150		

It is interpreted that P value is 0.590 which is greater than 0.05. Hence null hypothesis is accepted. Hence there is no significant relationship between gender and preference of online shopping.

**ANOVA**

		Sum of Squares	df	Mean Square	F	Sig.
factors that influence Online shopping[Price]	Between Groups	.078	1	.078	.161	.689
	Within Groups	71.762	148	.485		
	Total	71.840	149			
factors that influence Online shopping [Discounts]	Between Groups	.116	1	.116	.194	.660
	Within Groups	88.657	148	.599		
	Total	88.773	149			
factors that influence Online shopping [Seasonal sales]	Between Groups	.566	1	.566	1.052	.307
	Within Groups	79.627	148	.538		
	Total	80.193	149			
factors that influence Online shopping[More product Range]	Between Groups	1.283	1	1.283	2.541	.113
	Within Groups	74.691	148	.505		
	Total	75.973	149			
factors that influence Online shopping[Door step delivery]	Between Groups	.546	1	.546	.827	.365
	Within Groups	97.727	148	.660		
	Total	98.273	149			
factors that influence Online shopping [Returnability]	Between Groups	.871	1	.871	1.172	.281
	Within Groups	109.903	148	.743		
	Total	110.773	149			
factors that influence Online shopping[Time saving]	Between Groups	1.393	1	1.393	1.745	.189
	Within Groups	118.107	148	.798		
	Total	119.500	149			
Factors that influence Online shopping? [Accessibility]	Between Groups	.906	1	.906	1.180	.279
	Within Groups	113.687	148	.768		
	Total	114.593	149			
factors that influence Online shopping [Payment options]	Between Groups	1.053	1	1.053	1.918	.168
	Within Groups	81.240	148	.549		
	Total	82.293	149			
factors that influence Online shopping [Exchange facility]	Between Groups	1.616	1	1.616	2.921	.090
	Within Groups	81.858	148	.553		
	Total	83.473	149			

*Source-primary data*

# The Study of the Continuous and Comprehensive Evaluation in the Schools

**B Srinivas Rao**  
Research Scholar  
Krishna University  
Machillipatnam

## Abstract

**Objectives:** Since Continuous and Comprehensive Evaluation-CCE is a school based assessment model the respondent selected are teachers who are Post Graduate Teachers and Trained Graduate Teachers (500) all working in the residential pattern. The environment to assess the implementation of the CCE will be very apt and the respondents and the students spent together a large chunk of their time teaching and learning.

The schools are flooded with the service offers by various organisations to both the Government and private entities in the state. The offer have more commercial benefit to the service provider than the support solution for the benefit to the end users which always has a bottleneck for both to consider services offered for the benefit of the students in large and the teachers to certain extent. Most of the services are very superficial and blissfully non accountable. The services are not apt to the need of the organisations for their long term development.

**Research Approach/Methodology:** Here I am using combination of both the Questionnaire and Schedules for the proper elicits from the respondents. The coverage of the geographical area of my study is the twin cities of Hyderabad. The Descriptive research methodology, adapted in my research study. The data collection is of both the qualitative and quantitative for the holistic understanding of the study.

The fixed mind-set (Match education centre, Boston), the competency, belongingness, loyalty, professionalism and no social quotient in the teachers fraternity leads to the ignorance and non-compliance with one's own ability and talent to contribute towards to the social progress (Ellen Johnson Sirleaf-a Nobel laureate, 2011).

The Continuous & Comprehensive Evaluation –CCE, designed by the then MHRD has certain discrepancies as follows:

The application of the model in the higher grades in the schools.

The bandwidth for the micro level understanding was lacking in the teams of the SCERT and NCERT in the country.

There were no pre-exposure and training to the executors at their level.

There was no mechanism for the assessment of the performance of the teachers in the program.

There was no bait for the teachers executors to take up for the benefit of the students in their schools along with their existing work load.

There was no hand-holding procedures at the local level for the teachers in the schools either by the SCERT or NCERT or even by the private companies.

There was no partnership among the public and the private organizations in the country.

There was no R&D for the inclusion and practices of the Formative assessment tools and techniques in the classroom environment.

The curriculum was not integrated with the changes brought by the CCE in the system.

The time management was the major challenge among the teacher fraternity.

The size of the syllabus was threat for the executors of the CCE in the schools for the qualitative teachings.

The obsolete teacher training program: the B.Ed. and The M.Ed.

The teachers in the schools are engaged more in the non-productive activities.

The private sector contribution in the field of education has following anomalies:

A profit making proposition a challenge for the many small and big companies.

This service sector has long gestation period for getting the order and in the course of successful implementation.

The companies cannot be event partners in the schools rather they need to be process partner.

The proper choices of the HR in the planning, preparation and execution in the companies for the schools services. The companies like Educomp, Teach next, Vriti-infocom, and to name more had to fight for their survival and few of them closed completely or partially.

The services has very high attrition rate of employees because of the non-strategic and non-scientific Profit and loss account by the companies.

The services are sold as a product with no proper AMC.

The keywords: Continuous and Comprehensive Evaluation, the Scholastic and co-scholastic, assessment, Formative assessment and summative assessment, tools and techniques, belongingness, social quotient. **The finding and the implications:**

The teachers working are females (81%)

The awareness of the CCE (80%)

The awareness of the CCE component (74%)

Exclusively aware of the Formative assessment tools and Formative assessment techniques/

The selection of the tools (24.4%) and techniques' (24.2%) by the teachers in their teaching is miserably very low. It means that the teachers are not competent to implement them in the class for the benefit of the student even after they are all aware of. Secondly the teachers who have implemented few selected tools and techniques which were either easy (intact not formative in nature) or for their easy evaluation and record.

The selection of the life skills (29.4%) by the teachers in their classes is miserably very low. It means that the teachers are not competent to implement them in the class for the benefit of the student even after they are all aware (majorly) of it and its impact on the major stake holders.

The subtle difference between the tools and techniques and life skills was the major issue among the teachers' fraternity.

The responses with the regard of no objection (85.6%) for Formative assessment tools usage, objection (in the regular teaching practices were another strong evidence of the competency to be the reason for non-implementation.

The CCE motives of holistic and analytical development among the students will be only the dream and cannot be displayed for the betterment of the economy of the country.

The teacher's skills and its development are not dynamic in nature with the changing requirements and they cannot create the future citizens which is the major challenge for all of us.

The teachers who are the makers of the nation so they are bound to be a good implementers.

The students are not acquiring the 21<sup>st</sup> century skills which are very mandatory and essential for the future needs of the economic development.

The 21<sup>st</sup> century skills includes 4Cs-

Creativity.

Communication.

Critical thinking.

Collaboration.

The CCE has the provisions to address these skills strategically and scientifically. But the non-compliance in the implementation due to the competency in the part of the part of the teachers has led the nations to a different and uncertain path.

My suggested framework-Fig1 for the schools: My model has four different characteristics addressed for the easy understanding of the application of the various activities mentioned in the model. They are:

Concept/Content development with technological fusion. Adoption of the CCE in the schools with in its true spirit. The proper balance of all the major components like the Scholastic, Co-scholastic and Co-curricular activities in the day to day schedules of the schools.

The Formative assessments and the Summative assessments along with the co-scholastic and the co-curricular scores needed to be fed in the predesigned report card for the generation of the grades of the students.

The Higher order thinking items need to be developed and uploaded for the better use of the teachers in their lesson plans for the better learning with understanding. These will actually renders the privilege for the going of the teaching

and assessment hand-in-hand for the teachers on the classroom management.

There are many times tested innovative pedagogies been practiced by the schools and the organisation across the world with recorded evidences of their effective implementation. Like the:

Hakuta, Zwiers, Rutherford-Quach, Constructive Classroom Conversations MOOC-2013 – Fig2.

The Frayers model a tool for the assessment of the learnings of the students in the class irrespective of the grade and the subject- Fig3.1,3.2&3.3

The Question making digital platform for the teachers to participate and get assessed.

Online / offline support for the Teacher development program. IHP program can be done for their development. The program is 1hour program-1HP. It has two components:

Tentative topic

Felicitation of the Performer of the Precious 1HP.Seminars/Workshop/Training/literature study.

Objection handling in the classroom. Contribution of the we

Addressing the slow-learners and its mode.

Procedures of conduction. Each teacher can present for 15 minutes and 5 minutes of review –PASA Three Teachers every week. Principal/ School coordinator will decide the participants in TP a week ahead. PASA will be adapted in the assessment of the performance in TP.

Minutes will be written and recorded for the managerial helpThe School coordinator will be responsible for the smooth conduction of the 2HP in every respective Branch.



Best performer of the day will be awarded and felicitated by Principal. In the next wk.

The best performance likely be aired on Web/You-tube for easy access. This will be conducted every Saturday.

It is a much personalised time of the teachers for their development only.

The teachers can decide the non-participation of their Principal as it is their own personal time.

Summarize the concept learnt for the benefit of the forum.

Can distribute the hand-outs on the TP can be conducted both offline and online Presentation.

The 1HP Rubrics is explained in the Fig4.

Continuous (round the year) teacher training programs with the combination of the offline and online with the better needed blend of the modes. The topics of the training will both general for all and need based training demanded by the teachers as and when. The inclusion of the Virtual Conferences, Workshops, You-tube, webinars both the national and international platforms like Swayam, Noved, Coursera and other.

The backbone of the entire education domain is its appraisal mechanism, which ensures the development of the teachers and the schools. The inclusion of the tributary curriculum into the system like:

Field trip Program-FTP: It is meant for the fusion of both the fun and the learning together with small size and focused area of concept based of the class and the subject. Easy to manage and monitor the learning with proper supported document – templates. The FTPs are the eye-catching for the students who are highly kinaesthetic and shirkers. The most formal way of grooming the boys for the main streamline

Community Development Program-CDP: A very formal way to introduce to the vicinity and the global village. The means to improve the social quotient which is now very essential even beyond the IQ and EQ.

Art and craft manual: a strategic fusion of the science and arts into the classroom and all other learning avenues for learning with understanding.

Happiness Curriculum: Exercise to develop the values and the ethics to complete the holistic learning with the knowledge and the skills.

Entrepreneurial mindset: It is mainly focusing the mindset, values and ethics for being the entrepreneurs.

The rotational teaching classes by conducting one hour periods as against the traditional 45mins. The advantage is the probability of getting connected with the students is very high. The learning with understating will likely happen among the students. The teachers are in the position to go hand-in-hand both the teaching and assessment. In the next year academic year the length of the periods will be one and a half hour each.

Focus on the stake holder like the teachers and the students.

The professional application of the CCE in the schools by the teachers. Execution of the support models for the better performance of the student Learning circles of both the teachers and the students jointly.

Item making competition among the teachers and the student separately for the development of pool of quality items. Here the items will be basically the Higher Order Thinking –HOTs.

The outreach programs for the students for better hands on and application based learning. Here are some included manuals like the: Field trip programs – FTP, for all the classes and all

the subject (chapter and topic specific). It will have small unit with certain frequency visits (3 per class for all subjects) based on the criticality of the subject and the class. The FTPs includes the fun and the learning both balanced with formats and the templates for the recording and sharing by the students to the concerned subject teachers.

The another outreach program is the Community Development –CDP, for all social connect with the social issues directly to the society is the objective along with the hands on learning of the thought processes among the people and educating them where ever there is a gap of understanding. The connect is in the local language for the easy understating of the target audiences.

The principals, teachers and Junior Lecturers need to get appraised by the designed model-Fig5 with the pre-decided periodicals for the better understanding of the progress of the faculties. The performance has 360degree approach to the needs of the teachers and the teaching both. The exercise is robust and comprehensive achieving the highest modern standards for the present day need in connivance with the NEP 2020.

Additional and Deliverables

Books, Magazines

Videos

Expert Professional talk

Portfolio creation of all in the school campus.

Distractors.

Subordination

Non-productive activities by the teaching staff.

Curriculum rigidity

## REFERENCES

**Agrawal (2005)** Examination reform initiatives in India, Journal of Indian Education, Vol31, No1, pp27-35

Brooks, What future for education? and <https://www.coursera.org/learn/future-education>

Brown, Macbath, keegan, Foundations of Teaching for Learning: Introduction to Student Assessment Course and <https://www.coursera.org/learn/learning-assessment>

**Burserk et al., (1996)** Report card Grading and Adaptations: A national survey of Classroom Practices. Research report derived from [www.eric.ed.gov](http://www.eric.ed.gov)

Cope and Kalantzis, New Learning: Principles and Patterns of Pedagogy and <https://www.coursera.org/learn/newlearning/home/welcome>

Dixon , shewell, Cinco, Teach English Now and language-theories and <https://www.coursera.org/learn/language-theories/home/welcome>

Dixon , shewell, Cinco, Teach English Now Lesson Design and Assessment and <https://www.coursera.org/learn/lesson-design>

Fawaz, Townsend, Macbeth, Foundations of Teaching for Learning: Developing Relationships and <https://www.coursera.org/learn/teacher-relationships>

Gossmann, Barkar, Orchestrating Whole Classroom Discussion and <https://www.coursera.org/learn/classdiscussion/home/welcome>

Greenberg, Schwartz, Horne, Blended Learning: Personalizing Education for Students and <https://www.coursera.org/learn/blended-learning>

Griffin, Assessment and Teaching of 21st Century Skills and <https://www.coursera.org/learn/atc21s>

- Hakuta, Rutherford, Zwiers, Constructive Classroom Conversation, Coursera and [https://learn.stanford.edu/OA-CCC-Content-Article-2019-02-16\\_LP-Article.html](https://learn.stanford.edu/OA-CCC-Content-Article-2019-02-16_LP-Article.html)
- Helbert, Kaser, Macbeth, Foundations of Teaching for Learning: Planning for Teaching and Learning and <https://www.coursera.org/learn/teaching-planLeen>, teaching-character and positive classroom and <https://www.coursera.org/learn/teaching-character>
- Heyck-Merlin, How to be a together teacher and <https://www.coursera.org/learn/together-teacher>
- Jadal MM (2011)** Effect of continuous comprehensive evaluation on the students' attainment at primary level. International Referred Research Journal, September 2011Vol III\*issue-32.
- Kandelwal B.P.(2002)** "Examination and Test Systems at School Level in India". Their impact on institutional Quality Improvement'.pp100-115.
- Keegan, Brown, Macbeth, Foundations of Teaching for Learning: Introduction to Student Assessment <https://www.coursera.org/learn/learning-assessment/home/welcome>
- Lokey-vega, Cope, K-12 Blended & Online Learning and <https://www.coursera.org/learn/k-12-online-education/home/welcome>
- Macbeth, Foundations of Teaching for Learning: Being a Professional, Coursera and <https://www.coursera.org/learn/professional-teacher>
- Malakolunthu, Macbeth, Foundations of Teaching for Learning: Curriculum and <https://www.coursera.org/learn/teacher-curriculum/home/welcome>
- Moir, Kepp, teaching-elementary and <https://www.coursera.org/learn/teaching-elementary>
- Moir, Kepp, teaching-secondary and <https://www.coursera.org/learn/teaching-secondary>
- NCERT (2004)** "Evaluation Practices-Across the states (NB F23997, Unpublished), New Delhi, India, Kumar, Gautam, Pandit and Chandra.
- NCF (2005)** CCE has more careful thinking through about when it is employed in a system
- Osborne -Reading to learn, Coursera and <https://online.stanford.edu/courses/gse-y0026-reading-learn-science>
- Pooja Sehgal (2005)** Continuous and Comprehensive Evaluation- A study of the teachers' perception. Vol.13 No.1 January-June 2012.
- Rao P.M. (2006)** "Impact of Training in CCE on the Evaluation Practices of Teachers of Primary Schools in TN". Indian Educational Review. Vol.42No.1 (Jan 2010), pp.60-78
- Rosenstock, Wise, Yurich, how-to-teach-us and <https://www.coursera.org/learn/how-to-teach-us/home/welcome>
- Santos, The Science of Well-Being and <https://www.coursera.org/learn/the-science-of-well-being/home/welcome>
- Seidel, Successful Negotiation: Essential Strategies and Skills and <https://www.coursera.org/learn/negotiation-skills>
- Stoelinga, Critical Issues in Urban Education and <https://www.coursera.org/learn/urban-education>

## My suggested Framework

Fig 1

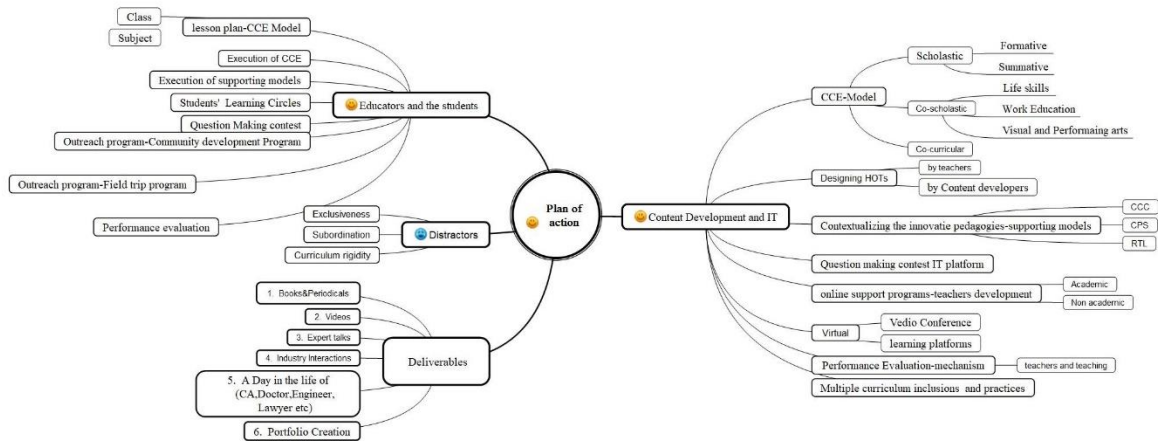
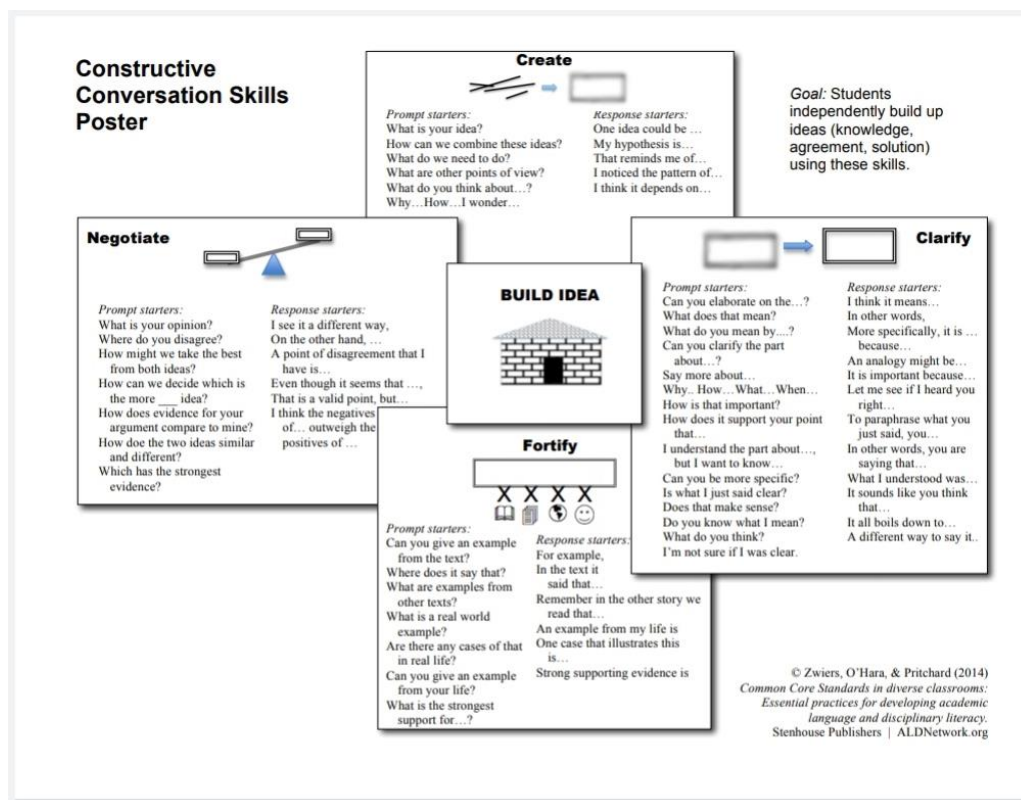
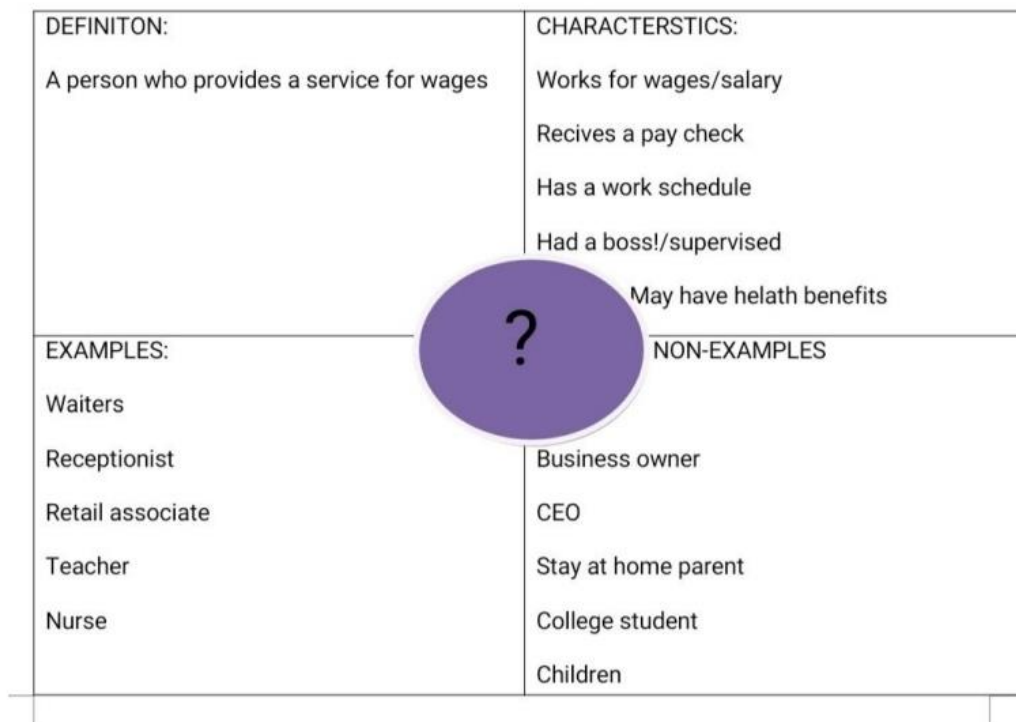


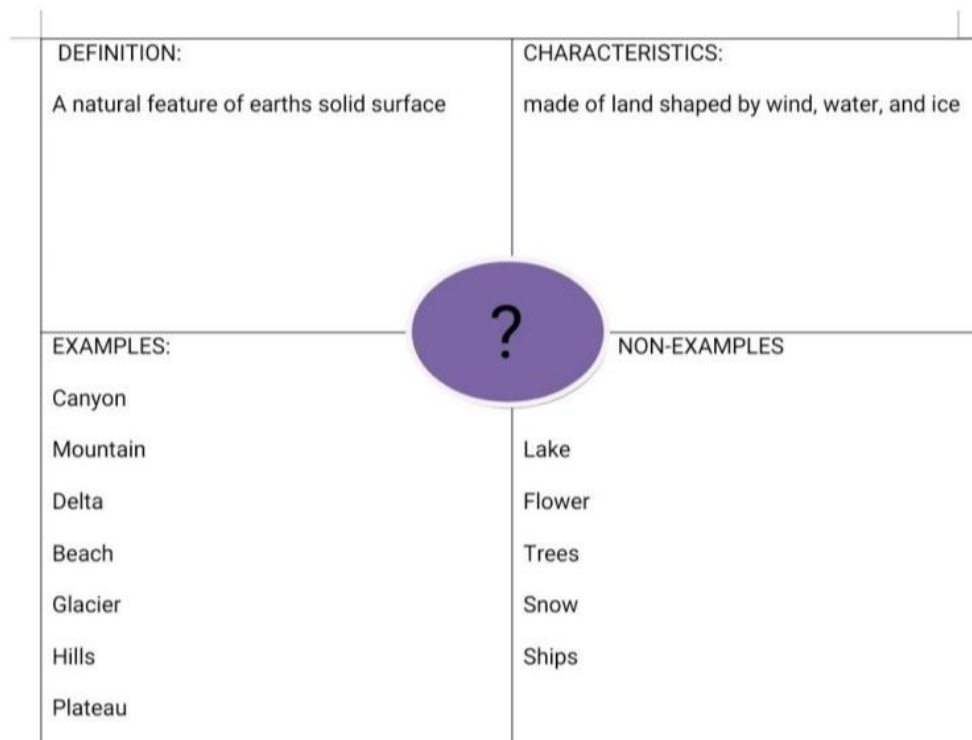
Fig 2



Frayers Model – Fig 3.1-Answer=Employer



Frayers Model – Fig 3.2-Answer Landform



## Frayers Model – Fig 3.3-Answer Law

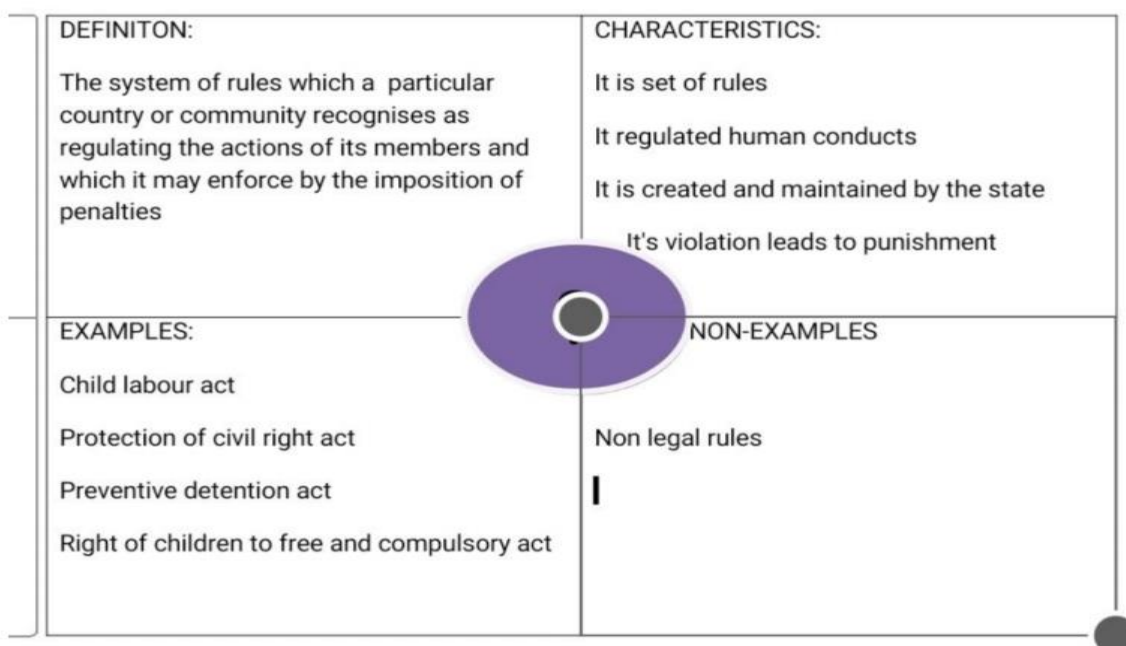


Fig 4

Name of the Teacher/HM/Principal:-----

Name of the Branch:-----

PART A-TEACHER PRESENTATION		1	2	3	4	5
1	The presentation of the content					
2	Effective Communication					
3	Interpretation of the Data					
4	Body language					
5	Outcome of the Study					

Question1-----

Name of the teacher: -----

Branch:-----

PART B – QUESTION HOUR		1	2	3	4	5
1	The quality of question					
2	Turns were ethical					
3	Turns were interconnected					
4	Turns within the topic					
5	Outcome of the debate					
	Sub total					

Fig 5



# Influence of Intellectual Capital on Financial Performance; Evidence from Listed Real Estate and Consumer Service PLCs in Sri Lanka

**N.C. Wickramaarachchi**

Department of Estate Management and Valuation,  
Faculty of Management Studies and Commerce,  
University of Sri Jayewardenepura,  
Gangodawila, Nugegoda,  
Sri Lanka

**B.K. Nelumika**

Department of Estate Management and Valuation,  
Faculty of Management Studies and Commerce,  
University of Sri Jayewardenepura,  
Gangodawila, Nugegoda,  
Sri Lanka

## Abstract

Insights into the intellectual capital (IC) on financial performance is relatively a modern phenomenon, attracts the interest of global researchers. Though famous in the banking and communication sectors, little evidence finds in Real Estate and the Consumer Service Sectors. This study focuses to assess the relationship between IC and financial performance (FP) of 46 Real Estate and Consumer Service PLCs listed in Colombo Stock Exchange, Sri Lanka, during 2015 - 2018. Secondary data from annual reports of the companies on IC represent the Value-Added Intellectual Capital (VAIC) model with its three major components. Return on Assets and Return on Equity were used to represent the FP. Results revealed that VAIC has a positive relationship with FP of all above 46 PLCs, showing a significant positive impact between CEE and FP. Recommends, more investments in IC associated activities, ensuring better performance where moderate and weak relationships exist.

**Keywords:** Intellectual Capital, Value Added Intellectual coefficient, Financial Performance Real Estate, Consumer services, Listed Companies, Sri Lanka.

**Reference** to this paper should be made as follows: N.C. Wickramaarachchi and B.K. Nelumika, (xxxx) 'Influence of Intellectual Capital on Financial Performance; Evidence from Listed Real Estate and Consumer Service PLCs in Sri Lanka',

**Biographical notes:** Dr Nishani Champika Wickramaarachchi is a Senior Lecturer at the Department of Estate Management and Valuation, Faculty of Management Studies and Commerce, University of Sri Jayewardenepura, Sri Lanka, with over 25 years of experience in teaching to Undergraduates and Postgraduates and supervising research. She holds a PhD in Economics Her research interest lies on Land Economics, Property Valuation and financing, Environment and Sustainability.

## INTRODUCTION

Research on the financial performance of companies gained the momentum of relying on the value of 'knowledge assets' being recognized as a vital resource. Current outcomes of most companies are based on knowledge-intensive activities and depend on intellectual capabilities captured in intellectual capital (IC). Several scholars have characterized IC in different terms such as knowledge assets, intangible assets, and intellectual assets based on how it contributes to optimizing value development productivity in a knowledge-based economy. Though in the absence

of a single definition, the term IC in literature has been identified as a set of non-financial assets including knowledge, human capital, and structural capital. Edvinsson (1997) preciously indicated that IC has many elements and can be summarized as the appreciation of that collective human and structural assets which have a knowledge as a component. It involves off-balance-sheet values and is a search for relationships among people, ideas, and knowledge. Hence, IC is a 'relationship issue' and not a thing or an objective.

Being intangible IC is not directly reported on a company's balance sheet



but plays a major role in value formation, with organizations in knowledge-based economies relying on knowledge assets rather than physical assets to improve their strategic advantages. Several organizations use the methods of training, research, and development to improve workforce skills. They have put money into consumer and seller relationships, as well as technology and data networks. Such actions, dubbed "intellectual capital investments." This change in investment behavior can be attributed to a growing focus on knowledge-based economies (Stewart, 2002; Zeghal and Maaloul, 2010).

The main argument that why IC is important in investment decisions, proved that the difference between the book value and the market value of a company is derived by the company's IC (Ousama et al., 2020). However, direct measuring was the challenge, faced by the traditional accounting methods. Traditional accounting practices will no longer be able to assess company output, in the knowledge-based socioeconomic era, where intellectual capital has become one of the development variables (Berzkalne and Zelgalve, 2014; Gan and Saleh, 2008). Therefore, there is an increasing need to implement innovative approaches that consider both intellectual and physical resources.

The financial sector is one of the most apposite areas for reviewing and exploring IC due to the financial industry's service and intellectual nature, which places a greater emphasis on expertise and employee skills than on financial and physical resources. Furthermore, this financial sector is well-known for its reliable data (Chang, 2013). Recent research in fields like banking, industrial, and communication are adopting Pulic's Value Added Intellectual Coefficient (VAIC) model to examine the relationship between intellectual capital and financial performance (Pulic, 2000; Ercan et al.,

2003; Pulic, 2004; Chen et al., 2005; Mondal and Ghosh, 2012; Joshi et al., 2013; Yalama, 2013) although there is little evidence in the Real Estate Sector. This approach aims to measure the effectiveness of key resources within the organization which comprehended three aspects of IC as Human Capital Efficiency (HCE), Structural Capital Efficiency (SCE), and Capital Employed Efficiency (CEE). Pulic views, the traditional accounting centered on cost control, whereas a higher profile analysis of the value creation method is required. To manage the interest, he points out; it must come under the valuation. VAIC model is used income statement and balance sheet values to determine if any value-added occurs in a firm that can be attributed to increasing its IC growth. It is expected that the VAIC metric will be designed in such a way that it would satisfy these criteria and measure the effectiveness of key resources within the organization.

Colombo Stock Exchange (CSE) in Sri Lanka maintains the registration of companies where there are limited numbers of companies already registered. These listed companies mostly reported the intellectual capital disclosure activities under the intangible assets in annual reports. On similar grounds with other countries, the company's financial statements do not show the actual image of the company's knowledge assets and the contribution to overall performance. Therefore, the finding of the study is mostly imperious for all stakeholders who are interested in companies' financial and non-financial details. Researchers have undergone with the IC performance identifying research in sectors like banking and communication in Sri Lanka, thus indicate an absence in Real Estate and Service sectors. Not knowing the importance of IC as a value creation resource, some companies may not be harnessing it yet with inadequate research findings in the said field. A typical example

from recent research in Turkish, where Nassar (2018) agreed that VAIC of Turkish Real Estate Companies shows a considerable association with the financial performance, yet poorly used the IC to capture more value. Considering the importance and requirement for valuation of IC in the Real Estate and Consumer Service companies, this study contributes to the valuation and comparison of the value-added intellectual coefficient (VAIC) of listed real estate and customer service companies in Sri Lanka. Hence the main objective of this research is to assess the relationship between IC and the financial performance of Real Estate and Consumer Service PLCs listed in CSE. The findings will support the interested parties of the companies both internal and external in providing them with knowledge for understanding and evaluating their performance, self-benchmarking, and enhancing their IC performance.

## **LITERATURE REVIEW**

### **Intellectual Capital**

In 1969, Jon Kenneth Galbraith was the one who introduced the concept of Intellectual Capital (IC) (Khalique et al., 2011). Even though it has been around for a long time, there is no agreement of an accurate definition to define IC yet. The vast majority of meanings are focused on common principles such as employee information, expertise, interactions, abilities, customer and employee engagement and satisfaction, company credibility, organizational processes and practices, organizational cultures, and value development (Davenport and Prusak, 1997; Nick Bontis, 2000; Ghosh and Mondal, 2009; Lu et al., 2014). According to Hall (1992) described that IC is the variety of contemporary value drivers successful in turning enterprise capital into extra-tangible belongings of value (Bontis, 2000; Yalama and Coskun, 2007). Similarly, IC is defined as the non-reported asset that can be used as a

strategic edge and to increase the company's potential valuation (Joshi et al., 2010; Mondal and Ghosh, 2012). Most concepts rely on how businesses successfully leverage information (intangible sources) to improve their competitive advantage or maximize the value of the firm.

As mentioned previously, the researchers have not settled on the components of intellectual capital and there is not a consensus in the literature on how to define intellectual capital. Nonetheless, it is generally accepted that intellectual capital is made up of three elements: viz., relation/ customer capital, structural capital, and human capital. The relational capital is defined Sveiby (1997) as "Customer and Supplier relationships". The main theme of relational capital is the knowledge embedded in the marketing channels and customer relationships that an organization develops through the course of conducting business which will decorate its competitive advantage (Bontis et al., 2000) Relational capital is related to an entity and its connection to external elements such as clients, resource suppliers, banks and shareholders. In other words, relational capital is an organization's capacity with its external stakeholders to build relational interest. Organizations benefit multiples by building partnership resources, such as customer and brand loyalty, customer satisfaction, market recognition and reputation, bargaining leverage, strategic alliances, and coalitions. But creating relational capital is not just necessary. The effective organization, too, should be able to keep its emotional capital.

There is no longer a good deal consensus on the definition of structural capital. Meanwhile, Ghosh and Mondal (2009) argued that structural capital is the infrastructure of human capital and consists of buildings, hardware, software, processes, patents, and trademarks. Consequently, in 2010, structural capital is

defined as patents, ideas, models, and administrative and computer systems (Diez et al., 2010). Further contributing to the views of Ghosh and Mondal (2009) and Diez et al., (2010) further claimed that structural capital will comprise internal factors like infrastructure, processes, and business culture, and at a comparable time. It is this capability that enhances the ability of employees but is not related to individual-level employees. In line with the definitions established above, generally, structural capital consists of all the non-human storehouses of knowledge in organizations that include the databases, organizational charts, process manuals, strategies, routines, and anything whose value to the organization is greater than its material value. Sveiby (1997) describes that human capital as "the ability to act in a wide range of situations to build tangible as well as intangible assets". It represents the employees' skills and knowledge which can be further improved with the aid of the training. Human capital may be restricted to micro (individual) (e.g. personal qualities, technical skills, and creativity) or macro (organizational) levels (e.g., teamwork, healthy work environment) (Joshi et al., 2013; Mondal and Ghosh, 2012). Hence, human capital is the most significant asset of a company and a source of innovation and strategic renewal which benefited as technical failures, risk-taking, and problem-solving.

### **Measuring IC in a Different Context**

Pulic (2000) published the first analytical analysis of intellectual capital, which looked at the impact of IC on firm results while developed an approach called "Value Added Intellectual Capital" (VAIC) for measuring IC and company financial results using accounting tools. It has paved the way for researchers from all over the world to assess IC productivity in a variety of fields. In the Malaysian Context, Bontis et al., (2000) studied the impact of accounting IC components (HC, SC, and RC) on the efficiency of

Malaysian service and non-service firms. They exposed the positive impact of HC and relational capital on the service sector. In the south Asian context, Kamath (2008) found that human capital had a key impact on Pharmaceutical companies' competitiveness and financial performance in India. Similarly, Makki et al., (2008) analysed the company facts from the Lahore Stock Exchange (Pakistan) for six years and found that companies in the oil and gas, chemical, and cement sectors had the best IC performance, while the performance of the banking sector was average, and public sector firms had the best IC performance. Again the Malaysian Context, Bontis et al., (2010) examined the relation between IC and financial performance in Malaysian industries and confirmed the positive impact of IC within two industry sectors. Simultaneously, Tan et al., (2010) analysed 150 companies listed on the Singapore Stock Exchange and found that the success of a company had a positive relationship with the magnitude of IC with the growth rate of the IC. IC's contribution to the success of a company was also varied by type of industry. Again, in the South Asian Context, Pal and Soriya (2012) researched pharmaceutical and textile companies in India and concluded that there was a positive association between IC and business profitability. Thus, Chang (2013) found that the impact of intellectual capital on financial performance is directly / indirectly positive while results by Lu et al., (2014) presented that the relationship between Intellectual Capital and the company's performance was positive and significant. Later more studies by Muhammad and Ismail (2014) in Malaysia observed the effect of IC efficiency on financial sector performance. The grades indicated that the banking sector depends more on intellectual capital than on the brokerage business and the insurance industry. The results also exposed a significant positive

association between IC and Return on Asset (ROA). The study also highlighted that, in creating market value, the Malaysian financial sector relies more on financial and physical capital than on intellectual capital. Therefore, the VAIC model has been developed and continued in a variety of studies to investigate the effect of intellectual capital on firm results all over the world.

Accordingly, the present study will be analysed the relationship between the efficiency of intellectual capital and financial performance of real estate PLCs and consumer service PLCs in Colombo stock exchange in Sri Lanka, VAIC and its components (CEE, HCE, and SCE) are used as indicators of intellectual capital and Return on assets (ROA) and return on equity (ROE) are seen as indicators of financial efficiency. Many findings in the literature claim that financial performance metrics and VAIC have a positive relationship. However, there is an on-going discussion about which VAIC components boost financial institution efficiency as per the different contexts. Therefore, this study explores the understanding regarding the relationships between IC and financial performance of Sri Lankan leading listed companies of real estate and customer service sector.

## **METHODS**

### **Population and Sample**

A total of 289 companies (banking, real estate, customer service, hotels, healthcare, etc.), were registered in the Colombo Stock Exchange (CSE) from 2015 to 2018. Amongst the study was selected all real estate (27) and consumer service (19) companies to fulfill the research aim. The selection of all listed real estate and consumer service companies in CSE is to ensure that this study will reflect the reality because the number of listed companies is considered small parallel to other stock markets. Therefore, the total sample consists of 46

companies per year for four years (2015 - 2018).

## **DATA AND METHOD OF ANALYSIS**

Preferably, the study selects the VAIC model as the most appropriate method to identify the relationship between intellectual capital (IC) and financial performance (FP) while measurement was conducted using a quantitative approach. Thus, descriptive statistics and inferential statistics whereas correlation and regression models were deployed to explore an overall picture in quantitative terms. Based on VAIC components, the data was obtained from secondary sources i.e. from the annual reports of the selected listed companies for a period of four (04) years representing 2015-2018.

### **Value Added Intellectual Capital (VAIC Model)**

The VAIC Model is an intellectual capital (IC) quantifiable measuring tool that is mainly used to measure the relationship between intellectual capital and financial performance. In 1998, Ante Pulic has developed the VAIC model. The initial studies were based on the relationship between intellectual capital and monetary indicators connected to performance. The model supported the value creation that was obtained in varied regional corporations. Thus, his studies developed the strategy to evaluate the efficiency of the intangible resources of the business (Pulic, 2004; Pulic, 2008). The model was subsequently improved and determined that the money invested in every unit of resource, creates a brand-new value for the businesses. The model considered that the human resources and structural resources associated with each other can be combined as specific resources, while corporations may generate greater value-added and coefficient (Pulic, 2008). In addition, the model was once outperforming other models whereby the model has been

primarily used to measure overall performance in mainly associated real estate's sectors such as finance, consumer services, and actual property from different countries over the previous ten years, such as in Brazil, Japan, Turkey, Malaysia, India, and Sweden. The increasing number of intellectual capital expertise and assessment had indicated the value and enhancement of management throughout different sectors. According to Pulic, (2004) the formula and its components of the model are developed, and deriving the variables of the intellectual capital is presented in Table 01.

In the analysis, two dependent variables were selected based on indicators of financial performance. The analysis would look for indicators of financial performance among the companies including Return on Assets (ROA), and Return on Equity (ROE). The primary independent variable of the study was identified as the Value-Added Intellectual Coefficient. Thus the VAIC model entails three variables. Viz., Human Capital Efficiency (HCE), Structural Capital Efficiency (SCE), and Capital Employed Efficiency (CEE), and the study aim to analyse all categories.

### **Hypothesis Development**

To identify the relationship between intellectual capital (IC) and its components of HCE, SCE, and CEE and companies' financial performance in terms of Return On Assets (ROA) and Return On Equity (ROE), the following hypotheses were derived:

H1: There is a positive relationship between Value Added Intellectual Capital (VAIC) and its components (HCE, SCE, and CEE) and firms' financial performance indicator of ROA.

H2: There is a positive relationship between Value Added Intellectual Capital (VAIC) and its components (HCE, SCE,

and CEE) and firms' financial performance indicator of ROE.

## **RESULTS AND DISCUSSION**

### **Descriptive Analysis**

Descriptive statistics simply displays the statistical characteristics of the variables in the study's model that are presented in Table 02. The data set has particularly explored the dissemination of each variable through descriptive measures such as mean and standard deviation. From Table 3, ROA shows a mean value of 0.035, 0.048, 0.036, 0.029 and maximum of 20%, 23%, 23%, and 39% in years 2015, 2016, 2017, and 2018 respectively, this implies that on average shareholders of consumer service and real estate companies earned 3.5%, 4.8%, 3.6% and 2.9% ROA in years of 2015, 2016, 2017 and 2018 separately. Thus ROE shows a mean value of 0.045, 0.064, 0.062, 0.030, and a maximum of 38%, 28%, 37%, and 42% in years 2015, 2016, 2017, and 2018 respectively, this implies that on average shareholders of consumer service and real estate companies earned 4.5%, 6.4%, 6.2% and 3% ROE in years of 2015, 2016, 2017 and 2018 separately. Hence, table 02 reflects that three components of VAIC such as HCE, SCE, and CEE have a respective mean value of 16.12, 15.12, and 0.10 in 2015; 16.61, 15.61 and 0.12 in 2016; 50.97, 49.97 and 0.12 in 2017 and 26.70, 25.70 and 0.12 in 2018. This infers that HC is the most successful factor in the issue of value production, followed by SC and CE in each study year. The standard deviation for the independent variables is the highest and equal in HCE and SCE as well as for dependent variables is the highest in ROE for all study years.

### **Correlation Analysis**

The Pearson correlation method was applied to identify the relationships between the variables. Correlation results are presented in Table 03. There is a statistically significant positive correlation

between VAIC and its components of HCE, SCE, and CEE and ROA, ROE, in every study year. Though the results satisfy the hypotheses formulated in the research as an overall picture there are some underlines to deeply discuss. A strong positive relationship ( $< 7$ ) reflects only in 2017 between CEE and ROE. In other years, a moderate positive relationship is observed amid CEE and ROE. Subsequently, a moderate positive effect reflects amid ROE and VAIC and its two components of HCE and SCE in the year 2018 while other study years of 2015, 2016, and 2017 reflect a low positive relationship. Meanwhile, A moderate positive relationship ( $< 3$ ) reflects amongst ROA and VAIC and its two components of HCE and SCE, in all study years apart from 2017 where a low positive relationship is identified. However, in between CEE and ROA are shows moderate positive effects in all study years.

### Regression Analysis

A simple linear regression analysis was accomplished using ROA (Return On Assets) and ROE (Return On Equity) as the dependent variables and VAIC and its components of HCE, SCE, and CEE as independent variables, using a linear model of  $y = a + b \cdot x$ .

$$\text{Model 01} = (\text{ROA}) = b_0 + b_1\text{HCE} + b_2\text{SCE} + b_3\text{CEE} + e$$

$$\text{Model 02} = (\text{ROE}) = b_0 + b_1\text{HCE} + b_2\text{SCE} + b_3\text{CEE} + e$$

The results of model 01 show that the VAIC is positive and statistically significant in all study years except in 2017 with ROA indicating that an increase in VAIC will increase ROA subsequently. Furthermore, Table 4 reflects that two VAIC components i.e., HCE and SCE ( $p < 0.05$ ), were statistically significant with profitability measurement of ROA in all study years excluding 2017. An interesting feature is the third component (CEE) of VAIC shows a positive and statistically

significant result with profitability measurement of ROA in all study years for real estate and consumer service companies in the Colombo stock exchange of Sri Lanka. Concerning VAIC as an overall interface in model 01, that supported H1 in the year 2015, 2016, and 2018. Conversely, statistical measurements of VAIC model 01 exclude H1 in 2017. The  $R^2$  value for model 01 is 0.354 that accounts for 35%.

Results of model 02 indicate that the model's explanatory influence is 49% (adjusted  $R^2 = 0.490$ ). The results reflect that VAIC has an insignificant relationship ( $p > 0.05$ ) with profitability as measured by ROE in study years of 2015, 2016, and 2017. However, VAIC is significant ( $p < 0.05$ ) with profitability as measured by ROE in 2018. According to model 02, the results suggest that when ROE is used as an indicator of performance, VAIC is much more important in 2018. Similar to the findings of ROA, the results show that HCE ( $p > 0.05$ ) and SCE ( $p > 0.05$ ), were statistically insignificant with the profitability (i.e., ROE) in all study years. While CEE ( $p < 0.05$ ) was statistically significant with the profitability (i.e., ROE) in all study years for real estate and consumer service companies in the Colombo stock exchange of Sri Lanka. Concerning VAIC as an overall interface in model 02, it not supported for H2 in all study years. While CEE is the only component that supporting for H2 in all study years.

### CONCLUSION

The study aims to analyse the relationship between the intellectual capital on the financial performance of the real estate PLCs and consumer service PLCs in the Colombo Stock Exchange (CSE) in Sri Lanka. Pulic's value-added intellectual capital (VAIC) model was applied to achieve the aim of this research. In VAIC methodology, VAIC is considered as an independent variable, it

contains three main attributes viz., Human Capital Efficiency (HCE), Capital Employed Efficiency (CEE), and Structural Capital Efficiency (SCE). Conversely, the dependent variable of financial performance realize with two main measurements, viz., Return on Assets (ROA) and Return on Equity (ROE). In this regard, the study selected 46 all real estate and consumer service companies listed in CSEs from 2015 to 2018.

The results reflect that there is a positive relationship between ROA, ROE, and VAIC and its components of HCE, SCE, and CEE in every study years. Amongst, CEE is the most productive component for the profitability of real estate and consumer service companies than the components of HCE and SCE for the study period of 2015-2018, especially with financial performance indicators of ROA and ROE in the Colombo stock exchange of Sri Lanka.

The present study's outcomes are in line with those of previous few studies of real estate and consumer service companies, e.g. Narwal & Yadav (2017) the studies on Indian real estate market, the findings clearly indicated that HCE and CEE have significant positive effect, while SCE is negatively associated with profitability of Indian Real Estate sector. Later Jaya and Setiawan (2019) claimed the investigations on real estate and property companies of Indonesia Stock Exchange (IDX), the results presented that CEE, HCE, and SCE simultaneously affected 61.80% ROA, CEE affected 47.75% ROA, HCE affected 50.41% ROA, and SCE did not affect ROA. While completely discrepancy results reflect from Nassar studies (2018) regarding the Turkish Real Estate Companies. The results reflected that the SCE has positive significant relationship with FP in the Turkish Real Estate Companies before and after crisis while CEE shows a significant negative relationship (Nassar, 2018).

Future IC research in real estate and consumer service companies should take into account how VAIC and its components can affect other financial performance metrics. The findings of this review, however, could be useful to real estate and consumer service companies while signifying more effort should be put into improving IC performance in real estate and consumer service companies to potentially improve profitability. Such efforts to increase IC performance would be beneficial and enable Sri Lankan real estate and consumer service companies to stay competitive; only then would CSE be able to achieve its goal of being the world's most efficient and powerful financial market. We can recommend increasing investment on IC with more attention on HCE and SCE to bring them for better performance of MV. Also we see that in Real estate and consumer service sectors use of IC is somewhat weak.

Furthermore, the results of this study strongly suggest that further studies be done either assessing the relationship between efficiency of value production or profitability of firm and that how impact on organization or firms' workers individual (eg: investor, shareholder) wealth, or exploring the underlying assumptions of the VAICs that might be revisited in order to analyse their possible ramifications on the validity of empirical testing and outcomes.

#### ACKNOWLEDGMENT

Center for Real Estate Studies (CRES),  
Department of Estate Management and  
Valuation, University of Sri  
Jayewardenepura

#### REFERENCES

- Berzkalne, I. & Zelgalve, E., 2014. Intellectual Capital and Company Value. *Procedia - Social and Behavioral Sciences*, Volume 110, pp. 887-896.
- Bontis, N., Chua Chong Keow, W. & Richardson, S., 2000. Intellectual

- capital and business performance in Malaysian industries. *Journal of Intellectual Capital*, 1(1), pp. 8-100.
- Chang, W. S., 2013. Are R&D and intellectual property rights related to the firms' financial performance? The perspectives on intellectual capital.. *International Journal of Technology, Policy and Management*, 13(3), pp. 245-260.
- Chen, M., Cheng, S. & Hwang, Y., 2005. An empirical investigation of the relationship between intellectual capital and firms' market value and financial performance. *Journal of Intellectual Capital*, pp. 159-176.
- Davenport, T. & Prusak, L., 1997. *Working knowledge - How organizations manage what they know*. Boston, MA: s.l.:Harvard Business School Press..
- Diez, J. et al., 2010. Negative soil feedbacks accumulate over time for non-native plant species. 13(7), pp. 803-809.
- Edvinsson, L., 1997. Developing intellectual capital at Skandia. *Long range Planning*, 30(3), pp. 320-373.
- Ercan, M. K., Ozturk, M. B. & Demirgunes, K., 2003. s.l.: s.n.
- Fabian, Z., 2010. Score correlation. *Neural Network World*. pp. 793-793-798.
- Gan, K. & Saleh, Z., 2008. Intellectual capital and Corporate Performance of Technology Intensive Companies. *Asian Journal of Business and Accounting*, pp. 113-130.
- Ghosh, S. & Mondal, A., 2009. Indian software and pharmaceutical sector IC and financial performance. *Journal of Intellectual Capital*, 10(3), pp. 369-388.
- Hall, R., 1992. The strategic analysis of intangible resources. *Strategic Management Journal*, 13(2), pp. 135-144.
- Jaya, T. & Jaya, S., 2019. Influence of intellectual capital on financial performance in real estate and property subsector companies. In: *Global Competitiveness: Business Transformation in the Digital Era*. London: Routledge, p. 34.
- Joshi, M., Cahill, D. & Sidhu, J., 2010. Intellectual capital performance in the banking sector: An assessment of Australian owned banks. *Journal of Human Resource Costing & Accounting*, pp. 151-170.
- Joshi, M., Cahill, D., Sidhu, J. & Kansal, M., 2013. Intellectual capital and financial performance: an evaluation of the Australian financial sector. *Journal of Intellectual Capital*, pp. 264-285.
- Kamath, G. B., 2008. Intellectual capital and corporate performance in Indian pharmaceutical industry. *Journal of Intellectual Capital*, 9(4), pp. 1469-1930.
- Kaufmann, L. & Schneider, Y., 2004. Intangibles: A synthesis of current research. *Journal of Intellectual Capital*, 5(3), pp. 1469-1930.
- Khalique, M., Shaari, N., Abdul, J. & Isa, A. H., 2011. Intellectual capital and its major components..
- Klein, D. & Prusak, L., 1994. *Characterising Intellectual capital*, Cambridge: Centre for Business Innovation,.
- Lu, W. M., Wang, W. K, W. K. & Kweh, Q. L., 2014. Intellectual capital and performance in the Chinese life insurance industry. *Omega*, 42(1), pp. 65-74.
- Makki, A., Lodhi, S. & Rashid, R., 2008. Intellectual Capital Performance of Pakistani Listed Corporate Sector. *International Journal of Business and Management*, 3(10).
- Mondal, A. & Ghosh, S. K., 2012. Intellectual capital and financial



- performance of Indian banks.. *Journal of Intellectual Capital*, pp. 515-530.
- Mondal, A. & Ghosh, S. K., 2012. Intellectual capital and financial performance of Indian banks. *Journal of Intellectual Capital*, pp. 515-530.
- Muhammad, N. M. N. & Ismail, M. K., 2014. Intellectual capital efficiency and firm's performance: Study on Malaysian Financial Sectors.. *International Journal of Economics and Finance*, 1(2), p. 206.
- Narwal, K. P. & Yadav, N., 2017. The Impact of Intellectual Capital on the Indian Real Estate Sector Profitability and Productivity. *Journal of Commerce and Accounting Research*, 6(1).
- Nassar, S., 2018. The Impact of Intellectual Capital on Firm Performance of the Turkish Real Estate Companies Before and After the Crisis. *European Scientific Journal*, 14(01), pp. 30-45.
- Neuman, W., 2011. *Social research methods: Qualitative and quantitative approaches*. 7th ed. Upper Saddle River: Pearson Education.
- Nick Bontis, W. C. C. K. ,. S. R., 2000. Intellectual Capital and Business Performance in Malaysian Industry. *Journal of Intellectual Capital*.
- Ousama, A. A., Al-Mutairi, M. T. & Fatima, A. H., 2020. The relationship between intellectual capital information and firms' market value: a study from an emerging economy. *Measuring Business Excellence*, pp. 39-51.
- Pal, K. & Soriya, S., 2012. IC performance of Indian pharmaceutical and textile industry. *Journal of Intellectual Capital*, 13(1), pp. 120-137.
- Pulic, A., 2000. VAIC (TM) - an accounting tool for IC management. *International Journal of Technology management*, 20(5-8), pp. 702-714.
- Pulic, A., 2004. Intellectual capital – does it create or destroy value?. *Measuring Business Excellence*, 8(1), pp. 62-68.
- Pulic, A., 2008. The Principles of Intellectual Capital Efficiency -A Brief Description.
- Riahi-Belkaoui, A., 2003. Intellectual capital and firm performance of US multinational firms. *Journal of Intellectual Capital*, June.
- Stewart, T., 1997. *Intellectual Capital: The New Wealth of Organizations*, Doubleday/Currency. New york: s.n.
- Sveiby, K., 1997. The Intangible Assets Monitor. *Journal of Human Resource Costing & Accounting*, 2(1), pp. 73-97.
- Tan, H. P., X, P. & Hancock, P., 2007. Intellectual Capital and Financial Returns of Companies. *Journal of Intellectual Capital*, 8(1), pp. 76-95.
- Yalama, A., 2013. The relationship between intellectual capital and banking performance in Turkey: evidence from panel data. *International Journal of Learning and Intellectual Capital (IJLIC)*.
- Yalama, A. & Coskun, M., 2007. Intellectual capital performance of quoted banks on the Istanbul stock exchange market. *Journal of Intellectual Capital*, pp. 256-271.
- Zeegal, D. & Maaloul, A., 2010. Analysing value added as an indicator of intellectual capital and its consequences on company performance. *ournal of Intellectual Capital*, pp. 39-60.

**Table 1. Variables in VAIC Model**

<b>Variable</b>	<b>Formula</b>
Value added (VA)	Operating profit + employee cost + Depreciation + Amortization (OP+EC+D+A)
Capital employed (CE)	Equity + long-term liabilities
Human capital (HC)	Total costs invested on employees
Structural capital (SC)	Value-added (VA) – human capital (HC)
Human Capital Efficiency (HCE)	VA / HC
Structural Capital Efficiency (SCE)	SC / VA
Capital Employed Efficiency (CEE)	VA / CE
Value Added Intellectual Capital (VAIC)	HCE+SCE+CEE
Price-earnings ratio	Market value per share/Earning per share
Assets turn over	Total Revenue/Total Book Value
Return on Assets	Net Income/Total Assets
Return on Equity	Net Income/Total Equity
Earnings per Share	Net Income-Preferred Dividends)/ (Average Outstanding Shares)
Firm Age	Age of the company from its establishment time
Firm Size	Log of firm's total assets
Firm Leverage	Total debt / Book value of total assets

Source: (Pulic, 2000; Pulic, 2004)

**Table 2. Descriptive Statistics on Financial Performances from 2015 to 2018**

	Valid No.	Mean	Std. Deviation	Min	Max
<b>2015</b>					
HC	46	103,809,299	268,974,158	510,560	1,700,022,000
SC	46	221,923,875	468,154,242	(245,112,893)	2,612,124,491
CE	46	2,873,739,748	4,222,626,257	(8,956,993)	27,496,780,916
HCE	46	16.121	43.442	-14.767	224.123
SCE	46	15.121	43.442	-15.767	223.123
CEE	46	0.102	0.090	-0.073	0.316
VAIC	46	31.344	86.896	-30.606	447.342
ROA	46	0.035	0.068	-0.128	0.207
ROE	46	0.045	0.114	-0.290	0.388
<b>2016</b>					
HC	46	113,951,308	280,495,346	540,000	1,767,935,000
SC	46	287,624,080	486,586,660	(23,471,712)	2,583,410,232
CE	46	2,942,855,442	4,454,778,670	(132,603,889)	29,082,629,366
HCE	46	16.619	40.308	-2.343	202.040
SCE	46	15.619	40.308	-3.343	201.040
CEE	46	0.125	0.087	-0.080	0.334
VAIC	46	32.363	80.615	-5.708	403.170
ROA	46	0.048	0.062	-0.113	0.237
ROE	46	0.064	0.091	-0.131	0.284
<b>2017</b>					
HC	46	120,986,504	303,991,289	94,000	1,907,231,000
SC	46	345,613,975	672,069,746	(69,998,581)	3,234,155,134
CE	46	3,314,502,939	5,735,877,803	(19,969,982)	37,952,060,126
HCE	46	50.979	230.000	-11.783	1554.660
SCE	46	49.979	230.000	-12.783	1553.660
CEE	46	0.121	0.115	-0.207	0.350
VAIC	46	101.080	459.989	-24.670	3108.358
ROA	46	0.036	0.088	-0.235	0.233
ROE	46	0.062	0.117	-0.237	0.376
<b>2018</b>					
HC	46	130,020,513	320,883,695	120,000	1,979,066,000
SC	46	317,118,817	550,408,751	(69,003,745)	2,744,256,865
CE	46	3,485,668,225	5,999,603,492	(25,552,297)	39,624,436,460
HCE	46	26.708	65.010	-32.077	329.626
SCE	46	25.708	65.010	-33.077	328.626
CEE	46	0.125	0.112	-0.157	0.417
VAIC	46	52.541	130.047	-65.312	658.669
ROA	46	0.029	0.120	-0.504	0.395
ROE	46	0.030	0.187	-1.005	0.423

Source: Annual reports of listed companies (2015-2018)

**Table 03:** Correlation Results of the Variables

Correlations				
2015				
	VAIC	HCE	SCE	CEE
ROA	.413**	.412**	.412**	.557**
ROE	.265	.264	.264	.697**
2016				
	VAIC	HCE	SCE	CEE
ROA	.310*	.310*	.310*	.405**
ROE	.214	.213	.213	.482**
2017				
	VAIC	HCE	SCE	CEE
ROA	.057	.057	.057	.632**
ROE	.011	.011	.011	.752**
2018				
	VAIC	HCE	SCE	CEE
ROA	.467**	.466**	.466**	.608**
ROE	.324*	.324*	.324*	.515**

Note: \*\* Significant at 1%, \* Significant at 5%

Source: Survey Data 2020

**Table 4:** Regression Analysis Results of VAIC and Its Components (HCE, SCE, and CEE) and ROA and ROE.

Variables		ROA (Model 01)				ROE (Model 02)			
		2015	2016	2017	2018	2015	2016	2017	2018
VAIC	$\beta$	1.011	0.310	0.057	0.467	0.265	0.214	0.075	0.324
	t	5.068	2.166	0.377	3.500	1.821	1.450	0.075	2.272
	Sig.	0.000	0.036	0.708	0.001	0.075	0.154	0.941	0.028
HCE	$\beta$	0.412	0.409	0.102	0.297	0.176	0.484	0.083	0.218
	t	3.003	3.080	0.866	3.205	1.650	1.689	0.825	1.856
	Sig.	0.004	0.004	0.296	0.005	0.106	0.071	0.414	0.960
SCE	$\beta$	0.346	0.057	0.117	0.341	0.189	0.027	0.083	0.213
	t	2.973	2.428	0.998	3.013	1.805	0.207	0.825	1.635
	Sig.	0.005	0.041	0.324	0.004	0.089	0.837	0.414	0.109
CEE	$\beta$	0.512	0.304	0.643	0.527	0.674	0.211	0.760	0.464
	t	4.400	2.285	5.472	4.658	6.308	1.999	7.589	3.555
	Sig.	0.000	0.027	0.000	0.000	0.000	0.048	0.000	0.001

Source: Survey Data 2020

# Reforms in Indian Capital Market: An Empirical Analysis

Dr. Sabina Batra

Associate Professor,  
PG Department of Commerce and Business Administration,  
Kanya Maha Vidyalaya,  
Jalandhar.

## Abstract

Dematerialisation has enabled the Indian Capital Market to take world's central stage and scale unprecedented heights of success. Indian Capital Market has become an Equity Heaven due to this recent trend of automation. There has been an exponential growth rate in the Securities market in India in terms of amount raised from the market, number of stock exchanges and intermediaries, number of listed stocks, market capitalization, trading volumes, turnover on stock exchanges and investors population. Various services offered by National Securities Depository Limited (NSDL) and Central Depository Services (India) Limited (CDSL), like Pledge and Hypothecation, Account Transfer, Stock Lending and Borrowing, Nomination, Tax Information Network (TIN), Speed-E, Internet – based Demat Account Statement (Ideas), Securities Trading Information Easy Access and Delivery (STEADY), etc bear testimony to the fact that it is consistently and continuously progressing, thereby, now ranking at par with internationally acceptable standards. In this study, an attempt has been made to analyze the perceptions of the investors about dematerialization. The analysis of the sample consisting of 200 respondents from Amritsar, Jalandhar, Ludhiana and Chandigarh has highlighted some very important facts about their investment behaviour. Regarding the respondents' profile, it is evident that married people who are in service and in the age group of 35-45 years are more inclined to investment in stock markets. From the response of 200 respondents about their awareness of this concept, it is clear that dematerialisation has become the order of the day, with its benefits penetrating all the segments of the society. The analysis has reiterated the fact that even today, investors have the highest preference for banks, followed by the stock markets. The main factor influencing the investment decision of the investors is their regular income. The investment of nearly 95.50% respondents has increased after the inception of dematerialisation, while only 4.50% respondents gave a negative response. The analysis of the reasons for the shift of investors from the traditional paper based system to demat mode reveals that majority of investors prefer the depository system due to easy transferability of shares made possible by it. The response of the investors for reverting to the traditional system has proved that nearly all the investors strongly approved of the depository system and found it to be **user friendly** and **conducive** to the needs of the common man.

## INTRODUCTION

Dematerialisation of shares has brought a metamorphic transformation in the Indian Capital Market. During the early part of 1990's, Indian Capital market ranked at the bottom of the list in terms of safe trading, efficiency in settlement of trades and risk inherent in trading. Today, with the launch of economic reforms, both equity and debt market have witnessed sea changes and India has become an EQUITY HEAVEN for investments, both from India and Abroad. The reforms of Dematerialisation and Rolling Settlement have brought tremendous improvements in the regulatory mechanism and

electronic trading has resulted in reduction in transaction costs, speedier execution of trades and increased liquidity.

## OBJECTIVES OF THE STUDY

The analytical review of literature and work already done on depositories and dematerialization clearly reveals that not much has been done to study the perceptions of the investors about dematerialisation. Considering the vital contribution of dematerialisation to liquidity, returns and volatility, the proposed study was undertaken with the objective to observe the perceptions of the investors about dematerialization and reforms in Indian Capital Market.

## RESEARCH METHODOLOGY

### Population and Sample

For the analysis of the demographic features and the behavioral factors of investors, which affect their investment decisions, primary data was collected from a sample of 200 investors through a questionnaire. Due to resource, time constraints, and due to easy accessibility, the study was confined only to the four major commercial cities of Punjab i.e., Jalandhar, Amritsar, Ludhiana and Chandigarh.

### Criteria for Selection of Investors

From the lists of investors obtained from HDFC, ICICI Securities, Ludhiana Stock Exchange, Master Capital, Invest Shoppe, Kotak Securities, India Bulls, India Infoline and SKI Capital, a sample of 240 respondents was taken comprising sixty investors from each of the cities mentioned above. But forty of them were later dropped, as the complete required information from some of them could not be obtained and some others were non-responsive. While selecting the investors for the purpose of this study, the following criteria were followed:

- a) Only the investors associated with the above mentioned depository participants/ brokers were chosen.
- b) Only the investors having a demat account with different depository participants were preferred.
- c) Equal number of investors was taken from Amritsar, Jalandhar, Ludhiana and Chandigarh.

### Sources of Data

#### Primary Data

Primary data was collected from sample investors through the following instruments of data collection:

#### A) Questionnaire

After scanning the literature on depositories and dematerialisation as well as preliminary discussions with certain stock exchange officials, a survey schedule i.e., questionnaire was prepared and tested on few investors and later revised in the light of experience gained.

#### B) Observation

Some information was gathered through personal observation and interaction with the officials of Ludhiana Stock Exchange, HDFC Securities, India Infoline, and ICICI. Frequent visits and interviews with leading brokers of Jalandhar and Ludhiana were very instrumental in enhancing the knowledge of the dematerialisation concept and in facilitating the completion of study.

### Collection of Data from Investors

Before the data was collected, an attempt was made to develop a rapport with the subjects by explaining the objectives of the study and clearing any apprehensions about the consequences of their volunteering the required information. Each of the selected investors was personally interviewed with the help of a pre-tested survey schedule and rating scale for the purpose of obtaining the required information.

### Theoretical Framework

## ECONOMIC TIMES UPDATES

March 10th, 2021

### How to open Demat and Trading Account Online

Many people are interested in opening demat and trading accounts with the all time high surge in the equity market. It was recommended that a comparative analysis of different brokerage plans with the rates and services offered should be undertaken while making investments.

February 1st, 2021

### **How to transfer shares from one Demat Account to another**

Electronic Trading has enabled investors to transfer shares from one demat account to another. Shareholders can view all their stocks and returns on investments by consolidating their shareholdings into a single demat account.

**December 2nd, 2020**

### **SEBI issues guidelines for transfer, dematerialisation of re-lodged physical shares**

Dematerialisation of shares has helped investors to maintain a transparent record of shareholding of companies and also addressed their rising concerns over beneficial ownership of entities.

**September 2nd, 2020**

### **CDSL demat accounts cross 2.5 crore mark**

Central Depository Services Ltd (CDSL) has added 1.5 crore demat accounts in a period of less than 5 years.

**September 2nd, 2020**

### **SEBI eases disclosure requirements on shares encumbered for margin obligations**

This circular highlighted that the decision regarding disclosure requirements has been taken after receiving representations from market participants and Securities and Exchange Board of India (SEBI).

**June 30th, 2020**

### **SEBI again eases compliance rules for processing Demat Request**

With increasing number of demat account opening requests, SEBI has relaxed the compliance rules for processing Demat Requests and this relaxation has been extended till July 31, 2020.

### **OTHER ARTICLES**

**Nathan (2003)** in his article lauded the efforts made by SEBI in moving the trading and settlement system to T + 2 basis, thereby placing the Indian stock market trading system ahead of most of the developed countries. Together with the introduction of T + 2 basis in 2002, the concept of Straight Through Processing (STP) was introduced for better processing of entire sequence of steps from the time an order is placed till it is settled. **Monga (2005)** highlighted the reduction made by SEBI in cost of investing under dematerialized system in her article. The new demat account holders will not have to pay account opening charges for buying securities. **Ramakrishan and Vikraman (2006)** made an attempt to analyse the impact of making PAN compulsory for opening the demat account. They observed that the tax noose is tightening systematically for demat account holder. The assessing officer of CIB can match the ITS with the individual's tax returns to check whether the investor has evaded or short paid taxes and also check whether the money for investments in stock market transactions is being laundered through this channel. **Mayya (2006)** in his article, attributed the entire success and changed scenario of Indian Capital Market to the trend of automation set up by NSE in 1994 and dematerialisation initiated by NSDL in 1997, which have become the order of the day. Settlement of transactions by demat has replaced the cumbersome procedure of settlement of transactions by physicals, doing away with bad deliveries. **(2013) Central Depository Services (India) Limited Secure Dependable Convenient COMMUNIQUE TO DEPOSITORY PARTICIPANTS CDSL/OPS/DP**, SEBI Circular dated December 04, 2013 on Simplification of DEMAT Account Opening Process required all DPs to refer to this circular

regarding simplification of the procedure for opening a Demat Account and ensure its compliance. **Phadnis (2018)** observed that Ministry of Corporate Affairs (MCA) as well as the Securities Exchange Board of India (SEBI) gave notification on mandatory dematerialization (Demat) of shares.

**www.karvy.com (2018)** highlighted that if we have shares in physical form, their transfer will not be possible after April 1<sup>st</sup>. 2019 unless we convert them into demat shares. **Vasal Vikas (2019)** focussed on the impact and future prospects for the shareholders of Indian unlisted public companies in light of this recent development in the capital market. To bring in further transparency, improve the Know Your Customer (KYC) framework and overall investor protection, the Indian government has recently made it compulsory for all unlisted public companies to dematerialize their securities. The regulations provide that any new issue of securities by an unlisted public company can only be in a dematerialized form. It further provided that before making any new offer for issue of securities, buy back of securities, issue of bonus shares or rights offer by an unlisted public company, the shares held by promoters, directors and key managerial personnel are required to be dematerialized. **Gaurav (2019)**, a Pune-based company secretary, explained the implications of the Companies (Amendment) Act, 2019, which contemplates dematerialisation of shares of private companies. **Jha (2019)** observed that Dematerialization of shares is optional and an investor can still hold shares in physical form. However, an investor has to demat the shares if he/she wishes to sell them through the Stock Exchanges. Similarly, if an investor purchases shares, he/she will get delivery of the shares in demat form only. **Olga (2019)** highlighted that the new SEBI guidelines have given standard rules for

drafting Power of Attorney agreements which have reduced the potential chances of frauds in India as earlier Brokers used to transfer mutual fund units as collateral security to provide for margin requirement on trades without getting consent from the investors.

The review of studies conducted by different committees and researchers unfurled various aspects relating to Dematerialisation like:

- The comparative analysis of stock markets vis-a vis other investment avenues.
- The impact of electronic trading and T+2 Rolling Settlement System on Volumes of Trade.
- The role of Depositories in curing the evils associated with paper based trading system.
- The effect of dematerialisation on Liquidity and Profitability.

Despite certain attempts made to study different aspects of dematerialisation, there remained certain pertinent gaps. Some of these gaps revolve around questions like:

- What are the perceptions of the investors about dematerialisation i.e. whether they have increased their investments in stock market and what are the consequential benefits in terms of their liquidity and returns.
- Are the investors satisfied with the services provided by the Depository Participants and what factors do they consider while choosing any DP.
- Would they prefer reverting to the paper based trading system?

In view of the above partially explored questions, a need was felt to undertake an indepth study which could examine and evaluate the perceptions of the investors about this significant concept.



## **Statistical Tools**

Multi stage sampling technique was used to select the cities, brokers and the respondents. Nine brokers were selected randomly to procure the lists of investors required for the purpose of collecting the primary data. Statistical analysis was done by using simple statistical techniques like frequencies, percentages as well as advanced statistical tools such as Analysis of Variance (ANOVA), Discriminant analysis and Student's t-test to arrive at meaningful conclusions.

## **RESULTS AND DISCUSSION**

The study incorporates the analysis of the investors' perceptions about dematerialization.

### **INVESTMENT HABITS OF THE INVESTORS**

Table 1 indicates preference of the respondents for various investment avenues. The results, on the basis of the weighted average, have reiterated the fact that, even today, banks are mostly preferred by the investors for their investment, followed by the stock markets, with insurance at the third number, post office at the fourth position and government securities enjoying the least preference. The analysis of variance clearly reveals that the banks and stock markets were highly and equally preferred by the investors. However, there was a wide variation in the preference for insurance, post office and government securities. After banks and stock markets, 2<sup>nd</sup> and 3<sup>rd</sup> preference was secured by insurance and post office investments respectively, while government securities were least preferred by the investors.

### **FACTORS AFFECTING INVESTMENT IN DIFFERENT INSTITUTIONS**

Regarding the factors affecting the investor's choice of various institutions, the analysis given in Table 2 indicates that the major factor being considered by majority i.e. 96% of investors, while planning their investment portfolio was regular income and the least considered factor was the cost involved in the investment process (45%). The other factors considered while making any investment included profitability aspect (94%), saving taxes (91.50 %), inherent lower risks (87.50%) and security (68.50%).

### **AWARENESS AND UNDERSTANDING OF THE DEMATERIALISATION CONCEPT**

Regarding the awareness of the investors about depository system, the results show that 100% of the respondents were aware about the depository system. To analyze the perceptions of the investors about the concept of dematerialisation, they were given different meanings of dematerialisation.

It is evident from Table 3 that 6.50% respondents perceived dematerialisation to be trading of the shares without any intermediary, 33.50% respondents favoured the second option i.e. conversion of physical certificates into electronic form, 9.50% respondents agreed with the statement that dematerialisation is trading of shares under the rolling system, while majority of respondents i.e., 50.50% were in favour of the fourth statement, which includes all the three previous statements. Though, all the respondents had heard about the depository system, only some of them were fully aware of the conceptual meaning and operations of this system.

### **IMPACT OF DEMATERIALISATION ON INVESTMENT**

To know about the impact of dematerialisation on the amount of investment, the investors were asked to specify whether their investments had increased or decreased after the introduction of the depository system. The results indicate that the investment of 191 respondents (95.50%) had increased after the inception of dematerialisation while only 9 (4.50%) respondents gave a negative response. Regarding the average amount of investment, we can deduce from Table 4 that the investors, whose investment had decreased by 100 to 75% were only 3%, by 75 to 50% was half percent, 50 to 25% was one percent, while one investor i.e., 0.50% had maintained the same amount of investment before and after dematerialisation. Remaining 95.50% investors gave a very encouraging response. There were 12.50% investors who were not investing before the inception of depository system but had started investing after dematerialisation. The investment of the highest proportion i.e. 28.50% of investors had increased up to 50% followed by 19.50% whose investment had increased each by 50 to 100% and 100 to 200%, while investors with a mammoth increase of more than 1000% were 1.00%.

#### **REASONS FOR OPENING THE DEMAT ACCOUNT:**

A perusal of Table 5 shows that there were various reasons for the investors' preference for the depository system. It seems from the table that the investors assigned highest preference score to the easy transferability of investments through dematerialisation. All other reasons such as speediness, liquidity, reduced operating costs and reduced bad deliveries, though secured different levels of preference score but statistically these were preferred equally by the investors. However, the investors

showed least preference for safety, as most of the investors preferred to have their shares in electronic form instead of physical form.

#### **REASONS FOR SELECTING A PARTICULAR DEPOSITORY PARTICIPANT:**

Table 6 shows various factors responsible for the investors' choice of a particular depository participant and the results indicate that the investors preferred a particular depository participant mainly due to the factor of convenience, followed by good infrastructure, market goodwill, safety, difference in charges and track record, while the least preferred factor was better services of the depository participant.

The results of ANOVA reveal that the options of market goodwill, better services, safety, track record, difference in charges were ranked by the respondents almost at par while the factor of convenience stands apart i.e., it was the most critical factor influencing the investor's choice.

#### **REASONS FOR THE POPULARITY OF DEPOSITORY SYSTEM:**

The data presented in Table 7 shows the importance of various reasons for the popularity of the depository system. It can be safely deduced from the analysis that depository system is significantly popular among investors mainly due to the assurance of freedom from worries of loss of shares through theft, mutilation, loss, fire, etc. They ranked this advantage at the top followed by the factor of immediate allotment and transfers, which was assigned the second rank of popularity. All other factors such as reduction of paper work, elimination of the problem of odd lots, facility of loan against pledged securities, saving in costs, shorter settlement cycle, receipt of non-cash benefits in electronic form, ease in portfolio reshuffling, facility of exchange of

pre-verified assets with good title and increased loan amount against demat securities as compared to physical shares, though had secured different levels of agreement score but they were statistically at par and received 3<sup>rd</sup> rank of popularity of a depository system. The analysis of variance indicates that all the options were ranked almost equally by the respondents bringing home the fact that investors favoured this system mainly due to the fact that it relieved them from the worries of bad deliveries, delayed deliveries and loss of shares due to theft, fire etc.

#### **LIKE TO REVERT BACK TO THE OLD SYSTEM:**

When asked about their intention to shift to the traditional paper based system, 191 (99%) respondents gave a negative response. The investors fully approved of the depository system and found this system to be user friendly and conducive to the needs of the common man.

#### **CONCLUSIONS AND SUGGESTIVE FRAMEWORK**

The incredible saga of dematerialisation has indeed made a fascinating study. It is a watershed event, which has changed the whole complexion of the Indian capital market. After the initial teething problems, demat has emerged as the most potent weapon in the hands of the investors, brokers and the corporates. The proposed study was conducted to analyze the perceptions of investors about dematerialisation. On the basis of the analysis, the following conclusions emerged:

The inception of dematerialisation, has led to an exponential spurt in trading volumes by providing the investors with a direct access to the markets. Majority of investors have increased their investment by about 50% of their initial investment.

The main reason for opening a demat account was found to be easy transferability of shares with no risks of bad and delayed deliveries.

Almost all the investors were facing problems like delay in dematerialisation process, no uniformity in charges and too much dependence on DPs. The system of DP charges to the investors are a virtual jungle.

The investors preferred this system as it relieved them from the worries of bad deliveries, delayed deliveries and loss of shares due to theft, fire etc. They were prejudiced against this system due to its inability to establish well-equipped branches in the rural areas.

The very fact that the demat accounts in both NSDL and CDSL are continuously on the rise, speaks volumes of the incredible success of the depository system. The entire success of this system can be attributed to reduced bad deliveries and shorter settlement cycle made possible by it. The analysis has highlighted certain areas where this system is lacking and could certainly improve upon. The first and the foremost requirement is that the goal of T+0 Rolling Settlement System should be achieved at the earliest. Another front, with imminent danger, is the liberal attitude of SEBI regarding the number of demat accounts that can be opened by an investor. This number should be reduced to avoid the scams like Roopelben's case. Further, another important factor to be touched upon is that the facility of Internet Trading should be provided free of cost to the ordinary investors. The disparities in the rate structure of different DPs and brokers should be dispensed with and all the DPs and brokers should levy charges on a uniform basis. PREVENTION IS BETTER THAN CURE. SEBI IS A WATCH DOG IN THE STOCK MARKET and it should strive hard to promote the awareness of this

system, which will add another feather in its cap and make this system scale further heights.

## REFERENCES

Nathan, Vaidya: Penultimate in Settlement, **The Hindu Business Line**, Sunday, January 05, 2003, pp 1-3

Monga, Rachna: SEBI makes Demat cheaper, **Business World**, February 14, 2005, p-6

Ramakrishnan, Hema and Vikraman, Shaji: Evaders beware I-T may get access to STT nos, **The Economic Times**, May 29, 2006, p-4

Mayya, M.R: Evolution of a Giant, **Dalal Street**, April 17-30, 2006, pp 86-88

**Convenient Communiqué To Depository Participants Cdsl/Ops/Dp**, SEBI Circular dated December 04, 2013

Phadnis Janhavi: **Is it mandatory to demat shares before 6th Dec 18? , Published on October 16<sup>th</sup>,2018** Dematerialisation of Shares-Know how to convert physical shares to Demat; A Step by Step Guide, <https://www.karvy.com> › **growth-hub, November 15, 2018**

**Vasal Vikas** :Dematerializing Unlisted Shares: How changes affect

shareholders, **Stock Market News, 6<sup>th</sup> December, 2019.**

**Pingle Gaurav: Dematerialisation of shares for private firms to increase compliance burden**, BUSINESS STANDARD, August 12, 2019

Jha Shankar Kumar: **Dematerialisation of Securities**, December 3, 2019, SEBI Articles

Olga Robert: **Is Your Demat Account Safe From Fraud?** Good Returns, Published April 25<sup>th</sup>, 2019

Various issues of **Economic Times (e-papers)**

## Various Websites

[www.bse.com](http://www.bse.com)

[www.cdslindia.com](http://www.cdslindia.com)

[www.capitalmarket.com](http://www.capitalmarket.com)

[www.economicindiatimes.com](http://www.economicindiatimes.com)

[www.financialexpress.com](http://www.financialexpress.com)

[www.nsdl.co.in](http://www.nsdl.co.in)

[www.nse.com](http://www.nse.com)

[www.rbi.org.in](http://www.rbi.org.in)

[www.SEBI.gov.in](http://www.SEBI.gov.in)

**TABLE 1: Investment Habits of the respondents**

Institution	Preference					No response	Weighted Preference	Overall
	1	2	3	4	5		Score	
Stock markets	95	39	30	17	19	0	2.13	1
%	47.50	19.50	15.00	8.50	9.50	0.00		
Banks	69	64	48	10	3	6	2.04	1
%	34.50	32.00	24.00	5.00	1.50	3.00		
Insurance	18	59	70	38	4	11	2.74	2
%	9.00	29.50	35.00	19.00	2.00	5.50		
Post office	10	27	27	89	36	11	3.60	3
%	5.00	13.50	13.50	44.50	18.00	5.50		
Govt. securities	8	8	17	33	114	20	4.32	4
%	4.00	4.00	8.50	16.50	57.00	10.00		
						F-ratio	62.38***	
						CD	0.38	

\*\*\* indicate significance at 1% level

Overall ranking is based on the value of CD

**TABLE 2: Factors affecting investment behaviour of the investors**

Factors	Yes	%age	No	%age	Rank
Regular Income	192	96.00	8	4.00	1
Tax Saving	183	91.50	17	8.50	3
Profitability	188	94.00	12	6.00	2
Risks	175	87.50	25	12.50	4
Security	137	68.50	63	31.50	5
Cost Involved	90	45.00	110	55.00	6

**TABLE 3: Conceptual Understanding of Dematerialisation**

Statement	Yes	%age	No	%age
1) Trading of shares without intermediary	13	6.50	187	93.50
2) Conversion of physical shares into electronic form	67	33.50	133	66.50
3) Trading of shares under Rolling System	19	9.50	181	90.50
4) All Above	101	50.50	100	49.50

**TABLE 4: Impact of Dematerialisation on Investment**

Percent Increase/Decrease	No.	%age
-100% to -75%	6	3.00
-75% to -50%	1	0.50
-50% to -25%	2	1.00
-25% to 1%	0	0.00
No change	1	0.50
From Zero Level	25	12.50
Upto 50%	57	28.50
50% to 100%	39	19.50
100% 200%	39	19.50
200% to 400%	21	10.50
400% to 600%	3	1.50
600% to 800%	1	0.50
800% to 1000%	3	1.50
>1000%	2	1.00

**TABLE 5: Distribution of respondents according to the reasons for opening a Demat Account**

Reasons	Strongly Agree	Agree	Don't Know	Disagree	Strongly Disagree	Weighted Score	Overall Rank
	Agree		Know		Disagree		
1. Easy transferability	144	50	6	0	0	4.69	1
%age	72.00	25.00	3.00	0.00	0.00		
2. Liquidity	103	77	19	1	0	4.41	2
%age	51.50	38.50	9.50	0.50	0.00		
3. Speediness	115	63	17	5	0	4.44	2
%age	57.50	31.50	8.50	2.50	0.00		
4. Reducing operating cost	102	71	19	3	5	4.31	2
%age	51.00	35.50	9.50	1.50	2.50		
5. Safety	100	65	26	6	3	4.27	2
%age	50.00	32.50	13.00	3.00	1.50		
6. Reducing bad deliveries	106	56	29	6	3	4.28	2
%age	53.00	28.00	14.50	3.00	1.50		
					F-ratio	8.03***	
					CD	0.20	

\*\*\* indicate significance at 1% level

Overall ranks are based on the value of CD

**TABLE 6: Reasons for selecting a particular Depository Participant**

Reasons	Strongly Agree	Agree	Don't Know	Disagree	Strongly Disagree	Weighted Score Of Agreement	Overall Rank
1. Convenience	151	42	5	2	0	4.71	1
	75.50	21.00	2.50	1.00	0.00		
2. Good Infrastructure	120	60	15	3	2	4.47	2
%age	60.00	30.00	7.50	1.50	1.00		
3. Market Goodwill	108	77	11	4	0	4.45	2
%age	54.00	38.50	5.50	2.00	0.00		
4. Better Services	98	77	16	4	5	4.30	2
%age	49.00	38.50	8.00	2.00	2.50		
5. Safety	101	70	25	4	0	4.34	2
%age	50.50	35.00	12.50	2.00	0.00		
6. Track Record	100	70	25	4	1	4.32	2
%age	50.00	35.00	12.50	2.00	0.50		
7. Difference in charges	108	58	28	6	0	4.34	2
%age	54.00	29.00	14.00	3.00	0.00		
					F-ratio	7.06***	
					CD	0.1983	

\*\*\* indicate significance at 1% level

Overall ranking is based on the value of CD

**Table 7: Reasons for the popularity of the Depository System**

Reasons	Strongly Agree		Moderately Agree		Somewhat Agree		Weighted Score	Overall Rank
	No.	%age	No.	%age	No.	%age		
a) Freedom from worries of loss due to theft, mutilation etc.	171	85.50	25	12.50	4	2.00	2.84	1
b) Immediate allotment and transfer	133	66.50	61	30.50	6	3.00	2.64	2
c) Savings in terms of costs like stamp duty, brokerage	102	51.00	63	31.50	35	17.50	2.34	3
d) Loan against pledged demat shares	96	48.00	77	38.50	27	13.50	2.35	3
e) Elimination of the problem of odd lots	95	47.50	81	40.50	24	12.00	2.36	3
f) Convenient portfolio reshuffling	95	47.50	64	32.00	41	20.50	2.27	3
g) Shorter settlement cycle	92	46.00	77	38.50	31	15.50	2.31	3
h) Limit of loan against demat shares doubled as compared to physical shares	79	39.50	84	42.00	37	18.50	2.21	3
i) Receipt of non cash corporate benefits in electronic form	92	46.00	74	37.00	34	17.00	2.29	3
j) Exchange of pre-verified assets with good title	87	43.50	78	39.00	35	17.50	2.26	3
k) Reduction of paper work on sale of demat shares	101	50.50	71	35.50	28	14.00	2.37	3
						F-ratio	14.33***	
						CD	0.1791	

\*\*\* indicate significance at 1% level

Overall ranking is based on the value of CD

# Designing Strategies for Sustainable Livelihood in Peri-Urban Settlement-A Case of Smart City Vadodara

**Pooja Shah**

Infrastructure Engineering and Technology,  
B.V.M Engineering College,  
V.V Nagar, Gujarat, India,

**Prof. Jagruti Shah**

Asst. Prof. Structural Engineering Department,  
B.V.M Engineering College,  
V.V Nagar, Gujarat, India,

## Abstract

Peri-urban settlements are characterized by various flows from the urban. These flows tend to have an impact on the social, economic and physical aspects in these settlements. The current paper puts forth the impacts on the livelihood sustainability in the peri-urban due to the urban impacts. The sustainable livelihoods framework given by DFID and Adapted by Homeless international is used for the analysis of the various livelihood groups in these settlements. Through the study various stake gainers and stakeholders are identified in the process of urban expansion with respect to the sustainability of livelihood options currently adopted. The analysis also focuses on the institutional mechanisms and governance setup prevailing in Vadodara. The intention of the study is to study the rapid physical development process operating in the rural-urban fringe area outside Vadodara urban Authority development in absence of a statutory Development Plan. The study is carried out for the peri urban area of Vadodara city looking to the pressure of physical development on Vadodara and variables changing like Demographic pattern, Land use and Infrastructure. So, it is significant to study the appropriate strategies of planning and management to solve the problems for future development.

**Keywords:** Infrastructure Facility, Land management, Peri-urban, Rural, Smart development, Smart City, Strategies, Sustainable, Sustainable Livelihood, Urbanization, Vadodara.

## INTRODUCTION

India has experienced a high rate of urbanization since independence due to the industrial and economic growth-oriented policies. Developing countries like India are passing through a phase of rapid urbanization, the magnitude of urban population in India is second highest in the world. Cities are growing and expanding very rapidly changing their limit.

The urbanization rate in India is likely to go up from 31.16% in 2011 to 38.2% in 2026. Villages, located today in the fringe Area will tomorrow agglomerate within an urban area. In India there are **6,50,216** villages out of them **1,25,000** villages are backward so there is a need for designing and building the village as a smart village. The surrounding villages often come under the influence of urbanization and pressure depends on the direction and intensity of growth of the city.

The fringe villages draw a large number

of people into the urban-rural interface, mostly because of internal and external factors such as economic activities and access to basic needs. With modernization and urbanization people migrate from one place to another place for different facilities such as education, employment and affinity of people towards the locality or city. The surrounding villages often come under the influence of urbanization and pressure depends on the direction and intensity of growth of the city. The villages located on the fringe are likely to be developed as the city limit expands.

## 1. WHAT IS PERI URBAN AREA?

Peri-urban areas are zones of transition from rural to urban land uses located between the outer limits of urban and regional centers and the rural environment. Peri-urbanization relates to those processes of dispersive urban growth that create hybrid landscapes of fragmented urban and rural characteristics.



The conversion changes in the way people use their environment, consequently to the spatial structure of the landscape, rapid population growth and migration. Peri-urbanization defined as the process in which the rural or the village area becomes urbane regarding physical, economic and social aspects.

Peri – Village area: The land surrounding the gamtal of a village within the administrative boundary shall be termed as a peri-village area.

### **What is a Peri-urbanization Settlement?**

Village or a settlement located on the immediate administrative boundary and ahead of a city

### **The Characteristics of Fringe Villages are:**

- Under the Pressure of development
- Urban Sprawl.
- Land Conversion and Subdivision
- Real Estate Development
- Population Growth Relatively High
- Occupational Changes
- Unauthorized Development
- **And Causes of Fringe Villages are:**
  - Availability of Land
  - Low Land Prices
  - Easy to Get Land Conversion and Construction Activity Permission
  - Lack of Monitoring System & Regulatory Authority
  - Development Charges Relatively Low
  - Locational Advantages
  - Commutable Distance
  - Corridor Development
  - Industrial Development
  - Existing Institutions
  - Better Environment

In India there are 7,935 town and 6.5 lakh villages out of them approx. 1.25 lakh villages are backward. The surrounding villages often come under the influence of

urbanization and pressure depends on the direction and intensity of growth of the city. So prime objective of this study is solving this village's problem.

The urban areas expand significantly towards its fringe areas and the more and more villages accommodates rapidly over a period of time and the issues of urban villages regarding the haphazard physical development and infrastructure services and finally to the quality of life of the villagers increases. The issues can be solved at an institutional level. It is very significant to study the appropriate method of planning and management to resolve the problems which hinders these villages to have the better quality of life.

### **OBJECTIVES OF THE STUDY**

To study the growth pattern of Vadodara and its Peri-urban settlement, understand the characteristics and the existing institutional framework for the administration & management of Peri-urban settlement and the concept of sustainability in the context of livelihoods, as applicable to the local context and evolve the appropriate framework to solve the issues of development of the Peri-urban villages.

### **STUDY AREA BACKGROUND**

Vadodara is the third largest city in the Indian State of Gujarat, after Ahmedabad and Surat. Vadodara urban authority development has an area of 714 km<sup>2</sup>. Vadodara district has 49.6% were urban, 50.4% were rural Population.

### **Why Vadodara?**

Due to increase in industrial and economic growth and having many favorable conditions the concentration of urban population increases exponentially, this will lead to shortage in habitat, housing and infrastructural facilities in the urban area. The Delhi-Mumbai Industrial Corridor passes through Vadodara resulted in a key destination for attracting industrial investments. Vadodara is the exclusive

producer of Dolomite and Fluorspar in Gujarat offering scope for tremendous growth in the processing industries.

Vadodara's Industrial Growth Vadodara City runs through the golden corridor, from Ahmedabad to Vapi, and is one of India's foremost industrial centers with dominant groups of chemicals and pharmaceuticals, cotton textiles and machine tools. Vadodara is divided into 2 Prants: Vadodara, Dabhoi

Dabhoi Vadodara is divided into 8 talukas: Dabhoi, Karjan, Padra, Savli, Sinor, Vadodara City, Vadodara Rural, Waghodia.

VUDA is established 1978. It consists of Municipal Corporation and other 98 adjoining Villages of Vadodara, Vagodia and Padra Taluka Town Planning and Urban Development Act 1976. VUDA has an area of 494.24 km<sup>2</sup>.

According to the 2011 India census, Vadodara metropolitan area had a population of 1,822,221. In Vadodara, 9% of the population is under 6 years of age. Gujarati, Marathi, Hindi, and English are the languages spoken in the city. Males constitute 52% of the population and females 48%.

### **SELECTED VILLAGES FROM THE STUDY AREA**

The following are the criteria for selection of the study villages:

1. High population growth rate
2. Low population growth rate
3. Higher density
4. Proximity to transport corridor
5. Geographical spread
6. The availability of strong public and private transport.

### **Proposed Villages**

Two villages outside VUDA limits urban boundary and just on its periphery were selected. These villages were selected because these villages are in a state of occupational change. These villages would be

affected by fast changing livelihood changes and market pressures. These villages are a part of Padra and Wagodia Taluka.

### **❖ Ghayaj Village Details**

The total geographical area of village is 737.54 hectares. Ghayaj has a total population of 2,667 peoples. There are about 594 houses in Ghayaj village. Padra is nearest town to Ghayaj which is approximately 2km away.

- **Demography details & Occupational**
- **Pattern Physical Profile**
- **Infrastructure Facility**

### **Water Supply**

Villages have 16 standpost, 4 hand pumps, 2 water storage tanks with capacity of 20,000 litters and lake.

### **Road Network and Transportation**

Village have pakka approach road. Road Length is 1958 feet, Road width is only 10 feet in gamtal area and also road condition is Average. Transport facility is quite good enough because of location of this village. All GSRTC buses coming from Padra are passing through this village having frequency 18 times per day and private transport facility is also available.

### **Sewerage & Storm water Drainage**

For Sanitation 80 % of village have covered channels, the water from same is diverted to wastelands in adjoining areas. 90% houses have toilets with septic tank. Water logging is a problem during rainy season in some part of village.

### **Solid waste Management**

The village has three-safai kamdar whose responsibility is to clean up entire village every day. A garbage truck comes 3 days a week for collection of solid waste for dumping site.

### **Electricity Supply**

99% households have electricity connection. There is continues supply of electricity with minimum cut off.

## Education

Village have three Aganwadi and one Primary School. Ghayaj village have Higher secondary school private (Aditi Science School)

## Health Care Facility

Any kind of facilities are not present in this Ghayaj village though all are present in padra which is 2 km away from this village.

### ❖ Sakariya Village Details

The total geographical area of village is 422.51 hectares. Sakariya has a total population of 654 peoples. There are about 163 houses in Sakariya village. Vadodara is nearest town to Sakariya which is approximately 12km away.

- **Demography details & Occupational Pattern**
- **Physical Profile**
- **Infrastructure Facility**

## Water Supply

Villages have 5 stand post, 2 hand pumps, 1 water storage tank, river and Lake. Water is provided daily for Five hour. In this village 85% houses have water tap connection.

## Road Network and Transportation

Village have pakka approach road and Kachha approach road. Road width is only 10 feet in gamtal area and road condition is Average. Somewhere is reducing less than 10 feet. Transport facility is quite good enough. GSRTC buses and Private buses Transport facilities are there.

## Sewerage & Storm water Drainage

For Sanitation 90 % of village have covered channels, the water from same is diverted to wastelands in adjoining areas. 90% houses have toilets with septic tank. Water logging is a problem during rainy season in some part of village.

## Solid waste Management

The village has two-safai kamdar whose responsibility is to clean up entire village every day. There is no proper dumping

site for solid waste that collecting solid waste is throne outside village area.

## Electricity Supply

99% households have electricity connection. There is continues supply of electricity with minimum cut off.

## Education

Village have Aganwadi and Primary School only.

## Health Care Facility

Any kind of facilities are not present in this village though all are present in Vadodara which is 12 km away.

## ANALYSIS OF THE STUDY VILLAGES

**Poor sewerage system:** In Ghayaj and Sakariya there is no proper drainage for wastewater. Households themselves make provision to drain it in open field which create unhygienic condition.

**Lack of storm water drainage:** Among the study villages, there is no provision for storm water drain in any villages. All villages have road with hard paving so it help it to drain out. But in some part of villages due to natural slope, condition become more problematic.

**Insufficient Solid waste management:** Each village have two or three-safai kamdar who are the responsible person for clean up the entire village. In these villages conditions shows that poor solid waste collection and major weak point is that dumping site lies near the water body in all study villages. And there is no proper method they follow for waste disposal, which will actually pollute surrounding environment.

**Poor road condition and transport facility:** Among the study villages internal road condition is poor. In some part of villages it is reducing less than 10 feet. And lack of storm water drain is also responsible for damaging the road condition. All study villages located on the main transport corridor so connectivity is quite good, but availability of public transport is less in numbers and very time consuming.

**Insufficient Medical facility:** In Ghayaj and Sakariya have no medical facility at village level.

**Inadequate educational facility with poor infrastructure Facility:** Among the study villages Social infrastructure facility are very weak though it is near to the city area.

**Lack of recreational and social amenities:** Among the study villages community hall need some renovation work with increased population.

### RECOMMENDATION & STRATEGIES

Strategies can be formulated on three different aspects:

- Physical aspect
- Administrative aspect
- Financial aspect

Formulation of Physical strategies:

Particular in these aspect strategies can be formulated through identification of major issues and make some relevant strategies to cope up the problems under particular agencies who provide the service.

### Quality of Life

The level of wellbeing of life style and the physical conditions in which people live. Those aspects of the economic, social and physical environment that make a community a desirable place in which to live or do business. Quality of life factors include those such as "climate and natural features, access to schools, housing, employment opportunities, medical facilities, cultural and recreational amenities, public services, E-Governance".

### Land use Planning

A well-balanced land-use plan must be prepared for each village to regularize the random development and consumption of peri-urban land.

### Water Supply

At present, in these four villages average 93% have water tap connection. The main source of water for various villages in Vadodara District area is the ground water;

being tapped through bore wells or the water supply schemes supported by GWSSB. With the rapid urbanization in the VUDA area water supply schemes are the utmost priority developmental work. GWSSB (Gujarat Water Supply and Sewerage Board) tries all the possible efforts to give pure drinking water to all dwellers of villages by various programs like IWSS (Individual Water Supply System), Sawajal Dhara, Sector Reform with 70 lpcd (considering only drinking water) by individual tap connection.

### Road Network and Transportation

The village roads are kaccha roads or earthen roads which only carry light traffic. It connects to the various City Roads. Village road mainly connects the villages or group of villages with each other for with the nearest road of higher category. Village roads plays and very important role in the development of the rural area. Village roads are generally on method with a single Lane width of stabilized soil or gravel. The responsibility of the construction and maintenance of the rural roads lies with the local district Authorities.

### Earthen Roads

Art and roads are generally constructed with earth materials. These are the kachha road in which Earth is one of the main constituents.

Water bound macadam roads which consist of broken pieces of the stones of varying size which ranges from 25 mm to 75 mm which are laid in three layers on the subgrade. The bigger size pieces of the stones are laid in the bottom course of the road.

Cement concrete road is a rigid pavement which consists of the rigid wearing surface on the top surface of the road.

The lifespan of the concrete road is greater and more durable as compared to Bituminous Road. The repair and maintenance work of the cement concrete road is very difficult due to the rigidity of the concrete.

## Sewerage & Storm water Drainage

There is a lack of adequate sewerage system with adequate treatment and disposal system for any of the outgrowth area.

Therefore, it has given a top priority for a systematic sewerage system with sewage treatment and disposal facilities.

## Solid Waste Management

### Solid Waste:

Solid waste includes wastes from kitchens, gardens, cattle sheds, agriculture, and materials such as metal, paper, plastic, cloth, etc. They are organic and inorganic materials with no remaining economic value to the owner produced by homes, commercial and industrial establishments. Most household waste in rural areas is organic, with little inorganic material, and is non-toxic. Because of its environment - friendliness, composting is a highly suitable method of waste management in rural areas.

### Liquid Waste:

When water is used once and is no longer fit for human consumption or any other use, it is considered to be liquid waste. Wastewater can be sub categorized as industrial and domestic.

- Industrial wastewater is generated by manufacturing processes and is difficult to treat.
- Domestic wastewater includes water discharged from homes, commercial complexes, hotels, and educational institutions.
- According to environment Protection Act 1993- "Waste means any discarded, rejected, abandoned, unwanted or surplus matter, whether or not intended for sale or for recycling, reprocessing, recovery or purification by a separate operation from that which produced the matter."

## Education System

In Education system focus on these are the area below,

- Establish more schools
- Work on school infrastructure
- Bring innovative teaching methods
- Promote computer literacy

- Better training of educators
- Introduction of technology
- Personalize education

There is a growing awareness among people about education; however the lack of infrastructure is being a major obstacle which needs an active intervention of the government.

### ➤ Health Care Facility

In a district, a community health centre (CHC) acts as a referral system and works immediately down below the district hospital, followed by a public health centre (PHC).

The PHC caters to 30, 000 population, followed by the sub centre (SC) at the lowest level. On an average one PHC caters to seven SCs.

1. Sub Centre : Most peripheral contact point between Primary Health Care System & Community manned with one HW(F)/ANM & one HW(M)
2. Primary Health Centre (PHC) : A Referral Unit for 6 Sub Centers 4-6 bedded manned with a Medical Officer In charge and 14 subordinate paramedical staff
3. Community Health Centre (CHC) : A 30 bedded Hospital/Referral Unit for 4 PHCs with Specialized services

## Open Space and Recreation Space

A park for intense and diverse recreational activities which may include, but are not limited to, equipped

A. Gardens & Benches	B. Senior citizen areas	C. Court games, play areas
D. Field games	E. Open space landscaping	F. Picnic tables, picnic area

## E-Governance

Despite the slow deployment, there are lots of e-governance initiatives, which are engaged in the development of the rural area. Different Facility like Kisan Call Center, Gyandoot, Jagriti E-Sewa, E-choupal Akashganga, CRISP, NEGP, NIC, TTK are there.

## Formulation of Administrative strategies:

Villages have limited resources in terms of all aspects. These urban fringe villages falls under Vadodara urban development authority. As part of administrative strategies village development authority can be form under the VUDA. So in

this manner VDA cell will be the responsible body for preparation for the development plan of village. As per prepared plan infrastructure will be provided with the help of relevant state and district level department. VDA will be responsible cell for the coordination in the all aspects with others department.

### **Formulation of Financial strategies:**

Financial strategies can formulate on the basis of revising service charges. Aim is to make the system self-reliant and self-financing at some extent. Financial resources of Villages are various grants at state and central level, revenue from land, service charges, and house tax etc... At some extent user charges can revise in these urban fringe villages against providing sufficient infrastructure facilities.

Thus it will help in improving quality of life and reducing burden on local authority.

- Water charge- Rs. 150 per household per connection.
- House tax- only 1% of house value per year
- Electricity charge-Rs.100 per household per year
- Cleanliness charge-Rs.50 per household per year

## **REFERENCES**

### **Books**

Sinha, M.M.P. *The impact of Urbanisation on Land-use in the Rural-Urban Fringe: A Case Study of Patna*, Concept, New Delhi, 1980.

R.Ramachandran. *Urbanization and Urban Systems in India*. Oxford university press, New Delhi, 1989

Kumar Bimal, *Urbanization and land use conflict at urban fringes*, A.P.H, New Delhi, 1998.

### **Articles**

[Geospatial Application Papers](#), Urban Planning, [Fringe Area Development](#)

Bhatt, Bhasker & Roopawala, Pooja. (2017). Sustainable peri-village in a potential peri-urban area.

D. Singh and P. A. Vyas, "Planning Strategies for the Development of Peri-Urban Area," IJSER, vol. 5, no. 7, pp. 27-32, 2015.

Jagruti shah, "R-Urban town: An approach for the development of fringe villages on Bharuch- Dahej Corridor, Case Study of Gujarat, India, Report, 2012

Urban Development Plans Formulation and Implementation Guidelines (1992), Institute of Town Planners, New Delhi, India

S. Janakarajan, SAWAS Journal.

Albino V., Berardi U., Dangelico R., "Smart Cities: Definitions, Dimensions, Performance, and Initiatives", Journal of Urban Technology, February 2015, 1-19.

Vivek N. Desai, Prof. Jagruti Shah and Gaurav Gohil, Village Development through SAGY: A Review Paper, ISBN No.: 978-93-53463-53-3

### **Reports**

Management Information System (MIS) for the Vadodara Urban Agglomeration, 2000

Revised draft development plan of VUDA 2011. Vadodara Urban Development Authority.

### **Web sites**

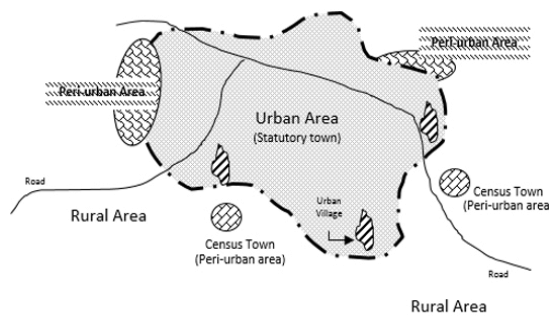
<http://www.irma.ac.in>, "Sustainable settlements in peri-urban areas: with special reference to impacts of transport and energy on natural resources management"

[www.vmc.ac.in/vadodara](http://www.vmc.ac.in/vadodara) municipal corporation (vmc)/may2020

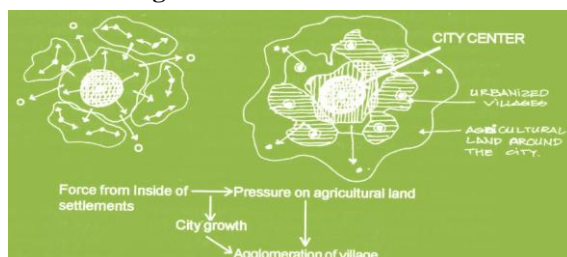
Road & Building Department, (Vadodara District), "Maps of Existing Road Network", Vadodara District.

[www.garvi.gujarat.gov.in](http://www.garvi.gujarat.gov.in)

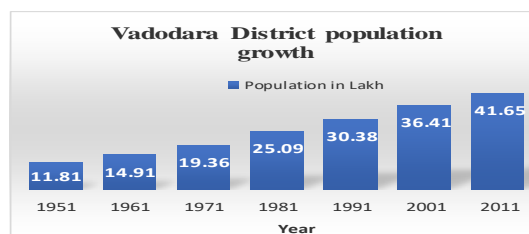
[www.census2011.co.in](http://www.census2011.co.in)



**Figure 1 Peri Urban area**



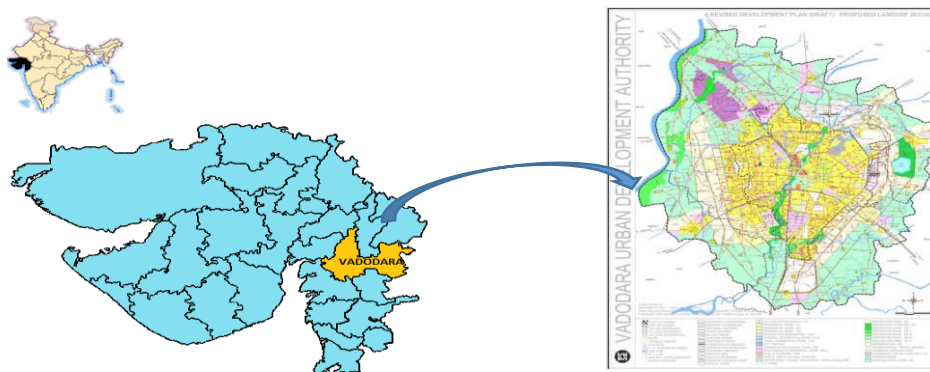
**Figure 2 Fringe Villages**



**Figure 3 Vadodara District Population Growth**



**Figure 4 Delhi Mumbai Industrial Corridors**

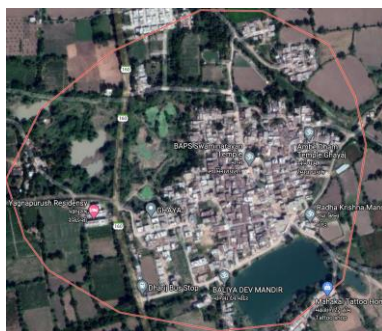


**Figure 5 Map of Vadodara**

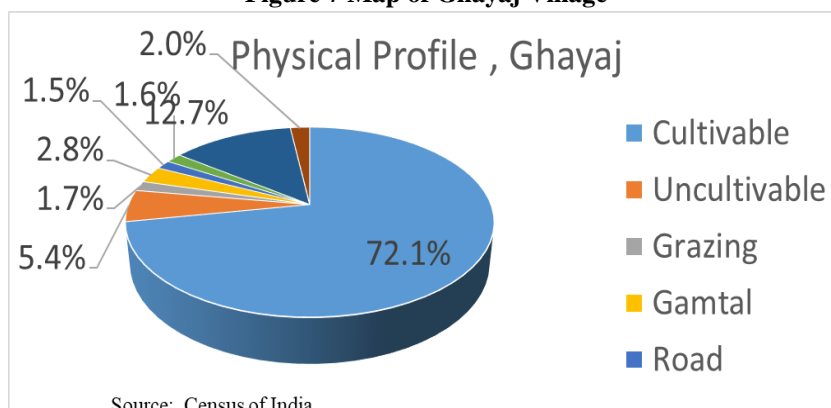




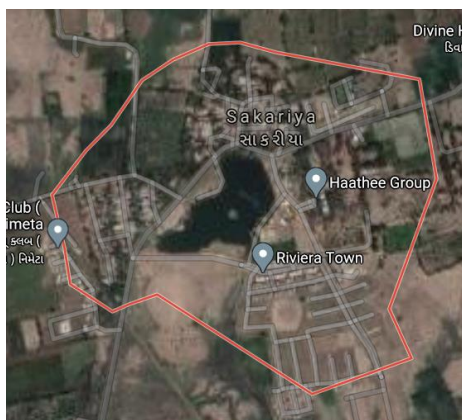
**Figure 6 Location of Study Villages in Vadodara District**



**Figure 7 Map of Ghayaj Village**

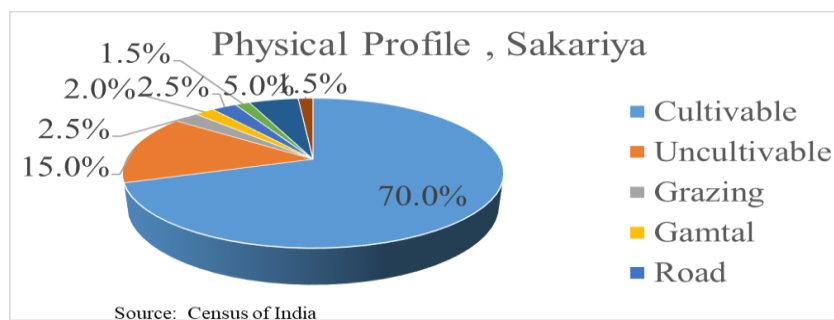


**Figure 8 Physical Profile of Ghayaj Village**

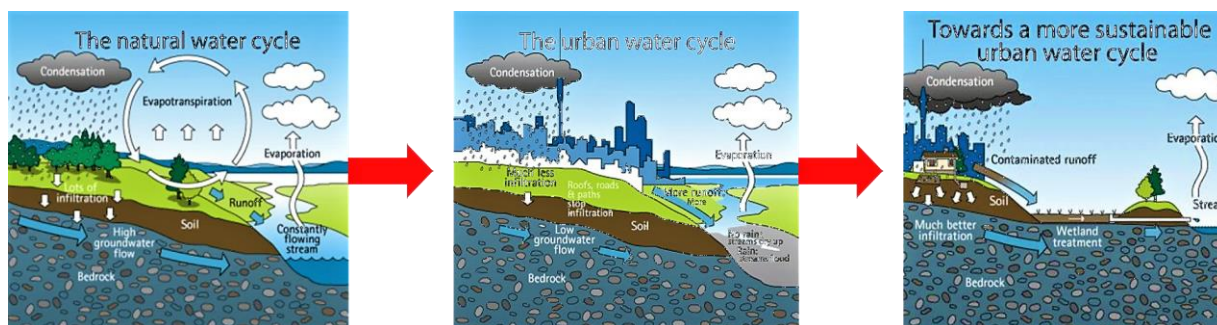


**Figure 9 Map of Sakariya Village**





**Figure 10 Physical Profile of Sakariya Village**



**Figure 11 Storm Water Drainage**



**Figure 12 Solid Waste Management**



**Figure 13 Education System**



**Figure 14 Open & Recreation Space**

**Table No 1 Population of Gujarat and Vadodara**

	No. of Villages	No. of Towns	No. of Households	Population		
				Total	Rural	Urban
India	6,40,867	7,935	24.88	121.02	83.31	37.71
Gujarat	18,225	348	1.21	6.04	3.46	2.57

**Table No 2 Population and area of Vadodara**

Authority	Vadodara District	(VMC)
Area (km <sup>2</sup> )	7546	159.31
Population in 2011 (Lakh)	41.65	17.41
Population in 2021 (Lakh) (Approx.)	43.91	22.4

**Table No 3 Details of Selected Villages**

Village	Taluka	Total No. of Houses	Population			Literacy			Total Workers			Cultivators	Agri. labourer
			Total	Male	Female	Total	Male	Female	Total	Male	Female		
Ghayaj	Padara	594	2667	1399	1268	84.76%	90.95%	78.03%	1237	888	349	143	744
Sakariya	Wagodia	163	654	330	324	87.48%	93.69%	81.21%	246	221	25	33	1

**Table No 3 Details of Villages**

Description	2021	2011	2001	1991	1981
Area of village (in Sq.km.)	7.375	7.375	7.375	7.375	7.375
Total population	3200	2667	2437	2806	2779
Male	1679	1399	1278	1472	1458
Female	1521	1268	1159	1334	1321
Total population (Pop. growth in %)	19.99	9.44	-13.15	0.97	
Population Density (per sq.km.)	434	362	330	380	377
Housing density (per sq.km.)	82.71	80.54	71.19	76.75	75.25
Nos.of Household	610	594	525	566	555
Cultivators	14.02	11.56	21.86	29.72	34.71
Agricultural labourers	56.27	60.15	44.42	42.45	44.22
Other services	29.72	28.29	33.72	27.83	21.08

**Table No 4 Details of Villages**

Description	2021	2011	2001	1991	1981
Area of village (in Sq.km.)	4.225	4.225	4.225	4.225	4.225
Total population	701	654	657	553	542
Male	355	330	332	302	281
Female	346	324	325	251	261
Total population (Pop. growth in %)	7.19	-0.46	18.81	2.03	
Population Density (per sq.km.)	166	155	156	131	128
Housing density (per sq.km.)	43.31	38.58	32.66	29.35	24.85
Nos.of Household	183	163	138	124	105
Cultivators	17.05	13.41	26.25	31.68	38.62
Agricultural labourers	5.68	0.41	3.75	12.38	24.14
Other services	77.27	86.18	70.00	55.94	37.24

**Table No 5 Analysis Data of Villages**

Village Name	Population Details		Population Growth Rate		Population Density (person per sq.km)		Average Household Size	
	Ghayaj	Sakariya	Ghayaj	Sakariya	Ghayaj	Sakariya	Ghayaj	Sakariya
<b>2021</b>	3200	701	19.99	7.19	434	166	4.6	4.9
<b>2011</b>	2667	654	9.44	-0.46	362	155	4.8	4.9
<b>2001</b>	2437	657	-13.15	18.81	330	156	5	4.9
<b>1991</b>	2806	553	0.97	2.03	380	131	5.48	5.14
<b>1981</b>	2779	542	-	-	377	128	5.4	4.96

**Table No 6 Land use break up**

Village Name	Ghayaj	Sakariya
Physical area (Hec.)	737.54	422.51
Cultivable	531.74	295.76
Uncultivable	40	63.38
Grazing	12.56	10.56
Gamtal	21	8.45
Road	11.36	10.56
Tank	12	6.34
Others	93.88	21.13
Non agri.	15	6.34
Distance from gamtal to City centre (in Km)	2	12
On the main corridor	440	400
Inner part	200-225	145-170

**Table No 7 Occupational Pattern**

Nos.	Worker classification	Ghayaj	Sakariya
1	Cultivators	11.56	13.41
2	Agricultural labourers	60.15	0.41
A	Primary	71.71	13.82
5	Industry	3.50	20.50
6	Construction	3.88	4.70
B	Secondary	7.38	25.20
7	Trade & commerce	7.40	3.55
8	Transportation	4.21	6.50
9	Other services	9.30	50.93
C	Tertiary	20.91	60.98
	(B + C)	28.29	86.18

**Table No 8 Issues Identify in Villages**

Village name		Ghayaj	Sakariya
Water Supply		95%	89%
Water Body		Y	N
Roads	WBM	N	N
	RCC	Y	Y
	Tar	Y	Y
	Gravel	Y	Y
	Stone paving	Y	Y
Sewerage & Storm water Drainage		80%	90%
Toilet Facility		97%	98%
Solid waste management:		N	N
Electricity		Y	Y
Transport facility		Y	Y

Education facility	Aganwadi	Y	Y
	Primary School	Y	Y
	Secondary School	N	N
	Higher Secondary School	Y	N
	Collage	N	N
Health Care Facility	Dispensary	N	N
	sub- PHC	N	N
	PHC	N	N
	Nearer Village	Padra	Vadodara
	Distance	2 km	12 km
Open & recreational spaces		N	N
Social amenity	Available with not enough facility		
Garden		N	N
Community Hall	Available with not enough facility		
Internet		Y	Y
Governances		Y	Y

Note: - Y for Yes (This Facility in this village is available) and N for No (This Facility in this village is not available).

**Table No 9 Formulation of Physical strategies**

Summarization of Problems (Issues)	Strategies	Responsible agency
Inadequate water supply with poor distribution systems.	Water tap connection for every household.	GWSSB
Poor sanitation and sewerage system.	Toilet for every household. In some case community toilet facility based on household size may work also. Grouping some houses and works out covered channel for rest of the houses.	
Lake of storm water drainage	Identify location of flooded area and try to incorporate natural slope for water disposal.	
Poor road condition and transport facility.	Identification of poor road condition and stage wise improvement.	GSRDC
Insufficient Medical facility	Revising norms for identification of sub PHC center and improvement in facility.	Zilla panchayat
Inadequate educational facility with poor infrastructure.	Incorporate requirement of school as per population size. Revision in supportive basic infrastructure services.	
Insufficient Solid waste management	Identification of proper dumping site for waste and for disposal also. Solid waste collection at every point of street.	Gram panchayat
Lake of recreational and social amenities	Provision of recreational facility on the basis of public priority, needs.	

**Table 10 Health Care Facility Norms**

Centre	Population Norms	
	Plain Area	Hilly/Tribal/Difficult Area
Sub Centre	5000	3000
Primary Health Centre	30,000	20,000
Community Health Centre	1,20,000	80,000

Source: <https://vikaspedia.in/health/health-directory/rural-health-care-system-in-india>

# Entrepreneurial Readiness of Women Students Studying in Indian Technical Institutions

**Archana M S**

Department of Higher Education ,  
Government of Karnataka,  
Bengaluru

**Dr. VijayaKumar M N**

Department of Industrial Engineering  
and Management,  
R V College of Engineering,  
Bengaluru

**Dr. M S Shyamasundar**

National Assessment and Accreditation  
Council, Bengaluru

## Abstract

This paper focuses on entrepreneurial readiness of potential women students who are willing to take up entrepreneurship as their career. It is believed that entrepreneurship taken as career at an early age is the current trend amongst the young people studying in technical institutions in India. Many studies have shown that the economic development of a country increases by the participation of the women youth population as entrepreneurs. Many research in the past has focused on entrepreneurial intentions but very few literature are there about entrepreneurial readiness. This paper presents the results of a pilot study designed to examine entrepreneurial readiness among the women students studying in technical education in India. To measure the Entrepreneurial Readiness of Women Students, a survey questionnaire that collects the demographic data as well as the antecedents effects on entrepreneurial readiness using 5-point Likert scale was administered. Data analysis of the pilot study is based on 133 completed responses. The results showed some insights about entrepreneurial readiness among the women students studying in technical institutions of India but further larger study may yield a better representation of women youth population having entrepreneurial readiness. The results of this pilot study helps policy makers of technical institutions to better formulate the entrepreneurial education in the campus that fosters entrepreneurship in women students.

**Keywords:** Women youth entrepreneurship, entrepreneurial readiness, Technical Institution

## Introduction

To build a strong healthy economy, developing countries like India should focus on strengthening entrepreneurship initiatives. Entrepreneurs play an important role in the developing of a nation by bringing out creative ideas into practice and also by providing employment that would eradicate poverty and unemployment. In a country like India, where women form half of the population, it becomes imperative to encourage women by educating them and providing support financially to become entrepreneurs. Today in India there are more than 6000 technical institutions with more than 2.6 Million students graduating every year. Only a handful of them especially women students turn out to be entrepreneurs. The fundamental question here would be to know why the number of

students getting into entrepreneurship are low? Are there students aspiring to become entrepreneurs but don't have enough support and resources to stride the path of entrepreneurship basically indicating that they are not ready to take up entrepreneurship. In recent days, women students have received more medals and accolades in education. Leveraging their skills and talent by providing proper mentorship would lead to more and more successful women entrepreneurs. There is a need to provide such ecosystem in the technical institutions for women students who have strong entrepreneurial intentions and are ready to become entrepreneurs. This paper focusses on measuring the entrepreneurial readiness of women students studying in technical institutions by focusing on availability of technical

support, financial support and social support. A pilot study was conducted using a 5 point Likert scale that was administered for 133 women students studying in technical institutions in India.

The readiness for entrepreneurship can be measured in the students when they are in college and should be allowed to explore this area by providing proper guidance and mentorship at the institution. Off late the importance of self-sufficient (Atma Nirbhar Bharat) initiative has been in limelight and a lot of individuals are looking into striding the entrepreneurial path. Women students should be encouraged to take up the challenges of entrepreneurship and ecosystem in the campus should support them to become successful Women Entrepreneurs. The readiness for entrepreneurship in general applies to those individuals who have high entrepreneurial intentions displaying qualities such as risk taking ability, positive attitude, leadership, team building capabilities and analyze their ecosystem in bringing out their creative ideas turning into usable products or services.

### Review of Literature

Women empowerment should start with encouraging them in science and technology (S&T). As science progresses, the contribution of the women and women entrepreneurs plays a vital role. Women students are doing really well and with little encouragement women can overcome any barriers to become a successful entrepreneurs. Family responsibilities, gender bias, lack of education, low in confidence, financial issues are some of the main challenges of women entrepreneurship. Many government schemes are made available to encourage women entrepreneurs. (Chaudhary 1995). Young graduates should show the enthusiasm in getting into social entrepreneurship and give back to the society. Defourny et.al. 2001 have

talked about how social entrepreneurship aims at serving community or specific group of people, or it could be group of people who have the same interest in solving a societal issue. Social enterprises work with limited profit distribution. (Defourny et.al. 2001) Many literature on the entrepreneurship revealed no specific tool to measure the entrepreneurial readiness of a women student in technical education. Coduras et al. 2016 built an instrument to estimate the readiness of entrepreneurship considering social, psychological, managerial as the factors. (Coduras et al.2016) Maximum scope for growth and opportunity can be achieved if entrepreneurship is taught and encouraged in technical education or at undergraduate level in institutions. Entrepreneur not only earns, the right way of looking at entrepreneurship would be entrepreneurs is that they learn while they earn. This is a real motivating factor for any entrepreneur as the knowledge and skills he/she develops while owning the enterprise are their assets for life time which usually is lacking when a person is an employee. (Subramanya et al. 2019)

### METHODOLOGY

#### THEORETICAL FRAMEWORK

Figure 1.1 below shows the Theoretical framework for Entrepreneurial Readiness of Women Students in Technical Institutions. The framework contends that Social, Financial, Technical, and Institution support have an influence on entrepreneurial readiness. **Social Support** refers to the normative behaviour of the people surrounding the aspirant and completely supporting the aspirant in his/her entrepreneurial journey. It could be the close family members, friends and in some cases peer group of the aspirants influencing their entrepreneurial readiness. In the case of women students, it becomes imperative that they get full support of their family members and

friends, if the girl child wishes to take up entrepreneurship.

**Financial Support** refers to the schemes offered by the Government and financial institutions providing working capital for small scale or large scale start-ups. Awareness about state government start up schemes, Venture Capitalists who can support the creative ideas and funding that would impact the entrepreneurial readiness. **Technical Resources** refers to having the right resources who are technical sound. Any idea has to be translated in terms of usable products or services and to make this happen technical resources play a major role. It becomes imperative to have good technical resources who can support the aspirants to convert their ideas into reality that would also indicate the entrepreneurial readiness. **Institution support** providing mentorship programs and courses related to entrepreneurship might have an influence on the entrepreneurial readiness of women students. Many institutions have incubation cell that helps the aspiring women students to incubate their ideas in the campus where such candidates can leverage the lab and other campus facilities.

### Measure and Instrument

All scales in this study were measured on 5 point Likert scale ranging from 1 with "not at all accurate" to 5 with "very accurate". Literature Review revealed many different models testing the entrepreneurial intentions (EI) however, very few literature talks about entrepreneurial readiness (ER). This theoretical framework focusses on measuring the entrepreneurial readiness (ER) against the four factors such as Social, Financial, Technical and Institutional Support as shown in Table 1.3 below.

### Data Collection

Data were collected from a sample of 133 women students studying in Technical Institutions in India. Due to the prevailing pandemic, self-administered questionnaire were delivered to the respondents through online mode. Out of 137 questionnaires, 133 questionnaires deemed usable for analysis with a response rate of 97.08%. Instrument showed a positive Cronbach's Alpha (reliability co-efficient) for all the factors ranging from 0.814 for institution support to 0.828 for Entrepreneurial readiness.

### RESULTS AND CONCLUSION

This section provides a detailed description of the respondents who are women students studying in technical education considered for pilot study. Overview of the demographic variables is also shown in the table 1.1. On the analysis of the above table with reference to the region, South region constituted highest score of 94.74%, North constituted score of 4% while West & Union Territories constituted the lowest & similar score of 1%. With reference to the Domain/Streams of the Women Students in Technical Education who have responded to the survey are as follows: Electronics, Electrical and Telecommunication (EEE/EEC/TC) achieved the highest score of 38%, Other categories like chemical, Biotech achieved an almost equal score of 37%. While Mechanical, Industrial Engineering and Management, Industrial Production (ME/IEM/IP) achieved 23%. Information Technology, Computer Science, Information Science (IT/CSE/ISC) achieved the lowest score of 2%. 74% of the Women Students who responded to the survey were not from business family, while other 26% of them were from business family. With reference to Father's Occupation of these women students, 29% of them were Business, 22% of them were Salaried, 18% of them were Govt,



Employed while only 11% of them were Professional, others constituted 20%. With reference to Mother's Occupation, Others achieved the highest score of 72%, Salaried & Govt. Employed achieved the similar score of 8%, Professional achieved the score of 6% while Business achieved the lowest score of 6%. Majority of Father's Education of these women students were undergraduate at 36%, 23% of them had education of PUC/Diploma, 25% of them were Post graduate while only 8% of them were Professional and Others achieved the score of 8%. Majority of Mother's Education was 37% of them were Under graduate, 22% of them were PUC/Diploma, 25% of them were Post graduate while only 5% of them were Professional and Others at 11%. Women students exposed to entrepreneurship are from 1st year achieved the score of 28%, 2nd year achieved the highest score of 29%, 3rd year achieved the score of 14%, while 4th year achieved the lowest score of 8%, No exposure achieved the score of 21%. With reference to Incubation Cell, yes achieved the highest score of 87% while NO achieved the lowest score of 13%. Many Women Students took a neutral stand on these factors that indicates that they are not quite ready for picking up entrepreneurship as their career right out of college. While Social, Technical and Institutional factors are highly significant and Financial support did not matter

much. In the table 1.3 shown above, the Kaiser-Meyer-Olkin (KMO) test value obtained is 0.88 that indicates that the sample chosen for the pilot study is adequate. This KMO is a very helpful metric gathered during the factor analysis. RMSR value is 0.0649 and Eigen value is greater than 1.

As shown in Fig 1.2 , 27% of the women students would like to join a start-

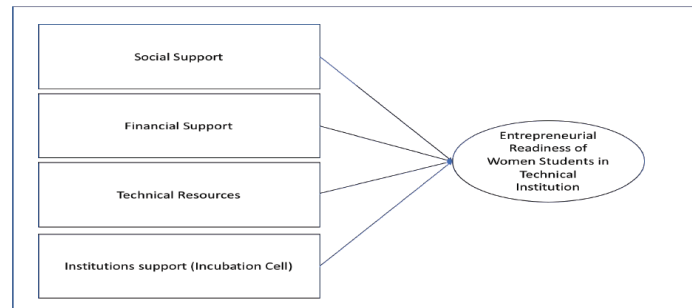
up to get experience in becoming entrepreneur versus 6% who want to choose entrepreneurship as their career right out of college , while equal percentage of students want to join core company in their domain. The pilot study indicated that more data collection might help in understanding the entrepreneurial readiness of Women Students studying in Technical Institutions.

## REFERENCES

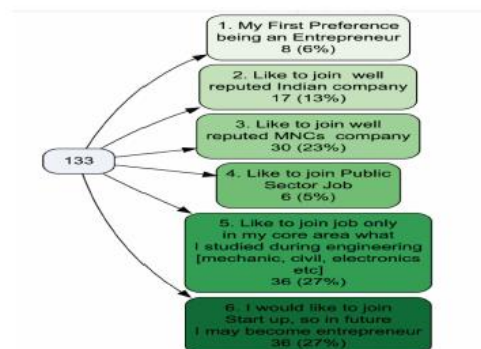
- Adnan Iqbal, Yahya Melhem, Husam Kokash, "READINESS OF THE UNIVERSITY STUDENTS TOWARDS ENTREPRENEURSHIP IN SAUDI PRIVATE UNIVERSITY: AN EXPLORATORY STUDY", European Scientific Journal, July edition vol. 8, No.15 ISSN: 1857 – 7881 (Print) e - ISSN 1857- 7431
- Alicia Coduras, José Manuel Saiz-Alvarez, Jesús Ruiz, "Measuring readiness for entrepreneurship: An information tool proposal", Journal of Innovation & Knowledge 1 (2016) 99–108
- Baker, E. W., Al-Gahtani, S.S., Hubona, G. S. (2007) The effects of gender and age on new technology implementation in a developing country: Testing the theory of planned behavior (TPB), Information Technology & People, 20(4), pp.352 – 375
- Bjerke, B. (2007) Understanding Entrepreneurship, Edward Elgar Publishing Ltd, Cheltenham
- Block, J. H., Kohn, K., Miller, D., & Ullrich, K. (2015). Necessity entrepreneurship and competitive strategy. Small Business Economics, 44(1), 37–54.
- Chaudhary P (1995) Women's Education in India: Myth and Reality,



- Haranand Publication, New Delhi, pp. 27–48
- Christos A , “The role of higher education in enhancing social entrepreneurship”, *Int. J. Social Entrepreneurship and Innovation*, Vol. 1, No. 2, 2011
- Defourny, J. and Nyssens, M. (2006) ‘Defining social enterprise’, in Nyssens, M. (Ed.): *Social Enterprise – At the Crossroads of Market, Public Policies and Civil Society*, Routledge, London, pp.3–26
- Giannetti, M., & Simonov, A. (2004). On the determinants of entrepreneurial activity: Social norms, economic environment and individual characteristics. *Swedish Economic Policy Review*, 11, 269–313
- Krueger, N.F. (1993). The impact of prior entrepreneurial exposure on perceptions of new venture feasibility and desirability, *Entrepreneurship Theory and Practice*, 18(1), Pp. 5-23.
- Krueger, N. F., Reilly, M. D. & Carsrud, A. L. (2000), Competing models of entrepreneurial intentions, *Journal of Business Venturing* 15 (5-6), 411–432.
- Porter, M. E. (2012). Entrepreneurship and Competitiveness: Implications for Saudi Arabia, *Global Competitiveness Forum*, Available on, [http://www.isc.hbs.edu/pdf/20120124\\_SaudiArabia\\_GCF.pdf](http://www.isc.hbs.edu/pdf/20120124_SaudiArabia_GCF.pdf) [Accessed on 13/04/2012].
- Postigo S, Iacobucci D, Tamborini MF (2006). Undergraduate students as a source of potential entrepreneurs: a comparative study between Italy and Argentina. In: Fayolle A, Klandt H (eds) *International entrepreneurship education, issues and newness*. Edward Elgar Publishing Limited, Cheltenham, pp 218–240
- Subramanya. K.N, Narahari. N S, Nagendra Guptha C. K, Archana M S, “Institutionalizing Entrepreneurship Education and Innovation Systems - A Case Study of an Institution in the Area of Technical Education”, *NATCON conference*, 2019



**Figure 1.1 : Theoretical Framework for Entrepreneurial Readiness**



**Figure 1.2: Career Preference of Women Students Studying in Technical Education**

## 4a. Descriptive analysis: General Demographic

Demographic Profile	count	percentage
Region.North	5	3.76
Region.South	126	94.74
Region.Union Territories	1	0.75
Region.West	1	0.75
Stream.EEE/EEC/TC	50	37.59
Stream.IT/CSE/ISC	3	2.26
Stream.Mechanical/IEM/IP	30	22.56
Stream.Others	50	37.59
Biz_Family.No	98	73.68
Biz_Family.Yes	35	26.32
Fr_Occupation.Business	38	28.57
Fr_Occupation.Govt. Employed	24	18.05
Fr_Occupation.Others	28	21.05
Fr_Occupation.Professional	14	10.53
Fr_Occupation.Salaried	29	21.80
Mr_Occupation.Business	7	5.26
Mr_Occupation.Govt. Employed	11	8.27
Mr_Occupation.Others	96	72.18
Mr_Occupation.Professional	8	6.02
Mr_Occupation.Salaried	11	8.27
Fr_Education.Others	11	8.27
Fr_Education.Post graduate	34	25.56
Fr_Education.Professional	10	7.52
Fr_Education.PUC/Diploma	30	22.56
Fr_Education.Under graduate	48	36.09
Mr_Education.Others	15	11.28
Mr_Education.Post graduate	33	24.81
Mr_Education.Professional	8	6.02

Table 1.1: Demographic Profile of Women students studying in technical education. (Respondents)

Factors	1- Strongly Disagree	2	3	4	5- Strongly Agree
Social	12.4%	20.5%	35.5%	20.3%	11.3%
Financial	26.7%	29.9%	25.2%	12.6%	5.6%
Technical	14.7%	22.9%	33.8%	18.8%	9.8%
Institutional	10.5%	16.5%	35.3%	21.8%	16%

Table 1.2: Survey analysis based on Factors

Key Statistics	Obtained_value
KMO	0.88
RMSR	0.0649678670239808
CorrRMSR	0.0493831769345677
TLI	0.929385541670213
Fit	0.903907268237747
Extraction	ML
Rotation	oblimin
Eigen value	>1
No_Factors	2
Communalities	>.5

Table 1.3: Factor and Reliability test

# Crisis Management Strategies Adopted by Micro and Small Enterprises during the Covid Pandemic

**Dr. S.R.K Prasad**  
Coimbatore Institute of  
Technology,  
Coimbatore.

**Dr. John R Raj**  
Coimbatore Institute of  
Technology,  
Coimbatore.

**Dr. R. Jayanthi**  
Coimbatore Institute  
of Technology,  
Coimbatore.

**Dr. S. Gokul Kumar**  
Coimbatore Institute of  
Technology,  
Coimbatore.

## Abstract

The present study aimed at analyzing the various crisis management strategies adopted by 10 micro and small enterprises located in Coimbatore during pandemic.

Qualitative approach has been adopted along with the case study method.

The study results stated that majority of the firms are considering the unexpected crisis planning as important which are impacted by the pandemic in terms of stocking all their produced items in warehouses due to lack of demand, reduced production, labour shortage, inability to meet new customers, lack of regular income, lack of raw material supply and losing their investments due to lack of sales as people are preferring for necessities alone at present.

The study firms have advised the new firms to include crisis management strategies in their initial planning phases and insisted on the importance of technology in managing the business during the pandemic situation.

This study aids in analyzing the various levels of impact created by Covid pandemic on the Micro, Small and Medium Enterprises located in Coimbatore city which helps the business enterprises, economy and Government to manage and revive their business in this competitive market.

**Key Words:** Crisis Management Strategies, MSMEs, Pandemic, COVID 19.

## INTRODUCTION

An economy consists of several sectors and development of all these sectors contribute significantly to the overall economic development of a nation. The growth of an economy is measured in terms of various factors and one such important determinant is the total production made by all the sectors during the year across the country (i.e., Gross Domestic Product). The Micro, Small and Medium Enterprises (MSMEs) play a huge role in the economic development of all countries. Almost 30% of the total GDP in India is contributed by all the MSMEs functioning in our country. The role of MSMEs and its contribution to the national GDP was 30.00% in 2011-12 followed by 30.40% in 2012-13, 30.20% in 2013-14, 29.70% in 2014-15, 29.20% in 2015-16 and 28.90% in 2016-17 respectively.

The Indian economy is termed as developing economy which stands at the 6<sup>th</sup> position in terms of Nominal GDP and holds the 3<sup>rd</sup> position depending on the Purchasing Power Parity (PPP) across the globe. The total number of MSMEs in India counts to 63.39 million as of 2020. In India, Tamilnadu holds 3<sup>rd</sup> highest number of MSMEs (9.6%) after Uttar Pradesh (11.3%) and West Bengal (9.9%). Further it holds 15.24% of India's micro enterprises along with 23.60 lakh registered MSMEs as of 2021 which generate a total employment of 151.61 lakhs in the state. The state witnessed an overall investment of Rs.2.73 lakh crores in MSMEs which offers 6000+ products and the Government of Tamilnadu has allotted more than 8000 acre land in 122 estates of Small Industries Development Corporations (SIDCO) as of 2021.

In Tamilnadu, Coimbatore stands at 2<sup>nd</sup> position next to Chennai, with a geographical size of 642.12 km<sup>2</sup> (247.92 sq mi) and well-known for the export of jewelry, pumps, motors, poultry, wet grinders, defence and auto components among other business enterprises. Further, the district is known as the Manchester of South India due to the textile hubs it holds and was ranked as 7<sup>th</sup> best city across the country by the Ease of Living Index in the year 2020. Coimbatore city has a total of 1,08,077 MSMEs (10.64%) as of 2019-20 with an estimated investment of Rs.16,51,273 lakhs which generate employment to 7,09,101 persons and stands at 2<sup>nd</sup> position after Chennai which has a total of 1,82,814 MSMEs (18.00%) with the investment of Rs.23,51,338 lakhs along with the employment of 13,07,235 persons.

The present study aimed at analyzing the various crisis management strategies adopted by 10 micro and small enterprises located in the Coimbatore city during the Covid pandemic situation. The main focus of the study was laid on examining the competitive strategies, importance of planning for unexpected crisis, impact of pandemic on their business operations, revenue loss sustained during pandemic, processes deployed to identify the strategies, crisis management plans, components of crisis management, impact of unexpected crisis planning on the business success and effectiveness of technology in tackling the pandemic. Based on the study findings, suggestions have been given for the new business units which are entering / planning to enter the market shortly and the approximate time period in which all the market conditions will come back to normal post pandemic.

### **PROBLEM STATEMENT**

The role of an economy is inevitable in the development of a nation.

The growth of an economy depends on the overall improvement in all sectors of the country which includes agriculture, forestry, auto components, automobile, aviation, fintech, financial services, biotechnology, capital goods, chemical, construction, defence, electronic systems, food processing, healthcare, information technology, business process management, leather, media, medical devices, metals, mining, oil & gas, pharmaceuticals, ports & shipping, railways, renewable energy, retail, e-commerce, roads & highways, telecommunication, textiles & apparel, thermal power, tourism and hospitality. The success or failure of these sectors creates a huge impact on the well-being of the society. The micro and small enterprises contribute tremendously to the growth of all the sectors of the economy. In recent times, the entire world has faced a lot of challenges due to the Covid 19 pandemic which created serious problems for all the micro and small enterprises functioning in the society. These micro and small enterprises need to adopt proper crisis management strategies to survive and come up during these difficult times. Hence, an attempt has been made to analyze the various crisis management strategies adopted by micro and small enterprises during the Covid pandemic in Coimbatore city.

### **RESEARCH QUESTIONS**

What are the problems faced by micro and small enterprises during the Covid 19 pandemic?

What are the crisis management strategies adopted by micro and small enterprises during the Covid 19 pandemic?

What are the preventive measures to minimize the impact of Covid19 pandemic on micro and small enterprises?

### **RESEARCH OBJECTIVES**

To analyze the various problems faced by micro and small enterprises during the Covid19 pandemic

To examine the crisis management strategies adopted by micro and small enterprises during the Covid 19 pandemic

To know the preventive measures to minimize the impact of Covid 19 pandemic on micro and small enterprises

### **Significance of the Study: - Write up about importance of the topic**

The micro and small enterprises play a crucial role in the development of an economy and its performance contributes hugely to the overall development of a nation. The impact of Covid 19 pandemic is very vast at the global level resulting in the decline of GDP to an extent of 4.5% in most major economies in the world. In Indian economy, the impact of pandemic was estimated at 85 billion rupees on aviation and tourism sector apart from the other sectors which includes food & agriculture, telecom, pharmaceuticals, oil and gas sectors of our country. This has a much higher impact on the micro and small enterprises in Coimbatore city also in terms of lack of demand from customers, problems in supply chain and other restrictions imposed due to the fear of Covid 19 pandemic. Hence, it paved the way to analyze the various problems faced during Covid 19 pandemic, crisis management strategies and preventive measures to be followed by micro and small enterprises to overcome the impact of Covid pandemic.

### **Research Design: - Qualitative Research – Case Study Method**

Since the focus of the present study is examining the various crisis management strategies adopted by micro and small enterprises during the Covid pandemic, it is essential to know the viewpoints of small sized firms which are

affected by the pandemic. Further, a qualitative approach has been adopted along with the case study method which serves the purpose of present study. Hence, 10 micro and small sized firms functioning in Coimbatore city have been identified for the study which is from diverse backgrounds namely textile, oil, automobile, cotton and leather industry. The various crisis management strategies adopted by the study firms have been analyzed and necessary suggestions have been put forth for the new firms who are about to start / planning to start their business operations in the near future post pandemic.

### **Primary and Secondary Data Collection: - Survey Instrument Design / Secondary Sources**

The study has been carried out based on the primary data collected from 10MSMEs functioning in the Coimbatore city. Further, the secondary data has been collected from various annual reports published by the Government of India, Government of Tamilnadu, other published reports on the performance of MSMEs and previous research publications.

### **Limitations of the Study**

The sample size is restricted to 10 micro and small enterprises only

The geographical location of the study is restricted to Coimbatore city alone.

### **LITERATURE REVIEW: - WRITE UP WITH VALID AND RECENT CITATIONS**

**Yogesh D Mahajan (2020)<sup>1</sup>** analyzed the impact of coronavirus pandemic on small and medium enterprises (MSMEs) in India. The study aimed at analyzing the impact of the coronavirus pandemic on MSMEs as a whole followed by its impact on SME employment and to suggest preventive measures to improvise the prevailing

situation of MSMEs in our country. The study was based on secondary data collected from various sources namely blogs, websites, newspapers and magazines in India. Further, the study was focused on examining the present situation of the manufacturing industry and the impact of pandemic on its employment. The study results stated that the biggest problems faced by MSMEs were reduction in demand and shattered supply chain throughout the industry. The study suggested that proper protection procedures need to be introduced followed by necessary sanitation, methods of sanitization, new policy for updated sourcing of information, registering with new vendors for the supply of materials, restructuring the product portfolio, revamping the supply chain and evaluating the disaster or contingency business plans.

**Ruochen Dai, HaoFeng, Junpeng Hu, Quan Jin, Huiwen Li, Ranran Wang, Ruixin Wang, LiheXu and Xiaobo Zhang (2020)**<sup>2</sup> examined the impact of Covid-19 on small and medium-sized enterprises: evidence from two-wave phone surveys in China during 2020. The study was focused on analyzing the impact of Covid-19 on 2508 MSMEs present in the country which was collected through 2 surveys in February and May, 2020. The study results stated that the MSMEs faced many problems due to Covid-19 namely labour shortage, logistics issue, raw material shortage, and demand reduction, lack of export, financial challenges and bankruptcy during the pandemic. Further, the study insisted that these problems need to be addressed at a faster rate so as to ensure the proper working of all developing economies in the world.

**MohsinShafi, Junrong Liu and WenjuRen (2020)**<sup>3</sup> studied the impact of Covid-19 pandemic on micro, small, and

medium-sized enterprises operating in Pakistan. The study focused on examining the various effects of Covid-19 on 184 MSMEs functioning in the country through an online questionnaire and to suggest measures for reducing the business loss as well as to survive in the pandemic. The study results indicated that the majority of the MSMEs were affected sternly and faced many problems namely financial issues, supply chain blockages, decreased demand resulting in reduced sales and profit during the pandemic. Further, the study suggested that the employees need to be protected from losing their jobs, accurate information need to be provided for making better decisions during pandemic, economy need to be boosted to overcome these difficult times, the Government should provide income and employment support to the MSMEs, and it should assist MSMEs to improve planning and resilience capability to face the difficulties arising in the pandemic.

**Krishnarajapet V Ramaswamy (2020)**<sup>4</sup> investigated the impact of Covid-19 on micro, small and medium enterprises in India along with the pandemic shock of Covid-19 and policy response – a bird's eye view during 2020. The study aimed at identifying the effect of Covid-19 on MSMEs and to analyze the extent to which the pandemic has affected the MSMEs in India. The study results evidenced that the MSMEs faced many problems due to the pandemic namely payment of wages and salaries, delayed payments from the customers, decrease in sales and profit, etc. Further, the study stated that various relief packages were offered by the Government in the name of relaxing tax returns and due dates, reducing the cost of credits offered by banks and special packages to offer collateral free loans to MSMEs. It was also observed that the commercial banks are

highly reluctant to offer loans to the MSMEs in these difficult times which may lead to increase in their respective non-performing assets (NPAs).

**Noor FzlindaFabeil, Khairul Hanim Phazim and Juliana Langgat (2020)<sup>5</sup>** inspected the impact of Covid-19 pandemic crisis on micro enterprises with reference to entrepreneurs' perspective on business continuity and recovery strategy during the pandemic in 2020. This study aimed at examining the crisis experience of two micro level enterprises functioning in the rural area of Sabah, Malaysia and the various business decisions taken for their business survival during the pandemic. The study was carried out through the unstructured telephonic interview which gave the required data related to survival approach of businesses and the various recovery plans adopted by them. The study results stated that the micro enterprises need to adopt several business recovery strategies such as product delivery, marketing, utilizing the economic stimulus funds offered by the Government. Further, it stated that assistance and support facilities should be offered to the micro enterprises to manage the crisis effectively. In addition to that, the basic business knowledge in terms of product delivery procedures, online marketing techniques, new product development, pricing and costing strategies will help the micro enterprises to recover from the pandemic.

**Nomita Sharma (2020)<sup>6</sup>** examined the challenges and opportunities for small and medium enterprises during Covid-19 in India. The study focuses on analyzing the various problems faced by MSMEs along with the opportunities provided during the pandemic in our country. The study results revealed that the MSMEs faced various challenges during these difficult times namely maintaining the business continuity, motivating the

employees, filling up the shortages in raw materials and other goods / services, maintaining the cash flow in business, managing their corporate image among others. Further, the results stated that the MSMEs need to develop ways for social distancing from customers in the market, draft policies for managing disaster, utilize technology for managing the business, innovate the business with lot of new things and adopt for retrofitting by manufacturing the things which are most needed by the present market, so as to manage the pandemic in a better way.

**Alves Jose C, Lok Tan Cheng, Luo Yu Bo and Hao Wei (2020)<sup>7</sup>** scrutinized the crisis management for small business during the Covid-19 outbreak in terms of business survival, resilience and renewal strategies of firms in Macau, China. The study focused on the crisis management followed by 6 small business units and the various strategies adopted by them to manage their business during the pandemic. The study results evidenced that the spontaneous reduction demand has created a high impact on all the small firms considered for the study. Further, it was found that small firms and new startups were able to show higher flexibility when compared with large firms in terms of low level operations and social responsibility compliance. In addition to that, it was also found that the firms had adopted flexible HR strategies along with other response strategies namely diversifying their product line, exploring untouched markets and developing the market learning aspect to manage the business during the crisis.

**Rahul Ranjan (2020)<sup>8</sup>** analyzed the challenges and opportunities of India's micro small medium enterprises in the new era of post Covid in India. The study aimed at analyzing the various problems faced by MSMEs and the possible chances of exploring the untouched areas



by using the NSS 73<sup>rd</sup> round data and Annual Survey of Industry (ASI). The study results stated that 16.1% (3.2 million) enterprises are registered in manufacturing followed by 38% (16.6 million) in services throughout the country. Further, it was noted that the registered enterprises were granted 98% of the total loans sanctioned whereas it was only 2% in case of unregistered firms. The results of regression analysis revealed that the variables such as modernization, number of skilled workers, environmental monitor variables and registration of firms had a positive impact on the output of MSMEs. In addition to that, the large scale enterprises need to make necessary changes in their structure so as to facilitate employment opportunities at the higher level and utilize the services of MSMEs to promote them in future.

**PravakarSahoo and Ashwani (2020)<sup>9</sup>**, studied the Covid-19 and Indian economy with reference to the impact on growth, manufacturing, trade and MSME sector in India. The present study aimed at examining the various impact of Covid-19 on the economic growth, manufacturing, trade and MSME sectors operating in the country followed by suggesting important control measures for managing the fall in economic development. The study results portrayed that the Covid-19 had impacted severely in all sectors including MSME and predicted the impact as 5.5 to 20% fall in manufacturing sector followed by 13.7% to 20.8% in exports, 17.3% to 25% in imports and the net value added of MSME sector to be 2.1% to 5.7% in 2020. Further, it also stated that more focused and forceful fiscal-monetary measures to be taken by the Government to manage the impact of Covid-19 on the Indian economy.

**Dovie Wilson (2016)<sup>10</sup>**, investigated the small business crisis management strategies in the USA. The

study focused on examining the various crisis management strategies adopted by small business owners with a view to survive during the unexpected interruption in their business operations. The study results revealed that the small business units need to develop effective processes for surviving the crisis followed by transparency, communicating openly and building relationships to improvise the business survival during crisis time and need to think creatively so as to overcome the resource crunch faced by the small business units. Further, the study suggested the small firms to secure themselves in adequate manner with insurance coverage, make necessary investment in the compensation policy of workers, develop healthy relationship with the competitors to detect various other business locations, keeping constant back of technology data during emergency, following transparency in communicating with both vendors and customers, ensuring adequate training for employees to work effectively and having emergency funds throughout the business life for managing the contingencies regularly.

### **Micro, Small and Medium Enterprises (MSMEs):**

According to the Ministry of Micro, Small and Medium Enterprises, Government of India, any manufacturing or service enterprise whose investment in plant and machinery or any equipment is estimated to be less than Rs.1 Crore whereas the annual turnover should be less than Rs.5 Crores is termed as "Micro Enterprises". Further, those enterprises whose investment in plant and machinery falls within the range of Rs.1 Crore to less than Rs.10 Crores along with an annual turnover of Rs.5 to Rs.50 Crores are called as "Small Enterprises". Finally, those enterprises having an investment of over Rs.50 Crores in plant and machinery

along with an annual turnover of Rs.50 Crores to Rs.250 Crores are known as "Medium Enterprises".

### **Categories of MSM Enterprises:**

The enterprises are classified into 3 types based on the Micro, Small and Medium Enterprises Development Act, 2006. Further, the Government of India has notified the latest classification of enterprises which are as follows:

### **Description of Study Firms:**

The 10 study firms have been selected on the basis of its functionality in Coimbatore which falls under diverse backgrounds namely Textile Garments (3), Oil (2), Leather (1), Automobile (1), Cotton (1) and Medical (1) item manufacturing firms. The above firms have been named as Firm 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 to maintain secrecy and to prevent the traceability of the study firms. The study firms were selected on the basis of their nature falling under the SME category, having considerable impact of pandemic on their business operations and their willingness to be part of the research study.

### **Data Analysis and Interpretation:-**

#### **Firm – 1:**

Firm 1 is engaged in the business of servicing four wheelers for the past 13 years. The firm has 10 employees working for it. The owner mentioned that Quality Service at reasonable cost is his differentiation strategy. He feels that it is important for the business enterprises to plan for crisis management strategies.

He said that the impact of COVID 19 on his business is high as his regular customers are postponing servicing their cars due to lock down and cash crunch. As customers are at their homes many are doing their car washing themselves thereby avoiding their trip to a service station. He mentioned that the revenue

loss for the business is around 50% during this period.

When asked about the processes he implemented to survive the crisis he said that he was very cautious with his operating expenses and tried to reduce all the non-essential costs. He also did scale down few of his firm's operations

When asked about the strategies to minimize the severity of the crisis he mentioned that he focused on cost management and employee management. He further added that to achieve the long-term business success they have introduced and followed the model of "Minimum workers with Maximum Productivity" plan to stand long-term in business.

When asked about his advice to the new entrepreneurs he said that, "to start a business is an easy option and anyone can do it, but to stay in business you have to identify and implement the action plan in all the levels of your business. This includes crisis and emergency management"

He further added that the pandemic has taught him resilience to carry on his life with enthusiasm in spite of all hardships He said," doing business is not everyone's job and without enthusiasm one cannot flourish in the business. So, we have to be prepared to face all the hurdles like pandemic, calamity, competition and employee retention while doing the business".

When asked about the role of technology in his business, he mentioned that the role of technology is very helpful during the pandemic situation.

When asked about the role of Government and Banks support during the pandemic, he said he has not availed any benefits or concessions so far and he feels that a lot more has to be done by

them to support the entrepreneurs during this crisis.

His prediction is that business will recover to the pre Covid levels within six months.

#### **Firm – 2:**

Firm 2 manufactures automobile products with a history of 50 years. The firm currently has 75 employees overall. The owner mentioned that the firm differentiates itself from its competitors by providing products with better and good quality.

During the public health crisis, all manufacturing units are temporarily shut down by order of the government, leading to lack of revenue for one and half months. The most significant impacts are decline of sales, temporary loss of customers due to the shutdown, panic in the community, and loss of staff. The adverse impact is considered as industry-wide though.

The owner feels that it is very important to plan for crisis management well in advance like the present situation. Due to covid-19 production has been reduced than normal days due to limited (50%) working employees. It was very difficult to get base materials from outside suppliers. Transportation also gets affected due to lockdown.

The short – term and long-term impact on the business is loss of productivity and inability to sell products in a proper manner and earn profit as before. He further mentioned that the revenue loss for the business is around 40% during this period.

Regarding the processes which the firm implemented to survive the crisis, the owner mentioned that in addition to focusing on the day-to-day operations that increase revenue, management must comprehend human characteristics to

address employee concerns during a crisis.

Crisis management strategies of the firm include discovery, explanation, apology, and rehabilitation may increase opportunities for a moral and legal recovery of an organization. The firm used the strategies like providing Work from home to employees and running the system with minimum employees.

In order to minimize the severity of the crisis the firm engaged in running required departments physically depending upon the situation solely.

He suggests that the new entrepreneurs must maintain a proper plan of work flow and assembling of goods from suppliers and selling of finished goods.

When asked about the role of technology in tiding over this crisis he mentioned that technology has helped tremendously during this lock down period for his employees to work from home to complete the admin related activities. Their employees were able to keep a proper database for goods and services, recording of accounting transactions and completing financial filings. During the public health crisis, top management communicates daily via Zoom and WhatsApp,

The owner believes that the impacts of COVID-19 are unique and industry-wide. Nevertheless, he thinks that small-sized enterprises may suffer lower economic loss as the fixed operating costs are lower than those of larger firms. Small firms may have an advantage in changing their HR policies swiftly during the outbreak to minimize economic loss without getting massive criticism from society. Small firms can also adopt revolutionary resilience strategies such as product diversification or industry diversification without going through bureaucratic processes.

When asked about when he expects for the business to resume to pre COVID levels, he mentioned that he is not sure about the exact time frame.

#### **Firm – 3:**

Firm 3 operates a medium-sized edible oil and oil products business. The business has been operating for over 30 years. The firm has 25 employees. The owner mentioned that price and customer experience is the differentiating strategy of their firm from that of their competitors.

During the COVID-19 outbreak, the firm recorded a sudden decrease in the sales as its major customers like shops, bakeries, hostels were not functioning. The owner mentioned that decrease in sales is the short term as well as long term impact of COVID 19 on their business. He further mentioned that the revenue loss for the business is around 30% during this period.

The firm tried to tide over this sudden decrease in sales by producing less quantity and storing and supplying only 50 % of its original capacity during this period. The business owner mentioned that performing proper demand analysis and catering only to the current demand was one of the main crisis management processes he followed. As there were fluctuations in sales drastically, he used to plan the production on a daily basis, based on the customer enquiries. They also had to deploy their workforce on a shift basis of three days a week for the employees with 50 % of them per shift.

The owner suggests that new entrepreneurs who are entering the business should definitely have a crisis management plan and they should have the capacity to analyze the scenario properly and base their decisions on the analysis. He mentioned that cost reduction is a big challenge in crisis situations.

He acknowledged that technology was very much useful during the pandemic for his admin staff to work from home and share the documents through mail and WhatsApp. He was appreciative of the services provided by banks to help during this crisis by way of providing additional loans and extending time for interest payments.

When asked about when he expects for the business to resume to pre COVID levels, he mentioned that he is not sure about the exact time frame.

#### **Firm – 4:**

Firm 4 is in the business of selling Kulfi and leather products. The business was established in the year 2005 and has 50 employees working for it. The owner mentioned that his shops have many unique products which are very much appealing to the customers and their shops are located on highways giving them a competitive advantage.

He feels that a crisis management plan is very important for any business irrespective of its size. After the outbreak of COVID 19 and the Government imposing lockdowns and operational constraints the business was hugely affected as they had to close their shops and there was no income for them.

The immediate and long-term impact on their business was loss of sales and thereby loss in their revenues. He further mentioned that the revenue loss for the business is around 50% during this period.

When asked about the crisis management plan and strategy he mentioned that he did not have any back up plan and he had to suffer the economic loss caused by the pandemic. However, he wants to look for an e-commerce platform to sell his products in future.

He opines that, new entrepreneurs should not start their business during this

pandemic and they have to shelve their plans till the situation returns to normalcy.

He said that, in his business technology's role is minimal and the Government and Banking support was helpful to some extent.

When asked about when he expects for the business to resume to pre COVID levels, he mentioned that it might take two years to come back to the recovery stage.

#### **Firm – 5:**

Firm 5 is involved in the garments business and the firm was established three years ago. The firm employs 80 employees in its business. The owner mentioned that it is important to have a crisis management plan for a business.

During the pandemic due to lockdown and operational restrictions the firm had to stop its manufacturing. Due to the irregular operations the firm lost few of its regular customers and sales. This has impacted both the short – term and long-term profitability of the business. He further mentioned that the revenue loss for the business is around 50% during this period.

He said that he did not have any crisis management plan or strategy to tide over this crisis. However, he did mention that he has started exploring alternative means of carrying out his business in future and also engaged in studying the trends of online business. He feels that entrepreneurs have to foresee the future trends and be prepared for such scenarios through their back up plans and strategies.

He mentioned that the Government just did their duty but the government doesn't take care of those who were most affected in this situation. When asked about when he expects for the business to resume to pre COVID

levels, he mentioned that it might take one year to come back to the recovery stage.

#### **Firm – 6:**

Firm 6 has been engaged in the ready- made garments business for the past 13 years. The firm has 30 employees working for it. The owner mentioned that their manufacturing process is sustainable in nature which is the differentiation strategy of their business. He feels that it is important for the business enterprises to plan for crisis management strategies.

When asked about the short-term and long-term impact of COVID 19 on their business he said that they had to shut down their operations and their production was affected. They were not able to produce for fulfilling the existing orders of their customers, and they were unable to ship the completed goods due to lock- down. The impact on the laborer's side was also huge as many employees have left to their native places due to lock down. He further mentioned that the revenue loss for the business is around 50% during this period.

When asked about the crisis management strategies he mentioned that as his production unit was closed, he had production loss but he was able to save the overhead costs. He shares that he was unable to fulfill his commitments given to the existing customers, but they understood the situation and provided grace periods. He mentioned that he took the responsibility of communicating with the customers whose orders are pending and rescheduled the delivery commitments. Cost cutting in all important areas was one of the strategies used by the business owner to minimize the loss due to production stoppage. He added that when we have a crisis in business it is better to inform our customers well in advance and provide the production update weakly to maintain the supply chain.

When asked about the advice for new entrepreneurs, he said that it is better to invest in knowledge during the pandemic and start the business after the economy returns to normal state.

He expressed his view that business is not only about making money. It has responsibilities so the first priority of a businessman is to protect the people who run the show. During the pandemic invest more on knowledge for fine tuning the business.

He said that technology is useful for connecting with employees and customers online. He said the loan moratoriums provided by the banks are helpful for saving the financial commitments and additional working capital helps the business to save their employees.

When asked about when he expects for the business to resume to pre COVID levels, he mentioned that it might take one year to come back to the recovery stage.

#### **Firm – 7:**

Firm 7 is in the business for the past two –years and they are selling the Cold pressed Coconut oil & Groundnut oil. The firm employs around 10 people. The owner mentioned that the firm differentiates itself from its competitors by providing products with better and good quality

The owner mentioned that crisis management is important for all businesses.

When asked about the impact of COVID 19 on their business, the owner mentioned that as their product is a staple food item, he did not face any difficulty in terms of demand but due to announcement of lock down and curtailing the transportation facilities their employees were not able to attend to the work. Labour shortage was the major

problem the firm encountered during the pandemic. He further mentioned that the revenue loss for the business is around 30% during this period.

During the crisis their supply chain was affected so they tried to sell only to the local dealers. The owner mentioned that in spite of his revenue loss he was very clear with neither compromising with quality nor increasing the price.

When asked about the crisis management plan he said that, he concentrated only on whole sale business.

When asked about his advice to the new entrepreneurs he said that, “Capital is the most important part of the business, whichever business you are in you have to enjoy the profits from it without disturbing the capital. Mismanaging the capital may lead to business loss.”

He added his experience that in his business he is providing good quality products at reasonable price. His oils are very pure and best quality. In the market there are many other manufacturers who indulge in adulteration of adding pharm oil and selling their products at a lesser price. Most of the times customers get lured away by the low price of the oil sold by his competitors and do not realize the importance of consuming quality products for taking care of their health.

When asked about when he expects for the business to resume to pre COVID levels, he mentioned that it might take one year to come back to the recovery stage.

#### **Firm – 8:**

Firm 8 is in the business of manufacturing Automobile, Medical & Textile plastic parts. The firm is in existence for the last 15 years and they have 25 employees working for them. The unique selling proposition of the company is supplying very precise, cost competitive

and high cost engineering plastic materials. He feels that it is very important for the business enterprises to plan for crisis management strategies.

When asked about the impact of COVID19 on their business he mentioned that his sales executives were not able to meet the new customers to get any new orders because customers were not allowing to meet in person, due to that their business growth is affected.

When asked about the short-term impact of the pandemic on his business he told that they faced revenue loss and were forced to reduce their manpower.

The medium- and long-term impact of the pandemic was reduction in business growth and loss of targets fixed for the business growth. He further mentioned that if the same situation continues, survival of the business will be the challenge. He mentioned that the revenue loss for the business is around 40% during this period.

When questioned about the processes they implemented to identify adequate strategies to survive the crisis he said that during the lock down period they moulded and supplied more than 10 lakh pieces of Safety Glasses for COVID 19 front line workers.

When asked about the components of his crisis management plan, the owner of the firm mentioned that they have installed automatic sanitizer dispenser at the gate and they have mandated all their employees to wear a mask and maintain the social distance. He added that the firm has decided to reserve minimum 10% of their revenues to manage the unexpected crisis.

When asked about his advice to the new entrepreneurs he said that, "My advice is learn continuously and be a master in your Core business and in order

to face any crisis you should be physically and mentally strong."

When asked about the role of technology in aiding the business during this pandemic he said that it is very useful for online meetings and interacting with their customers through Zoom App and participating in the training programs & webinars

When asked about the support of Bank & the Government to tide over this crisis he did not get any direct support from the Government but his bank provided the loan amount by increasing his cash credit limit with one-year interest holiday and with a reduced interest rate of 8.75 %.

When asked about when he expects for the business to resume to pre COVID levels, he mentioned that it might take two years to come back to the recovery stage.

#### **Firm – 9:**

Firm 9 is in the business of knitted garments. The firm was established two and half years ago. The firm currently has around 30 employees. When asked about their differentiation strategy, the owner mentioned that they do manufacturing of selective products with best quality and measurements in the market. He feels that it is very important for the business enterprises to plan for crisis management strategies.

When asked about the impact of COVID 19 on his business, he shared that he has lots of stock in his godown and his sales are completely affected as shops are closed and people are also not inclined to buy new garments during this period. He says all his working capital is locked up in the form of piled up stocks.

When asked about the short-term impact of the pandemic he shared that he has lots of stock in his godown and due to

the shortage of working capital he was unable to pay to his suppliers on time.

When asked about the medium-term impact of COVID 19 on his business, he mentioned that all his stocks in the godown may have to be repacked after the lock down to retain their fresh look otherwise he has to sell them at a reduced margin. He mentioned that the revenue loss for the business is around 30% during this period.

When asked about the processes he implemented to identify adequate strategies to survive the crisis he shared his experience that, as he predicted the lock down beforehand he purchased all the raw materials for credit from his regular vendors so that he can safeguard his own funds for emergency purposes. He also planned to resume the operations of his manufacturing process with a reduced strength of 10 employees. However, he was confident that after the lock down he will be able to sell his stocks and clear his dues with the vendors. He further added that he has not taken heavy loans so far for his business so this is his survival strategy for now and the rest depends on the market.

When asked about the strategies to minimize the severity of the crisis, he said that it is very important to keep a good relationship with your debtors by honouring your commitments on time. The trust which the debtors have on you will help you to get grace period to pay back your dues during unexpected crisis situations like the present pandemic.

When asked about his advice to new entrepreneurs, he mentioned that, "If they have already started the business then they have to look for survival strategies, else they have to wait for the pandemic to get over and then start their business after proper market analysis."

When asked about his view on surviving the crisis he said that "Plan is

more important in your business if you plan it accordingly you can survive and you have to be very serious about your plan otherwise after this crisis also you can't survive."

When asked about the role of technology in aiding his business he said that Social media is very helpful to know your market, to keep an update on the trends and preferences of your customers. He also says today's entrepreneurs have to be digital savvy to survive in this hyper connected world of mobile phones and other smart gadgets.

When asked about the Government and banks support during this pandemic he said that he did not avail any such support and survived on his own funds.

When asked about when he expects for the business to resume to pre COVID levels, he mentioned that it might take one year to come back to the recovery stage.

#### **Firm 10:**

Firm 10 has been engaged in the business of selling food products for the past 25 years. There are 6 employees working for the company. The owner mentioned that maintaining taste and hygiene along with quality are their differentiation strategies.

He feels that it is very important for the business enterprises to plan for crisis management strategies.

When asked about the impact of COVID 19 on his food business he mentioned that the pandemic has caused a huge financial strain and pressure on the survival of his business. When asked about the medium and long-term impact of COVID 19, he mentioned that as the lock-down and operational restrictions are imposed by the Government, he does not have sales in his business and there is revenue loss. He is unable to meet out the



fixed and operating expenses out of his business revenue. He mentioned that the revenue loss for the business is around 50% during this period.

When questioned about the processes they followed to survive the crisis, he said that as his customers were unable to come out during the lock-down the firm started reaching out to their customers by offering them door deliveries.

When asked about the strategies to minimize the severity of the crisis, he said that currently he is focusing only on satisfying the present demand and not involved in any new investment.

When asked about his crisis management plan he replied that the Government policies on lock down and operational restrictions are changing continuously so it is better to take actions based on the situational analysis.

When asked about his strategies to minimize the severity of the crisis he mentioned, after the COVID 19 crisis, he has prepared his mind to face any difficult situations in his business with confidence.

When asked about his advice for new entrepreneurs he said that, "it is better to do all background work and planning during the pandemic period and start the business after the pandemic ends".

When asked about the role of technology in aiding his business during the pandemic he said that WhatsApp is very useful for sharing his product information and receiving orders from his customers.

When asked about the Government and banks support during this pandemic he said that even though he did not avail any benefits from them it is an important duty of the banks to support the businessman during a crisis like this.

His prediction is that business will recover to the pre Covid levels within six months.

### **1. Monetary Impact and Time Loss**

The research findings clearly evidenced that all the participated firms are highly affected by the Covid-19 pandemic in terms of unnecessary dumping of stocks, lack of manpower, lack of demand from the customers, reduced production, decrease in sales, loss of precious time, inability to meet new customers for getting fresh orders and close down of business operations among other impacts. Further, the participated firms are expecting their businesses to recover back in a period ranging from 6 months to 2 years post pandemic.

### **2. Strategies on Crisis Management**

The research findings indicated that the participated firms have adopted different crisis management strategies to handle the present pandemic which includes reducing the raw material purchase, extending the credit period by requesting suppliers, providing work from home for the employees, analyzing the current demand for their goods and services, rescheduling the prior commitments given to their customers, utilizing the time to improve their quality and cost reduction, following the Government norms in employing the reduced workforce and analyzing the market conditions to react accordingly. The research firms have utilized a combination of all these measures to manage their business effectively during this pandemic.

### **3. Strategies for Business Survival**

Based on the research findings, it is quite clear that the participated firms have adopted different strategies for their business survival during this pandemic which includes reducing the scale of operations, maintaining employee welfare,

purchasing raw materials at reduced volume and processing through sub-contractors, analyzing day-to-day demand of their products, planning for offering their products / services with the help of ecommerce platform, reframing the business strategies, minimizing the cost of overheads and concentrating on the supply of goods and services to the wholesalers due to time constraint. Thus, the firms were able to frame better strategies for their business survival during this pandemic time.

#### **4. Flexibility, Dynamic Learning and Tactical Business Renewal**

The research findings stated that the participated firms were aiming at flexibility and focused on analyzing the short-term impacts of pandemic which includes inability to manage the accounts receivables from the customers, lack of working capital due to the cash flow shrinkage, loss of productivity, lack of proper sales, losing the profits, inability to manage the routine expenses, lack of adequate customers, lead time issues, loss of business revenue, inadequate manpower and inability to convert stocks into cash during these difficult times. Further, the long-term impact of pandemic on MSMEs includes tremendous increase in price of raw materials due to lack of supply in the market, inability to plan for future growth and unfavourable market conditions among others. The participated firms were able to identify all the short-term and long-term impact of pandemic and trying to make tactical policy changes to renew their business during the post pandemic period.

#### **5. Effect of Business Size**

The research findings specified that the participated firms have lost their business revenue ranging from 20% to more than 50% due to the Covid-19 pandemic. Even the medium sized firms having over 100 employees also got

affected by this pandemic. The highest loss was incurred by Firm 4 and Firm 5 with over 50% of revenue loss followed by firm 10 with around 50% loss of revenue lined by Firm 2, Firm 6 and Firm 8 with 40% revenue loss, trailed by Firm 3, Firm 7 and Firm 9 with 30% whereas Firm 1 suffered a revenue loss of 20%. Further, it was noted that the smaller firms with less than 50 employees were able to manage their revenue loss better when compared with those firms with more than 50 employees during this pandemic.

#### **6. Policy Framing**

The research findings narrated that the participated firms have framed new policies to tackle the present crisis which includes stock clearance policy to clear the unsold stocks through credit sale, revised human resource policy to address the workforce issues effectively, modified production policy based on the market demand, new marketing policies for conducting online survey projects in estimating the customer demands, revised policies for avoiding commitment failures, production loss and to minimize the business overheads, revised marketing strategies to concentrate on local market rather than expanding the geographical market coverage, product diversification policies to concentrate on various products based on current market demands and reformed purchase policy to purchase raw materials on credit to utilize the funds effectively along with making use of the limited workforce to continue the production process by following the standard operating procedures imposed by the Government on regular basis to minimize the impact of pandemic on their business units.

### **SUGGESTIONS**

#### **1. Insinuations for MSMEs**

Based on the research findings, it is quite clear that the participated MSMEs got considerably affected by the Covid-19

pandemic. Therefore, the firms are advised to keep lower stocks, sell their products based on market demand, reduce the selling price and sacrifice the profit to optimum level to ensure business survival, plan the work properly, make arrangements for raw material supply, clear the unsold stocks by framing new marketing strategies, adopt to dynamic market conditions, try to minimize the impact of pandemic on their business unit, analyze the various opportunities available during the pandemic in terms of dynamic learning, maintain adequate business capital to continue the business operations and framing new crisis management strategies to manage this pandemic effectively.

### **2. Insinuations for Policy Making**

With reference to the research findings, the participated firms have shown high importance towards planning for the unexpected crisis which contributes to their long-term business success. The firms insisted that long-term vision is highly essential to ensure the business survival and the future happenings should be foreseen well in advance to include it as part of initial planning process itself. The participated firms have suggested that the customers need to be informed well in advance about the issues in production and supply chain, so as to manage the crisis effectively. Further, 10% of the routine business revenue has to be set aside to manage the unexpected crisis like the Covid-19 pandemic which helps in meeting the business obligations and to survive during the difficult times.

### **3. Insinuations for Future Research**

The previous research studies focused on the crisis management strategies adopted by different firms during the concerned pandemics which have been witnesses in the recent past. When compared with those pandemic, the Covid-19 pandemic is completely different

and the impact of this pandemic on MSMEs is highly inevitable. The present study focused on analyzing the overall impact of pandemic on the MSMEs and to examine the various strategies adopted by them to handle this present Covid-19 pandemic. In future, the studies can be carried out based on the prevailing pandemic and the extent to which it affects all the business units in the economy.

### **CONCLUSION**

The present study concentrates on identifying the various problems faced by MSMEs during the pandemic, crisis management strategies adopted by the MSMEs and to suggest various preventive measures to minimize the impact of pandemic on the MSMEs. The impact of pandemic on MSMEs was estimated to be high and all the participated firms have done reasonably well in identifying the various impact of pandemic and to react better to manage the pandemic effectively in terms of reducing the production, managing the workforce effectively, framing new strategies to tackle the issues, focusing on product diversification, analyzing market demand, future scope among others. Thus, the present study helps the MSMEs in analyzing the various problems faced by the MSME sector and the means to manage the impact of Covid-19 pandemic on their business enterprises. Further, this study can be extended throughout India to analyze the overall impact of Covid-19 on MSMEs in the country.

### **REFERENCES**

- Yogesh D Mahajan (2020), Study on Impact of Coronavirus Pandemic on Small and Medium Enterprises (MSMEs) in India, GIS Science Journal, 7 (9), 1-6.
- Ruochen Dai, HaoFeng, Junpeng Hu, Quan Jin, Huiwen Li, Ranran Wang, Ruixin Wang, LiheXu and

- Xiaobo Zhang (2020), The Impact of Covid-19 on Small and Medium-sized Enterprises: Evidence from Two-wave Phone Surveys in China, Working Paper-549, Center for Global Development, Washington DC, September, 2020.
- MohsinShafi, Junrong Liu and WenjuRen (2020), Impact of Covid-19 Pandemic on Micro, Small, and Medium-sized Enterprises Operating in Pakistan, Research in Globalization 2 (2020), 100018, <http://dx.doi.org/10.1016/j.resglo.2020.100018>
- Krishnarajapet V Ramaswamy (2020), Impact of Covid-19 on Micro, Small and Medium Enterprises in India, Pandemic Shock of Covid-19 and Policy Response – A Bird's Eye View, Crisis and Fragility: Economic impact of Covid-19 and Policy Responses, Part-2, 158-171.
- Noor FzlindaFabeil, KhairulHanimPhazim and Juliana Langgat (2020), The Impact of Covid-19 Pandemic Crisis on Micro-Enterprises: Entrepreneurs' Perspective on Business Continuity and Recovery Strategy, Journal of Economics and Business, 3 (2), 837-844.
- Nomita Sharma (2020), Covid 19: Challenges and Opportunities for Small and Medium Enterprises (MSMEs), Research Article, University of Delhi, <http://ssrn.com/abstract=3650473> or <http://dx.doi.org/10.2139/ssrn.3650473>
- Alves Jose C, Lok Tan Cheng, Luo Yu Bo and Hao Wei (2020), Crisis Management for Small Business during the Covid-19 Outbreak: Survival, Resilience and Renewal Strategies of Firms in Macau, Research Square, City University of Macau, <https://doi.org/10.21203/rs.3.rs-34541/v1>
- Rahul Ranjan (2020), Challenges and Opportunities of India's Micro Small Medium Enterprises in the New Era of Post Covid, Research Square, Institute for Human Development, <https://doi.org/10.21203/rs.3.rs-153359/v1>
- PravakarSahoo and Ashwani (2020), Covid-19 and Indian Economy: Impact on Growth, Manufacturing, Trade and MSME Sector, Global Business Review, 21 (5), 1159-1183.
- Dovie Wilson (2016), Small Business Crisis Management Strategies, Ph.D Thesis, Walden University, Minnesota, USA.
- NiharRanjan Jena, Lina R Thatte and KET's VG (2018), Performance of the Micro, Small and Medium Enterprises (MSMEs) Manufacturing Sector in Select States in India: The Concept of MSME Manufacturing Business Facilitator (MSME-MBF) Index, Academy of Entrepreneurship Journal, 24 (1), 1528-2686-24-1-122.

#### Annexure:

The interview questions for this study were designed in a general format to leave room for exploration. The questions were focused enough to solicit responses that contribute to the main research topic, which is crisis management strategies for micro and small business owners during the COVID 19 Pandemic.

#### Interview Questions:

1. How long have you been in this business?

2. How many employees do you have?
3. What products does your company manufacture / sell?
4. How do you differentiate your firm from your competitors?
5. How would you rate the importance of planning for an unexpected crisis in your business?
  - a. Very Important
  - b. Important
  - c. Neutral
  - d. Not Important
  - e. Least Important
6. How would you rate the importance of planning for an unexpected crisis in your business?
7. How has the COVID 19 pandemic impacted the operations of your business?
8. Would you please describe the short-term impacts of the COVID 19 pandemic on your business?
9. Can you mention the approximate revenue loss for your business during this COVID 19 pandemic?
  - a. 10 %
  - b. 20%
  - c. 30%
  - d. 40%
  - e. 50% and above
10. What are the medium, to long term impacts of the COVID 19 pandemic on your business?
11. What processes did you implement to identify adequate strategies to survive the crisis?
12. What strategies did you deploy to minimize the severity of the crisis?
13. What are the components of your crisis management plan?
14. How does planning for an unexpected crisis contribute to long-term business success?
15. What are the key components of your crisis intervention plan?
16. What advice would you give to others who are considering opening a small business, about including crisis management strategies in the initial planning phases?
17. Are there any other comments you would like to add to our conversation about the success factors and strategies related to your business surviving the unexpected crisis like COVID 19 pandemic?
18. When do you expect the business to return to pre Covid level?
  - a. After 6 Months
  - b. After 1 year
  - c. After 2 Years
  - d. Never
  - e. I don't know

**Findings of the Study:**

<b>S.No.</b>	<b>Findings of the Study</b>	<b>Nature of Impact on MSMEs</b>
1	Monetary Impact and Time Loss	Sustained monetary loss due to lack of demand and loss time owing to lockdown of business units.
2	Strategies on Crisis Management	Forced MSMEs to change the strategies for managing the crisis effectively.
3	Strategies for Business Survival	Mandated the MSMEs to adapt different strategies for their business survival by altering the business operations accordingly.
4	Flexibility, Dynamic Learning and Tactical Business Renewal	MSMEs were redirected to be flexible, learn from the changing business environment and need to follow various tactics in bringing back their business to pre-pandemic level.
5	Effect of Business Size	The business size was found to be immaterial and the impact of pandemic was spread across all sizes of business units.
6	Policy Framing	Urged the MSMEs to modify their business policies in handling the impact of pandemic.

**Table 1 – Categories of Enterprises**

<b>S.No.</b>	<b>Category</b>	<b>Plant &amp; Machinery Investment</b>	<b>Business Turnover</b>
1	Micro Enterprises	Less than 1 Crore	Up to 5 Crores
2	Small Enterprises	1 – 10 Crores	5 – 50 Crores
3	Medium Enterprises	11 – 50 Crores	51 – 250 Crores

Source: MSME Policy – 2021, Department of MSME, Government of Tamilnadu

### Sector – Wise Distribution of MSMEs in Tamilnadu:

In Tamilnadu, the functional MSMEs are distributed into various sectors as follows:



Chart 1 – Sector-Wise Distribution of MSMEs in Tamilnadu

# Central Transfers and Fiscal Dependence of States in India- An Analysis of Fiscal Dependency of Assam

**Santosh Borkakati**  
Research Scholar

Department of Basic Science and Humanities  
& Social Sciences,  
National Institute of Technology, Mizoram, India

**Konthoujam Gyanendra Singh**

Associate Professor of Economics,  
Department of Basic Science and Humanities  
& Social Sciences,  
National Institute of Technology, Mizoram, India

## Abstract

Assignments of revenue and expenditure responsibilities are very complex issues in fiscal federalism. Most of the federal countries of the world suffer from vertical fiscal imbalance, due to a mismatch in decentralization of revenue-raising powers and expenditure responsibilities, as well as horizontal fiscal imbalance due to regional disparities. Fiscal transfers from national governments to sub-national governments are designed to correct these imbalances. In India, states are highly dependent on central transfers as, for most of the states, more than half of the revenue receipts are transfers from the centre. This paper analyses the trend of central transfers to the state Assam and examines the dependency of the state on central transfers. The study finds high fiscal dependence of Assam on central transfers, only around one-third of revenue expenditure of the state has been met from its own revenue.

**Keywords:** fiscal imbalance, central transfer, Finance Commission, revenue dependence, Assam

## INTRODUCTION

One major issue of debate in India's fiscal federalism has been that whereas the states of India are assigned with more expenditure responsibilities, the revenue assignment has been inadequate to meet the growing expenditure of states. While the central government enjoys greater taxing power, the states are entrusted with greater expenditure responsibilities (Rao and Singh, 2007; Heredia-Ortiz and Rider, 2005). The central government collects around 60-68 per cent of the combined revenue receipt of centre and states whereas the states have to bear 50-60 per cent of combined revenue expenditure (Panda, 2019). Moreover, taxes that are assigned to the central government are found to be more elastic and productive than the states. During the period 2000-08, the buoyancy of central taxes was 1.49 per cent against the buoyancy of states taxes at 1.18 per cent (Thirteenth Finance Commission, 2009). Again, there are significant differences among the states in the level

of development and revenue-raising capacity. So, the revenue assignment in India has both vertical and horizontal fiscal imbalances (Rangarajan and Srivastava, 2008). Consequently, fiscal transfers from the centre constitute a significant portion of the revenue receipts of states. For most of the states, central transfers constitute more than 50 per cent of the total revenue receipts of states.

In federal countries, generally, intergovernmental fiscal transfers are used to correct the vertical and horizontal fiscal imbalance among the different tiers of governments. In most of the federations various forms of fiscal transfer mechanisms, such as revenue sharing, equalization grants, special purpose grants, etc., are used to address the problem of vertical as well as horizontal fiscal imbalances (Boadway & Shah, 2009). Recognizing the fiscal imbalance between the centre and the states, the Constitution of India has provided a mechanism to transfer funds from the centre to state governments by way of tax



devolution and grants-in-aid. In the Indian federal set-up, institutional mechanism for the transfer of resources from the central government to the states revolves around three institutions, viz., the Finance Commission, the erstwhile Planning Commission and various ministries of the central government. The primary mode of transfer of resources from the centre to the states has been the Finance Commission. The major chunk of resources from the centre to states is transferred on the recommendation of the Finance Commission. The Constitution has made provision for the formation of a Finance Commission for every five years to recommend devolution of sharable central taxes to the States; framing down the principles of distribution and shares of individual states as well as grants-in-aid (Rao, 2018).

However, fiscal transfers in federations are associated with a several shortcomings and undesirable effects. Fiscal transfers from the centre to the states, often, result in soft budget constraint and fiscal indiscipline in sub-national governments (Bhatt & Scaramozzino, 2013). Though fiscal transfer is necessary to correct the vertical and horizontal fiscal imbalances, high dependency on fiscal transfer leads to a loss in fiscal autonomy and minimum efforts on the part of sub-national governments in mobilizing revenue. Since the 1990s, the fiscal position of states of India has deteriorated due to rapid increase in revenue expenditure and also because of the disappointing growth of own revenue of states (Rao, 2002). The states of India have witnessed a long-term deterioration of their ability to finance their current expenditure from their own revenue (Singh & Vasishtha, 2004). Moreover, an increasing number of pan Indian schemes, which are either fully or partially funded by the central

government, is also pushing the state governments more dependent on central transfers. The wide inter-regional differences in terms of economic development is such that the low-income states of India like Bihar, Orissa, Madhya Pradesh, Uttar Pradesh, etc., and the special category states received a significantly high amount of central transfers to meet their expenditure requirements (Rao & Srivastava, 2014). Due to the low level of economic activities and developmental gap, the northeastern states, which are special category states, have been highly dependent on central transfers; central transfer constitute around 90 per cent of revenue receipt of Nagaland, Manipur and Mizoram (Reserve Bank of India[RBI], 2018). Assam, which is the centre of most economic activities in the entire northeastern region, has been receiving more than 60 per cent of its revenue receipt as central transfers (Datta & Datta, 2015).

In this backdrop, attempts are made in this paper to examine the trend of central transfers to Assam during the period from 1990-91 to 2016-17 and assess the revenue dependence of the state on central transfers. The remainder of the paper is structured in the following manner. In the next section, literature has been reviewed and the third section discusses data and methodology. The fourth section examines the trend in central transfers to states, the fifth section is on central transfers to Assam and the sixth section analyses the fiscal dependency. The last section concludes the paper with remarks.

## REVIEW OF LITERATURE

In the theoretical literature of fiscal federalism, the fundamental objectives of intergovernmental fiscal transfers in a federation are to achieve fiscal balance, equity in distribution, and efficiency in allocation (Buchanan, 1950; Musgrave,

1961; Breton, 1965, Oates, 1972). According to many studies conducted across the world, sub-national governments' share in total public expenditure exceeds their share in total revenue, implying that grants from national governments are everywhere a major component of sub-national finance (Ambrosanio and Bordignon, 2006; Gordin, 2006). A large number of studies on state finances and intergovernmental transfers in India suggest that the existence of sharp vertical and horizontal fiscal imbalances is responsible for weak fiscal position of states and consequently, dependence on fiscal transfers from the centre (Rao, 2002; Singh and Vasishtha, 2004; Kannan, Pillai, Kausaliya and Chander, 2004). The increased dependence has been contributed by the mismatched in the growth of expenditure of states and the mobilisation of own revenue, and also by an increase in discretionary transfers from the centre (Srivastava & Rao, 2009). Singh and Vasishtha (2004) argued that the fiscal transfer mechanism in India has not been transparent and objective; the states with political bargaining power received more transfers from the centre. Rao and Srivastava, (2014) found an increase in dependence on central transfers for all states; high income states of India are less dependent whereas the poor states are highly dependent on central transfers.

The continued and increasing fiscal dependence of states had led to some undesirable effects. Heredia-Ortiz and Rider (2005) observed that high dependency of states on central transfers has weakened the accountability and fiscal discipline of states. Debnath and Battacharjee (2019) found that an increase in unconditional transfers led to a decrease in tax collection of states whereas conditional transfers tend to have a positive impact on the tax collection of

states. Panda (2017) found that central transfers highly influence the size and pattern of state spending, and adversely affect the budgetary efforts of states to raise their own revenue and rationalize expenditure. He suggested a review of the existing method of central transfers and framing of new modalities to make federal transfers more objective and transparent. Though the system of fiscal transfers from the centre has been able to direct more resources towards the poor states, it has been less effective in encouraging states to observe fiscal discipline (Bhatt & Scaramozzino, 2013). The fiscal transfer system in India has become gap-filling in nature, playing an accommodative role to the fiscal imbalances of states which indirectly incentivizes the states to carry on fiscal imbalance (Rao, 2005; Bhatt & Scaramozzino, 2013; Panda & Nirmala, 2013).

From the review of literature, it is evident that states of India are fiscally dependent on central transfers and the mechanism of transfer provides, indirectly, incentives to states to remain fiscally dependent. In this perspective, the goals of the present study are to investigate the trend and pattern of central transfers to Assam and examine the extent of revenue dependence of the state.

## DATA AND METHODOLOGY

The study, entirely, is based on secondary sources of data. The relevant data are obtained from the reports of Indian Public Finance Statistics published by the Ministry of Finance, Government of India; State Finance: A study of Budgets, Reserve Bank of India; Report of Finance Commissions of India. Data on Gross State Domestic Product (GSDP) of Assam are obtained from Central Statistical Organization, Government of India.

The period for the study is from 1990-91 to 2016-17. The various forms of central transfers are examined through

simple statistical measures, such as percentage, average, ratios, etc. The revenue dependency of the state is examined by measuring the revenue gap.

## **RESULTS AND DISCUSSION**

### **Trend and Pattern of Central Transfers to States**

The main transfers of resources received by the states are the share in central taxes and grants as per the recommendations of Finance Commissions and these transfers are statutory in nature. On the other hand, the transfers received under the erstwhile Planning Commission and various central ministries are discretionary in nature. The Planning Commission provided plan grants and loans to states, and the various central ministries provide grants to states for Central Sector Schemes and Centrally Sponsored Schemes. Over the years, the nature and size of these transfers to the states have been changing. Different Finance Commissions have used different sets of criteria for both vertical sharing and horizontal distribution of revenue. Till Tenth Finance Commission different formulae were used for the devolution of income tax and union excise duties between the centre and states. The Tenth Finance Commission recommended bringing in all sharable taxes into one pool. Through the Eightieth Constitution (Amendment) Act, 2000, all shareable central taxes were brought into one divisible pool (Sury, 2010). Thus, from the Eleventh Finance Commission onwards devolution of central taxes to states has been done through one set of criteria from the shareable pool of central taxes. From Table 1 it is evident that the recent Finance Commissions have successively been increasing the share of states. The Fourteenth Finance Commission considerably increased the share of states in central taxes to 42 per cent from 32 per

cent under Thirteenth Finance Commission.

The share in central taxes received by states as per devolution has fluctuated around 25 per cent to 30 per cent (Figure 1) during the period of Ninth Finance Commission to Thirteenth Finance Commission (1990-91 to 2014-15). But in the first two years of the Fourteenth Finance Commission, the share of states in central taxes has increased significantly to 35.17 per cent in 2015-16 and 36.08 per cent in 2016-17 because of the increased devolution recommended. It is seen that the share of states in central taxes differ from that of Finance Commissions' recommendations. The reason being that the recommendations of Finance Commissions apply to the 'divisible pool' of central taxes which excludes revenue from cesses and surcharges, cost of collection, and certain other earmarked taxes.

The Finance Commission also recommends grants-in-aid to states to meet assessed revenue deficit of states after tax devolution, remove disparities among the states in the provision of administrative and social services, performance grants, state-specific needs, environment-related grants, for natural disaster, etc. Most of these state specific grants are conditional and their actual realizations depend upon fulfilling the conditions imposed (Chakraborty, 2010). The Fourteenth Finance Commission limited the number of grants to Post Devolution Revenue Deficit Grants, Disaster Relief Grant and Grants to Local Bodies (Fourteenth Finance Commission, 2014). Figure 2 shows the trend of grants by Finance Commissions to states as a percentage of total transfers to states by the Finance Commissions. The Sixth Finance Commission recorded the highest share of grants, 26.1 per cent, and the Seventh Finance Commission accounted

for the lowest share of grants at 7.7 per cent. This reflects that different Commissions have adopted different outlook and criteria in the provision of grants to states.

The total central transfer of resources to states also includes the grants from the erstwhile Planning Commission and various ministries of central government. The total central transfer which was 40.33 per cent of gross revenue receipt of the centre during the Ninth Finance Commission declined significantly during the Tenth and Eleventh Finance Commission (Table 2). The main reason for the decline in central transfers was the deteriorating fiscal situation of the centre and states during the late 1990s and early 2000s which led to a decline in grants from the Planning Commission and central ministries. During Thirteenth Finance Commission, total central transfer increased to 41.33 per cent of gross revenue receipt of centre.

The actual amounts of transfers realized by the states are the Net Transfers obtained after deducting the repayment of debt to central government from Gross Transfer. Till 2004-05, there existed significant variation between the Gross Transfer and the Net Transfer of resources to states (Figure 3). It is seen from the figure that both Gross and Net transfer has significantly declined during the period 1998-99 to 2004-05, but the fall in Net Transfer is more than the Gross Transfer. The difference which existed between the Gross and Net transfer also widened during this period and in the year 2003-04, this difference became as high as 13.35 per cent of total receipt of centre. However, since 2005-06, this difference between the Gross and Net transfer has declined significantly and in recent years, only a nominal difference remains between the two. Since 2014-15, both

Gross Transfer and Net Transfer to states have increased considerably.

### **Trend and Pattern of Central Transfers to Assam**

To meet horizontal equity in the distribution of states' share in central taxes among the states, the Finance Commissions of India have formulated criteria with different factors, such as population, income distance, area, index of infrastructure, tax effort, fiscal discipline, fiscal capacity distance, etc. Till Ninth Finance Commission, different sets of criteria were used to distribute the share of income tax and excise duties among the states. The Tenth Finance Commission applied a uniform formula for inter se distribution of income tax and union excise duties (Table 3). From Eleventh Finance Commission since all shareable central taxes were brought into one divisible pool, one set of criteria are applied in the inter se distribution shareable taxes. From the First Finance Commission, population was taken as a common basis to determine the share of individual states, but its weightage declined from 100 per cent in First Finance Commission to 10 per cent in Eleventh Finance Commission. From Third Finance Commission 'backwardness' emerged as an important factor to determine the inter se share of taxes. 'Distance to per capita income' factor became important from Eighth Finance Commission and from Tenth Finance Commission this criterion turned to be the major factor in determining the share of each state. Recent Finance Commissions have introduced factors, such as fiscal discipline, fiscal capacity distance, demographic change, forest cover, etc., in devolution criteria. Thus, the devolution criteria have undergone significant changes over different Finance Commissions which led to changes in the

share of individual states over different Finance Commissions.

The share of Assam in Finance Commissions' transfers to states (share in taxes and grants) has gradually declined from 4.6 per cent in First Finance Commission to 3.31 per cent in Fourteenth Finance Commission (Table 4). Assam received highest amount of share 5.04 per cent during Fourth Finance Commission and the lowest 2.49 per cent under Seventh Finance Commission. The mean share of Assam in total transfers to states by Finance Commissions, from First to Fourteenth Finance Commission, is calculated at 3.86. Since the Ninth Finance Commission (2<sup>nd</sup> Report), the deviation of share of Assam from the mean share has become negative with the successive Finance Commissions. It means that the share of Assam in Finance Commission's transfers to states has declined in recent Finance Commissions.

During the study period, the share of Assam in inter-state distribution of central taxes has remained mostly stable: the maximum share is 3.60, the minimum share is 2.87 and the mean share is 3.31 (Figure 4). However, in the first two years of the Fourteenth Finance Commission, a noticeable fall in the share of Assam in central taxes has been seen. On the other hand, the share of Assam in inter-state distribution of non-plan revenue grants has fallen sharply from around 6 per cent during the Ninth and Tenth Finance Commissions to below 2 per cent during the Thirteenth and Fourteenth Finance Commission (Figure 4). The Fourteenth Finance Commission recommended revenue deficit grant for Assam only for two years, 2015-16 and 2016-17, as the Commission found assessed revenue deficit only for the aforesaid two years (Fourteenth Finance Commission, 2014). So, Finance Commission's grant to Assam is expected to further decline during the

period of the Fourteenth Finance Commission.

In case of other transfers, in addition to the grants received for state plan, central sector scheme and centrally sponsored schemes, Assam also receives grants for special plan scheme under North Eastern Council. Other transfers received by Assam have been substantial as in some years, during the study period, other transfers accounted more than the Finance Commission's transfers in the total central transfers to Assam (Figure 5). The primary reason was that Assam, being declared as a special category state in 1991, received assistance for the state plan under loan to grants components in the ratio of 10:90. However, in the first two years of the Fourteenth Finance Commission, there is seen a steep fall in the share of other transfers in total central transfers to Assam.

#### **4.3 Fiscal Dependency of Assam**

The ratio of own revenue to revenue receipt and the ratio of own tax to revenue receipt is two key parameters to measure the fiscal capability. A High ratio of own revenue to revenue receipt indicates that the state is more self-reliant and less dependent on centre transfer. From the composition of revenue receipt of Assam (Figure 6) we see that the own revenue of the state accounted only around 35 per cent of the revenue receipt of the state and around 65 per cent of revenue receipt is from central transfers and in recent years, the share of own revenue of the state has shown a further declining trend. The own tax revenue of the state, which is the principal component of own revenue, has remained smaller than the share of the state in central taxes and even the grant-in-aid received is more than the own tax revenue of the state during the study period. Figure 7 reflects that the ratio of own revenue to revenue receipt and the ratio of own tax to revenue receipt of

Assam has remained far behind the ratios of All States. The ratio of own revenue to revenue receipt of Assam in comparison to the All States' ratio is significantly lower and it shows the very weak fiscal capacity of the state to mobilize resources on its own. Similarly, the ratio of own tax to revenue receipt of Assam is much lower than that of All States; whereas the own tax of Assam accounted around 25 per cent revenue receipt of Assam, the own tax of All States accounted around 47 per cent of revenue receipt.

The extent of revenue dependence of Assam during the study period from Ninth Finance Commission to Fourteenth Finance is presented in Table 5. It is quite clear that the revenue-dependence of Assam has been so serious that the own revenue of the state could meet only around 35 per cent of its revenue expenditure and the rest are dependent on central transfers. Consequently, the revenue gap of the state has been around 65 per cent of the revenue expenditure during the study period. During Twelfth Finance Commission (2005-10) there was a fall in the revenue gap which, primarily, was due to the squeeze in revenue expenditure as Assam implemented the FRBM Act in 2005 (Borkakati & Singh, 2021). Thereafter, the revenue gap again started to rise and in recent years it has widened further. The transfer from the Finance Commission, on average, financed 60.46 per cent of revenue gap and the total central transfer met around 60 per cent of total expenditure of the state during the study period.

### CONCLUSION

From the discussion above, it is clear that the fiscal dependency of Assam is quite high, and no reduction in the revenue dependency of the state has been observed over the study period. The revenue gap of the state is so high that the own revenue of the state meets just a

little over one-third of revenue expenditure. The main reason for very high dependence on central transfers may be attributed to the very low Own Tax-GSDP ratio of the state. Throughout the study period, the revenue mobilisation effort of Assam has been quite dismal. The growth rate of own tax and own revenue has remained much lower than the rate of growth of share in central taxes and central transfers. Though the share of central transfers in revenue receipt of Assam shows an upward trend in recent years, the share of Assam in the inter se distribution of central taxes and grants to states has declined in recent Finance Commissions. As the Fourteenth Finance Commission recommended revenue deficit grants to Assam only for the first two years, the grants from the Finance Commission will significantly decline in coming years. The only way forward is to focus on revenue mobilisation efforts to enhance own revenue receipt. But with the introduction of GST in 2017, the states of India are left with very limited space for taxation on its own. It will be of much interest to examine the trend of revenue receipt of Assam in the post GST period.

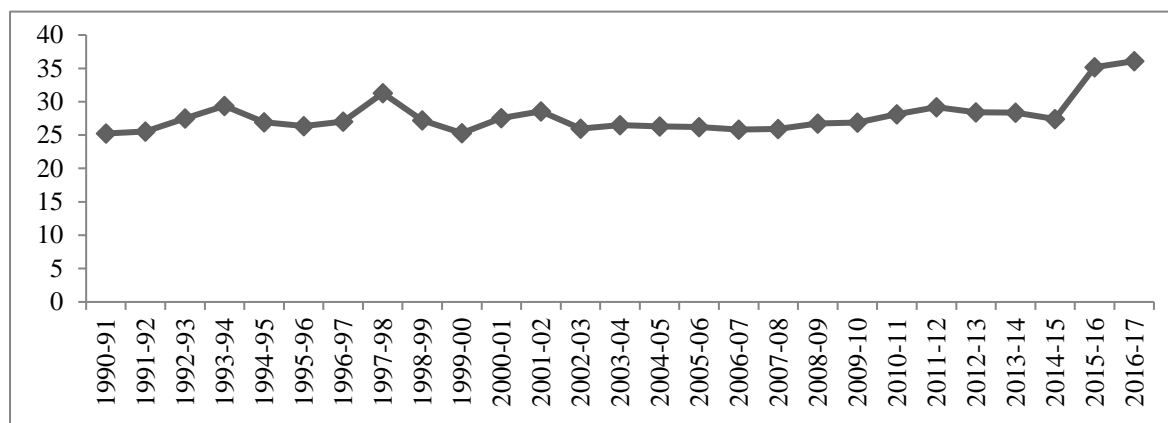
### REFERENCES

- Ambrosanio, M. F., & Massimo B. (2006). Normative versus positive theories of revenue assignments in federations. In A. Ehtisham & B. Giorgio B (Eds.), *Handbook of fiscal federalism*. Edward Elgar Publishing Limited. <https://doi.org/10.4337/9781847201515.00021>
- Bagchi, A., & Chakraborty, P. (2004). *Towards a rational system of centre-state revenue transfers in India: An exploration* (Working Papers 04/16). New Delhi: National Institute of Public Finance and Policy.

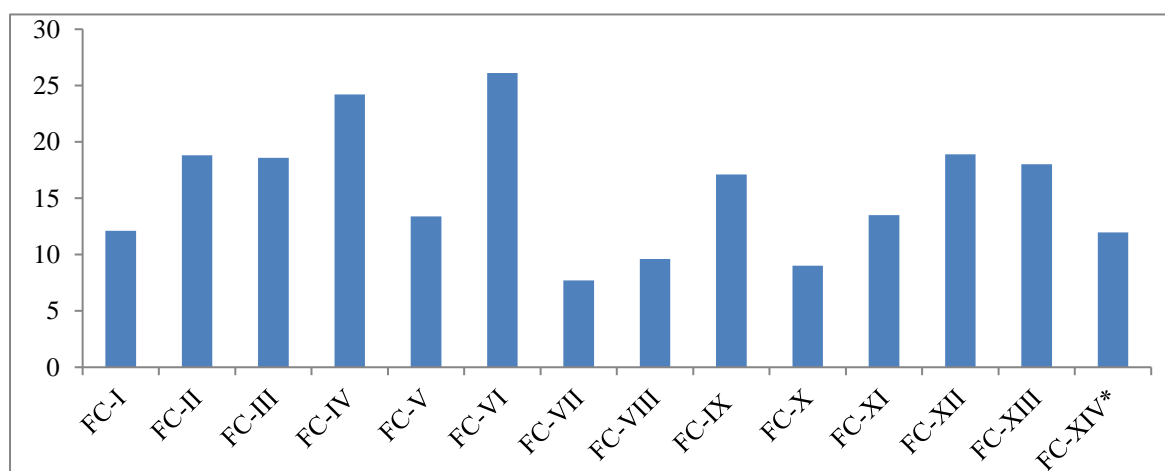
- Bhatt, A., & Scaramozzino, P. (2015). Federal transfers and fiscal discipline in India: An empirical evaluation. *Public Finance Review*, 43(1), 53-81. <https://doi.org/10.1177/1091142113515049>
- Boadway, R. & Shah, A. (2009). *Fiscal federalism: Principles and practice of multiorder Governance*. New York: Cambridge University Press.
- Borkakati, S. & Singh, K.G. (2021). Fiscal responsibility law and subnational finance in India- An analysis of Assam's fiscal scenario. *Economic Horizons*, 23(1), 71-83. <https://doi.org/10.5937/ekonhor2101071B>
- Buchanan, J.M. (1950), Federalism and fiscal equity. *American Economic Review*, 40, 583-599.
- Breton, A. (1965). A theory of government grants. *The Canadian Journal of Economics and Political Science*, 31(2), 175-187. <https://doi.org/10.2307/140062>
- Chhetry, D.B. (2017). Tax assignment in selected federations: Lessons for Nepal. *People: International Journal of Social Sciences*, 3(3), 510-526. DOI- <https://doi.org/10.20319/pijss.2017.33.510526>
- Chakraborty, P. (2010). Deficit fundamentalism vs fiscal federalism: Implications of 13<sup>th</sup> Finance Commission's recommendations. *Economic and Political Weekly*, 45(48), 56-63.
- Datta, M. K., & Datta, P. (2015). Revenue mobilization efforts of special category states: The case of Assam in North-east India. *South Asian Journal of Macroeconomics and Public Finance*, 4(20), 178-204. <https://doi.org/10.1177%2F2277978715602394>
- Devnath, A & Bhattacharjee, N. (2019). Central transfers and tax generation efforts of Indian states. *Economic and Political Weekly*, 54(48).
- Fourteenth Finance Commission (2014). Report of the Fourteenth Finance Commission. New Delhi: Ministry of Finance.
- Gordin, J.P. (2006). Intergovernmental fiscal relations, 'Argentine Style'. *Journal of Public Policy*, 26(3), 255-277.
- Kannan, R., Pillai, S.M., Kausaliya, R. & Chander, J. (2004). Finance Commission awards and fiscal stability in states. *Economic and Political Weekly*, 39(5), 477-491.
- Musgrave, R. A. (1959). *The theory of public finance*. New York: McGraw-Hill.
- Ministry of Finance (2019). *Indian public finance statistics 2017-18*. Government of India.
- Oates, W. E. (1972). *Fiscal federalism*. New York: Harcourt Brace Jovanovich.
- Panda, M. (2019). Resource sharing between centre and states and allocation across states: *Some issues in balancing equity and efficiency*. Finance Commission of India. [https://fincomindia.nic.in/writereaddata/html\\_en\\_files/fincom15/StudyReports/Resource%20sharing%20between%20Centre%20and%20States%20and%20allocation%20across%20States.pdf](https://fincomindia.nic.in/writereaddata/html_en_files/fincom15/StudyReports/Resource%20sharing%20between%20Centre%20and%20States%20and%20allocation%20across%20States.pdf)
- Panda, P.K. (2017). Budgetary impacts of central fiscal transfers in India: Evidence from state level data. *Vision: Journal of Indian Taxation*,

- 4(2), 20-38. <https://doi.org/10.17492/vision.v4/02.11782>
- Panda, P.K., & Nirmala, V. (2013). Central fiscal transfers and states' spending in India: An analysis of incentive effect. *Economics Bulletin*, 33(2), 1229-1246.
- Rangarajan, C., & Srivastava, D. K. (2008). Reforming India's fiscal transfer system: Resolving vertical and horizontal imbalances. *Economic and Political Weekly*, 43(23), 47-60.
- Rao, C.B., & Srivastava, D.K. (2014). Dependence of states on central transfers: State-wise analysis. *Global Business Review*, 15(4), 695-717. <https://doi.org/10.117/F0972150914543241>
- Rao, M.G. (2002). State finances in India: Issues and challenges. *Economic and Political Weekly*, 37(31), 3261-71.
- Rao, M.G. (2004). Linking central transfers to fiscal performance of states. *Economic and Political Weekly*, 39(18) 1820-1825.
- Rao, M.G., & Singh, N. (2007). The political economy of India's fiscal federal system and its reform. *Publius: The Journal of Federalism*. 37(1): 26-44. <https://doi.org/10.1093/publius/pj1014>
- Rao, M.G. (2018). Central transfers to states in India: Rewarding performance while ensuring equity. NITI Aayog. <https://doi.org/10.13140/RG.2.2.26441.80489>
- Reserve Bank of India. (2005-2019). *State finances: A study of budgets*. Mumbai.
- Reserve Bank of India. (2018). *Handbook of statistics on Indian states*. Mumbai.
- Singh, N., & Vasishtha, G. (2004). Patterns in centre-state fiscal transfers: An illustrative analysis. *Economic and Political Weekly*, 39(45):4897-4903. <https://doi.org/10.2307/4415769>
- Srivastava, D.K., & Rao, C.B. (2009). *Review of trends in fiscal transfers in India* (A Report submitted to Thirteenth Finance Commission). Madras School of Economics.
- Sury, M.M. (2010). *Finance Commissions and fiscal federalism in India*. New Delhi: New Century Publications.
- Thirteenth Finance Commission (2009). *Report of the Thirteenth Finance Commission*. Finance Commission of India.



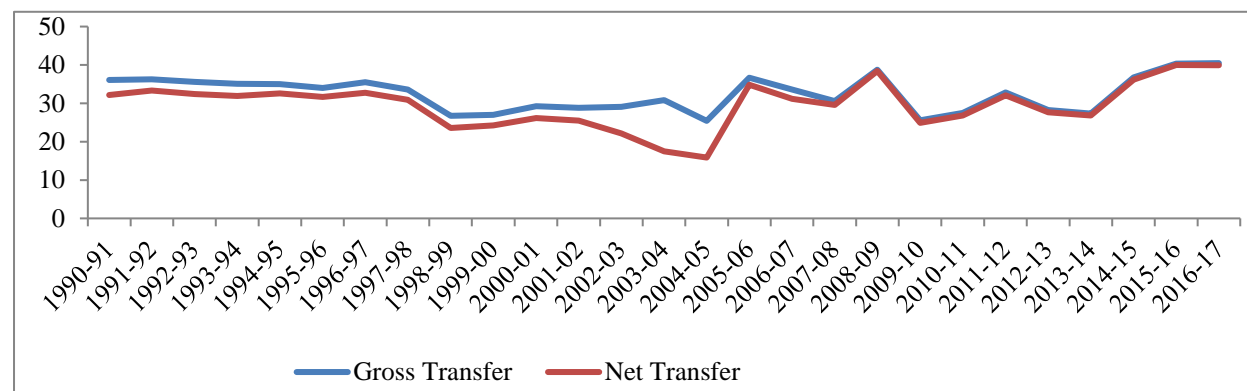
**Figure 1.** States' Share in Central Taxes (%)

Source: Author's Calculation based on 'Indian Public Finance Statistics', 2017-18, Ministry of Finance, Government of India.

**Figure 2.** Grants as Percentage of Total Finance Commission's Transfers to States

Note: \* Calculated from the recommended transfers by Fourteenth Finance Commission.

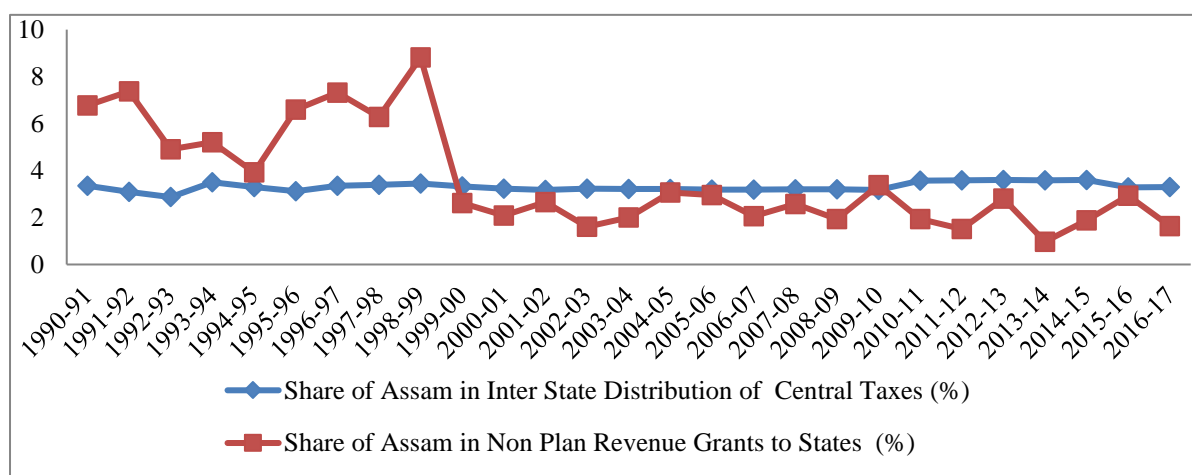
Source: Fourteenth Finance Commission Report, Page Nos. 140 and 437.

**Figure 3.** Central Transfers to States as a Percentage of Total Receipt of Centre

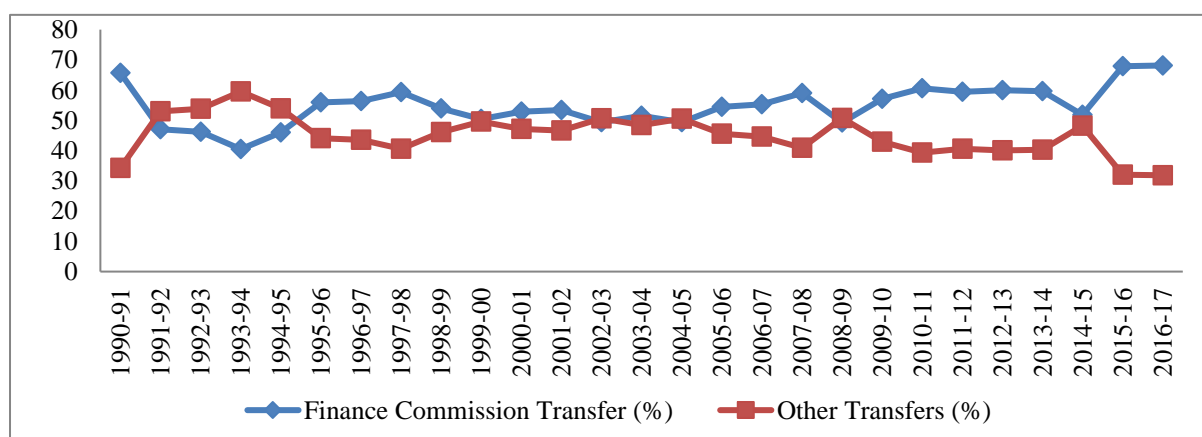
Note: Gross Transfers = Share of states in central taxes + Grants to states + Loans

Net Transfers = Gross Transfer – Repayment of Loans by States.

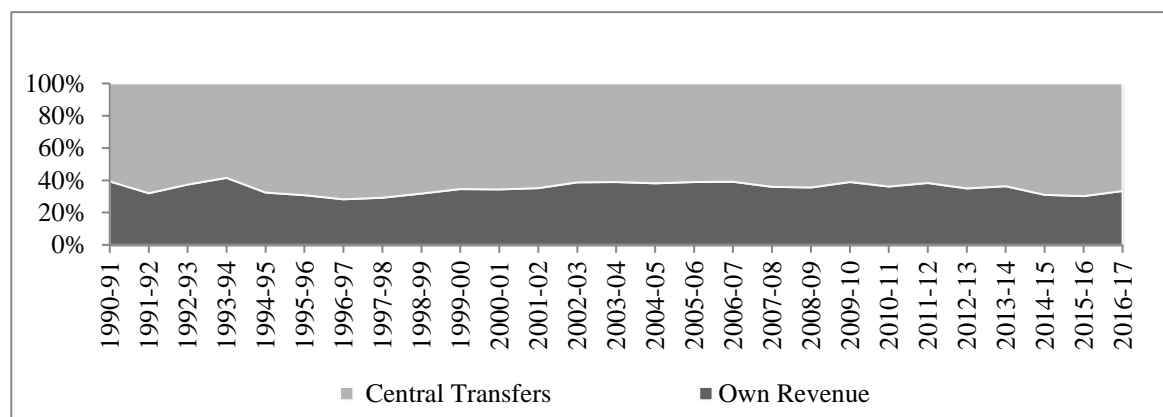
Source: Indian Public Finance Statistics, 2017-18, Ministry of Finance, Government of India.

**Figure 4.** Share of Assam in Taxes and Grants under Finance Commissions' Transfers (%)

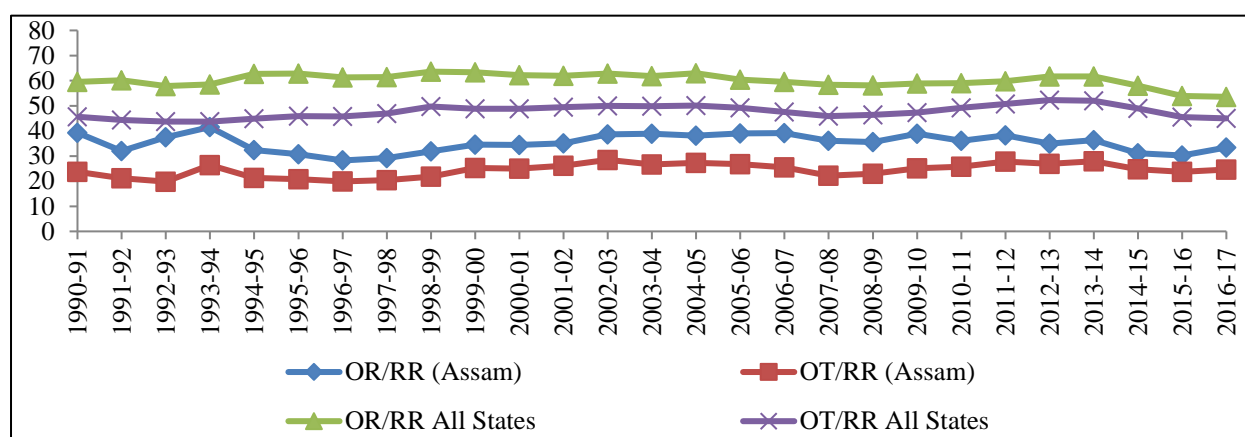
Source: Author's calculation based on 'Indian Public Finance Statistics', 2017-18, Government of India and 'State Finance: A Study of Budgets', RBI.

**Figure 5.** Finance Commissions' Transfer and Other Transfers as Percentage of Total Central Transfers to Assam

Source: Author's calculation based on 'State Finance: A Study of Budgets', various issues, RBI.

**Figure 6.** Share of Own Revenue and Central Transfers in Revenue Receipt of Assam

Source: Author's calculation based on 'State Finance: A study of Budgets', various issues, RBI.

**Figure 7.** Ratio of Own Revenue to Revenue Receipt and Own Tax to Revenue Receipt (%)

Note: RR=Revenue Receipt; OR=Own Revenue; OT= Own Tax

Source: Authors' calculation based on 'Handbook of Statistics on Indian States', 2018, RBI.

**Table 1.** Vertical Distribution: States Share in Divisible Pool of Central Taxes

Finance Commissions (FC)	Divisible Pool of Central Taxes		
	Gross Tax Revenue (Net of Cost of Collection, Cess and Surcharges) (%)	Income Tax (Net Proceeds) (%)	Union Excise Duties (Net Proceeds) (%)
FC-I (1952-57)		55.0	40.0
FC-II (1957-62)		60.0	25.0
FC-III (1962-66)		66.7	20.0
FC-IV (1966-69)		75.0	20.0
FC-V (1969-74)		75.0	20.0
FC-VI (1974-79)		80.0	20.0
FC-VII (1979-84)		85.0	40.0
FC-VIII (1984-89)		85.0	45.0
FC-IX: 1 <sup>st</sup> Report (1989-90)		85.0	45.0
FC-IX: 2 <sup>nd</sup> Report (1990-95)		85.0	45.0
FC-X (1995-2000)		77.5	47.5
FC-XI (2000-05)	29.5		
FC-XII (2005-10)	30.5		
FC-XIII (2010-15)	32.0		
FC-XIV (2015-20)	42.0		

Source: Reports of Finance Commissions of India.

**Table 2.** Transfers from Centre to States as Percentage of Gross Revenue Receipts of Centre

Finance Commission	Finance Commission's Transfers			Other Transfers			Total Transfers
	Share in Central Transfers	Grants	Total FC's Transfers	Plan Grants	Non-Plan Grants	Total Other Transfers	
1	2	3	4=2+3	5	6	7=5+6	4+7
FC-IX	21.37	3.42	24.79	14.49	1.06	15.55	40.33
FC-X	22.22	2.34	24.56	10.57	0.67	11.24	35.79
FC-XII	20.59	3.88	24.47	10.1	0.7	10.8	35.27
FC-XIII	22.03	4.7	26.73	10.99	1.07	12.06	38.79
FC-XIII	23.95	3.93	27.87	12.87	0.59	13.45	41.33

Source: Fourteenth Finance Commission Report, Page 52.

**Table 3.** Distribution Criteria for Inter- State Share of All Taxes and Duties (%)

Finance Commission	Population	Income Distance	Area	Infra-structure	Tax Effort	Fiscal Discipline	Fiscal Capacity Distance	Demographic Change	Forest Cover
FC-X	20	60	5	5	10	-	-	-	-
FC-XI	10	62.5	7.5	7.5	5	7.5	-	-	-
FC-XII	25	50	10	-	7.5	7.5	-	-	-
FC-XIII	25	-	10	-	-	17.5	47.5	-	-
FC-IVX	17.5	50	10	-	-	-	-	10	7.5

Source: Reports of Finance Commissions of India.

**Table 4.** Share of Assam in Total Transfer by FCs to States (%)

Finance Commission	Share of Assam	Deviation from Mean Share*
FC-I (1952-57)	4.6	0.74
FC-II (1957-62)	4.33	0.47
FC-III (1962-66)	4.47	0.61
FC-IV (1966-69)	5.04	1.18
FC-V (1969-74)	3.65	-0.21
FC-VI (1974-79)	4.58	0.72
FC-VII (1979-84)	2.49	-1.37
FC-VIII (1984-89)	4.07	0.21
FC-IX 1 <sup>st</sup> Report (1989-90)	4.12	0.26
FC-IX 2 <sup>nd</sup> Report (1990-95)	3.73	-0.13
FC-X (1995-2000)	3.67	-0.19
FC-XI (2000-05)	3.05	-0.81
FC-XII (2005-10)	3.22	-0.64
FC-XIII (2010-15)	3.63	-0.23
FC-XIV (2015-20)	3.31	-0.55

\* The mean share of Assam across all Finance Commission is 3.86.

Source: 1. Thirteenth Finance Commission Report, Page No.28.

2. Report of the Fifth Finance Commission of Assam, Page No. 22.

**Table 5.** Revenue Dependence of Assam

Finance Commission (FC)	Own Revenue as Percentage of Revenue Expenditure	Revenue Gap**	Finance Commission Transfer as Percentage of Revenue Gap	Total Central Transfer as Percentage of Total Expenditure
FC-IX 2nd Report (1990-95)	35.56	64.44	57.54	59.24
FC-X (1995-2000)	30.37	69.63	54.76	61.79
FC-XI (2000-05)	34.07	65.93	45.02	50.94
FC-XII (2005-10)	43.13	56.87	70.11	63.32
FC-XIII (2010-15)	35.90	64.10	59.80	59.23
FC-XIV (2015-20)*	34.00	66.00	75.55	66.66
Mean	35.51	64.49	60.46	60.20

Note:\* Only the first two years (2015-16 and 2016-17)

\*\*Revenue Gap is the difference between revenue expenditure and own revenue as a percentage of revenue expenditure.

Source: Author's calculation based on 'State Finance: A study of Budgets', various issues, RBI.

# Influence of Small / Niche / Community Banks on the Financial System: An Investigation

Joshy Mathew K  
Research Scholar,  
College of Engineering Trivandrum.

Dr. Regi Kumar V  
Professor,  
College of Engineering Trivandrum.

## Abstract

An economy's success is determined by its financial system and its ability to attach all its related subjects to this system including banking. But still 31% adults living in this world are unbanked as per World Bank reports. This spotlight the need of small banks in the areas where banking services has not reached. This paper reviews the important concepts, developments and possibilities of Small Banks in developing countries. It is concluded that small banks are essential in developing and under developed nations than in the developed nations where a gradual decline in the number of small banks.

**Keywords:** *Small Banks, Community Banks, Bank size, Deposits, Lending, SBCS, SME, Small farms, Efficiency.*

## INTRODUCTION

Crucial and challenging are the financial system to reach the common people and small business and ensure that adequate financial flows happen at this base. Large banks that work on a high capital do not address all the challenges that an economy is facing at base level. Small banks on the other hand tends to take advantage of the at this juncture. Small Banks, Community Banks, Niche Banks as interchangeably used. The US law defines a small bank as "a bank that, as of December 31 of either of the prior two calendar years, had assets of less than \$ 1.098 billion. Intermediate small bank means a small bank with assets of at least \$ 274 million as of December 31 of both of the prior two calendar years and less than \$ 1.098 billion as of December 31 of either of the prior two calendar years." (McKee & Kagan, 2018) mentions about a recent classification of Community banks by Federal Deposit Insurance Corporation (FDIC) as having \$10 billion or less in assets. And in India, Small Finance banks as it is known are those having a

minimum capital of Rupees 100 crores. And we can also find the presence of small banks in other countries as well. The small banks were instrumental during the crisis and post crisis in supporting the small businesses to survive. The Small Business Lending Fund of \$ 4 Billion to rejuvenate the small business in US after the crisis was channelled through the small banks (Amel & Mach, 2014).

The loans and interest as it an unavoidable part of the large chunk of interest income, the impact of collateral on the credit, interest rate and SME's credit risk are crucial. However, study done by Ashiqur Rahman, shows that there no additional benefits that the small banks in Bangladesh enjoy over that of large banks when collateral is considered for credit approvals for SME (Rahman, Rahman, & Ključnikov, 2016). However, when it comes to the information for credit processing, Small Banks depend more on soft information while Large banks analyse hard information (Berger & Frame, 2007). The decision about the credit sanctioning depends on the comparative advantages of the institution,

the information available about the firm, and the expected costs and accuracy of each of the feasible technologies, all of which affect the expected profitability (Berger & Frame, 2007).

The growth of large banks, their technological advancements pose serious challenges to the sustainability of the small banks. (McKee & Kagan, 2018) depicts that approximately 4% of the community banks in US cease to exist every year since 1992. But the authors at the same time says about the importance of such banks in under-banked segments as they are still a relevant source for consumer financial services.

The new age of FinTech and risk aversion is bringing changes product diversification in the whole banking system. In this context, the Small banks have started to give attention to non-interest generating income in order to mitigate the risk in Loan products (Stiroh, 2004). Competition from the parallel and unparallel counterparts is another analysed as another reason for the changes in the products that are in the market. This has left well managed community banks with a potentially exploitable strategic position in the industry (DeYoung, Hunter, & Udell, 2004).

This paper reviews about the concepts, developments and possibilities of the small banks. The review concludes that small banks are an important medium to reach to the unbanked and poor population. But the small bank requires technological and innovative products with competitive advantage to that of large bank products.

This paper divides the objectives of the review into the hypothesis known by the name "Small Bank Advantage" (Zhang, Song, & Zhong, 2016), , the lending success to SME and Small farms, Customer satisfaction, Diversification and

demography, Small Business Credit Scoring and Small bank efficiency.

### **Features of Small / Niche Banks**

The small banks are having unique features of operating in a particular geographical area. Such banks have the capacity to serve financial products that are required in that particular area which a large bank may not be able to provide satisfactorily. Even though the number of small banks is coming down annually (McKee & Kagan, 2018) they have found in areas that are underserved by traditional financial service organisations.

The ownership of the small banks is mostly private that incentives the owners/managers to reduce risk and maintain equity, human capital and franchise values (Stiroh, 2004). It has interest generating activities and other activities that generate noninterest income.

As the small banks are functioning in limited areas the methodology that these banks adopt for the smooth service with the customers is relationship banking with which they are able to lend to small enterprises more efficiently (Akhavain, Goldberg, & White, 2004). This is primarily due to the opaqueness and information asymmetry (Rahman, Rahman, & Ključnikov, 2016) (Stiroh, 2004). It is also found by the author (Akhavain, Goldberg, & White, 2004) that de-novo banks that are new banks with less than 3 year since inception lend more small business loans which are expected financial product for small enterprises including small farms. It is also found that the established similar size banks and large banks lend less in this category of small business loans and the proportion of de-novo banks towards small business loan also falls once that are established.

The small banks are having lower asset base than that of the larger banks. This in turn pressures the small bank to demand for collateral for their lending purposes (Rahman, Rahman, & Ključnikov, 2016). In developing or underdeveloped countries this could be difficulty for the SME sectors as they may not have enough asset base to be given as collateral.

The main features of small banks are thus listed in the table 2.1.1

### **Performance Drivers of Small / Niche Banks**

The performance drivers of small/niche banks are reviewed and the factors that are considered are

- SME and Small Farms
- Customer Satisfaction
- Diversification and Demography
- Small Business Credit Scoring
- Small Bank Efficiency

The influences of these factors are reviewed and summarised as in the chart shown as figure 3.1.

### **SME AND SMALL FARMS**

There are times in the financial system when the banks become larger and change their prospects of lending and other products. (Berger & Udell, 1995) has highlighted the need of small banks that understand the needs of local markets and common people's financial needs, which was onset when Large banks began to change their focus from small financial volumes to larger financial volumes. They have found that the Large Banks tend to provide fewer loans to SME. But the studies show that small banks enjoy the advantages of fewer agency problems due to its simpler organisation structures, which help them to produce and deliver qualitative information more effectively than large banks. This ability of Small banks to

handle the soft information help them to maintain a healthy relationship with the SMEs. It is also understood that Small Bank's loan officers will be more prudent in constructing relationship with new borrowers, as cost for initialising soft information is sunk in nature (Zhang, Song, & Zhong, 2016). The further study done by (Zhang, Song, & Zhong, 2016) used two-way choice perspective by analysing both firms' and banks' choices to test the relationship between bank size and SME lending, during both crisis and non-crisis times. They also studied the effect of lending when SMEs already had a relationship with the Small banks and when there was no existing relationship among them. The samples included SME loan data from 2005 to 2007 and 2010 to 2013 from China non-crisis and crisis time respectively. 1731 banks were sampled from non-crisis time in which large banks were 704 and small banks 1027. From the crisis period 211 samples, in which 99 large banks and 112 small banks was taken for the study. Regression was used to for the analysis.

The results of the study were as follows. The study showed the SMEs having good financial condition and more hard information tend to apply loan from Larger banks. However, was not able to prove that the SMEs having more soft information applied for loans from the Small Banks. The study proved that when there is a pre-existing relationship, Small Banks have advantage in offering relationship lending to SMEs irrespective of crisis or non-crisis time. The study failed to prove the same when there was no pre-existing relationship. The relationship strength was studied in which the result shows that a SME having good financial condition and available soft information is less likely to change their lending banks and tends to lend from small banks. Due to hold-up problem

Small banks were also found facing the challenge of maintaining the relationship with SME for a longer time (Zhang, Song, & Zhong, 2016).

The small banks are located geographically in the areas that are having farms. A study done by (Akhavain, Goldberg, & White, 2004) analyses the small banks' lending to small farms. They found that small banks are the most important lender to the small farms which were half of the number and value of loans in various small farm loan size categories in 1999. The percentage of small farm loans under \$2,50,000 to the asset size of the banks also shows 9.5% for small banks which is highest among all categories of banks. The large banks on the other side where only able to lend on less the 10% of the same. The banks which become larger in size later due to acquisition reduce their lending to small farms. The authors see this as a challenge for small farmers, which the small banks should address. The lending facility for small banks are better off when it comes to De Novo Banks. Since they are banks that are just started off, they have the strategy to lend to small farms which the large banks are least lending. But the longer tenure of the farm operator makes De Novo Banks to lend less.

### **Customer Satisfaction**

If any bank needs to survive it needs to satisfy its customers through their products and professionalism. It was found, the Small Banks having larger presence and holding constant level of competition had fewer customer complaints (Sedunov, 2020), which shows customers satisfaction to the services being provided. Small banks are no different as they have also started their diversification of products. Such decisions help to utilise the competitive opportunities in front of them (Stiroh, 2004). The customer complaints data

from Consumer Financial Protection Bureau from 2012 to 2017 was used by (Sedunov, 2020) to prove the hypothesis the increased Small Bank presence decreased the customer complaints and increased local banking market competition decreased the customer complaints. Cross-sectional OLS regression and panel regression were used to test the hypothesis. The study concludes with the finding that markets with many small banks and high competition, and markets with few small banks and low competition have fewer customer complaints. The study also comments that small banks in competition tends to keep short-term relationship with customers which helps to achieve short-run profit maximisation goals, rather than focusing in long-term relationships. With small banks advantages of relationship lending and soft information the small banks may reduce the negative impact on service quality that may come with higher levels of competition (Sedunov, 2020). The presence of large banks within the same geographical market also pressures small community banks to improve the efficiency by being more competitive and utilizing the more technologies for the operations (McKee & Kagan, 2018).

### **Diversification and Demography**

Diversification of the services is another tool that can be used to improve or sustain in the market by giving adequacy to customer satisfaction. The study done by (Stiroh, 2004) found that Community banks do better when they stay focused on their major activities. Getting into new services with less experience, non-interest income activities could turn risky for such banks. The reason being non-interest income having inverse relationship with the risk-adjusted performance, as are commercial and industrial lending, other lending, fee-based activities and trading. (De Young &



Roland, 2001) argue that fee-based activities like are inherently more volatile and hence community banks must carefully weigh the trade-offs between a more diversified set of activities and expansion into volatile business lines that have been historically associated with worst outcomes. The study done by (McKee & Kagan, 2018) states that small community banks with higher deposit rates tend to increase their efficiency by activities other than increased loan growth.

A demographical comparative analysis was also conducted by (Sedunov, 2020) which tried to find out the relations when the demography was classified into white and non-white, high-income population and low-income population, high education. The results showed that the coefficient on the Small Banks is larger in counties of high non-white population, low-poverty and high-education. This suggests that the trust of these factors is high towards the small banks which makes the relation relevant. (Sedunov, 2020) suggest the scope of research in the area of what types of banks are affected with complaints and how a complaint impacts the bank's performance and business model.

### **Small Business Credit Scoring**

The lending process of small banks are based on the soft information of the applicant. But (Berger & Frame, 2007) mentions about a lending technology known as Small Business Credit Scoring (SBCS) to evaluate applicants for "micro credit" under \$2,50,000. This method is much used by large banks for evaluation for the "micro credit" and the data as to the number of small banks that use SBCS technology is not evident in this review study. This technology analyses the consumer data of the applicant firm and combines with the available data using statistical methods to

predict the future credit performance of the loan applicant. The reason why small banks may also have introduced credit scoring in their loan products may be due to the high success of the credit scoring that is applied in other banks in consumer credit markets, that resulted in low cost, commoditised credits that are often sold into secondary markets, yielding significant growth in consumer credit availability. The SBCS uses the available hard information like personal consumer data on the owner obtained from consumer credit bureaus database, data about the business collected by the financial institution, firm's information from commercial credit bureaus. And this is used particularly for opaque small businesses where availability of authorised information is less. However, the authors also state that SBCS is also applied in relatively transparent small businesses. This lending technology started to used from the 1990s, which the authors infer as a late arrival. The reason is the significant heterogeneity of the borrowers, which makes the prediction difficult, significant variations in the underwriting approaches both within and across banks and the credits of various sizes. The accuracy of the prediction was later improved when the analysts were able to correlate the credit information of the principal owner and the variation of their small business credit's performance. The introduction of SBCS has helped the banks to reduce its dependency on relationship-based lending, which also helps in lowering the cost for lending. The new technology helps in making the accept or reject decision rather quickly with more accuracy, lowering risks and more volume of credits.

In the SBCS system the banks have a choice to decide upon the method in which the technology will be applied. The authors (Berger & Frame, 2007)

mention about the “Rules” in which the bank purchases the credit scores from a credit score vendor and use it for the credit’s approvals accept or reject criterion. However, the authors warn that this method may exacerbate the opacity problems and result in greater future credit losses. The motivation why banks use “rule” is the low-cost advantage which they enjoy over “discretion” in which banks have to build their own models and use other factors to reach the accept reject decision. The accuracy of discretion over the “rule” is higher but comparatively less cost advantage. In both the methods it was found that the banks tend to charge higher interest rate due to chances of higher risk in loans in “rule” and higher technology cost in the “discretion” method. Further study shows the banks new trend of lending outside the local market. This is because of the new advantage that SBCS provides like less requirement of close personal contact and less physical monitoring. One another reason could be the increased competition in the local market that forces the banks to search for new markets outside the local market.

### **Small Bank Efficiency**

The study done by (McKee & Kagan, 2018) investigates “how the response of the financial performance of a community bank responds to macroeconomic and regulatory changes is related to gradations in asset (institution) size”. For which they have considered time range from 2010 to 2014 studying internal and external factor that affect eleven financial performance items. Comparing between the great recession which started from the year end of 2007 and post-recession after 2010 the authors find that the community banks declined by 14% but the average small community bank grew in assets by 16.4%, loans by 24.2% and deposits by 9.4%. Post-

recession the small community banks decline rate became 26% from 2010 to 2014. Average small community banks assets decreased by -12.9%, loans by -17.9% and the net income by -42.5% when compared with the year 2010. The authors found a widening gap of loans to total assets between the small community banks and the large banks. Where small community banks loan to total assets was 65.8%, the large banks had 89.2%. This raises a need in the part of small community banks to convert their assets into more effective loan products. Macroeconomic factors that are in the county where the small community bank has presence, influence the loan characteristics, and the managerial and ownership responses to macroeconomic, technological and regulatory conditions substantially transformed the operations of the small community banks. The Macroeconomic variable- unemployment rate becomes significant and showed improving the small community banks efficiency, suggesting the declining loan and deposit demand requires banks to compete in terms of price. But this was found opposite at the places where the headquarters was situated. The study also analyses the income level of the community and puts that unless there is a sizable percentage changes in income, the lending operations and the efficiency of small community banks remains less significant.

The study analysed the x-efficiency which is the ratio of minimum cost and actual cost. And based on the study it was found that the small community banks with assets of \$1billion or less, the average efficiency decline as the asset size increases. Further the study also suggests to increase the deposits held as loans, which will in turn help to reduce the liquidity risk of small community banks. The efficiency of small

community banks was also improved when the equity capital was increased. This shows an opportunity as well as a challenge for such banks to reach for equity capital within their capacity.

### CONCLUSION

The Small banks form an integral part of the financial system which is having a specialised duty of reaching to the local community and their financial needs. The papers reviewed here shows how such banks were efficient during the crisis times and post crisis challenges faced. However, the study shows that the geographical area taken for study is more or less in the developed nations like US. When we shift the focus to the developing and under developed nations, we should assume that small banks have a key role in uplifting the lives of the poor and marginal people by strengthening them with adequate financial stability. In such a situation the Small banks need to come up with more banking products that suite their needs, which perhaps a larger bank may not be able to provide.

The adaptation of new banking technologies will be inescapable and the small banks need to prove itself in it. We could assume the challenges that could affect during these adaptations will be having sufficient IT personnel in the Small banks to make sure that the new technologies are in fact helping small banks to reduce the transaction costs, able to sustain the customer base and expand operations. Another possible challenge will be to improve the financial and technological literacy of the people living in developing and underdeveloped regions. Small banks will have to address less should expect back lacks in the competition. At this context the loan approval and lending procedures which are more soft information based should be advanced and the officials should be equipped for this transition. The larger

banks have been better ready to invest in technologies and for reaching more markets. In such a condition the small banks will have to reframe their relationship lending model to the new age banking technologies.

Mergers and acquisitions among the small banks could turn to be a possibility for the small banks to get the support from a strategic conglomerative move which may give some competitive edge than the large banks. But effort must be taken to ensure that such moves don't deprive the financing facilities that the existing customers, Small and Medium Enterprises Small farmers and Small farms enjoyed before mergers and acquisitions. The lending risk is way much important just as it is important for any large banks. Small Banks' ability to reduce or handle lending risk could be an area to be deeply explored and analysed.

As per the Global Findex database globally there were 1.7 billion adults who remained unbanked in the year 2017. Every year we see the gap between the banked and the unbanked getting shortened, but still the gap is not filled. The unbanked people who are in poorest house holds are twice as that in the rich households. All these data trumpet the need of small banks and introducing innovative products to have a better and speedy financial inclusion.

### REFERENCES

- Akhavain, J., Goldberg, L. G., & White, L. J. (2004). Small Banks, Small Business, and Relationships: An Empirical Study of Lending to Small Farms. *Journal of Financial Services Research*, 3-245.
- Amel, D., & Mach, T. (2014, December). The Impact of the Small Business Lending Fund on Community Bank Lending to Small Businesses.

*Finance and Economics  
Discussion Series .*

- Berger, A. N., & Udell, G. F. (2007). Small business credit scoring and credit availability. *Journal of Small Business Management*, 5-22.
- Berger, A. N., & Udell, G. F. (1995). Universal banking and the future of small business lending. *IDEAS Working Paper Series from RePEc; St. Louis*.
- De Young, R., & Roland, K. P. (2001). Product Mix and Earnings Volatility at Commercial Banks: Evidence from a Degree of Total Leverage Model. *Journal of Financial Intermediation*, 54-84.
- DeYoung, R., Hunter, W. C., & Udell, G. F. (2004). The past, present, and probable future for community banks. *Journal of Financial Services Research*, 85-133.
- McKee, G., & Kagan, A. (2018). Community bank structure an x-efficiency approach. *Review of Quantitative Finance and Accounting*, 19-41.
- Rahman, A., Rahman, M. T., & Ključnikov, A. (2016). Collateral and SME financing in Bangladesh: an analysis across bank size and bank ownership types. *Journal of International Studies*, 112-126.
- Sedunov, J. (2020). Small banks and consumer satisfaction. *Journal of Corporate Finance*.
- Stiroh, K. J. (2004). Do community banks benefit from diversification? *Journal of Financial Services Research*, 135-160.
- Zhang, X. m., Song, Z. l., & Zhong, Z. (2016). Does "small bank advantage" really exist? Evidence from China. *International Review*

*of Economics and Finance*, 368-384.

### Web References

- Financial inclusion on the rise, but gaps remain, global Findex database shows.* (2018, April 19). World Bank. <https://www.worldbank.org/en/news/press-release/2018/04/19/financial-inclusion-on-the-rise-but-gaps-remain-global-findex-database-shows>
- (n.d.). Home | Global Findex. <https://globalfindex.worldbank.org>
- Press releases. (n.d.). Reserve Bank of India. [https://www.rbi.org.in/Scripts/BS\\_PressReleaseDisplay.aspx?prid=32614](https://www.rbi.org.in/Scripts/BS_PressReleaseDisplay.aspx?prid=32614)
- US Legal. (n.d.). *Small bank law and legal definition.* Legal Definitions Legal Terms Dictionary | USLegal, Inc. <https://definitions.uslegal.com/s/small-bank/#:~:text=Accordingto12CFR228.12,ofthepriortwocalendar>



<b>Table 3.1.2</b> Small Farm Loans (under \$250,000) as a Percentage of a Bank's Assets, Averages for June 1999. These data are from USSBA (2000).	
<b>Asset size of Bank</b>	<b>Small Farm Loans as a % of a bank's assets</b>
<b>&lt;\$100m</b>	9.5
<b>\$100m-\$500m</b>	2.9
<b>\$500m-\$1b</b>	1.2
<b>\$1b-\$10b</b>	0.4
<b>&gt;\$10b</b>	0.1

# Factor Influencing the Investors' Behavior towards the Selection of Pension Schemes

**Anita Taneja**

Ph.D. Research Scholar,  
Lovely Professional University,  
Phagwara, Punjab

**Dr. Mahesh Kumar Sarva**

Associate Professor,  
Lovely Professional University,  
Phagwara, Punjab

## **Abstract**

India is a developing country, it is facing the challenge to secure the old age population as it is estimated that in 2050, Indian old age population will be increased up to 316759 thousand and it will be 17% of the total population of India. Government of India is expanding its social security system to financially protect the elderly population. Various Defined Benefit (DB) and Defined Contribution (DC) pension schemes are provided by the government and private pension fund managers. But the selection of pension scheme depends up on the pension scheme's features and fund available for the investment and requirement of corpus at the time of retirement. Various factors influencing the behavior of investors towards the investment in pension schemes like prior information available about the pension schemes, formalities to start the investment in pension scheme, cost of services, rate of return, liquidity and flexibility, tax relief, withdrawal procedure and so on. The main purpose of this paper is to find out the relationship of demographical variables and factor influencing the selection of pension schemes to do the investment for the old age security. A well-structured questionnaire was used to collect the data to know the factors influencing the behavior toward the selection of pension plans on the basis of demographical characteristics of salaried class investors.

**Keywords:** Pension Schemes, Factor Influencing, Behavior, Investors, Haryana.

# **A Study on Job Satisfaction of KSRTC Women Conductors in Kerala with Reference to Kollam District**

**Abin P Jose**  
Research Scholar,  
University of Kerala, Trivandrum

## **Abstract**

The women conductors' job satisfaction is one of the major issues to be addressed, especially in case of Kerala State Road Transport Corporation. The dissatisfaction of job can be also leads to adverse effect in the productivity of employees. In the current scenario, the job dissatisfaction among women conductors in the corporation is largely increased. This study tries to isolate the level of job satisfaction, working conditions, influencing factors of job satisfaction. An investigation based on the influencing factors of job satisfaction of women conductors that gives a clear picture to find out the solution for job satisfaction of female conductors in KSRTC. The sample for the study was consisted 120 women conductors selected at random from the list of women conductors in Kottarakara, Ayoor, Chadayamangalam, and Punalur depots of KSRTC in Kollam district. The statistical tools used for the analysis was a percentage analysis. The result of the analysis indicates that working condition, welfare schemes, monetary incentives, have a significant effect on job satisfaction of women conductors in KSRTC.

**Key Words:** *Job satisfaction, Women conductors, KSRTC*

## **INTRODUCTION**

As an important part of the family and social setup of every country women are contributing in every spare of society. They are participating equally in every sector in our country and prove themselves. The wages of working women provide the much-needed support and financial stability. And in the process, she proves her merit in a traditionally patriarchal society. Now they have entered into the world of paid economy. They have one more role that demands more responsibilities. Working women have a dual role, dual burden, and dual responsibilities. They are enough capacity to prove their efficiency. The transport industry has long been considered a men working world till recently, women were away from this sector longer period but today they are entering this sector especially as bus conductors in large number in KSRTC and other transport

industry in Kerala as well as parts of India. In the beginning of women as bus conductors, the public were looking at them very strangely and astonishingly due to women entering the male sectors. This for a while perturbed to the conventional and traditional mid-set.

Job satisfaction is defined as the level of contentment employees feel with their job. This goes beyond their daily duties to cover satisfaction with team member's satisfaction with organizational policies and the impact of their job on employee's personal lives. Job satisfaction is the part of life satisfaction. It is with one's feelings or state of mind regarding the nature of their work. The nature of bus conductor's work is entirely different from other occupations. They are faced since it is a mobile work, women bus conductor's work by standing have to



bear vibration and sound of the bus, and interact with the commuters of multi-personalities etc. Their comfort and satisfaction about job, working conditions, etc., are the important factors in the efficiency of the organisation. Without the satisfaction of these factors, that is negatively affecting the performance of the organization.

### **STATEMENT OF THE PROBLEM**

Role of women is the key to the overall development and growth of the organization, their comfort and satisfaction about the job, working conditions, etc. are the important factors in the efficiency of the organization. The negative result of all these factors leads to dissatisfaction of job and it will adversely affect the performance of the organization. The study is an attempt to examine the job satisfaction of women conductors in KSRTC with reference to Kollam District. Under this study we can make suggestions for improving the job satisfaction of women conductors in KSRTC.

### **OBJECTIVES OF THE STUDY**

1. To study job satisfaction of women conductors in KSRTC.
2. To know the present job status of women conductors.
3. To learn factors influencing and affecting job satisfaction of women conductors in KSRTC.
4. To make suggestions for improving work life of women conductors in KSRTC.

### **HYPOTHESIS OF THE STUDY**

This study proposes the following hypothesis:

H<sub>0</sub>: There is no significant relation between salary and job satisfaction

H<sub>0</sub>: There is significant relation between salary and job satisfaction

### **SIGNIFICANCE OF THE STUDY**

The job satisfaction for working women is of great importance to the family, society and the organization. It helps the perceptible changes in the mind-set of working women and the organization to its policy for consequent productivity and enhances job satisfaction. Their commitment and satisfaction are very much important for the overall development of an entity. The study also gives importance to ensuring proper job satisfaction to the women workers and consequences for its failure

### **SCOPE OF THE STUDY**

The study focused on the job satisfaction of women conductors in KSRTC with reference to Kollam District. Women workers play a significant role in the efficiency of every organization. Hence, proper ensuring of job satisfaction of women workers is essential for better policy implementation. Analysing job satisfaction of women conductors in KSRTC is determining the factors affecting job satisfaction of women conductors, work environment etc. and ensure them to create better involvement in their work.

### **RESEARCH METHODOLOGY**

**Research Design:** The study has adopted a descriptive, analytical and exploratory Research Design so as to gather relevant knowledge on moonlighting.

**Sample Design:** In order to determine an appropriate sampling technique, it is necessary to identify the population and the sample in the context of our study. We have chosen KSRTC women conductors regarding Kollam District as to be our population. We have chosen a sample of 120 Women Conductors, a part of the population that is to be examined, which we believe is adequate to represent the whole population.

**Sample Techniques:** We have applied random, also known as simple probability sampling method. This method can be considered as representative since the units from the population are chosen randomly preventing the sample being biased. The questionnaire was given to 120 respondents.

#### **Data Collection:**

Primary data is collected through survey method. Survey was conducted using well-structured questionnaire. The secondary data was collected from journals, magazines, publications, reports, books, dailies, periodicals, articles, research papers, website, manuals and booklets.

#### **Framework of Analysis:**

The primary objective of the study was to understand the job satisfaction of KSRTC women conductors regarding Kollam District. The respondents were asked to give their opinions on job satisfaction of KSRTC women conductors. A pilot study was conducted in order to validate the questionnaire and to confirm the feasibility of the study.

#### **Tools of Analysis:**

Tools used for the purpose of this study are mathematical and statistical such as percentages, graphs, etc. for the purpose of analysis and interpretation. Primary data was collected and analyzed using the SPSS.

#### **Time Period:**

This study takes a time period of 9 months .i.e., November 2019 to March 2020.

### **REVIEW OF LITERATURE**

**Abhilasha Joshi Sharma (2013)** assessed women suffer from excess stress due to their in abilities to prioritise their work schedule though they carry multiple role at same time, like managing work, family, relations, finance, etc... which in turn puts an effect on work-life

balance problem faced in job, competition at work place, lack of promotional opportunities and lack of appreciation from higher officials leads to stress. Sexual harassment by male colleagues can also be a vital factor.

**Parthi and Gupta (2016)** indicated significant gender difference on the sub dimensions of optimism and resilience of psychological capital. Female employees were also observed along the dimensions of reward and inter under personal relations and altruistic behaviour for organisational demote. Job satisfaction is the key to sources for an employee.

**Lakshmi S.N (2017)** carried out a research on the topic of "propensity to turnover amo

ng female employees- A study on Kerala State Road Transport Corporation" here the researcher point out that, as a provision to provide women empowerment and gender equality, KSRTC introduced women participation in conductor cadre in 1990. Here the researcher trace out the variables, job satisfaction and organisational commitment and its influence on women employees turnover intentions. The result reviled that age, employer's education, job satisfaction, continuance commitment and length of service had a crucial effect on their turnover intentions. In order to increase satisfaction and communication system, salary and allowance, job promotion technologies adopted by the organisation, welfare facilities, and grievance redressed procedures, condition of bases and industrial relations.

**Mourya and Agarwal** in their study "factors affecting stress and wellbeing of women employees" proposed a theoretical formation that encourages towards the wellbeing of women employees. The researcher explored the literature and pointed out that wellbeing of female workers should not be neglected.

The work conditions should be according to the wellness of female employees. The overall performance and quality of work of the employee demonstrate the wellbeing of the employee. The good wellbeing of female employees increased the turnover the performance of the institutions.

### **WOMEN BUS CONDUCTORS IN KSRTC**

Women are the forerunner of society and play an important role in every field of life, without their contribution no society can nurture properly. The changing roles of women in India have led to their greater contribution in the employment sector and changes in many aspects of Indian life. Women have complied duty to perform when compared to men. They have more commitments at home in managing house and children. The odd hours of duties to women will definitely like the family life. Work pressure and workload affect the family life and the family problems affect the work. So, the imbalance of work-life can lead to stress and health problems hamper job performance. This work-life balance is a challenging task on the part of female employee. Women should be in a position to make a balance between work and life. For that women have to play a dual role. Nowadays, society filled with the conflicting responsibilities, chaotic roles and commitments. The balance between paid work and unpaid work of life has become a predominant issue at workplace

KSRTC is a passenger transport corporation providing bus service in Kerala and to neighbouring states Tamilnadu and Bangalore; it was established by government of Kerala in 1965. It is high time that corporation as a whole bus remittance supporting it in a big way the earlier dependence on financial supporting from central government and the state government has reduced even though the remarkable performance of the

employees would restrict the corporations to a great extent therefore ensuring the smooth functioning of the corporation. The investigation about the organisational attitudes of the employees is needed in the 21st century the role of the women seems to have in various working fields. The role of the women as conductors in transport vehicle is one among them even though KSRTC was started with the male dominance, the description to open the gateway to the women force has become a history in 1990. In KSRTC female employee show their presence in both administrative and operational workspaces. If we have a closer look at the gender balance in KSRTC, it shows that it is still male dominating. It is a fact that working women have to face certain challenges and problems by virtue of being a woman. The teamwork is being used here referring to paid work or employment is challenged term with many alternations suggested such as work-life integration, work-life interface etc. various studies have been carried out regarding work-life and thereafter find that what happened at the workplace have significant input individuals and families. Work-life balance means adjusting the pattern of work so that employees can benefit from a better if between their work and areas of their personal life and in the long run hope to achieve sustainable development and probability. The probability and productivity of the organisation depends upon factors that are inter-related performance and commitment of employees. These factors depend on the workforce of the organisation. But every employee has to aspect of her being a personal life and professional life. Both of these are different to separate and form a source of conflict.

## CHALLENGES OR PROBLEMS FACED BY WOMEN CONDUCTORS

The challenge and problems faced by women conductors can be analysed in different dimensions. That are,

1. Nature of work
2. Working environment
3. Occupational stress factors
4. Occupational health hazards
5. Job satisfaction and motivational factor

### Nature of Work

The nature of bus conductor is entirely different from other occupations since it is service sector for the public. They have to work in different shifts every day and interact with commuters of multi personalities on several occasions they have to bear the misbehaviour of commuters. Being women it is a challenging task for them.

The important problems are given below

#### a.Shift Work

The bus conductors have to work in different shifts on rotation basis. Work that is scheduled outside "normal" daylight hours (ie.9am to 5pm) is called "shift work". Shift work schedules can vary from one work place to another. Workers may rotate through shifts timing is one of the major hurdles for women bus conductors due to house hold management, taking care of their children, safety and travelling between house and office. The second shifts closes 10pm, and after that they have to stay at depot for another 30 minutes and the organisation does not provide any transportation facilities for women employees who are in night shifts reach home at very late hours.

#### b.Feeing about Work-load

The work load relates to the quantum of work that a person is expected to complete in a specified time. Employees experience a heavy work load

for many reasons, including tight deadlines, layoffs that have caused staff shortages, and unplanned company growth that has created more work for the same shift. It is difficult to manage a shift with over workload and even the most dedicated employees often reach their breaking points. In some circumstances the organisation assigns the work based on calculations of time. But it will be practically difficult in many situations. In such situations the employees are put under lot of pressure in work and even when the work schedule is same. This stressful situation has made them feel heavy work and more stress. It results in many physical, mental and social complications.

#### c. Work by Standing

Work by standing is one of the challenging tasks for women bus conductors since the nature of work is always mobile in the bus and within the bus. Getting in and getting down from the bus frequently at every stop till they reach last destination, issuing tickets is absolutely difficult. These have prolonged and have lifelong effect on them which reduced their potential for other activities. Relatively drives have a place to sit and work, though they face muscular and piles related problems. Nevertheless, conductors have to face more problems because of bad and bumpy roads and humps and shock absorbers, resulting in frequent jerks leading to all ailments.

#### d. Commuter's Misbehaviour

Some commuters behave abnormally with women conductors. This commuter's behaviour has led to more stress and unhappiness. This happens at every routine trip in their work schedule. The passenger's limit is not predictable and sometimes it is uncontrollable. Many a times the buses are overcrowded, excess, over and above the approved limits. Due to this many difficulties are

faced by the conductors in discharging their duty. During second shift problems of drunken commuters arise. Due to this commuters behave abnormally.

#### **e. Appreciation of Work**

The employees in bureaucracy naturally expect appreciation by their employers for their sincere and committed work. It may be either by rewards or in the form of a rise in the emoluments or through promotions. The conductors who have higher education demand the organization to consider their qualification for promotions to recruitments for higher post but this is not considered by the organization. Due to this they have regretted their appointment as conductors.

#### **Working Environment**

##### **a. Satisfied with Working Environment**

It is the quality of the employees work environment that has a strong input on the level of employee's motivation and subsequent performance. How well they engage with the organization, especially with their immediate environment, influences to a great extent their error rate, level of innovation and collaboration with other employees, absenteeism and, ultimately, how long they stay in the job.

##### **b. Problems and Challenges at Work-place**

The work place increasingly is more diverse than ever before. Many of the biggest work place challenges women face revolve around gender. From decades women entered the male dominated occupations and they were surrounded by large number of male colleagues. Women working in transport industry especially as bus conductors were surrounded by large number of male colleagues and higher officers.

##### **c. Assignment of Extra Work load**

The allotment work load is always according to the rules of the organization in spite of it there will be certain norms of

relaxations for women due to house hold responsibility. The conductors grievances is that while assigning extra load to women employees there should be some consideration based on children care and house hold responsibility and their age and health conditions. Due to this situation the respondents have gone under some conflicts in their family and stress.

##### **d. Cooperation by Male Colleagues**

Co-operation is one of the important concepts to be analysed in the work place to understand the administration of the employees and the welfare benefits taken towards the employees by the industries. When the same nature of work is assigned to male and female employees there is need to analyse the gender discrimination inside the industry which shows the problems faced by the employees in the industry.

##### **e. Sexual Harassment**

Sexual harassment at the work place is widespread and often subtle. It was not considered as a problem or given much importance till recently. Even women victimized by sexual harassment don't like to disclose the issue due to self-respect. In spite of all these difficulties women are working for financial stability or independence.

##### **f. Physical Exploitation**

Different scenarios in the work environment make someone more at risk for experiencing or witnessing physical abuse or exploitation in the work place. It can happen while meeting with co-workers, meeting with higher official or work-related social settings.

#### **Occupational Stress Factors**

##### **a. Occupational stress factors**

Work related stress maybe defined as the physical and emotional response that occurs when the requirements of the job do not match the capabilities, resources or needs of the employee.

Stress is not necessarily a negative phenomenon. But if the person is unable to cope or if support is lacking, then stress became negative and can lead to physical and psychological problems or illness, along with impairing morality and productivity.

Stress can have negative impacts on both the employees and the organization. The bus conductors cannot afford the time to relax and “winds down” when they are faced with work variety, discrimination, dual role and conflicting tasks.

#### **a. Financial Problem**

The “financial problem” related stress is also one of the important stress factors which is experienced by the women conductors. It is not work oriented problem but due to the low salary and household responsibilities. Hence, they experienced stress due to family management and this is a very important factor for causing stress to women conductors.

#### **b. Commuter's Behaviour**

The women conductors have to interact commuters of multi personality on the bus every day while performing their duty. Some commuters be have abnormality. These behaviour cause stress mentally and physically to the conductors. Sometimes these stresses are carried home even after finishing the work due to mental disturbances. Hence, “commuter's behaviour” is also one of the stress factors for the women conductors.

#### **c. Attitudes of Higher Officials**

Sometimes the conductors are stressed by attitudes of their higher officers. The attitudinal factors are found in distribution of work, assignment of extra work load, sanctioning of leaves, sexual harassments, non-cooperation by male colleagues and physical exploitation etc... Under these entire stressful environments

they are working because of their economic necessity and self-sufficiency.

### **Occupational Health Hazards**

Occupational health hazards are related to nature of work, work timing, working environment which normally affect the health of working people. The condition of conductor's profession in the transport industry is comparatively different from other professions. They have to work by standing in their working hours and walk around on the bus to issue tickets. According to the effects on their health due to their occupation is not merely of same kind to all conductors. They have expressed different health related problems of different measures.

The health problems are given below

- Leg pain
- Fatigue
- Body pain
- Back ache
- Allergies
- Swelling of lower limbs and varicose veins problems
- Blood pressure
- Acidity, Gastritis and Knee pain
- Miscarriage

### **Job Satisfaction and Motivational Factors**

#### **a. Job Satisfaction**

Satisfaction is the favourableness or a favourableness with which the employee views his work. It expresses the amount of agreement between one's expectations of the job and rewards that the job provides. Job satisfaction is a part of life satisfaction. The nature of one environment of job is an important part of life as job satisfaction influences one general life satisfaction. Job satisfaction, thus, is the result of various attitudes possessed by an employee. In a narrow sense, these attitudes are related to the job under the condition with such specific factors such as wage, supervisors of employment,

conditions of work, social relation on the job, prompt settlement of grievances and fair treatment by the employer. However, more comprehensive approach requires that many factors are to be included before a complete understanding of job satisfaction can be obtained. Such factors as employee's age, health, temperature, desire and level of aspiration should be considered. Further his family relationship, social status, recreational outlets, activity in the organizations etc. contribute ultimately to job satisfaction. Job satisfaction is in regard to one's feelings or state-of-mind regarding the nature of their work.

### **b. Work Efficiency and Promotion**

To analyse job satisfaction, promotion and work efficiency is one of the important key factors. The same routine work for a long period with lead to loss of interest in the work, and irregularity in the work will exist.

### **c. Motivational Factors**

Motivation is defined as the process that initiates, guides and maintains goal-oriented behaviours. Motivations is what causes us to act, whether it is getting a glass of water to reduce thirst or reading a book to gain knowledge. It involves the biological, emotional, social and cognitive forces that activate behaviour.

## **DATA ANALYSIS AND INTERPRETATION**

### **Issues faced by She conductors**

The following table shows the issues faced by SHE Conductors.

The table 4.1 shows the mean value of each variable relating to the issues faced by She Conductors. The outcome of the analysis shows that Women Conductors are not satisfied with the Bonus and Incentives given by KSRTC. It received a mean score of 24 and Standard Deviation of 32.29. Most of the respondents asserted that they are dissatisfied in the welfare schemes

provided by KSRTC. It is clear from the above table that majority of the respondents reacted negatively about the statement Quality of working environment. Majority of the respondents are dissatisfied in their job.

### **Feedback of Lady Conductors**

The following table shows the feedback of lady conductors.

Table 4.2 shows the mean value of each variable that act as a feedback of lady conductors. The outcome of the analysis shows that women conductors are not satisfied with the work environment of women conductors. The present study reveals that majority of the respondents prefer a neutral opinion regarding the statement satisfaction about the working hours. Majority of the respondents stated that Co-workers are friendly and helpful.

## **FINDINGS OF THE STUDY**

Most of women conductors are under the age group of 30 to 40 year (56.67%) and lowest in below 30 years (16%).

90% of women conductors are married and 6.67% are single.

Majority of the respondents are qualified degree level of education (66.67%), 13.30% are diploma 10% are SSLC. 10% are HSE qualification can be attained.

90% of respondents are worked in permanently and 10% are worked in the contract base.

70% of respondents are completed above 4 years in their service and 20% are complete 2-4 years and 10% 1-year service in KSRTC.

Most of the respondents are gating RS 20000 – RS 30000 as monthly income.

86.6% of respondents are not satisfied with their monthly income.

Most of the respondents that long time for salary revision is the main cause for the dissatisfaction

90% of respondents are not satisfied with the training programme conducted by KSRTC.

Most of the respondents are facing extreme level of job stress (50%) and 33.33% are faced moderate level of job stress.

Outcome of the analysis shows that majority of the respondents face issues in the workplace regarding bonus & incentives, welfare schemes

Majority of the respondents have negative feed back

### **SUGGESTIONS**

Based on the study, the following suggestions are put forward.

Facilitates better welfare scheme, which leads to workers to take an active interest in their job and work with a feeling of involvement and participation.

If Improving salary scale, bonus and other incentives for women conductors, which help to increase their commitment to the organizations.

By providing refreshment classes and programmes, which reduce the overstress of the women workers.

To improving their working environment through providing better hygienic facilities, refreshment facilities, improving co-workers attitudes.

Facilitates proper feedback system from women conductors to know the problems faced by them and also helps to take proper solutions.

Allotting working hours after considering the opinion of women conductors, which helps to their better involvement in work.

### **CONCLUSION**

Job satisfaction is essential for every employee, especially the women workers, without this, which adversely affect the performance of the organization. Women job satisfaction is important as it

has an impact on their mental health, productivity, performance of the organization. It provides a better working environment for the workers in order to ensure job satisfaction. Their commitment and satisfaction are very important for the overall development of the organisation. From the analysis of job satisfaction of women conductors in KSRTC, the following conclusions are to arrive. According to the factors influencing job satisfaction of women conductors, it should clear that, KSRTC was failed to ensuring these factors to the women conductors. They cannot be satisfied with their working environment. The organization should be focused on providing a better working environment to its worker's satisfaction about salary and other incentives are very poor, the firm should be made better welfare measures to the women workers. Through providing effective training programmes, which are reflecting the efficiency of their jobs. On the basis of the above conclusions, we observed that the organisation has to maintain improvement in the above items; it helps to increase the job satisfaction of women conductors.

### **REFERENCES**

'A study of job satisfaction among women workers', Manju Gupta, India Journal of Industrial Relation, Vol.14, No.3 (Jan; 1979). PP.449-459.

'Work life balance of women employees', R. Balaji, International Journal of Innovative research in science, engineering and technology, Vol.3, issue10, October2014.

<https://www.indianjournals.com/ijor.aspx?target=ijor:sjm&volume=6&issue=3&article=005>

<https://www.indianjournals.com/ijor.aspx?target=ijor:zjibemr&volume=5&issue=7&article=010>

[https://web.archive.org/web/20180421082526id\\_/http://www.apjor.com/splissue/06042018Full%20Text.pdf#page=28](https://web.archive.org/web/20180421082526id_/http://www.apjor.com/splissue/06042018Full%20Text.pdf#page=28)



**Table No: 4.1**  
**Issues faced by She conductors**

<b>Statements</b>	<b>Mean</b>	<b>S.D</b>
Are you satisfied with the bonus and incentives given?	24	32.29
HOW DO YOU FEEL ABOUT WELFARE SCHEME FROM KSRTC?	24	28.17
QUALITY OF WORKING ENVIRONMENT	24	25.67
YOUR OVERALL JOB SATISFACTION WITH YOUR JOB	24	26.41

*Source: Primary Data*

**Table No: 4.2 Feedback of Lady Conductors**

<b>Statements</b>	<b>Mean</b>	<b>S.D</b>
Your work environment is excellent and secure.	24	18.19
DO YOU SATISFIED WITH YOUR ALLOTTED WORKING HOURS?	24	19.33
CO-WORKERS ARE FRIENDLY AND HELPFUL.	24	35.97

*Source: Primary Data*

# Invisible Lacunae in Responsible Tourism Management in Kerala

**Dr Satheesh Babu A.T.**  
(Assistant Professor)

Department of Commerce, Govt. Arts College, Trivandrum, Kerala. India

## **Abstract**

As tourism industry started flourishing and paved ways for a country's economic structure Governments and stake holders started pondering their minds and efforts towards creating an effective and responsible tourism atmosphere in their respective countries. Major obstacles in India in regard to this have been identified as stringent, non-friendly or non-user friendly regulations for visitors especially in the visa matters and other legal purposes. Safety concerns especially for women travelers and lesser transport and infrastructural facilities to add misery to some of the visitors. But a major concern which is not really visible or discussed much is found to be hindering tourist movements to interior India. The mindset of the majority of the Indian rural population need to be educated enough to accommodate and accept foreign tourists, accepting their cultural and behavioral standards, to some extend their dress code too. Isolated incidents of mass protests against the tourists entering their rural areas are being reported. If this is not curtailed or rectified effectively more modern tourists who wish to explore deep into rural India will be in trouble. Some unhealthy hygienic problems prevailing in rural India may also mar the tourists from exploring further. Governments and tourist promoters could easily tackle this problem and manage the tourism in a responsible way by conducting some planned awareness programmes in such areas. India has got a rich tradition of "**AdhithiDevoBhava**" meaning the tourists or visitors who come to our houses should be treated as God. This campaign alone could make our rural people responsible towards visiting tourists.

**Key Words:** rural tourism, responsible tourism, adhithi devo bhava,

## **Selection of the Topic**

The review of literature indicated the gaps in researches on invisible lacunae in responsible based Tourism in South India despite awareness about it among stakeholders and scattered success stories on ground. However the choice of the theme, invisible lacunae in responsible tourism management in south India for research level enquiry and thesis was the outcome of many factors.

## **INTRODUCTION**

Rural development is really a point of deep concern in India where majority of population (68%) is still living in villages in condition of extreme poverty, ill- health and illiteracy; and are poorly organized for effective participation in programs of their own welfare. The disempowered populace lack technical knowledge and have no access to resources except human capital for improving their economic condition. Keeping in view the inadequacy and inconsistency that the economy faces, it is essential to pursue a suitable policy with a deliberate rural focus and strategic developmental outreach towards the

disadvantaged districts / regions of the economy. The success of rural Indian economy is dependant to a great extent on the growth of agriculture sector with no other considerable alternate sector that may be enriching for the rural Indian economy. Thus any policy measure to be introduced in this sphere has to be taken up in right earnest.

## **TOURISM POTENTIAL IN INDIA**

Tourism in India, offering large and diverse range of tourism products all across the length and breadth of the

country, still remains quite insignificantly low both in terms of share of the world arrivals and tourism receipts, despite having much larger share in terms of geography, better tourism products and still the more – better prospects of developing manmade tourism. Tourism is being utilized by many underdeveloped / remote areas across the world as the best instrument for growth of neglected, remote and rural / backward areas. Tourism in India can ensure significant development in terms of the infrastructure at the destinations, generate local employment, and induce multi- sectoral overall growth of the economy and above all effect into the optimum share of global tourist arrivals and earnings that still remains elusive.

Tourism business is assumed as human industry because of its significant importance of manpower working in it. The human factor is the most significant one, since it is the people who have to use all other resources. The people in tourism industry are service-producers and service-providers as well. They are also managers for the service and planners who can create added-value for tourism product. However, when it comes to retailing the tourism products, we fail to assimilate the human development or the local communities who are not only beneficiaries but are also the epitome of India's culture and ethos. Many destinations or tourism products lack an insufficient promotional activity for rural / underdeveloped areas although endowed with sufficient tourism product. This arises out of putting marginal relevance of these products as a cultural tourism destination, the seasonal nature of tourism itself, or insufficient hospitality infrastructure. The question is that how local community can offer a viable solution for tourism development and removes its barriers in local communities? This can be done by

increasing the community capacity in tourism.

## REVIEW OF LITERATURE

Smith, Baugh-Littlejohns & Thompson (2001) describe community capacity building as the "essence of development". The development of such areas for tourism requires the need to cater to the requirements of the local community. Social and economic benefits must firstly benefit the local population and then tourism. Tourism can also serve as an instrument for effective marketing for the underdeveloped / rural areas as well as generating employment for such areas.

Discussing this issue, Martha Frederick (1992), in the book, "Tourism as a Rural Economic Development Tool: An Exploration of the Literature", gives an effective solution to the above mentioned problems. She considers that tourism can be an important source of jobs for economically underdeveloped / rural areas. Tourism offers business opportunities to local residents and can serve as a vehicle for marketing a place to potential residents and firms. In tourism sector, family firms or the local communities can be effectively utilized for retailing the Indian tourism beyond the borders of the country.

Rhodri Thomas, Gareth Shaw, and Stephen J. Page (2011), mention how small firms are important from various points of view, all leading to the consolidation of the industry towards building from a developing state to robust economy.

Further, Jean-Luc Arregle, Michael A. Hitt, David G. Sirmon and Philippe Very (2007) appropriates social capital theory and argue that family firms are unique as they work as a single entity, where at least two forms of social capital coexist: the family's and the firm's. Finally, they suggest the family firms' insights are

generalizable to several other types of organizations more so often with service orientation. Tourism, being the highly labour intensive activity, creates a high proportion of employment opportunities for low and semi skilled workers, particularly for poor, female (Women make up 70% of the labour force in tourism) and young workers (Report of the Working Group on Tourism, 12th Five-Year Plan, 2011). In India, the technical planning and assistance can prove crucial to tourism development success for many small communities with limited resources in the short run and may solve the long run shortfall of human resource development for growth in Indian tourism.

### **OBJECTIVES OF THE STUDY**

The objectives for the present study have been planned to understand dynamics of Invisible Lacunae in Responsible Tourism Management in Kerala. These are:

1. To identify the possibilities and opportunities responsible Tourism Management in Kerala.
2. To examine the Invisible Lacunae in the responsible tourism Management in Kerala:
  - i. To study the potential of foreign tourists in various rural communities based activities.
  - ii. To study the engagement of various communities based activities where tourists do/can participate.
  - iii. To study the mindset and role of rural communities in the promotion of responsible Tourism.
  - iv. To study the major obstacles in responsible tourism in Kerala.
3. To study the satisfaction level of tourists in the responsible tourism in Kerala.

### **HYPOTHESES OF THE STUDY**

Three hypotheses have been developed to assess the responsible tourism in the light of research objectives.

#### **Hypothesis 1**

- H0 There is low potential of Responsible Tourism Management in rural Kerala.
- H1 There is high potential of Responsible Tourism Management in rural Kerala.

#### **Hypothesis 2**

- H0 Tourists coming to rural areas of Kerala do not participate in community based activities.
- H1 Tourists coming to rural areas of Kerala to participate in any community based activities.

#### **Hypothesis 3**

- H0 The rural communities have no positive mindset and role in the promotion of responsible Tourism
- H1 The rural communities have positive mindset and role in the promotion of responsible Tourism

#### **Hypothesis 4**

- H0 There is no major obstacles in responsible tourism in rural Kerala.
- H1 There is major obstacles in responsible tourism in rural Kerala.

#### **Hypothesis 5**

- H0 Tourists are not satisfied with Rural Based Tourism in Kerala.
- H1 Tourists are satisfied with Rural Based Tourism in Kerala.

### **RESEARCH DESIGN**

#### ***Sample Selection***

The sample of the study included different stakeholders in tourism mainly hosts/communities, tourists and Government representatives. The communities, tourists were contacted in the sampled villages while government officials were contacted at their respective offices. Sampling for primary data

collection has been done at two levels; first for choosing villages from each selected Districts of Kerala (Two Districts) and second for selecting respondents from different groups in these villages. Two villages have been selected from two Districts in Kerala. Total four villages have been selected where tourism is active through rural tourism scheme (Table 1).

Purposive sampling was used to collect the data depending on the availability of tourists and hosts in the sample villages at the time of data collection. It has been assumed that this would not disturb results as the sample villages are small in size that is also a typical feature of villages of Kerala. The distribution of villagers, tourists and from the selected villages is shown in table 2

### **Data Collection**

The data for the study was collected from both primary and secondary sources. 50 sample respondents were selected from each Village under study. A total of 200 samples were selected for the study (100 samples each from two districts of Kerala, South India) Primary data was collected from villagers and tourists with the help of structured questionnaires. The survey was intended to understand the views of local communities and tourists on responsibility based Tourism Development through their participation in it. Data collected from government was also primary but interview method was used here. Secondary data was collected from government agencies, research reports, statistical reports and articles published in news papers, electronic media and websites.

### **Data Analysis**

The data was analyzed through descriptive statistics such as percent analysis, mean, standard deviation and

factor analysis. SWOT analysis, matrix and Chi-Square, Correlation were used for qualitative data.

### **Limitations of Study**

A few difficulties arose in the fieldwork. One of the biggest challenges was the collection of official statistical data of tourist arrivals at different tourists visiting villages. The fieldwork was also constrained by the limits of time and budget. The severe climate conditions and inaccessibility to these areas added more hardness to the fieldwork.

### **Use and Application of study findings**

The study is confined to the selected villages of Kerala. The scope of the study is limited to investigate the perception of host community on selected issues related to responsibility based tourism development in selected villages of Kerala. Experience and expectations of host community from growing tourism were given due attention. The study also examines the perception and profile of tourists in two broad segments: domestic and international of a comparative study.

### **Objective 1**

***The first objective was to identify the possibilities and opportunities responsible Tourism Management in Kerala.***

Identification and mapping of resources is an extensive process and the information for the same was collected through observation, interview with locals, tourists and government officials. The identification and mapping of tourist resources in Kerala has been done on the presumption that all natural and cultural resources of the state are suitable for responsibility based Tourism Development as these are very fragile and cannot be maintained without the active involvement of the community.

### **Objective 2 and Hypothesis 1**

***The second objective was to examine the Invisible Lacunae in the responsible tourism Management in Kerala, it has been divided into four sub objectives and hypothesis was framed for the same as follows:***

*i. To study the potential of foreign tourists in various rural communities based activities.*

Hypothesis 1

*H0 There is low potential of Responsible Tourism Management in rural Kerala.*

*H1 There is high potential of Responsible Tourism Management in rural Kerala.*

The potential was assessed with the help of awareness of tourists about Kerala and rural holidays, their participation in community based activities and involvement of communities in various activities for tourists.

In the view of above H0 is rejected and H1 is accepted. (*There is high potential of Responsible Tourism Management in Kerala*)

P value is less than the significance level so reject the null hypothesis (5% level of significance, Value 1.96 for Normal Distribution)

***ii. To study the engagement of various communities based activities where tourists do/can participate.***

Hypothesis 2

*H0 Tourists coming to rural areas of Kerala do not participate in community based activities.*

*H1 Tourists coming to rural areas of Kerala do participate in community based activities.*

Data analysis shows that both domestic and international tourists are extremely interested in various community based activities like a day hikes to pilgrimage sites near village area, natural trail nearby village and cultural shows. Some of the international tourists like to

explore the area by involving in trekking, bird and butterfly watching.

In the view of above H1 is accepted and H0 is rejected. (*Tourists coming to rural areas of Kerala do participate in community based activities*)

P value is less than the significance level so reject the null hypothesis. (5% level of significance, Value 1.96 for Normal Distribution)

***iii. To study the mindset and role of rural communities in the promotion of responsible Tourism in Kerala.***

Hypothesis 3

*H0 The rural communities have no positive mindset and role in the promotion of responsible Tourism*

*H1 The rural communities have positive mindset and role in the promotion of responsible Tourism*

The analyses were done on the basis of the mindset and role of communities of rural people in the Kerala. It is understood that the mindset of the majority of the Kerala rural population have no cooperative approach towards activities of foreign tourists, accepting their cultural and behavioral standards, to some extend their dress code too.

In the view of above H1 is rejected and H0 is accepted. (*The rural communities have no positive mindset and role in the promotion of responsible Tourism*)

P value is more than the significance level so accept the null hypothesis. (5% level of significance, Value 1.96 for Normal Distribution)

***iv. To study the major obstacles in responsible tourism in Kerala.***

Hypothesis 4

*H0 There are no major obstacles in responsible tourism in rural Kerala.*

### ***H1 There are major obstacles in responsible tourism in rural Kerala.***

In the above study revealed that there were some obstacles in the responsible tourism in rural Kerala. Major obstacles in India in regard to this have been identified as stringent, non-friendly or non-user friendly regulations for visitors especially in the visa matters and other legal purposes. Safety concerns especially for women travelers and lesser transport and infrastructural facilities to add misery to some of the visitors. But a major concern which is not really visible or discussed much is found to be hindering tourist movements to interior of Kerala.

In the view of above H1 is accepted and H0 is rejected. (*There are major obstacles in responsible tourism in rural Kerala*)

P value is less than the significance level so reject the null hypothesis. (5% level of significance, Value 1.96 for Normal Distribution)

### **Objective 3 and Hypothesis 5**

3. To study the satisfaction level of tourists in the responsible tourism in Kerala.

### ***H0 Tourists are not satisfied with Rural Based Tourism in Kerala.***

### ***H1 Tourists are satisfied with Rural Based Tourism in Kerala.***

The analysis was based on the satisfaction with overall tour experience in villages of Kerala. The tourists were very much satisfied with the overall tour experiences in the villages and due to this they pleased and decided to visit this place again the visit to these villages exceeds their expectations. They strongly recommend their friends and relatives to visit these villages because the tradition and culture of Kerala is unique.

It is inferred that, tourists are very much satisfied with overall tour experience in villages. Therefore, H1 is accepted and H0 is rejected. (*Tourists are satisfied with Rural Based Tourism in Kerala*)

P value is less than the significance level so reject the null hypothesis. (5% level of significance, Value 1.96 for Normal Distribution)

### **RESEARCH FINDINGS**

The identification and mapping of tourist resources in Kerala has been done on the presumption that all natural and cultural resources of the state are suitable for responsibility based Tourism Development as these are very fragile and cannot be maintained without the active involvement of the community.

The potential was assessed with the help of awareness of tourists there is low potential of Responsible Tourism Management in rural Kerala.

On the basis of the study it is identified that Tourists coming to rural areas of Kerala to participate in any community based activities.

The tourists were very much satisfied with the overall tour experiences in the villages and due to this they pleased and decided to visit this place again the visit to these villages exceeds their expectations.

The mindset of the majority of the Kerala rural population have no cooperative approach towards activities of foreign tourists, accepting their cultural and behavioral standards, dress code.

There are major obstacles in Kerala are stringent, non-friendly or non-user friendly regulations for visitors especially in the visa matters and other legal purposes. Safety concerns especially for women travelers and lesser transport and infrastructural facilities to add misery to some of the visitors. But a major concern which is not really visible or discussed much is found to be hindering tourist movements to interior India.

### **RECOMMENDATIONS**

Using the research findings, the study has established the following recommendations and suggestions.

There should be tourist friendly regulations, proper guidelines and code of conduct for the promotion of rural tourism in Kerala.

Provide Education and Proper Training to local rural communities in tourism activities of the respective States of Kerala.

The effective involvement of local rural people in the tourism decision making process, in the sharing of tourism benefits and in tourism's contribution towards poverty alleviation.

Organize more tourist friendly shows and handcraft sales which help the rural people to earn income for their livelihood.

### CONCLUSIONS

Even though there are many obstacles in the rural tourism in the Kerala, like stringent, non-friendly or non-user friendly regulations for visitors especially in the visa matters and other legal purposes. Safety concerns especially for women travelers and lesser transport and infrastructural facilities to add misery to some of the visitors. The mindset of the majority of the Kerala rural population need to be educated enough to accommodate and accept foreign tourists, accepting their cultural and behavioral standards, to some extent their dress code too. Rural tourism has many potential benefits for the rural population in Kerala including employment, social benefits, self reliance, education of children, business opportunities etc. The rural tourism also promotes the economic structure of the country. Governments and tourist promoters could easily tackle this problem and manage the tourism in a responsible way by conducting some planned awareness activities

### REFERENCES

- Acharya, Sarthi and Mitra, Anup (2000). The Potential of Rural Industries and Trade to provide decent work conditions: A Data Reconnaissance in India, SAAT working papers, South Asia Multidisciplinary Advisory Team (SAAT), ILO, New Delhi.
- Bhattacharya, Shampa and Battacharya, Manas (2000). Environmental Effects of Rural Industrialization in India, SAAT working papers, South Asia Multidisciplinary Advisory Team (SAAT), ILO, New Delhi
- Gaur, K.D.( 1997). Economic Development of India (Problems & Prospects), New Delhi: Radha Publications.
- Khatoon, Syeeda (2005). Impact of Economic Liberalization on Rural India. Also available online at <http://unpan1.un.org/intradoc/groups/public/documents/APCITY/UNPAN024228.pdf>
- Meyer, Dorothea, Ashley, Caroline and Poultney, Clive (2004). Pro Poor Tourism Pilots Programme, UK, [www. propoortourism.org.uk](http://www.propoortourism.org.uk), Accessed on February 4, 2009
- National Council of Applied Economic Research(2003). Quarterly Review of the Economy, New Delhi, March 2003
- Pradhan, Rudra Prakash (2003). Agri Infrastructure and Modern Farm Practices: Their Impact on Agricultural Productivity, The Indian Journal of Economics, Vol.LXXXIV, part 2.
- Report of the High Level Group on Services Sector (2008). Planning Commission, Government of India, New Delhi
- Shai, Suman (2000). Farmer's Rights and Food Security, Economic and



- Political Weekly, Vol.35(11). March 11- 17,2000.
- Singh, Romeshwar (2000). No Globalization and Free Trade in Jobs, says ILO; NAI AZADI Udghosh, Vol.7(2), April-June
- Smith, N., Baugh-Littlejohns, L & Thompson, D. (2001). Shaking out the cobwebs: Insights into community capacity and its relation to health outcomes, Community Development Journal. Vol. 36, (1):30-41.
- Sharma, Devinder (2000). 'WTO and Indian Agriculture: Trading in Food Insecurity', The Tribune, Chandigarh
- Vanhove N. (1981). Tourism and employment, International Journal of Tourism Management, Volume 2(3): 162- 175, September 1981, UK.
- Vyasulu, Vinod; Vani, B. P.; Indira, A. (2000). Rural Industries in India: Lessons from a survey, TIDE, Development Research Foundation, Bangalore, South Asia.

**Table.1 Sample selection of the Villages under Study**

Sl.No	States of Kerala (South India)	Villages/Districts of each Districts
1	Idukki	a) Kattappana (Idukki, Kerala)
		b)Kumili(Idukki, Kerala)
2	Wayanadu	a)Kalpeta (Wayanadu, Kerala)
		b)Sultanbetari (Wayanadu, Kerala)

*Source: Primary Data***Table.2 Distribution of Samples**

<i>Name of Villages</i>	<i>Number of Sampled Villages</i>	<i>Number of Sampled Tourists</i>	
		<i>Domestic</i>	<i>International</i>
<b>Kattappana (Idukki, Kerala)</b>	<b>50</b>	<b>28</b>	<b>22</b>
<b>Kumili(Idukki, Kerala)</b>	<b>50</b>	<b>30</b>	<b>20</b>
<b>Kalpeta (Wayanadu, Kerala)</b>	<b>50</b>	<b>35</b>	<b>15</b>
<b>Sultanbetari (Wayanadu, Kerala)</b>	<b>50</b>	<b>25</b>	<b>25</b>
<b>TOTAL</b>	<b>200</b>	<b>118</b>	<b>82</b>

*Source: Primary Data*

**ENGINEERING**

# A Survey of Extraction Based Approaches on Multi-Documents

**Pavan Kartheek Rachabathuni**

Dept. of Computer Science and Engineering  
Bapatla Engineering College  
Bapatla, India.

**Yunus. Sk**

Dept. of Computer Science Engineering  
Bapatla Engineering College  
Bapatla, India.

## **Abstract**

Text Summarization solves climacteric problems in furnishing information to the necessities of user. Due to explosive growth of digital data on internet, information floods are the results to the user queries. This makes user impractical to read entire documents and select the desirables. To this problem summarization is a novel approach which surrogates the original document by not deviating from the theme helps the user to find documents easily. Summarization area was broadly spread over different research fields, Natural Language Processing (NLP), Machine Learning and Semantics etc... Summarization is classified mainly into two techniques Extract and Abstract. In this paper we give a deep review of multi-document summarization uses extract techniques.

**Keywords:** Extract Summarization; Text Summarization; Multi-document Summarization.

## **INTRODUCTION**

Today the problem of information overload is increasing rapidly. Especially social media, online information services, and other digital format of documents are uploading to internet with a lightning speed. The retrieval of desirable documents to the end users is becoming burdensome. Search engines retrieve immense volumes of documents to the specific user query. This become strenuous situation to read all the documents to get required document. Text search and summarization are two indispensable technologies that complement each other. A summary can be loosely defined as a short version of text that is produced from one or more texts. The base line of summary is concise form of original document without loss of crucial information. A good summarizer includes sentences that are most important to document's context which spans over all topics present in the document. The process of summarization are of two way Extract and Abstract. These both ways can implement either in

text-to-text or graph-to-text generation approaches. In general, summary must satisfy the needs of user. These summaries are categorized into Generic and Query dependent [20]. Generic and Query dependent summaries relay on statistic, syntactic, semantic techniques to include the gist of the document. To be specific a subtle difference among them is Query dependent, generates summary with respect to the query given by the user accounting similarity. Various similarity measures were employed to fulfil the requirement of query dependent [20] [25] [28] like cosine, jaccard etc... The other aspect is redundancy, measures should be taken care to get rid of redundancy from the summary.

Extract summarizer, the operations of these summary systems extracts sentences from the actual document and place directly into the summary. Extract summarizer is capable generating both generic and query dependent summary. The extraction procedure extracts important sentences or key phrases [8] [9] [34] by employing either individual or

combination of statistical measures of word level and sentence level features, deep syntactic analysis, semantic analysis, and document discourse structure after preprocessing the document. The preprocessing module includes elimination of stop words, figure, tables, links etc... These extracted sentences are organized into summary utilizing sentence ordering techniques to achieve coherence. The procedure explained is appropriate for Single document summary generation. Though many of these techniques are included in Multi document summarization but a need to consider Redundancy: Similar information in different documents, Compression Ratio: To what extent the summary length has to be confined from a document set, Co-referential problems: Same entities may refer in different documents in different forms, Document Relevance: What percentage of similarity between documents is considered as relevant while generating multi document summary and Cohesiveness among paragraphs: Same content is expressed in documents in different ways, if the content is essential to mention in final summary it will appear only once. For example, a user makes a query on search engine in search of documents using keyword "computing". The results to the query leads to document floods based on keyword existed in the document but conceptually all the documents may not be relevant. To this an eminent solution is Text summarization. Summarization produces condense form to the original documents which helps in retrieval of necessary information from the huge volumes of text documents and identification of context of document. Relaying on summary the user was provided with a facility to find the most desirable documents. Because of multiple relevant documents to a query there is a necessity of Multi document

summarization which is a sub component. While generating summary, the specified issues

earlier mentioned has to be resolved in this context. This article presents in depth review of different techniques that generate Extract summaries form Multi documents. Further the article organized as follows. Section II discuss the major types of Extraction text summarization techniques. Section III presents conclusion.

## **COLLECTION OF EXISTING TECHNIQUES**

### **A. MEAD**

(Dragomir, et al.) [7] MEAD an open source multi-document multilingual summarizer. It is a collection of summarization algorithms such as position-based, centroid-based, largest common subsequence, keywords, query-based. These algorithms are used arbitrarily.

Summary is obtained on following procedure in four stages. First, XML based content is generated from documents cluster. Second, the sentence features are extracted for each sentence of the cluster. Third, a score is given to each sentence. Four, on the base of cross-sentence dependencies [12] among the sentences scores are refined. The sentences with high score beyond threshold are extracted for generation of summary. The MEAD comprises of Centroid, SimWithFirst, Length, RealLength, Position, QueryOverlap, KeyWordMatch and LexPageRank features. MEAD is capable of producing one-sentence summary using a linear combination of features as the scoring function. MEAD uses four classifiers and six rerankers in generation of summary. Classifiers: Default, Lead-based, Random, Decision-tree. Rerankers: Identity, Default, Time-based, Source-based, CST-based, Maximal Marginal Relevance (MMR) [3]

[17]. The summary is evaluated using MEADeval which has co-selection and content-based metrics. Co-selection consists precision, recall, Kappa, and Relative Utility as metrics. Content based metrics are co-sine (TF\*IDF), simple cosine, unigram and bigram-overlap and relevance correlation. Refer Table 1.

## B. CBS

(Radev, Hongyan Jing, Malgorzata, & Daniel, 2003) [33] Proposed a Centroid-based summarizer which can be applied on both single and multi-documents. The main concept used in TDT (Topic Detection and Tracking) [32] [2] is employed in CBS to rank sentences. For each document centroid is calculated and finds the similarity among centroids. Those documents which are closer to centroid forms cluster [16] [32] and those documents which are less similar to centroid forms another cluster. A centroid is a vector of keywords with TF\*IDF [1] values greater than threshold. If the current document is to be clustered to existing cluster TF\*IDF of new document is to be closer to centroid of existing. The sentences in each document are compared with centroid to find centrality of the sentence with cluster. Centroid based summarizer (CBS) is used in MEAD a multi-document multi lingual summarizer. CBS uses centroids generated by CIDR [32]. Two techniques are used in this summarizer for generating final summary, cluster-based relative utility (CBRU) [33] or cluster based sentence utility (CBSU) and cross-sentence informational subsumption (CSIS). CBRU calculates the relevance of the sentence with the centroid on the scale from 1 to 10. CSIS is the technique which avoids redundancy in the sentences from the same or different clusters. As the final summary is collection of sentences on single topic from different clusters (multi documents) which are generic or query independent. This technique is very

similar to MMR (Maximum Marginal Relevance) applied in generation of query dependent single document summary. A Score is calculated for each sentence in the clusters and the existence of the sentence in the summary is decided by Mead extraction or Centroid based algorithm. This algorithm uses three parameters centroid, position and first sentence overlap [33] values of the sentence to calculate score. Using this score and a summary compression rate as input to the algorithm, extracts the sentences with higher score values. A redundancy based algorithm is applied on the extract of Mead which reranks the sentences after reduction of redundancy penalty. This will be done until no rerank will be again computed on the newly generated extract. The author discusses multiple techniques for evaluating summaries like Single document summaries, Utility based evolution for both single and multiple document summaries, Interjudge agreement, system performance, Normalized system performance and using CSIS to evaluate multi document summaries. Refer Table 1.

### Advantages:

- CBS is a multi-document multilingual summarizer.

### Limitations:

- CSIS reflects that certain sentences have some redundant information therefore, it omits those sentences from summary instead of fusing those sentences, not to eliminate unexplored content.

## C. NeATS

(Lin & Hovy, NeATS: A Multidocument Summarizer, 2002) Next Generation Automated Text Summarization [6] [19] is a multi-document summarizer generates extract type generic summary in a coherent order. The summarization procedure is as

follows, content selection, filtering and presentation.

In content selection phase the techniques used are term frequency, sentence position, topic signature [18] and term clustering. Given a set of documents as input to this phase in the form of topic groups, a query will be generated by Webclopedia [11] query generation module, identifies keywords from each topic group on computing unigram, bigram and trigram topic signatures using likelihood ratio  $\lambda$ . The topic means concept and signature means vector of related keywords. These signature words with fewer occurrences to total text size of the topic group are removed. The remaining signatures are clustered through lexical connection to identify subtopics. The sentences having signature words are ranked using Webclopedia's ranking algorithm. Filtering phase comprises of MMR, Sentence Position and Stigma words filters eliminates redundancy and rerank the sentences. The optimum position policy [17] technique used in Summarist [10] summarizer is employed as filter for removal of sentences with sentence position greater than 10 in the original document. The authors point is, sentence with position greater than 10 in the original document have less importance. The sentences with stigma words like sentences start with conjunctions, questions, dates, and time expressions are given with fewer score in order to eliminate from final summary which may cause discontinuity. To reduce the redundancy among sentences in the final summary an algorithm Maximum Marginal Relevance is used. It measures the number of words between two sentences are same. Stemmed word overlap and threshold value are used to compute overlapped ratio.

Coherence and cohesion [29] [31] [32] is achieved in the final summary by

using Buddy System [6]. Every sentence is paired with its suitable introductory sentence of the document unless it is short of minimum 5 words. If the introductory sentence contains less than 5 words, choose the next sentence as the lead sentence. Time frames in the sentences are normalized to actual dates and reorder the sentences to improve cohesion and to reduce time disambiguation. To make the final summary, the highest scored sentence pair is included and the sentence pair most different to existing summary sentences is to include as next sentence. The difference between sentences is based on overlapped ratio. This process is repetitive until desired length of the summary is obtained. Author states the summarizer would be made sensitive to desired focus topics, input by a user. The input is a set of topic groups. Each topic group is a set of approx. 10 newspaper articles selected by the evaluation organizers. Refer Table 1.

#### **Advantages:**

- Unigram, bigram and trigram concepts are used in content selection which improves efficiency of NeATS.

#### **Limitations:**

- No sentence compression, discourse processing techniques were used.
- The measures for grammar, coherence, and cohesion, the results are confusing.

#### **D. MMR-MD**

(Jade Goldstein, Vibhu Mittal, Jaime Carbonell, & Mark Kantrowitz, 2000) [14] MMR-MD is of type extraction based query dependent uses cluster approach. This summarizer employs a metric named, relevant novelty. This approach mainly concentrates on reduction of redundancy and enhances

relevance, diversity in final summary. The measuring of novelty and relevance is carried individually and provide a linear combination as metric called Maximum Marginal Relevance Multi Document (MMR-MD). The working procedure is as follows, segment the documents into passages (Phrases, Sentences, n-sentence chunks or paragraphs) and index them using inverted indices. Identifies passages relevant to the query using cosine similarities, the value below threshold are discarded and then apply MMR-MD, based on desired length of summary passages are selected to compute passage redundancy using cosine similarity. These passages are clustered utilizing passage similarity score. Two cosine similarity measures are used to identify the sentences relevant to generate summary. The first similarity measures with query and document, linguistic and statistical features such as (query expansion, position of the passage in the document, presence/absence of named entities in the passage), coverage score and sequence of documents in collection. Second computes the similarity with selected passage with previous selected passages, negative weights to the passages that belong to the clusters from which other passages already have come from and negative weights to documents from which passages have already been selected. Text passages with high marginal relevance are relevant to query, useful for summary and minimal similarity to previous selected passages. Users are provided with the facility to select the compression rate (interactive dynamic summary generation). Based on the compression rate the selected passages are reassembled into summary using summary cohesion criteria (document ordering, news-story principle, topic cohesion, time line ordering). This article discusses various types of summaries and requirements of Multi document summaries. Refer Table 1.

### **Advantages:**

- Eliminates redundant information from multiple documents.
- Achieves high compression rate.

### **Limitations:**

- Co-references, pronominal resolution, dependency parsing to identify events, time frame normalization are not taken into account.

### **E. Cluster Approach with TSF-ISF**

(Kogilavani & Dr.Balasubramani, 2010) A cluster model summarizer summarizes input documents in form of extract generic summary. The summarizer is composed with components document clustering, ranking the sentences using feature profile, summary generation and chronological ordering sentences. In document clustering phase the sentences in the documents are tokenized into words, eliminate stop words and generate stem words using Porter stemmer algorithm. For each word in the document is assigned with TSF-ISF (Term Synonym Frequency – Inverse Sentence Frequency) [16] value. This is similar to Term Frequency Inverse Document Frequency, to improve accuracy word sense is adopted employing WordNet [23]. i.e. TSF-ISF calculates importance of the word among all the sentences in the document set considering synonyms of that word. Documents are clustered on selecting a document initially and the centroid value is calculated by utilizing the TSF-ISF values of all terms in the document. For all the documents calculate document centroid and compare with cluster centroid. If the cosine similarity is beyond the threshold value which is manually given, then the document is aligned to particular cluster updating the cluster centroid value to the mean of TSF-ISF values of all the elements present in cluster. Else the document is assigned to new cluster. Repeat the procedure till all



the documents in the set are aligned to clusters. In sentence ranking phase, the sentences scores depend on feature profile comprises of term frequency, position, sentence length, sentence centrality, sentence with proper noun, sentence with numerical value features. The linear summation of all these feature values projects sentence scores. According to the scores of sentences, position and chronology of sentence in the document sentences are ordered in clusters. Top scored sentences are considered in final summary. To eliminate redundancy the sentences already present in the summary are compared with extracted sentences if found similar those extracted sentences are skipped. Refer Table 1.

#### **Advantages:**

- The summarizer results significant improvement in quality of summary than MEAD when compared, MEAD uses 3 features less in number while calculating sentence scores.
- Allowing synonyms while clustering documents improves accuracy of identifying similar documents.

#### **Limitations:**

- No standard measure while choosing of first document as cluster centroid, if the selection of document changes, a notable impact will be laid on the formation of clusters.
- The order of selecting the documents to form clusters may affect at sentence reordering in clusters.
- No consideration of time frame in sentences influences the loss of coherence among sentences.

#### **F. Graph Based Cluster Approach using CRF**

(Pinaki, 2013) [24] Proposed a summarizer uses graph based cluster approach to generate both query dependent and generic summaries. The

system is mainly organized into three components, document graph generation, key phrases extraction module and summary generation module. Assuming all documents are on same topic [4], first a document graph is constructed with the given document set. Each document is tokenized to sentences and aligned into nodes of the graph. The edges are placed between nodes corresponds to different documents nodes in the form of bipartite graph edges and nodes within the document. The edges exist between nodes when the two node sentences share similar words. This exhibits measure of correlation between nodes. Each node is assigned with edge score which is the summation of scores of all out going edges. The nodes with highest edge scores above the threshold are consider as seed nodes. After seed nodes are extracted, the edges are placed between inter document nodes, the document graph is now called as search graph. This process is carried to identify the important relevant content across multiple documents. To make the final summary more informative, Markov graph clustering algorithm [28] is run on the search graph, forms clusters according to subtopics in the document set. Conditional Random Field (CRF) [5] [13] key phrase extraction system a probabilistic model is employed to extract Key-phrases from document set. Key phrase extraction system contains features Dependency parsing, POS feature, Chunking, Named Entity, Term frequency range, Word in Title, Word in Body, Stemming[22], Context word feature. Considering the extracted key phrases, the sentences in the search graph are assigned with Key phrase dependent score and Key phrase independent score. According to combined scores of sentences those are present in clusters, clusters scores and ranks are calculated. Summary generation module comprises of sentence selection, sentence compression [15], sentence

ordering. The top two highest weighted sentences are considered from each cluster. These sentences are split into multiple phrases like noun phrase, verb phrase, preposition phrase by Stanford Parser [21] and are passed as input to sentence compression. The compressed sentences are ordered by not skipping semantic relations among the sentences. Refer Table 1.

#### **Advantages:**

- As the summarizer is purely based on statistic and syntactic text processing, it can be used to multilingual [26] [27] text documents.
- The user is provided with facility to select the size of the summary dynamically.

#### **Limitations:**

- Time frames and Date formats are not considered while achieving coherence among sentences.
- Key phrase extraction module is not 100% accurate.

### **CONCLUSION**

This survey article explores the study of current trends and techniques of Extraction method in Multi document Summarization. Summary is abridged form of original document without departing from main theme. An extractive summary is the selection of important sentences from the original text and order them in a cohesive manner. The importance of sentences is calculated based on statistical, linguistic and semantic features of sentences. Deciding appropriate weights to these features, the effectiveness of summary is obtained. The final important aspect to consider in summary generation is redundancy. Redundant information in final summary deteriorates the quality. Similarity measures like cosine, jaccard etc... have to employ to identify and eliminate redundant information. Here the document provides the comprehensive review of

different techniques proposed by various authors. It expounds advantages and limitations of all techniques analyzed above.

### **REFERENCES**

- A. C., O. M., G. J., & L. B. (1997). "A scalable summarization system using robust NLP". Proceedings of the workshop on intelligent scalable text summarization at 35th meeting of the association for computational linguistics and the 8th conference of European chapter of the association for computational linguistics, (pp. 66-73).
- A. J., P. R., & L. V. (1998b). "On-line new event detection and tracking". Proceedings of 21st annual international ACM 57-GIR conference on research and development in information retrieval (pp. 37-45). Melbourne, Australia: ACM.
- C. J., & G. J. (1998). "The use of MMR, diversity -based reranking for reordering documents and producing summaries". In M.-f. A., & Z. J.. Melborne, Australia: preceedings of 21st annual international ACM SIGIR conference on research and development in information retrieval.
- Chen, & Kuang-hua. (1995). "Topic Identification in Discourse". Proceedings of 7th Conference of the European Chapter of ACL, (pp. 267-271).
- Chengzhi ZHANG, Huilin WANG, Yao LIU, D. W., Yi LIAO, & Bo WANG. (2008). "Automatic keyword Extraction from Documents Using Conditional Random Fields". Journal of Computational Information Systems, 1169-1180.
- Chin-Yew Lin, & Eduard Hovy. (2002). "From Single to Multidocument

- Summarization: A Prototype System and its Evaluation". ACL, 457-464.
- D. R., T. A., S. G., B. J., A. C., E. D., . . . J. O. (n.d.). "MEAD - a platform for multidocument multilingual text summarization".
- E. D., & B. M. (2005). "A Keyphrase-Based Approach to Summarization: the LAKE System". Proceedings of Document Understanding Conferences. . DUC-2005.
- F. E., P. G., W. I., G. C., & N. C. (1999) proceedings of 16th International Joint Conference on Artificial Intelligence). Domain Specific Key phrase Extraction. (pp. 668-673). Morgan Kaufmann.
- H. E., & L. C. (1999). "Automated text summarization in SUMMARIST". In M. I., & M. M., Advances in automatic text summarization. Cambridge, MA: MIT Press.
- H. E., G. L., H. U., & L. C. (2000). "Question Answering in Webclopedia". proceedings of the TREC-9 Conference. NIST. Gaithersburg, MD.
- H. H., N. S., T. S., L. T., B. W., & X. Z. (2002). "Cross-document summarization by concept classification". 25th annual international ACM SIGIR conference on Research and development in information retrieval (pp. 121-128). ACM NewYork NY, USA.
- J. D., A. M., & Pereira, F. C. (2001). "Conditional Random Fields: Probabilistic Models for Segmenting and Labeling Sequence Data". proceedings of the 18th International Conference on Machine Learning (ICML01), (pp. 282-289). Williamstown, MA, USA. .
- Jade Goldstein, Vibhu Mittal, Jaime Carbonell, & Mark Kantrowitz. (2000). "Multi-Document Summarization By Sentence Extraction". proceedings of the 2000 NAACL-ANLPWorkshop on Automatic summarization (pp. 40-48). Stroudsburg, PA, USA: Association for Computational Linguistics.
- Kevin Knight, & Daniel Marcu. (2000). "Statistics based summarization --- step one: Sentence compression". the American Association for Artificial Intelligence Conference (AAAI-2000), (pp. 703-710).
- Kogilavani, & D. P. (2010). "Clustering and feature specific sentence extraction based summarization of multiple documents". International journal of computer science & information Technology (IJCSIT) , 99-111.
- L. C., & H. E. (1997). "Identifying Topics by Position". proceedings of the 5th Conference on Applied Natural Language Processing (ANLP). Washington, D.C.
- L. C., & H. E. (2000). "The Automated Acquisition of Topic Signatures for Text Summarization". proceedings of the COLING Conference. Strasbourg, France.
- L. C., & H. E. (2002). "NeATS: A Multidocument Summarizer". proceedings of DUC 2002 workshop on Text Summarization.
- Mani I, & E, B. (1998). "Machine Learning of Generic and User-Focused Summarization". AAAI.
- Manning, D, C., Surdeanu, Mihai, Bauer, John, . . . McColosky David. (2104). "The Stanford CoreNLP Natural Language Processing Toolkit". proceedings of 52nd Annual Meeting of the Association for Computational Linguistics:

- System Demonstrations, (pp. 55-60).
- Martin Porter. (1980). "An algorithm for suffix stripping". Program, 130-137.
- Miller G. (n.d.). "Nouns in WordNet: A lexical Inheritance System". Five papers on WordNet Princeton University.
- Pinaki Bhaskar. (2013). "Multi-Document Summarization using Automatic Key-Phrase Extraction". proceedings of the Student Research Workshop associated with RANLP 2013, (pp. 22-28). Hissar, Bulgaria.
- Pinaki Bhaskar, & Sivaji Bandyopadhyay. (2010a).. "A Query Focused Multi Document Automatic Summarization". In: the 24th Pacific Asia Conference on Language, Information and Computation (PACLIC 24), (pp. 545-554). Tohoku University, Sendai, Japan.
- Pinaki Bhaskar, & Sivaji Bandyopadhyay. (2012b). "Cross Lingual Query Dependent Snippet Generation". International Journal of Computer Science and Information Technologies (IJCSIT), 4603-4609.
- Pinaki Bhaskar, & Sivaji Bandyopadhyay. (2012c). "Language Independent Query Focused Snippet Generation". Information Access Evaluation. Multilinguality, Multimodality, and Visual Analytics: Third International Conference of the CLEF Initiative, CLEF 2012, Rome, Italy, Proceedings, Lecture Notes in Computer Science (pp. 138-140). Berlin, Heidelberg, Germany.: Springer Verlag.
- Pinaki Bhaskar, & Sivaji Bandyopadhyay. (2010b). "A Query Focused Automatic Multi Document Summarizer". the International Conference on Natural Language Processing (ICON), (pp. 241-250). IIT, Kharagpur, India. .
- R. B., M. E., & Mckeown, K. R. (1999). "Information fusion in the context of multi-document summarization". proceedings of 37th annual meeting of the Association for Computational Linguistics.
- R. D. (2000). "A common theory of information fusion from multiple text sources, step one: Cross document Structure". proceedings 1st ACL SIGDIAL Workshop on Discourse and Dialogue. Hong Kong.
- R. D., & M. K. (1998). "Generating natural language summaries from multiple on-line sources". Computational Linguistics, (pp. 469-500).
- R. D., H. V., & M. K. (1999). "A Description of the CIDR system as used for TDT-2". DARPA broadcast news workshop. Herndon, Virginia.
- Radev, D. R., Hongyan Jing, M. S., & D. T. (2003). "Centroid-based summarization of multiple documents". Information Processing & Management, ELSEVIER, 919-938.
- W. I., P. G., F. E., G. C., & N. C. (1999). "KEA: Practical Automatic Keyphrase Extraction". proceedings of 4th ACM Conference on Digital Libraries (pp. 254-255). Berkley, CA: ACM Press.

## Appendices

**Table 10**  
**Comparisons**

AUTHORS		Pinaki Bhasker, 2013	Dragomir, et al	Dragomir R, Jing H, Stys, Tam D 2003	Lin CY, Hovy E, 2001, 2002	Kogilavani, Bela Subramani P 2010	Jade G, Vihnu M, Jaime C, Mark K
TECHNIQUES		<ul style="list-style-type: none"> <li>Key-Phrase Extraction</li> <li>Graph Based Clustering</li> <li>Markovv Graph Clustering algorithm</li> <li>Coherence</li> <li>Semantic Closeness</li> </ul>	<ul style="list-style-type: none"> <li>MEAD Evaluation Techniques</li> <li>Co-Selection, Content-Selection</li> <li>Machine Learning Classification algorithms</li> <li>Defaults, Lead-based, Random, Decision tree</li> <li>Reranking Techniques</li> </ul>	<ul style="list-style-type: none"> <li>Cluster Based Relative Utility</li> <li>Cross Sentence Information Substitution</li> <li>Centroid Based Algorithm</li> <li>Redundancy Based Algorithm</li> </ul>	<ul style="list-style-type: none"> <li>Weblopedia's Ranking Algorithm</li> <li>Weblopedia's parsing</li> <li>Cue Phrases</li> <li>Topic Signature</li> <li>Maximum Marginal Relevance</li> </ul>	<ul style="list-style-type: none"> <li>Document Clustering Algorithm</li> <li>Coherence</li> <li>Chronological order</li> </ul>	<ul style="list-style-type: none"> <li>Maximum Marginal Relevance</li> <li>Relevant Novelty</li> <li>Cluster Approach</li> <li>Cohesion</li> <li>Document Ordering, News Story Principle, Topic Cohesion, Time Line Ordering</li> </ul>
TOOLS		CRF System, Stanford POS Tagger, WORDNET, Stanford parser, PorterStemmer	MEADVal, DUC Conversion, SentJudge, CIDR, Sentral utilities, Preprocessors	TDT	Buddy System, WordNet	WordNet, PorterStemmer	————
FEATURES	POS	✓	✓	✗	✗	✗	✗
	NER	✓	✗	✗	✗	✗	✓
	TF	✓	✓	✓	✓	✓	✓
	TF-IDF	✗	✓	✓	✓	✓	✓
	TSF4SF	✗	✗	✗	✗	✓	✗
	TIME FRAME NORMALIZATION	✗	✗	✓	✓	✗	✗
	COREFERENCE RESOLUTION	✗	✗	✗	✗	✗	✗
	PRONOMIAL RESOLUTION	✗	✗	✗	✗	✗	✗
	STIGMA WORDS FILTERING	✗	✗	✗	✓	✗	✗
	STEMMING	✓	✓	✓	✓	✓	✗
	DOCUMENT DISCOURSE STRUCTURE	✓	✓	✗	✓	✓	✓
	SEMANTIC NORMALIZATION	✗	✗	✗	✗	✗	✗
	SEMANTIC ANALYSIS	✓	✗	✗	✗	✗	✗
	SUMMARY LENGTH	✓	✓	✗	✓	✓	✗
	SENTENCE LENGTH	✓	✓	✗	✓	✓	✗
	PREPOSITION	✗	✗	✗	✗	✗	✗
	SEMANTIC WORD CO-OCCURENCE	✗	✗	✗	✓	✗	✗
	CONTEXT OF WORD	✓	✗	✗	✗	✗	✗
	DEPENDENCY PARSING RELATIONS	✓	✗	✗	✗	✗	✗
	LEMMA	✗	✗	✗	✗	✗	✗
	SENTENCE CENTRALITY	✗	✗	✗	✗	✓	✗
	SENTENCE WITH NUMERICAL DATA	✗	✗	✗	✗	✓	✗
	SENTENCE WITH PROPER NOUN	✗	✗	✗	✗	✓	✗
	LEX PAGERANK	✗	✓	✗	✗	✗	✗
	QUERY OVERLAP	✗	✓	✗	✗	✗	✗
	SIM WITH FIRST	✗	✓	✗	✗	✗	✗
	LENGTH (Threshold Sentence Length)	✗	✓	✗	✗	✗	✗

# A Review of Video Stabilization Algorithms

G. Balachandran

Research Scholar,

Sathyabama Institute of Science and Technology,  
Chennai, India

Dr. J. Venu Gopala Krishnan

Professor,

Jeppiaar Engineering College  
Chennai, India

## Abstract

Because videos recorded via handheld cameras almost suffer from high-frequency tremor, it is essential to stabilize the video. Video stabilization in computer vision is an algorithm utilized to enhance the quality of images by eliminating unnecessary camera movements and jitters owing to hand jiggling and accidental camera panning. Different strategies were used to stabilize the captured video clips. Several of the existing strategies seem to be either complicated or do not work well for the sluggish and smooth action of portable smartphone videos. The aim is, therefore, to synthesize a special stabilized video stream by discarding the unnecessary motion between the consecutive images of the portable smartphone videos. Numerous 2D, 2.5D, and 3D motion approaches are used in motion estimation and stabilization. This paper provides a review of 2D, 2.5D and 3D based and deep learning-based video stabilization, its strategies.

**Keywords:** Video stabilization; Features based Video stabilization; Deep learning-based video Stabilization.

## INTRODUCTION

Due to improvements in technology, videos from cheaper multimedia devices, such as mobile phones can be taken. Yet due to the handshake of the operator, the cameras on moving items (i.e., global motion) or the noise generated by moving objects in the scene (i.e., local motion), the video captured becomes shaky. Video stabilization is a technique that used enhances the consistency of footage by eliminating unnecessary camera shakes and jitters. Removing excessive movements in a camera motion-triggered video series is an integral part of video processing in manufacturing, military, and consumer applications.

Video stabilization is being achieved by either a hardware or a post-image processing mechanism. The hardware mechanism would be further segregated as a mechanical or optical stabilization mechanism. In the initial stage of the camcorders, mechanical stabilization processes based on vibration

feedback were built via sensors such as gyros accelerometers etc. If the gyroscope recognizes motion, a signal is transferred to the motors to move the wheels in order to ensure stability [1].

Optical stabilization evolved after mechanical image stabilization. Uses a prism or movable lens assembly to adjust the direction of light as it passes via the camera lens device. It enables the optical system to alter the motion sensors of the camera [2]. These techniques do not apply to small camera modules that are embedded in mobile devices. Such techniques do not contribute to small-scale camera modules mounted on cell phones owing to their compactness and related costs.

Digital video stabilization attempts to stabilize and compensate for unwanted motion by digital video processing. The post-image processing algorithm contains three main stages that contribute to the video stabilization method. Camera motion evaluation, motion smoothing or compensation and image warping [3].

Several algorithms have been proposed to stabilize videos taken from various camera systems in different environments by customizing these three phases. Post-image processing methods are beneficial for mechanical or optical methodologies, as modern VLSI techniques make camera design much smaller.

### **Basic of Video Stabilization**

Digital image stabilization seeks to smooth and compensate for unwanted motion through digital video processing. There are usually three main stages in the post-image processing process.

They are

1. Motion Estimation
2. Motion Smoothing or compensation
3. Image warping

### **Motion Estimation**

Video stabilization is accomplished by measuring the interframe movement of neighboring frames first. Inter - frame movement describes the movement of the image, which is often called global motion. Using several motion estimations method, it is possible to calculate object movement or camera movement detected in video frames. The motion estimation method could be categorized as a feature-based mechanism or a pixel-based mechanism. Feature-based mechanism is quicker than pixel-based mechanisms.

### **Motion Smoothing**

The purpose of the motion smoothing is to eliminate high-frequency tremors from the projected movement of the camera. It can be achieved by low pass filters. It is an aspect that much of the video stabilization technology intends to enhance, and several approaches have been suggested, like particle filters, Gaussian filters, and Kalman filters.

### **Image Wrapping**

Image warping wraps the current frame as per criteria of smooth motion and creates a stable series.

In recent decades, the convolutional neural network (i.e., CNN) has been extremely successful in the area of computer vision problems, such as target discovery [4-6], image recognition [7-9], and segmentation [10-12]. In particular, some conventional problems in video processing with deep neural networks, such as image noise removal[13] [14] and video debugging[15] [16], have been reconsidered. However, CNN is also used for video stabilization[17, 18] [19]. Given the number of frames, these methodologies compute one or more homographs which enforced to the stabilized frame synthesis. CNN-based strategies are more reliable than conventional stabilization strategies, because they are proficient at retrieving high-dimensional spatial information, rather than depending on artificial extracting features and trying to match, the accuracy of which depends greatly on the performance of the videos. However, in terms of applied mesh based transformation, they are pretty comparable with the conventional approaches, which could be very unstable in the situation of heavy parallax. Simply put, warping of a certain quantity of homographs is a rational estimate of the real transition of the interframe. However, its prediction error may vary greatly for different videos, particularly those with a strong parallax.

### **Digital Video Stabilization**

Current offline stabilization methods measure the camera path from a 2D, 2.5D, or 3D viewpoint and afterward synthesize a new smooth camera path to eliminate unnecessary high-frequency movement.

**2D methods:**

In familiar, 2D methods have low computational cost and it can be easily tackled. Nevertheless, 2D approaches are suffering from potential complications. First of all, the 2D features observed due to light changes and motion blur are unbelievable. It's also hard to get long feature paths in videos with important features. The 2D feature points are tracked in [20] and solve for a framework that smoothness its enclosure tracks. [21] involves initializing the method by means of a camera path determined from the function tracks. [22] Large recordings of features and simple motion scenarios are also required. Many approaches try to examine the relative location of the characteristic points. [23] Stabilize own-trajectories derived from it. [24] makes use of epipolar geometry to sustain the corresponding location of the characteristic points. [25] also helps to preserve the relative location of the feature points.

Next, the use of parametric movement portraits is generally not adequate to steady parallax-impact videos, because pixel changes in the same scene were not subject to any restriction on homography. In this article considered the scene to be just a jet, and a full frame homography used to video stabilization[26, 27]. Separate the image frames into blocks and implemented a regional homography in [20, 28], but still cannot manage complex variations in the depth of the scene effectively. The optical flow in [29] is used to deflect the actual frames. It is, however, quite sensitive to movement displacements. In [30] monitor the real motion of the each pixel rather than the pixel model that gathers only the movement vectors at each pixel location. It makes the system efficient for parallax and it may not need the loading of movement discontinuity areas.

**2.5D methods:**

2.5D approaches explicitly smooth the trajectory of monitored video-stabilizing features. For this purpose [23], it smoothed out some of the basic paths of the substructure created by the feature tracks. This [24] research uses the stabilization strategy "epipolar transfer. [25] Each direction has been described with a Bezier curve and smoothed with a spatial-temporal optimization process. The 2.5D approaches allow the use of partial 3D details contained in long tracks of features. In [31] directly hybrid the 2D and 3D approaches and adopts the bundled-path technique.

**3D methods:**

Unlike 2D approaches, when measuring the camera position in 3D space, 3D methodologies aim to investigate the 3D position of attribute points in the image. Such works normally manage parallax smarter than 2D methodologies, as the movement is evaluated physically in real 3D model. The camera direction is smoothed out in these works and the 3D image features are recreated to new camera locations to direct the warping[32, 33] or the approaches using image-based rendition[34] to synthesize an image from the actual frames. Nonetheless, in Structure from Movement the 3D approaches prone from robustness and complexity problems. Also, there are video stabilization approaches that require unique hardware details or emphasis on a particular camera captured video. [32] A depth camera is required for video stabilization. [35] requires a light field camera. [36] uses information from gyroscopes to help stabilize videos. [37] focuses on 360 camera recorded videos. Many of these activities show good results but have restricted implementation because most clips may



not contain the additional information needed in these methodologies.

### Deep Learning based methods:

Deep neural methods have been widely implemented in recent decades to computer vision algorithms, including segmentation[38] [39], recognition [40], [9], [8], content generation [41] [42] [43], recoloring [44], and image caption [45] etc., attempting to achieve relative or even greatest performance compared to classic artificial methodologies. Regarding the spatial and temporal accuracy of images, comparable to some conventional 2D video techniques, deep learning approaches can also be used for camera posing prediction [46], target detection[4-6], image recognition[7-9], and segmentation[10-12],etc. Lately, [47] tried to promote a deep CNN for video stabilization.

### 1. Comparative results:

In this section we presented some comparative results for various methods It's in Fig. 3, Method of comparison [30] with other methods [20] [33] [21] of video stabilization. Method [30] works much better than other methods because this method handle more complex optimization problem and good for real time scenarios.

### 2. Conclusion:

This paper provides a review of about 2D, 2.5D, and 3D based and deep learning-based video stabilization algorithms. 2D based methods suffer from a potential issue like unfit for parallax but 3D based methods handle parallax better than 2D methods. And also, a review of deep learning-based methods was presented in this paper. According to the review of most of the paper while working with low light, low quality video, and strong parallax, the best video stability is to be achieved. Most of the research has achieved its goals. However, the research did not work with low contrast and noisy

videos (Gaussian and Salt and Pepper). In our next work, we'll deal with low-contrast footage and noisy video.

### REFERENCE

- Rawat, P. and J. Singhai, *Review of motion estimation and video stabilization techniques for hand held mobile video*. Signal & Image Processing: An International Journal (SIPIJ) Vol, 2011. **2**.
- Wu, H., et al., *Video stabilisation with total warping variation model*. IET Image Processing, 2017. **11**(7): p. 465-474.
- Biswas, D. and C. Mertz. *Motion compensation for structured light sensors*. in *Unmanned Systems Technology XVII*. 2015. International Society for Optics and Photonics.
- Girshick, R. and R. Fast, *IEEE Int. Conf. Comput. Vis. Santiago, Chile, December, 2015*: p. 7-13.
- Ren, S., et al. *Faster r-cnn: Towards real-time object detection with region proposal networks*. in *Advances in neural information processing systems*. 2015.
- Li, P., X. Chen, and S. Shen. *Stereo r-cnn based 3d object detection for autonomous driving*. in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2019.
- Deng, J., et al. *Imagenet: A large-scale hierarchical image database*. in *2009 IEEE conference on computer vision and pattern recognition*. 2009. Ieee.
- He, K., et al. *Deep residual learning for image recognition*. in *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2016.

- Simonyan, K. and A. Zisserman, *Very deep convolutional networks for large-scale image recognition*. arXiv preprint arXiv:1409.1556, 2014.
- Kayalibay, B., G. Jensen, and P. van der Smagt, *CNN-based segmentation of medical imaging data*. arXiv preprint arXiv:1701.03056, 2017.
- Kim, Y., et al. *Cnn-based semantic segmentation using level set loss*. in *2019 IEEE Winter Conference on Applications of Computer Vision (WACV)*. 2019. IEEE.
- He, K., et al. *Mask r-cnn*. in *Proceedings of the IEEE international conference on computer vision*. 2017.
- Xie, J., L. Xu, and E. Chen. *Image denoising and inpainting with deep neural networks*. in *Advances in neural information processing systems*. 2012.
- Davy, A., et al. *A non-local cnn for video denoising*. in *2019 IEEE International Conference on Image Processing (ICIP)*. 2019. IEEE.
- Su, S., et al. *Deep video deblurring for hand-held cameras*. in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2017.
- Tao, X., et al. *Scale-recurrent network for deep image deblurring*. in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2018.
- Xu, S.Z., et al. *Deep video stabilization using adversarial networks*. in *Computer Graphics Forum*. 2018. Wiley Online Library.
- Wang, M., et al., *Deep online video stabilization with multi-grid warping transformation learning*. IEEE Transactions on Image Processing, 2018. **28**(5): p. 2283-2292.
- Vlahović, N., N. Ilić, and M. Stanković. *Deep Learning in Video Stabilization Homography Estimation*. in *2018 14th Symposium on Neural Networks and Applications (NEUREL)*. 2018. IEEE.
- Liu, S., et al., *Bundled camera paths for video stabilization*. ACM Transactions on Graphics (TOG), 2013. **32**(4): p. 1-10.
- Grundmann, M., V. Kwatra, and I. Essa. *Auto-directed video stabilization with robust l1 optimal camera paths*. in *CVPR 2011*. 2011. IEEE.
- Buehler, C., M. Bosse, and L. McMillan. *Non-metric image-based rendering for video stabilization*. in *Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition. CVPR 2001*. 2001. IEEE.
- Liu, F., et al., *Subspace video stabilization*. ACM Transactions on Graphics (TOG), 2011. **30**(1): p. 1-10.
- Goldstein, A. and R. Fattal, *Video stabilization using epipolar geometry*. ACM Transactions on Graphics (TOG), 2012. **31**(5): p. 1-10.
- Wang, Y.-S., et al., *Spatially and temporally optimized video stabilization*. IEEE transactions on visualization and computer graphics, 2013. **19**(8): p. 1354-1361.
- Matsushita, Y., et al., *Full-frame video stabilization with motion inpainting*. IEEE Transactions on pattern analysis and Machine Intelligence, 2006. **28**(7): p. 1150-1163.

- Gleicher, M.L. and F. Liu, *Re-cinematography: Improving the camerawork of casual video*. ACM transactions on multimedia computing, communications, and applications (TOMM), 2008. **5**(1): p. 1-28.
- Yu, J. and R. Ramamoorthi. *Selfie video stabilization*. in *Proceedings of the European Conference on Computer Vision (ECCV)*. 2018.
- Liu, S., et al. *Steadyflow: Spatially smooth optical flow for video stabilization*. in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2014.
- Yu, J. and R. Ramamoorthi. *Robust video stabilization by optimization in cnn weight space*. in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2019.
- Liu, S., et al., *A hybrid approach for near-range video stabilization*. IEEE Transactions on Circuits and Systems for Video Technology, 2016. **27**(9): p. 1922-1933.
- Liu, S., et al. *Video stabilization with a depth camera*. in *2012 IEEE Conference on Computer Vision and Pattern Recognition*. 2012. IEEE.
- Liu, F., et al., *Content-preserving warps for 3D video stabilization*. ACM Transactions on Graphics (TOG), 2009. **28**(3): p. 1-9.
- Bhat, P., et al. *Using photographs to enhance videos of a static scene*. in *Proceedings of the 18th Eurographics conference on Rendering Techniques*. 2007.
- Smith, B.M., et al. *Light field video stabilization*. in *2009 IEEE 12th international conference on computer vision*. 2009. IEEE.
- Karpenko, A., et al., *Digital video stabilization and rolling shutter correction using gyroscopes*. CSTR, 2011. **1**(2011): p. 2.
- Kopf, J., *360 video stabilization*. ACM Transactions on Graphics (TOG), 2016. **35**(6): p. 1-9.
- Long, J., E. Shelhamer, and T. Darrell. *Fully convolutional networks for semantic segmentation*. in *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2015.
- Zhao, H., et al. *Pyramid scene parsing network*. in *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2017.
- Krizhevsky, A., I. Sutskever, and G.E. Hinton. *Imagenet classification with deep convolutional neural networks*. in *Advances in neural information processing systems*. 2012.
- Gatys, L.A., A.S. Ecker, and M. Bethge. *Image style transfer using convolutional neural networks*. in *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2016.
- Isola, P., et al. *Image-to-image translation with conditional adversarial networks*. in *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2017.
- Zhu, J.-Y., et al. *Unpaired image-to-image translation using cycle-consistent adversarial networks*. in *Proceedings of the IEEE international conference on computer vision*. 2017.

- Huang, H.Z., et al. *Learning natural colors for image recoloring*. in *Computer Graphics Forum*. 2014. Wiley Online Library.
- Vinyals, O., et al. *Show and tell: A neural image caption generator*. in *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2015.
- Nakajima, Y. and H. Saito, *Robust camera pose estimation by viewpoint classification using deep learning*. Computational Visual Media, 2017. **3**(2): p. 189-198.
- Wang, M., et al., *Deep online video stabilization*. arXiv preprint arXiv:1802.08091, 2018.
- Wang, Z., Z. Zhao, and F. Su. *Real-Time Tracking With Stabilized Frame*. in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops*. 2020.
- Zhao, M. and Q. Ling, *PWStableNet: Learning Pixel-Wise Warping Maps for Video Stabilization*. IEEE Transactions on Image Processing, 2020. **29**: p. 3582-3595.
- Huang, C.-H., et al., *StableNet: Semi-Online, Multi-Scale Deep Video Stabilization*. arXiv preprint arXiv:1907.10283, 2019.

Some recent deep learning-based methodologies, advantage and limitations were discussed below:

S.No	Ref	Methodologies	Advantage	limitation
1	[48] [17]	An adversarial framework is used to assess the stabilization of a video frame. It consists of a processing network with spatial transformer structures incorporated in various layers and produces a stabilized frame by measuring a suitable affine transformation.	It is able to handle low quality complicated unsteady video	Need considerable computation, and does not suit for real-time scenario
2	[18]	In this model, they train the 2-branch Siamese model and attempt to determine the transformation of the homography directly from the ongoing frame and the preceding stabilized frames.	Low latency, able to manage low quality videos and able to handle real time videos	Trying to control the cropping proportion in this network wasn't supported which can produce warping boundaries inside the stabilized video.
3	[30]	Utilizing optical flow to track the motion of the pixels. Instead of directly judging the warp field, they improve the neural network weights that make up the warp field. Their optimization for each new video must be replicated	Able to manage complex optimization issues	Need high computational time
4	[49]	Developed a novel PWStableNet, to compute warping maps with the same scale of input frames and warp each pixel under that same stable view to its desired location. This may be the first deep learning approaches for video stabilization based on pixels-wise.	Good at low quality videos	It may suffer degradation of performance when functioning previously untrained systems, particularly large rapid movement or high parallax
5	[50]	The network gradually processes each unstable frame from low resolution to high resolution on a multi-scale basis and then generates an affine transition to stable the frame.	Robustness.	It manages tremors at high frequency better than tremors at low frequencies Can't handle complex problems
6	[19]	It estimates the offline image conversion based on CNN for movement compensation in video clips stabilization. The suggested CNN was precisely used to approximate the 6-degree free affine matrix describing global movement between two frames in a clip	Good at offline videos or image	Can't handle the real time scenario
7	[15]	Introduced a DL solution for video deblurring, which an end-to-end CNN is trained to study how to collect information along all frames	Good at low light videos. Provide high quality performance results.	Problem in training and dataset

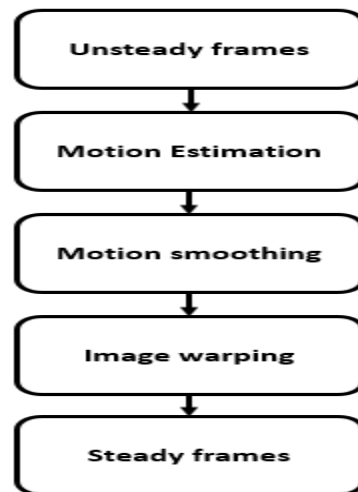


Figure. 1 Flow of video stabilization

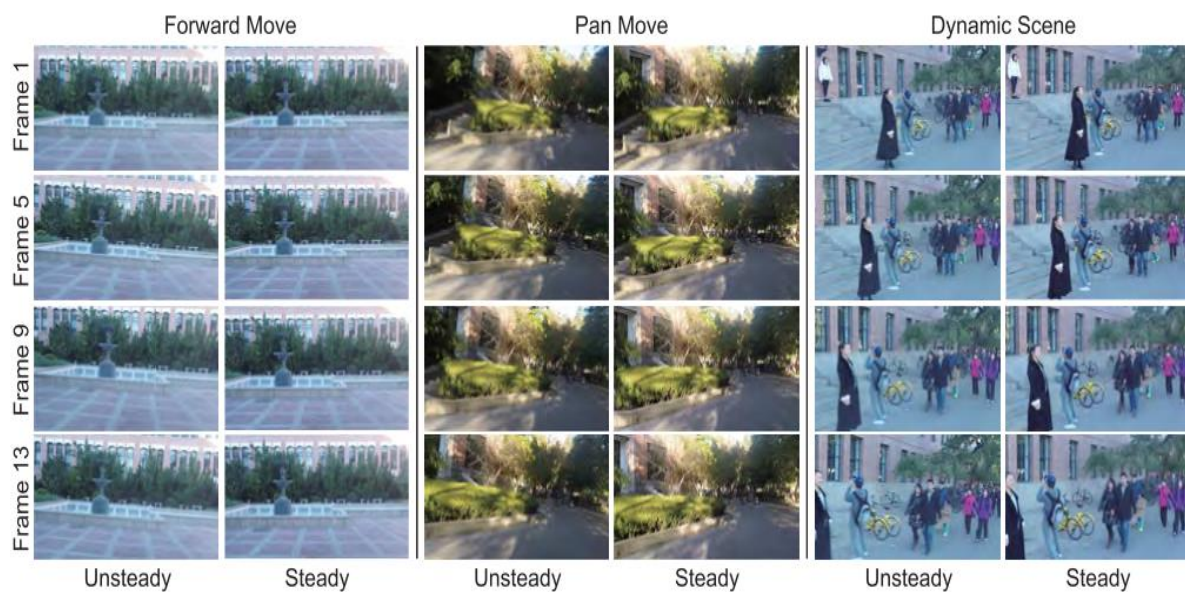


Figure 2 Sample frame set from Deepstab dataset [18]

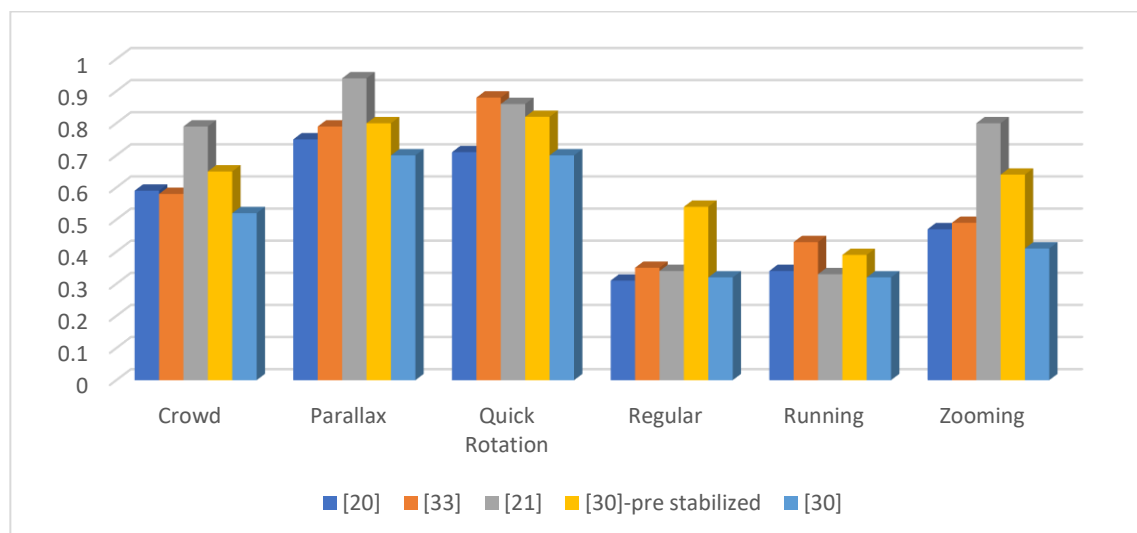


Figure 3. Quantitative comparisons result for various algorithms

# Biomedical Application of Iron Oxide Nanoparticles: Hyperthermia Cancer Therapy”

Jayashree Kamaraddi

RVCE, Dept of Biotechnology, Bangalore

Dr. Narendra Kumar S

Department of Biotechnology,  
RVCE, Bangalore,  
Karnataka, India

## Abstract

Nanotechnology deals with the nanoparticles are of size range from 1-100nm. Nanotechnology gives an advanced platform for the treatment improvement in medical field providing good therapeutic nanomedicines which helps in targeted drug delivery, cancer treatment, tissue repair and enhanced drug delivery etc. nanomedicines are more effective which provokes a target organ to give desired response. Medical applications and biotechnological advances, including magnetic resonance imaging, cell separation and detection, tissue repair, magnetic hyperthermia and drug delivery, have firmly profited from iron oxide nanoparticles (IONPs) due to their special properties, such as superparamagnetism, size and possibility of receiving a biocompatible coating.

Iron oxide nanoparticles (IONPs) were the original first generation of nanomedicines that arrived at real clinical use. Mainly, several IONPs-based magnetic resonance imaging contrast agents acquired approval by US Food and Drug Administration (FDA). The positive response of superparamagnetic iron oxide nanoparticles (SPIONs), in terms of biodegradability, circulation, elimination, toxicity, and manipulation of their structure/activity relationship, has empowered them to discover their way into market as an iron supplement, MRI contrast agents, MPI tracers, and hyperthermia and magneto-mechanical actuators. This Review focuses on the most current progress regarding the application of SPIONs as magnetic therapeutic agents for hyperthermia cancer treatment.

**Key words:** Iron oxide, nanoparticles, green synthesis, nanotechnology, Nanomedicine, Biomedical application.

# Efficient Channel State Information (CSI) Estimation Using Deep Learning Techniques for Future Generation High Speed Networks

Syeda Ayesha Unisa

## Abstract

Medium capacity and energy efficiency of a network can be enhanced using a suitable Multiple Input Multiple Output (MIMO) architecture which highly depends upon effective estimation of Channel State Information (CSI). Therefore, a deep learning framework is introduced in this article for the effective estimation and reduction of critical Channel State Information (CSI) overhead using massive Multiple Input Multiple Output (MIMO) architecture along with cloud technology. The proposed DP-MIMO model can enhance efficiency of CSI feedback medium as well as enhances accuracy of signal transmission and quality of signals significantly. Utilization of Cloud Computing and Big Data technologies can be very effective in expanding network access capability in 5G technology. Moreover, the dataset utilized for obtaining simulation results is developed using proposed DP-MIMO architecture after training of COST2100 channel model. Cloud technology can provide immense strength to implementation of 5G wireless cellular network by providing their exceptional resource pooling capabilities and high storage capacity. Increase in correlation is equivalent to decrease in signal-to-noise ratio. Furthermore, the proposed DLCSI model outperforms all the state-of-art-CSI estimation techniques and effectively reconstructs CSI which provides strength to massive MIMO system for 5G cellular network implementation considering performance matrices like NMSE, Correlation factor, CSI estimation accuracy. The performance results obtained using proposed DP-MIMO architecture are highly superior to other state-of-art original *CsiNet* and the normalized *CsiNet* techniques in terms of NMSE and  $\rho$ .

**Keywords:** Multiple Input Multiple Output (MIMO), Channel State Information (CSI), Deep Learning Techniques and 5G technology.

## INTRODUCTION

The significance of Cloud computing technology is rated very high by Information and Communication Societies due to its ability to access wide-ranging demand of configurable computing assets without hefty management struggles. Cloud computing technology provides several services such as resource sharing, on-demand access, elasticity, pay-per-use facility and multitenancy. This characteristic of cloud computing platform can be very advantageous for Communication community along with IT industries. Cloud technology can make a robust, agile, flexible, cost-effective and dominant

communication network by expanding its virtualization and resource pooling capabilities [1]. Cloud technology is gaining attention of various network operators for designing innovative and improvised services and fulfill the market requirements with greater flexibility and scalability. The utilization of Cloud computing, Big Data Analytics and Internet of things (*IoT*) applications can provide several significant opportunities which can leverage mobile network operators in adoption of 5G technology [2].

Wireless sensor networks, cloud computing, Internet of things (*IoT*) applications and Mobile Edge Computing



technologies are combining together to form a substantial solution for 5<sup>th</sup> Generation (5G) and Long Term Evolution (LTE) mobile networks [2]. Excessive demand of 5G technology has raised due to immoderate user terminals, frequent utilization of internet associated devices, abundant internet content and utilization of high-powered devices with bigger screens. Moreover, Excessive demand of resources, storage capacity and mobile sensing in 5G adoption has gained attention of various researchers of academic as well as industry level. Several researchers have analyzed the importance and significance of cloud computing in 5G adoption. An efficient implementation of 5G technology requires a facility of handling several billions of node traffic at a time and a network which must be robust enough to provide lower latency and higher storage as well as lightning speed. However, cloud computing platform is capable of delivering 10 times lower latency, 100 times lightning execution and 1000 times more storage facility which can revolutionize mobile network industries, their services, company benefits and customer experiences. 5G implementation has also become essential due to its capacity of handling frequent temporal and spatial fluctuation patterns in high traffic and can provide diverse facilities with high quality terminal needs [1]. massive MIMO system can notably expand its back age compared to a single-antenna.

However, various challenges has emerged in adopting 5G technology such as effective architectural design, resource sharing management, privacy enhancement and security threat protection etc. However, Wireless networks can provide high efficiency, reliability, efficient channel modulation, coding and decoding strategies, better

coverage area. Therefore, a proper coordination between wireless sensor networks with cloud and *IoT* applications is very essential. A wireless channel capabilities can be determined using power and bandwidth which provides information about channel transmission with minimum error rate. Moreover, for effective utilization of future wireless sensor networks, massive Multiple Input Multiple Input (MIMO) technique is one of the trending technique which authorizes large bandwidth and large antenna to ensure maximum information rates [3-5]. This technique ensure high spectrum throughput and large data rates. However, power utilization and cost becomes very high for setting up expensive Radio-Frequency (RF) medium at every antenna. Moreover, channel prediction becomes challenging with the utilization of large antenna with expensive Radio-Frequency (RF) mediums in massive Multiple Input Multiple Input (MIMO) technique [6].

Therefore, utilization of low-power, dense, small-antenna, and adoption of spatial reconstruction phenomena are very encouraging solutions to control heavy demand of future information rates [7-8]. The quality of signal transmissions is heavily rely upon Channel State Information (CSI) in massive Multiple Input Multiple Input (MIMO) technique. Moreover, CSI estimation from the source station directly for downlink medium is very challenging. Thus, feedback channels are utilized for estimating Channel State Information (CSI). However, utilization of antennas get increased in order to handle large feedbacks received. Therefore Compressive Sensing (CS) methods can be utilized to handle this issue. However, Compressing Sensing (CS) methods works proficiently only in the spatial region otherwise transmission gets failed. Besides, several researchers have shown

interest in setting up a balance between wireless sensor networks with cloud computing technology in order to implement 5G in real time. Some of the literatures are presented in below paragraph.

In [9], a deep learning technique is introduced for extraction of Channel State Information (CSI) in feedback medium for *denoising* networks in coordination with Multiple Input Multiple Input (MIMO). In this technique, CSI is encoded into a code word. In [10], deep learning technique is adopted for allocating resources in vehicular networks. This technique introduces a resource sharing model for resource allocation wirelessly. In [11], a deep learning technique is presented for channel prediction based on *Millimeter Wave (mmWAVE)* MIMO model. This technique extract structures from huge training data. In [12], a deep learning technique is introduced for CSI extraction for Massive MIMO. A recovery mechanism is designed for channel structure learning. In [13], a detailed survey is conducted on 5G wireless networks based on *Millimeter Wave (mmWAVE)* MIMO model. Various Channel estimation techniques are discussed in brief. However, various issues has been encountered the above mentioned literatures such as critical path loss, directional sensitivity, narrow bandwidth, blockage sensitive, low signal quality, presence of short wavelengths, regulatory and spectrum problems etc.

***The contribution of work can be classified as follows:***

Moreover, an efficient Multiple Input Multiple Input (MIMO) based Channel State Information (CSI) overhead reduction technique for 5G technology is required. Therefore, a deep learning framework is introduced in this article for the effective estimation and reduction of critical Channel State Information (CSI)

overhead using massive Multiple Input Multiple Input (MIMO) architecture along with cloud technology. This technique is utilized to enhance spectrum throughput and mitigate bandwidth utilization. Cloud computing is utilized for dynamic allocation of resources and provides high storage capacity. The proposed Deep Learning-massive Multiple Input Multiple Output (DP-MIMO) architecture is utilized to mitigate feedback overhead in the Channel State Information (CSI) feedback medium. The proposed DP-MIMO model can enhance efficiency of CSI feedback medium as well as enhances accuracy of signal transmission and quality of signals significantly. increase capacity at lower frequencies, or for analog beam-forming providing coverage at millimeter-wave frequencies.

The objective of the research work is to propose an efficient resource allocation scheme Channel State Information (CSI) Estimation Using Deep Learning. and to improve the accuracy of spectrum prediction

## RESEARCH GAPS

The deep learning methods are utilized to handle absolute and imaginary coefficients which is acquired from the correlation of upstream and downstream CSI components. The CSI feedback matrices are employed for fixing correlation between upstream and downstream CSI components.

In section 2, a mathematical modelling of wireless networks in 5G technology is presented. In section 3, experimental outcomes and their comparative analysis with existing techniques are shown and section 4 concludes our paper.

**I. Proposed Deep Learning-massive Multiple Input Multiple Input (DP-MIMO) Architecture:**

This section discusses about the mathematical modelling of Deep Learning-massive Multiple Input Multiple Input (DP-MIMO) Architecture. The proposed DP-MIMO model works efficiently in coordination with wireless sensor networks, cloud computing and *IoT* applications. The Channel State Information (CSI) prediction is a quite challenging process. Thus, signal transmission quality can be affected. Therefore, Cloud Computing and Big Data Analytics can be utilized to enhance quality of spectrum and signal transmission. Big Data Analytics technology can handle real time processing efficiently. Moreover, Cloud computing can be very handy in dynamic allocation of resources and provides high storage capacity. Thus, Cloud Computing and Big Data technologies can be very effective in expanding network access capability in 5G technology. Moreover, Low-power, dense and small-antennas can be adopted for controlling heavy signal transmission demand in 5G which can enhance channel throughput, signal transmission rates and channel estimation. And the presence of spatial diversity patterns in deep learning based massive Multiple Input Multiple Output (MIMO) mechanism can enhance poor channel estimation. A comprehensive mathematical modelling of proposed DP-MIMO model is presented in the following section.

All the above mentioned literatures have considered that the *mmWave* MIMO system is an efficient solution for the implementation of 5G wireless cellular network in real-time. However, the solutions provided for effective channel estimation are far away from practical implementation and the possibilities of designing better CSI prediction strategies are very high. Therefore, a Deep Learning-based Channel State Information

(DLCSI) Model is adopted in this literature for precise critical CSI prediction based on the effective *massive* Multiple Input Multiple Input (MIMO) system.

#### A. Modelling of Proposed Deep Learning-massive Multiple Input Multiple Input (DP-MIMO) Architecture:

This section provides mathematical analysis of proposed Deep Learning-massive Multiple Input Multiple Input (DP-MIMO) Architecture. The massive Multiple Input Multiple Input (DP-MIMO) Architecture is utilized to enhance spectrum throughput. The quality of signal transmissions is heavily rely upon Channel State Information (CSI) in massive Multiple Input Multiple Input (MIMO) architecture. The source station (*eNS*) of the network require to obtain downstream CSI efficiently to deliver higher spectrum throughput. Moreover, downstream CSI feedback can be delivered using Consumer Equipment (CE). Therefore, source station needs Consumer Equipment (CE) to enhance spectrum throughput.

It is analyzed that in a massive Multiple Input Multiple Input (MIMO) architecture with a solitary cell, Source Station (*eNS*) consist of  $M_a \gg 1$  antenna and Consumer Equipment (CE) consists of a solo antenna. Here, Orthogonal Frequency Division Multiplexing (OFDM) has been adopted to handle  $M_g$  signal carriers and downstream obtained signal at the  $m^{th}$  signal carrier is expressed by,

$$x_b^{(m)} = f_b^{(m)c} \cdot z_K^{(m)} \cdot r_b^{(m)} + m_b^{(m)}, \quad (1)$$

Where, the transmitted signal is denoted by  $r_b^{(m)}$  and  $r_b^{(m)} \in \mathbb{J}$ , the signal transmission using spatial filtering process can be represented as  $z_K^{(m)} \in \mathbb{J}^{(M_a \times 1)}$ . And medium vector of a signal can be represented as  $f_b^{(m)} \in \mathbb{J}^{(M_a \times 1)}$  and signal noise can be expressed as  $m_b^{(m)} \in \mathbb{J}$ . Here,  $(\cdot)^c$  can be represented as the

conjugate displacement. Similarly, upstream obtained signal at the  $m^{th}$  signal carrier is represented as,

$x_v^{(m)} = z_Y^{(m)C} \cdot f_v^{(m)} \cdot r_v^{(m)} + m_v^{(m)} \cdot z_Y^{(m)C},$	(2)
--	-----

Where, the signal reception using spatial filtering process can be represented as  $z_Y^{(m)} \in \mathbb{J}^{(M_a \times 1)}$  whereas signal noise can be expressed as  $m_v^{(m)} \in \mathbb{J}$ . The upstream CSI components in a spatial frequency field can be represented as,

$\tilde{C}_v = \left[ f_v^{(1)}, \dots, f_b^{(M_g)} \right]^C$ $\in \mathbb{J}^{(M_g \times M_a)}$	(3)
--	-----

Similarly, the downstream CSI components in a spatial frequency field can be represented as,

$\tilde{C}_b = \left[ f_b^{(1)}, \dots, f_b^{(M_g)} \right]^C$ $\in \mathbb{J}^{(M_g \times M_a)}$	(4)
--	-----

Here, the focus of this article remains on downstream CSI feedback system. Thus, suppose that Consumer Equipment (CE) seamlessly obtain downstream CSI component  $\tilde{C}_b$  whereas upstream CSI component  $\tilde{C}_v$  is seamlessly obtained by source station (*eNS*). As downstream CSI component  $\tilde{C}_b \approx M_g \times M_a$ , then downstream CSI feedback overhead becomes large for a massive MIMO architecture due to large  $M_a$ . The reduction of downstream CSI feedback overhead can be achieved by using an essential property of a wireless medium that CSI component in upstream and downstream have some amount of similar sparsity level in spatial delay region. Thus, a medium response matrix can be changed from frequency to time domain using Inverse Discrete Fourier Transform (IDFT) by following equation,

$C_g D^C = C_\phi$	(5)
--------------------	-----

Where,  $D$  is a one dimensional DFT matrix and can be represented as  $M_a \times M_a$ . After performing inverse transform, all the elements in the matrix  $C_\phi \in M_g \times M_a$  becomes almost zero excluding the elements first  $\hat{M}_g$  row. After performing inverse transform of matrices  $\tilde{C}_v$  and  $\tilde{C}_b$ , first  $\hat{M}_g$  row elements can be represented as  $C_v$  and  $C_b$  respectively. However, downstream CSI feedback overhead  $\hat{M}_g \times M_a$  is still very large. Therefore, compression of CSI feedback can be routed from inverse downstream CSI matrix  $C_b$  at the Consumer Equipment (CE) side.

Moreover, an encoder is required for compression of CSI feedback signal and reconstruction of that signal can be achieved using a decoder. Here, for better spectrum and feedback efficiency both upstream and downstream CSI components are combined together using Deep Learning-massive Multiple Input Multiple Input (DP-MIMO) Architecture. Suppose that the reconstructed downstream CSI components using decoder can be denoted as  $\hat{C}_b$ . The CSI components obtained using encoder and decoder can be represented by following equations,

$t = g_e(C_b)$	(6)
----------------	-----

$\hat{C}_b = g_d(t, C_v)$	(7)
---------------------------	-----

The downstream CSI feedback overhead can be mitigated using proposed Deep Learning-massive Multiple Input Multiple Input (DP-MIMO) Architecture. Deep learning techniques are utilized for faster processing of CSI estimation process. Deep learning techniques utilizes absolute and imaginary parameters obtained from the correlation

of upstream and downstream CSI feedback components. For setting up correlation between upstream CSI components and downstream CSI components, CSI matrices are utilized. These CSI matrices in a time domain can be analyzed by obtaining their correlation coefficients. CSI components are complex in nature. Thus, correlation of both imaginary and absolute parameters are obtained separately. The obtained correlation coefficient of imaginary and absolute parameter for an upstream and downstream CSI feedback are inconsistent. It can be evident from Frequency Division Duplex (FDD) that, phase in time domain provide lower correlation than magnitude in time domain. Therefore, individual correlation of phase and magnitude in time domain is obtained of CSI components. The correlation of phase remains low for both upstream and downstream CSI components whereas correlation of magnitude provide higher outcomes for both upstream and downstream CSI components. Moreover, absolute parameters provide higher correlation whereas correlation is very low by considering their signs.

Therefore, unlike state-of-art-techniques, the proposed DP-MIMO architecture individually feeds back the absolute and imaginary parameters as well as their signs. The uncorrelated data of upstream and downstream CSI feedback components and their signs are sent back which is vital step to reduce CSI feedback overhead.

The key characteristic of proposed DP-MIMO architecture are fully linked layer size and the quantity of feature maps utilized. The feature map quantity and fully linked layer size becomes twice using the proposed DP-MIMO architecture due to conversion of upstream and downstream CSI feedback components into absolute

and imaginary parameters. This can be evident from above discussion that Consumer Equipment (CE) can be utilized for encoding phase components and their signs due to their low correlation whereas source station (*eNS*) is used to decode the downstream CSI components by combining both the feedback of Consumer Equipment (CE) and its own upstream CSI components.

## RESULT AND DISCUSSION

This section discusses about the performance evaluation of the proposed Deep Learning-massive Multiple Input Multiple Input (DP-MIMO). The proposed DP-MIMO model works efficiently in coordination with wireless sensor networks, cloud computing and IoT applications. The proposed DP-MIMO architecture is compared with various state-of-art-CSI techniques in terms of modelling parameters Normalized mean-squared error (NMSE) and correlation between upstream and downstream CSI components over different compression ratios. The proposed DP-MIMO model is introduced to estimate the Channel State Information (CSI) and mitigate overhead and enhances the spectrum efficiency which can be very advantageous for 5G technology. Cloud computing is utilized for dynamic allocation of resources and provides high storage capacity. The proposed DP-MIMO model can prove very handy in providing dynamic resource allocation for a 5G technology. The proposed DP-MIMO model can enhance efficiency of CSI feedback medium as well as enhances accuracy of signal transmission and quality of signals significantly. Moreover, Deep learning techniques are utilized for faster processing of CSI estimation process. The performance of proposed DP-MIMO architecture is highly superior in comparison with various state-of-art-

techniques. The performance results are presented in the following section.

### A. Experimental Analysis:

This section discusses about the experimental analysis and simulation results obtained using the proposed DP-MIMO architecture. The dataset for the simulation of DP-MIMO architecture is developed using COST2100 channel model. The dataset is developed using proposed DP-MIMO architecture after training of COST2100 channel model. Normalized mean-squared error (NMSE) and correlation between upstream and downstream CSI components ( $\rho$ ) over different compression ratios ( $\gamma$ ) are the two parameters which are utilized for performance evaluation of proposed DP-MIMO architecture and compared with original *CsiNet* and the normalized *CsiNet* in feedback channel [9]. The performance results obtained using proposed DP-MIMO architecture are highly superior to other state-of-art original *CsiNet* and the normalized *CsiNet* techniques in terms of NMSE and  $\rho$  which is shown in Table 1. Here, Figure 1 shows the NMSE performance of proposed DP-MIMO architecture over various compression ratios ( $\gamma$ ) in comparison with original *CsiNet* and the normalized *CsiNet* in feedback channel. The effect of NMSE take significant degradation using DP-MIMO architecture over the existing *CsiNet* techniques. Moreover, the NMSE of DP-MIMO is always lower than the state-of-art *CsiNet* techniques. Figure 2 shows the correlation factor  $\rho$  performance of proposed DP-MIMO architecture over various compression ratios ( $\gamma$ ) in comparison with original *CsiNet* and the normalized *CsiNet* in feedback channel. The performance of correlation factor  $\rho$  highly significant than *CsiNet* techniques. It is evident from the simulation results that the proposed Deep

Learning-massive Multiple Input Multiple Output (DP-MIMO) architecture can effectively utilized to mitigate feedback overhead in the Channel State Information (CSI) feedback medium as well as can estimate CSI efficiently.

### CONCLUSION

The significance of Channel State Information (CSI) estimation is very essential for effective adoption of 5G technology. Therefore, a Deep Learning-massive Multiple Input Multiple Input (DP-MIMO) Architecture is introduced for efficient CSI estimation in coordination with cloud technology. For effective resource allocation and to exploit massive storage capacity cloud technology is adopted in this work. Moreover, MIMO is used for spectrum throughput enhancement and reduction of bandwidth utilization. Furthermore, the proposed DP-MIMO architecture is utilized to mitigate feedback overhead in the Channel State Information (CSI) feedback medium. The proposed DP-MIMO model can enhance efficiency of CSI feedback medium as well as enhances accuracy of signal transmission and quality of signals significantly. A comprehensive mathematical modelling of proposed DP-MIMO architecture is presented for the effective estimation of CSI. The dataset for the simulation of DP-MIMO architecture is developed using COST2100 channel model. Normalized mean-squared error (NMSE) and correlation between upstream and downstream CSI components ( $\rho$ ) over different compression ratios ( $\gamma$ ) are the two parameters which are utilized for performance evaluation of proposed DP-MIMO architecture and compared with original *CsiNet* and the normalized *CsiNet* in feedback channel. The performance results obtained using proposed DP-MIMO architecture are highly superior to other state-of-art techniques.

## REFERENCES

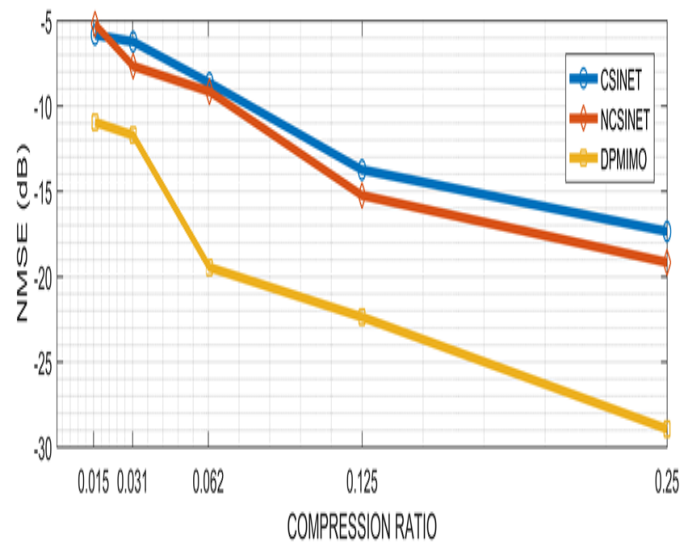
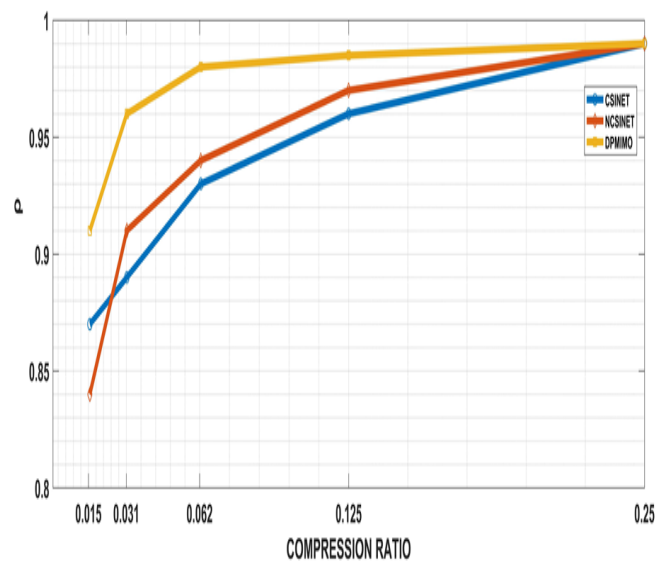
- D. Wubben et al., "Benefits and Impact of Cloud Computing on 5G Signal Processing: Flexible centralization through cloud-RAN," in *IEEE Signal Processing Magazine*, vol. 31, no. 6, pp. 35-44, Nov. 2014, doi: 10.1109/MSP.2014.2334952.
- X. Wang, G. Han, X. Du and J. J. P. C. Rodrigues, "Mobile cloud computing in 5G: Emerging trends, issues, and challenges [Guest Editorial]," in *IEEE Network*, vol. 29, no. 2, pp. 4-5, March-April 2015, doi: 10.1109/MNET.2015.7064896.
- A. L. Swindlehurst, E. Ayanoglu, P. Heydari, and F. Capolino, "Millimeter-wave massive MIMO: The next wireless revolution?" *IEEE Commun. Mag.*, vol. 52, no. 9, pp. 56–62, Sep. 2014.
- A. F. Molisch, V. V. Ratnam, S. Han, Z. Li, S. L. H. Nguyen, L. Li, and K. Haneda, "Hybrid beamforming for massive MIMO: A survey," *IEEE Commun. Mag.*, vol. 55, no. 9, pp. 134–141, 2017.
- B. Wang, F. Gao, S. Jin, H. Lin, and G. Y. Li, "Spatial- and frequency wideband effects in millimetre-wave massive MIMO systems," *IEEE Trans. Signal Process.* vol. 66, no. 13, pp. 3393–3406, 2018.
- H. He, C. Wen, S. Jin and G. Y. Li, "Deep Learning-Based Channel Estimation for Beam-space mmWave Massive MIMO Systems," in *IEEE Wireless Communications Letters*, vol. 7, no. 5, pp. 852-855, Oct. 2018, doi: 10.1109/LWC.2018.2832128.
- M. Dohler, R. Heath, A. Lozano, C. Papadias, and R. A. Valenzuela, "Is the PHY layer dead?" *IEEE Commun. Mag.*, vol. 49, no. 4, pp. 159–165, Apr. 2011.
- N. Bhushan, J. Li, D. Malladi, R. Gilmore, D. Brenner, A. Damnjanovic, R. T. Sukhavasi, C. Patel, and S. Geirhofer, "Network densification: The dominant theme for wireless evolution into 5G," *IEEE Commun. Mag.*, vol. 52, no. 2, pp. 82–89, Feb. 2014.
- Ye, Hongyuan & Gao, Feifei & Qian, Jing & Wang, Hao & Li, Geoffrey. (2020). Deep Learning based Denoise Network for CSI Feedback in FDD Massive MIMO Systems.
- L. Liang, H. Ye, G. Yu and G. Y. Li, "Deep-Learning-Based Wireless Resource Allocation With Application to Vehicular Networks," in *Proceedings of the IEEE*, vol. 108, no. 2, pp. 341-356, Feb. 2020, doi: 10.1109/JPROC.2019.2957798.
- H. He, C. Wen, S. Jin and G. Y. Li, "Deep Learning-Based Channel Estimation for Beam-space mmWave Massive MIMO Systems," in *IEEE Wireless Communications Letters*, vol. 7, no. 5, pp. 852-855, Oct. 2018, doi: 10.1109/LWC.2018.2832128.
- J. Li et al., "Deep Learning-Based Massive MIMO CSI Feedback," 2019 18th International Conference on Optical Communications and Networks (ICOON), Huangshan, China, 2019, pp. 1-3, doi: 10.1109/ICOON.2019.8934725.
- A. N. Uwaechia and N. M. Mahyuddin, "A Comprehensive Survey on Millimeter Wave Communications for Fifth-Generation Wireless Networks: Feasibility and Challenges," in *IEEE Access*, vol.

- 8, pp. 62367-62414, 2020, doi: 10.1109/ACCESS.2020.2984204.
- L. Liang, H. Ye, G. Yu and G. Y. Li, "Deep-Learning-Based Wireless Resource Allocation With Application to Vehicular Networks," in *Proceedings of the IEEE*, vol. 108, no. 2, pp. 341-356, Feb. 2020, doi: 10.1109/JPROC.2019.2957798.
- S. Chen, Q. Gao, R. Chen, H. Li, S. Sun and Z. Liu, "A CSI acquisition approach for mmWave massive MIMO," in *China Communications*, vol. 16, no. 9, pp. 1-14, Sept. 2019, doi: 10.23919/JCC.2019.09.001.
- C. Lv, J. Lin and Z. Yang, "CSI Calibration for Precoding in mmWave Massive MIMO Downlink Transmission Using Sparse Channel Prediction," in *IEEE Access*, vol. 8, pp. 154382-154389, 2020, doi: 10.1109/ACCESS.2020.3017787.
- Y. Teng, M. Liu, F. R. Yu, V. C. M. Leung, M. Song and Y. Zhang, "Resource Allocation for Ultra-Dense Networks: A Survey, Some Research Issues and Challenges," in *IEEE Communications Surveys & Tutorials*, vol. 21, no. 3, pp. 2134-2168, thirdquarter 2019, doi: 10.1109/COMST.2018.2867268.
- J. Guo, C. Wen, S. Jin and G. Y. Li, "Convolutional Neural Network-Based Multiple-Rate Compressive Sensing for Massive MIMO CSI Feedback: Design, Simulation, and Analysis," in *IEEE Transactions on Wireless Communications*, vol. 19, no. 4, pp. 2827-2840, April 2020, doi: 10.1109/TWC.2020.2968430.
- L. Cheng, G. Yue, D. Yu, Y. Liang and S. Li, "Millimeter Wave Time-Varying Channel Estimation via Exploiting Block-Sparse and Low-Rank Structures," in *IEEE Access*, vol. 7, pp. 123355-123366, 2019, doi: 10.1109/ACCESS.2019.2937628
- C.-K. Wen, W.-T. Shih, and S. Jin, "Deep learning for massive MIMO CSI feedback," *IEEE Wireless Commun. Lett.*, vol. 7, no. 5, pp. 748–751, Oct. 2018.
- L. Liu et al., "The COST 2100 MIMO channel model," *IEEE Wireless Commun.*, vol. 19, no. 6, pp. 92–99, Dec. 2012.
- L. Doyle, J. Kibiada, T. K. Forde, and L. DaSilva, "—Spectrum without bounds, networks without borders," *Proc. IEEE*, vol. 102, no. 3, pp. 351-365, Mar. 2019.
- X. Siya, W. Lei, L. Zhu, G. Shaoyong, Q. Xuesong and M. Luoming, "A QoS-aware packet scheduling mechanism in cognitive radio networks for smart grid applications," in *China Communications*, vol. 13, no. 2, pp. 68-78, Feb. 2016
- J. Ren, Y. Zhang, N. Zhang, D. Zhang and X. Shen, "Dynamic Channel Access to Improve Energy Efficiency in Cognitive Radio Sensor Networks," in *IEEE Transactions on Wireless Communications*, vol. 15, no. 5, pp. 3143-3156, May 2016
- Ekram Hossain and Monowar Hasan, -5G Cellular: Key Enabling Technologies and Research Challenges|| *IEEE*, 2015



**Table 1 NMSE (dB) and  $\rho$  for various compression ratios  $\gamma$** 

$\gamma$	<i>CsiNet</i>		Normalized <i>CsiNet</i>		DP-MIMO	
	NMSE (dB)	$\rho$	NMSE (dB)	$\rho$	NMSE (dB)	$\rho$
1/4	-17.36	0.99	-19.17	0.99	-28.983	0.99
1/16	-8.65	0.93	-9.16	0.94	-19.47	0.98
1/32	-6.24	0.89	-7.67	0.91	-11.72	0.96
1/64	-5.84	0.87	-5.22	0.84	-10.96	0.91

**Figure 1 Performance Comparison of DPMIMO over *CsiNet* and Normalized *CsiNet* in terms of NMSE****Figure 2 Performance Comparison of DPMIMO over *CsiNet* and Normalized *CsiNet* in terms of  $\rho$**

# Novel Utilization and Applications of Rice Husk as Green and Sustainable Biomass

Shaik Abdul Vaheed  
Student

Sejal Masade  
Student

Dr. Madhuri Pydimalla  
Assistant Professor  
Department of Chemical Engineering,  
CBIT Engineering College,  
Gandipet, Hyderabad,  
Telangana, 500075

## Abstract

Research on agricultural wastes management is state of the art and desirable subject in engineering subcategories. Recent developments in the reuse of agricultural residues/resources have led to environmental sustainability and cleaner technology emphasizing the utilization of natural resources. As a staple food for much of the world, rice production is widespread and its annual production generates huge quantities of husk ( $\sim 1.5 \times 10^{11}$  kg). Rice husk is easily collected and cheap, so it has always had some use as an energy source for small applications, and in recent years a number of rice husk derived products have been developed and is considered as one of the abundant and valuable agro-based residues. It contains a combination of cellulose, hemicellulose, and lignin, along with appreciable amounts of silica and inorganic components (ash). Rice husk pellets represent an alternative to diesel oil and coal for small scale electrical power generation. It is one of the abundant lignocellulosic biomass with potential as a feedstock for bioethanol production. Because of its high specific surface area, it has proven to be a potential low-cost material in the applications of water treatment and building materials. There are several reviews which demonstrate the ability of rice husks to remove various pollutants from water, including dyes, phenols, organic compounds, pesticides, inorganic anions, and heavy metals. Biogas can be generated by anaerobic microbial degradation of a combination of treated rice straw and animal waste. Fluidized bed fast pyrolysis with catalytic treatment of rice husk can economically produce primary pyrolysis oil that is suitable as boiler fuel oil and for the production of catalytically treated, upgraded, liquid-products. This economically valuable agriculture waste product is a great source of silica and has many comprehensive applications. Therefore the main objective of this review paper is to discuss the current research works focusing on the characteristics and suitability of Rice husk over a wide field of applications.

**Keywords:** Rice Husk, Biogas, Bio ethanol, Boiler fuel oil, Water treatment,

## REFERENCE

- Ahmaruzzaman, M. and Vinod, K. Gupta.  
2011. Rice husk and its ash as low-cost adsorbents in water and wastewater treatment. Ind. Eng. Chem. Res., 50: 13589-13613.
- Patil, N.B. and Sharanagouda, H. 2017. Rice husk and its applications: Review. Int. J. Curr. Microbiol. App. Sci., 6(10): 1144-1156.

# A Review on Chipless RFID Tags

**Akhila Madhav, Sumi M,**

APJ Abdul Kalam Technological University  
NSS Engineering College, NSS Nagar,  
Akathethara, Kerala

**Harikrishnan A**

APJ Abdul Kalam Technological University  
NSS Engineering College, NSS Nagar,  
Akathethara, Kerala

## **Abstract**

RFID has become an active research topic for the past few years and has been extensively used in various applications. This paper reviews on different types of Chipless RFID system and its advantages. Chipless RFID was introduced to compete with conventional methods such as optical barcodes in terms of cost. Cost reduction can be achieved in RFID tag systems by elimination of chip from tags and they are replaced by metal structures which utilise electromagnetic signature for data encoding. Major issues to be considered while designing a tag are size, coding capacity, capability of being printed economically, polarization and angle of incidence effects.

**Keywords:** Chipless RFID, Multiresonator, Retransmission based tags, Backscatter based tags

## **INTRODUCTION**

Chipless RFID is a low-cost alternative for conventional chip-based RFID counterparts which uses ASIC based chips. Although it is difficult to compete against chip-based transponders concerning reading range and data storage capacity, manufacturing of chipless transponders is much simpler and cheaper since power and IC are not required. Chipless RFID system is taking the world by storm since it is a contactless and an electronic product identification technique with least human involvement that can be used for mass item tagging. Chipless RFID has become a premier data capturing technology and can be used in application involving extreme environments. It can replace the existing barcode system due to several advantages such as high storage capacity, better range, reliability, robustness, line of sight independence, multiple reading capability and it can be reprogrammed.

The RFID system consist of three components: RFID reader (transceiver and antenna), transponder (RFID tag) and

an application server or middle- ware. RFID reader /interrogator transmits and receives radio waves to communicate with tags. Reader can be fixed or mobile. RFID tags can transmit data about an item through radio waves to antenna / reader combination. These are used collectively for tag identification.

RFID transponders can be of three types: active, semi-passive and passive RFID tag systems. Active tags use an inbuilt power supply which can be either a battery or a permanent power supply for signal processing and transmission of this signal to the reader. Such tags have longer reading range but limited life validity. Inbuilt power supply in semi active tags can be used for signal processing while EM waves are utilized as an energy source in passive tags for data processing. The detection range of passive tags is hence limited but has longer life expectancy.

## **Constraints related to implementation**

Chipless RFID is considered to be very productive and a prospect for commercial application in future. The research are in place for some time to

incorporate following features to make it more robust and competitive.

- In day to day applications the size of the tag becomes a vital factor for the effective customization. While implementing Chipless RFID size of the tag has it's own role.
- Coding capacity of chipless RFID is directly related to the size of the tag as explained in several papers. Numerous objects can be simultaneously tagged by increasing the capacity thus making it more versatile but always the size of the tag must be under consideration.
- Researches are done on reducing the cost of implementation of chipless RFID so that they can be printed economically for competing against other conventional methods.
- The identified properties of substrate influences the designed tag characteristics. Hence the designers need to establish more viable tag designs to avoid such substrate influences.
- Radio frequency detections by the antennas, point of interference, angle of incidence, elevations becomes a point of interest while designing the tag because the tag structures may or may not be symmetric in shape.

### **Classification of Chipless RFID tags**

Based on encoding techniques, chipless RFID can be classified as time domain, frequency domain, phase based and hybrid tags. Encoding of data can be done using different electromagnetic aspects such as time, frequency, amplitude, phase and polarization. Data encoding in TDR (time domain reflectometry) based tags uses reflections of the signal from piezoelectric substrate while particular frequency bands are used in spectral signature or frequency domain

based tags. In TDR based tags, tag attached to the object consist of a set of reflectors and data encoding is done based on the echoes reflected from these reflectors. Hence tag code can be identified by the presence or absence of echoes and their respective time positions. Frequency signature based chipless RFID tags encodes data using several resonant structures into the spectrum. In frequency domain based tags, tag gets interrogated by an RF signal and the data encoded into the frequency signature is retransmitted back to the reader. Existence or absence of resonant frequency indicate the presence of data bit in the corresponding operating spectrum.[1] suggest a phase based encoding technique which consist of microstrip patch antennas loaded with open circuit stubs in which phase of the backscattered signal can be varied by changing stub length. Hybrid domain techniques [2,3] make use of more than one domain. Such techniques require large bandwidth and is not preferable for low-cost readers.

Frequency domain based tags can be operated using either retransmission or backscattering method. Retransmission based tags consist of multiresonators placed between two UWB antennas. Large tag size and complex structure are few limitations of such tags. In contrast to this those tags using backscattering method has an advantage of getting significant area reduction as it consist of scatters or resonating elements. Among printable tags, spectral signature based tags have higher data density. To improve the performance of chipless tags, the designing should be in consideration with reducing the allocated bandwidth (spectral efficiency) and to incorporate higher number of bits to the corresponding occupied space (spatial efficiency).

Currently Chipless RFID is having a significant place in commercial market but the limitations of chipless RFID tags are in consideration which includes shorter detection range, low data encoding capacity, complexity in tag design structure and they are non-rewritable. To improve data encoding capacity in single dimension multiple elements are required but increasing the number of resonators will result an increase in the tag size. Also there exist a maximum number of elements that can be used in a specific bandwidth, a UWB reader antenna which has a wider bandwidth has to be designed while increasing the operating bandwidth. For commercialising such tags, bit capacity must be very high on lossy, inexpensive and flexible substrates. Besides item tracking, RFID systems can also be implemented to monitor environmental conditions and can also act as sensors to measure temperature, humidity, pressure etc. Chipless tags possess a longer shelf life since they are passive and hence can be implemented in transportation and logistics, supply chain management, asset tracking, security access control, food safety and several other applications.

#### **TIME DOMAIN BASED CHIPLESS RFID**

Former category of chipless RFID include encoding of information in time domain [4]. In time domain reflectometry tags, pulse signals are sent from the reader and after the tag interrogation and processing, the echoes transmitted by the tag is listened by the reader to decode the tag ID. Encoding in such tags is done by a train of pulse signals. The main advantages of such tags compared to chipped tags are low cost and greater reading range. While compared to other chipless categories it has certain limitations such as limited bit encoding capacity and it requires high speed RF frontends.

#### **SAW tags**

One of the popular category of TDR based tags are SAW (surface acoustic wave) tags which are commercially available as explained in [5,6,7,8]. SAW tags designed in 2.4GHz ISM band consist of an antenna connected to Inter digital transducer (IDT) which is a metallic structure as shown in 1. The metallic structure is designed using lift-off or etching technique on a piezoelectric substrate. It follows the principle of piezoelectricity. In this when a mechanical stress is applied on dielectric crystals, electrical polarization is developed and similarly when an electric field is applied, mechanical distortions is generated. When the tag is interrogated by a signal, an electric field is developed in IDT and it will generate SAW waves due to piezoelectric coupling. The metallic reflectors existing on the substrate reflect the wave partially back to IDT and the remaining is transmitted to the reflectors. At the reader section, data encoding is done from the electromagnetic signals and is reconverted by IDT from SAW pulse signals.

SAW tags can be classified into following categories as explained in [9, 10].

- Transducer based tag is considered as a former version of SAW tag, which consist of one input IDT and numerous output IDT. Output IDT are electrically connected and they function as both reflectors and transducers.
- Reflector based SAW tag are those in which output transducers are eliminated and instead reflectors were used.
- unidirectional based SAW tags are those in which all the reflectors are existing on one portion of IDT and it has a significant reduction of tag size.

SAW tags suffers from certain limitations such as high propagation delay, temperature sensitivity of piezoelectric materials, mechanical force sensitivity of piezoelectric materials, losses occurring due to conversion of EM wave to acoustic waves and vice versa.

### **Delay line tags**

Another category of TDR based tags in which coding capacity is limited are delay line tags [4]. It can be considered as a replica of SAW tag which utilizes microstrip technology. Such tag consist of delay lines or transmission lines placed on a microwave substrate. These substrate include reflectors with discontinuities or complex impedances located at particular positions. ID generated by such tag basically consist of reflections or echoes that gets produced due to the interrogation of the pulse from the reader at the discontinuity. Coding capacity is low in such tags due to following factors. It includes the length of the transmission lines which are large and thus measurable delay can be produced or interrogation pulses must be of narrow bandwidth so as to avoid reflected pulses overlapping. [11] proposes a chipless RFID tag based on delay line consisting of inductor- capacitor as components for ID generation. Realization of generated tag ID is done by transmission line equivalent of inductor and capacitor. In [12] author proposes a design in which LC delay line is replaced by transmission delay line elements. The later delay line tag consist of two microstrip transmission lines in which one of the line is short and straight the other one is long. To avoid any kind of reflections, the end of transmission line branches are terminated using a resistor or with port of same impedance. Layout of this tag is proposed to be independent of operational frequency. The physical length of conventional delay lines are required to be large and hence practical

implementation is difficult. In [13] another tag consisting of slow wave structures such as left handed artificial lines are proposed.

The number of bits which can be coded primarily depends on the number of pulses stored in a conventional transmission line and also on the line losses and pulse detection ability. Hence artificial transmission line can be considered to be more effective. For improving the coding bit density, another tag was proposed in [14] which is based on CRLH (composite Right-Left Hand) transmission lines. Such tags are metamaterial based transmission lines.

### **Group delay based tags**

[15,16] represents another type of tags using time domain technique which are known as group delay based tags. Such tag use group delay as a primary factor to achieve PPM (pulse position modulation). In [16], the author proposes a group delay tag based on transversely cascaded microwave C section elements. The proposed structure has several advantages compared to conventional methods such as it is planar, can be identified in millimeter -wave frequency range and different frequency can be achieved by changing the length of C sections. The figure 2 indicate a C section structure which is a DDL (Dispersive delay line) that is utilized for generating group delay at a particular frequency. These structure can be considered as similar to all pass filter and equalisation operations can be done. Compared to this method, another tag which provides a greater group delay swing and higher coupling capability along with larger bandwidth and smaller size is explained in [17].

### **TFT (Thin film transistors) based tags**

Thin film transistor tags are small in size and provides greater functionality, but requires more power compared to

other chipless tags. Manufacturing process required for such tags is high and hence preferred only for sensing applications. TFT tags developed by using metal oxide semiconductor technology utilizes Indium- Gallium-Zinc-Oxide (IGZO) and is explained in [18]. In [19] author proposes a multi-bit organic transponder operating in 13.56MHz RF frequency range. A TFT transponder which satisfies the EPC (Electronic Product Coding) specifications when they are combined with high k-dielectrics is proposed in [20].

### **On-off keying (OOK) modulation**

OOK is one of the simplest technique which uses time domain encoding. In a particular duration, signal presence is indicated by logic 1 while absence implies logic 0. In [21] chipless transponder using this technique is explained. In such tags due to impedance mismatches, pulses sent by reader are transmitted back to the reader after interrogation with the tag. To obtain a fully printable tag, the substrate is taken as paper [22]. Conventional microstrip line is replaced by tapered microstrip line [23] for compensating the mismatch that can occur while printing silver on paper instead of copper on PCB.

### **PPM (Pulse Position Modulation)**

In this tag, each time slot is splitted into  $2n$  pulse positions [24]. Each slot consist of only a single reflector which can reflect back pulse belonging to a specified frequency. One important factor to be taken care of is that the reader must be synchronized to detect the pulse position within a particular slot. A reflected pulse signal includes two type of mode: structural mode and antenna mode. Structural mode is constant for most of the tags and hence it can be considered as a reference for synchronization. These tags require smaller number of reflectors over OOK based tags.

## **FREQUENCY DOMAIN BASED CHIPLESS RFID**

Ideally chipless tags must have a simpler design, cheaper or cost-effective and can be printed on any substance compared to other conventional techniques. Two designs have emerged for frequency domain based tags: retransmission based tags and back scatterd based tags. The former includes two orthogonally polarized antennas and several resonant structures between them as in 3 while the later consist of resonators of varying sizes as in 4.

Chipless RFID based on multiresonators have resonators tuned at different predetermined frequencies for efficient storing and retrieving of the data. Resonators are the devices that exhibit resonant behaviour and can oscillate at resonant frequency with greater amplitude. Depending on whether resonant elements are tuned or detuned, each tag will have a unique spectral identification code. Most tags can produce only two states corresponding to each resonator which is either 0 or 1. The presence or absence of resonance at a specific frequency in a frequency domain based tag implies 0 or 1 as code in the tag ID. Even if the data is encoded in both amplitude and phase of frequency response in chipless RFID tags, only one bit of information can be attained for each element [25]. Data encoding in multiresonators can be done either by shorting or removing some of the resonators. Each resonator corresponds to a particular resonant frequency, so when a resonator is removed or shorted, frequency associated with that resonator is either removed from the spectrum or it is shifted out of the frequency band considered. If a resonance point exist in the frequency band of interest then the bit is encoded as '1' and if it disappears then the bit is considered as '0'. Removal of

resonator elements will result in wastage of the tag area while shorting them will ensure the same tag layout. Laser techniques or etching methods can be adopted to remove shorting and encoding the data.

Frequency based chipless RFID tags can be classified as co-polar and cross-polar based tags [26]. In co-polar tags, data can be encoded and decoded accurately only when polarization of both transmitter and receiver antennas are same since reflected and emitted waves have same polarization. Whereas in cross-polar tags, transmitter and receiver antennas should have different polarization since the emitted wave is converted into a reflection wave of different polarization. Advantage of cross-polar tag over co-polar tag is that the detection range and accuracy has improved compared to the latter because the former technique reduce effects of reflection in the tag response due to environmental conditions.

## **RETRANSMISSION BASED CHIPLESS TAGS**

**Spiral shaped resonator** In [27,28] authors explain a printable passive chipless RFID consisting of spiral resonators as shown in figure 5 placed close to a microstrip line and two cross polarized UWB monopole antennas. Dimensions of each spiral resonator will determine its corresponding resonant frequency. The removal of spirals or shorting the turns of the spiral establishes data coding. The layout is protected by shorting the spirals during future printing techniques and the shorting of spirals can be removed by using laser cutting techniques or by conventional etching methods. The bit width of chipless RFID established during the process indicates the number of spiral resonators that has been utilized. It indicates the tag area proportional to the bit width of chipless

RFID. Hence it is not economically worthy at all.

Resonators used in [27,28] were microstrip coupled spiral resonators. The multiresonator structure proposed in [29] uses a coplanar waveguide that can be etched on one side of the substrate. The proposed resonator is a rectangular slot with two open stubs from both sides. Tag ID is programmed by shorting the two stubs which shift the resonant frequency to a much higher frequency.

### **SRR (Split ring resonator)**

Certain chipless RFID structures are also based on metamaterials [30] which are artificially made electromagnetically homogeneous structures that provides performance enhancement and dimension minimization along with certain properties which does not exist in nature. SRR (Split ring resonator) is a commonly used metamaterial structure for developing chipless RFID tags and consists of two different half wavelength concentric rings coupled to a unique resonant frequency. A retransmission based chipless tag based on CSRR (complimentary split ring resonator) structure and two orthogonally polarized microstrip broadband monopole antennas is explained [31]. CSRR can be considered as a negative form of SRR. CSRR consist of two concentric circles with slot on opposite ends. Both rings act together as a stop band as shown in figure 6. Since CSRR resonators have very high Q values, bandwidth will be smaller as compared to other resonator structures. CSRR with smallest length is found to be more sensitive to change in thickness of the substrate. Multiresonators circuit for data encoding consisting of dual band resonator which is MCSRR (Modified complementary SRR) is explained [32]. MCSRR is kept along transmission line which is acting as a feed line.

Another tag was proposed in [34] in which  $4N$  words can be generated using



N resonators. This was achieved using modified complementary split ring resonators (MCSRR) as shown in figure 7. The area and operational bandwidth required in CSRR has been reduced drastically by using MCSRR. A single MCSRR can achieve all four data combinations (00,01,10,00).

**Dual band resonator** A tag consisting of dual band resonators and two rhomboid antennas which function when orthogonally polarized is proposed in [35]. In such tag, N stub loaded dual band resonators can code around  $3N$  words. Improvement of operating bandwidth is achieved in this tag as compared to conventional half wavelength resonator tags. When conventional resonators [27] are used, only single bit encoding can be done thus leading to only two possible data bits (0,1). The stub loaded resonators can code two bits of data and hence three combinations can be obtained (00,01,11).

**E shaped resonator** The tag includes E shaped microstrip resonators and two cross polarized circular broadband monopole antennas as explained in [36]. Design modifications can be achieved with minimal layout variations as shown in figure 8.

Arm length of each E resonator are different and hence each will produce different stop band resonances. A particular resonance in such tags can be shifted out of the operational frequency range by either removing the particular E resonator or by making a cut in the arm of the resonator. Another compact chipless RFID tag which can store two bits of information is a coupled line microstrip resonator with two orthogonally polarized wideband monopole antennas as proposed in [37]. Each resonator in such tags can store data into two frequency slots and is more economical than conventional chipless tags.

**U shaped resonator** A U-shaped reconfigurable microstrip resonator with isolated (K-1) legs, high coding capacity which are small in tag size is explained in [38]. Resonant frequency can be adjusted since U frame is connected to one of the leg of the resonator using a metal strip. Each resonator in such tags can achieve more than one bit of information. Also each resonator represents one of the K state of resonance. By sharing a particular bandwidth between two resonators spectral efficiency can be improved.

### BACKSCATTER BASED CHIPLESS TAG

**Slot resonator** A tag composed of a slot loaded dual polarized chipless RFID is proposed in [40]. It consists of four rectangular metallic patches filled with multiple slot resonators. It uses a quite simple method. By shorting the slot at the corners, corresponding resonance frequencies are established out of the considered frequency band. By placing the slots of same polarization for adjacent frequencies alternatively in two patches, the mutual coupling between the slots can be kept minimum. The number of bits in same frequency band width are doubled by placing two identical sets in horizontal and vertical polarizations. It gives an advantage over the spiral resonators-based tag [27,28] by reducing the tag area enormously as multiple slots shall be kept into the same patch as shown in figure 10. Limitation of such tag is that the cross polar response will be too small to identify if the tag is turned by an angle exceeding certain limits.

**I slot resonator** The paper proposed in [41], explains I slot resonators which are etched in both horizontal and vertical directions on a square metallic patch as shown in figure 11. This doubles the encoding capacity of the tag in the frequency band of interest. Slot length variation technique is utilized for reducing

the tag size as well as to reduce mutual coupling between successive slots. Variation in each of the slot length is exploited to encode 2 bits of data. One major drawback is the complexity of the reader structure. The dual polarized antennas provides inaccessible measurements. This needs to be done using linearly polarized antennas for horizontal and vertical polarities.

**Ring resonator** In [42], chipless RFID tag consisting of slotted ring resonators is explained as in figure 12. Each slot corresponds to a resonant frequency. One advantage of such tag is symmetrical structure. This makes it independent of tag orientation. Removal of any slot indicates '0' bit. Limitation of such tag explains, by varying slot width sharper resonances are obtained which increases overall tag size.

A modified version of slot ring resonator which is a fully printable, planar, orientation independent, single layer discretized circular slot resonators on a circular patch is explained in [43]. This reduces total tag size since discretized circular slot resonators as shown in figure 13 can resonate at a lower frequency for the same diameter as compared to circular slot resonator [42]. Here the circular shape of slot resonator is approximated as a discrete shape that is in the form of rectangles. Resonant frequency of each slot depends on the slot radius. While accumulating multiple slots a minimum distance must be maintained between the slots for reducing coupling effects which is a major drawback of such tags.

**C shaped resonator** The paper proposed in [1] explains, C shaped resonators with simple resonating structures. These resonators are used in applications which require high data

capacity and an average tag size. In this resonator encoding of data is done by frequency coding technique. The overall length of the resonators will depend on wavelength, hence resonators having largest length tend to resonate at small frequency and vice versa. In [44] a nested C shaped slots that can be deployed on curved surfaces is explained. The presence of a slot indicate the logic state as '1' while its absence is taken as '0'. This tag offers high bit density and is more flexible and compact than the former C slot structure. Chipless tags without ground plane can be designed if the detuning effect is eliminated as designed by Smail Tedjini [45]. The design proposed in [46] by Smail Tedjini indicates a tag in which detuning effect was reduced by using a correction technique based on a coplanar quarter wavelength sensing strip line resonator. In the proposed design resonant frequencies can be varied by shorting the resonator at predefined locations.

**L slot resonator** Two orientation independent multiple L slot resonator based tags are proposed in [47]. In one configuration multiple L shaped slot resonators are cascaded with each other as shown in figure 14, while the second configuration consist of alternate resonators on one side of the substrate and remaining resonators are placed in an inverted fashion on the other end of the substrate. The former configuration allows addition of extra resonators without an increase in tag size. Due to the proximity of the slots, mutual coupling is increased and tag reading becomes less accurate. The later configuration explains the reduction of mutual coupling between resonators, hence it provides an improved performance and printing flexibility. Limitation of such tag is that, tag size is proportional to the number of encoding bits. In [48] a dual polarized L shaped

resonators are proposed that can increase bit encoding capacity. New codes were generated by changing resonator length with respect to the slot length.

**M slot resonator** Another tag which uses slot length variation technique for improving its coding capacity and robustness is explained in [49]. The paper explains a compact dual polarized chipless RFID tag which uses inverted M shaped slot structure. The number of notches in the desired frequency range can be achieved by adding or removing the slot resonators. Slot length in such tags are inversely related to resonant frequency. Since ground plane is absent the wave is guided in between two strips and electrical field exist around the strips. Tag is configured by filling or defiling the slot and the former case will shift the frequency out of the operating frequency band.

**Square loop resonator** A FSS unit cell consisting of several concentric square loop resonators is put forward in [50], which exhibit advantages such as scalability without any increase in size, polarization independence and operating capability even when mounted on metallic objects.

**Triangular shaped resonator** One major challenge in designing chipless RFID is the effect of surrounding environment. As the surrounding environment is dynamic in nature and high reflections from items behind the tag causes an interference in determining tag ID. This can be eliminated by using a cross polar chipless RFID tag which is insensitive to tag orientation. The resonator unit [51] proposed consists of three resonator arranged in a triangular fashion which can be read at all angles and hence was suggested for practical applications. A leaf shaped resonator [27] is proposed, which is a form of split ring resonator. The leaf shaped resonator

consist of half a circle along with two strips. A cross polar reflection can be generated at all rotational angles except when the excitation field becomes aligned with the gap in the structure.

The significant challenges while designing chipless tags in frequency signature domain is the limited bandwidth and quality factor of the resonating structures. Due to broadening of resonance, designing of resonators with low quality factor is not practically feasible and resonators with high quality factors is required which is proposed in [52]. A hairpin resonator is a modified form of the above proposed leaf shaped resonator [51,52] to improve the quality factor and it consist of an extended arm strip and a narrow gap size. Another tag resonator structure which is of flower shaped [51] was suggested to employ less sensitivity to cross polar orientation. Bowtie shaped resonator structure which is a compact, low cost and flexible tag is analysed in [53]. Designing of the tag is in such a way that each slot in the upper metal patch corresponds to a gap in the lower patch and vice versa, which eliminates the mutual coupling effect.

## HYBRID TAGS

Hybrid tags are used in certain conditions where more than two logic states are required for assigning resonator structures. This is achieved in most of the tag designs by encoding in frequency domain [54-56]. Each resonator have different resonating frequency. Another method which can be used to obtain hybrid condition is encoding the data into amplitude spectrum either using resonators [57] or using RCS technique [58]. In [59] author proposes a tag in which data encoding can be done into phase and frequency domain. Another tag [60] in which frequency of a notch along with bandwidth is proposed. Notch frequency in such tags are controlled by

changing resonant element dimensions.

### CONCLUSION

The paper shows a review of author's study on various chipless RFID tags. The Chipless RFID provides various scope and uses for the future references. The detailed study and researches on chipless RFID tags establishes its domain and vulnerability. By eliminating the limitations effectively, chipless RFID has its reach to establish as a very prominent tag identification method. From the review in order to establish chipless RFID technology as a commercially economical solution and to replace conventional methods several work need to be done. Since most of the paper explains performance of the tag in laboratory settings hence studies are to be done to validate the read range in real environmental setup.

### REFERENCES

- Mumtaz, M., Amber, S. F., Ejaz, A., Habib, A., Jafri, S. I., Amin, Y. Design and analysis of C shaped chipless RFID tag. In 2017 International Symposium on Wireless Systems and Networks (ISWSN) (pp. 1-5). IEEE. (2017, November). doi:10.1109/ISWSN.2017.8250009
- Babaeian, F., Karmakar, N. C. Hybrid chipless RFID tags-A pathway to EPC global standard. IEEE Access, 6, 67415-67426. (2018). doi:10.1109/ACCESS.2018.2879050
- Vena, A., Perret, E., Tedjini, S. Chipless RFID tag using hybrid coding technique. IEEE Transactions on Microwave Theory and Techniques, 59(12), 3356-3364. (2011). doi:10.1109/TMTT.2011.2171001
- Forouzandeh, M., Karmakar, N. C. Chipless RFID tags and sensors: A review on time-domain techniques. Wireless Power Transfer, 2(2), 62-77.(2015). doi:10.1017/wpt.2015.10
- Saldanha, N., Malocha, D. C. P4J-1 design parameters for SAW multi-tone frequency coded reflectors. In 2007 IEEE Ultrasonics Symposium Proceedings (pp. 2087-2090). IEEE. (2007, October). doi:10.1109/ULTSYM.2007.525
- Han, T., Wang, W., Wu, H., Shui, Y. Reflection and scattering characteristics of reflectors in SAW tags. IEEE transactions on ultrasonics, ferroelectrics, and frequency control, 55(6), 1387-1390.(2008). doi:10.1109/TUFFC.2008.802
- Harma, S., Plessky, V. P., Li, X., Hartogh, P. Feasibility of ultra-wideband SAW RFID tags meeting FCC rules. IEEE transactions on ultrasonics, ferroelectrics, and frequency control, 56(4), 812-820.(2009). doi:10.1109/TUFFC.2009.1104
- Preradovic, S., Karmakar, N. C., Balbin, I. (2008). RFID transponders. IEEE microwave magazine, 9(5), 90-103. doi:10.1109/MMM.2008.927637
- Plessky, V. P., Reindl, L. M. Review on SAW RFID tags. IEEE transactions on ultrasonics, ferroelectrics, and frequency control, 57(3), 654-668.(2010). doi:10.1109/TUFFC.2010.1462
- Vasconcelos, H. M., Santos, E. J. Design, microfabrication, and analysis of SAW RFID tag. In 28th Symposium on Microelectronics Technology and Devices (SBMicro 2013) (pp. 1-4). IEEE.(2013, September). doi:10.1109/SBMicro.2013.6676115
- Chamarti, A., Mohammad, W., Ramisetty, S., Vemarigi, J., Dandgey, U.,

- Varahramyan, K. A low cost flexible-substrate wireless sensor tag based on sensor switch element. In Proceedings Electronic Components and Technology, 2005. ECTC'05. (pp. 523-527). IEEE.(2005, May). doi:10.1109/ECTC.2005.1441315
- Chamarti, A., Varahramyan, K. Transmission delay line based ID generation circuit for RFID applications. IEEE microwave and wireless components letters, 16(11), 588-590.(2006). doi:10.1109/LMWC.2006.884897
- Mandel, C., Schussler, M., Maasch, M., Jakoby, R. A novel passive phase modulator based on LH delay lines for chipless microwave RFID applications. In 2009 IEEE MTT-S International Microwave Workshop on Wireless Sensing, Local Positioning, and RFID (pp. 1-4). IEEE. (2009, September). doi:10.1109/IMWS2.2009.5307891
- Schussler, M., Damm, C., Maasch, M., Jakoby, R. Performance evaluation of left-handed delay lines for RFID backscatter applications. In 2008 IEEE MTT-S International Microwave Symposium Digest (pp.177-180). IEEE.(2008, June). doi:10.1109/MWSYM.2008.4633132
- Gupta, S., Nikfal, B., Caloz, C. RFID system based on pulse-position modulation using group delay engineered microwave C-sections. In 2010 Asia-Pacific Microwave Conference (pp. 203-206). IEEE. (2010, December).
- Gupta, S., Parsa, A., Perret, E., Snyder, R. V., Wenzel, R. J., Caloz, C. Group delay engineered noncommensurate transmission line all-pass network for analog signal processing. IEEE transactions on microwave theory and techniques, 58(9), 2392-2407. (2010). doi:10.1109/TMTT.2010.2058933
- Gupta, S., Sounas, D. L., Van Nguyen, H., Zhang, Q., Caloz, C. CRLH-CRLH C-section dispersive delay structures with enhanced group-delay swing for higher analog signal processing resolution. IEEE transactions on microwave theory and techniques, 60(12), 3939-3949.(2012). doi:10.1109/TMTT.2012.2224362
- Myny, K., Lai, Y. C., Papadopoulos, N., De Roose, F., Ameys, M., Willegems, M., Genoe, J. 15.2 A flexible ISO14443-A compliant 7.5 mW 128b metal-oxide NFC barcode tag with direct clock division circuit from 13.56 MHz carrier. In 2017 IEEE International Solid-State Circuits Conference (ISSCC) (pp. 258-259). IEEE. (2017, February). doi:10.1109/ISSCC.2017.7870359
- Myny, K., Steudel, S., Smout, S., Vicca, P., Furthner, F., van der Putten, B., ... Heremans, P. Organic RFID transponder chip with data rate compatible with electronic product coding. Organic Electronics, 11(7), 1176-1179. (2010). doi:10.1016/j.orgel.2010.04.013
- Cantatore, E., Geuns, T. C., Gelinck, G. H., van Veenendaal, E., Gruijthuijsen, A.F., Schrijnemakers, L., ... De Leeuw, D. M. A 13.56-MHz RFID system based on organic transponders. IEEE Journal of solid-state circuits, 42(1), 84-92.(2006). doi:10.1109/JSSC.2006.886556
- Zhang, L., Rodriguez, S., Tenhunen, H., Zheng, L. R. An innovative fully

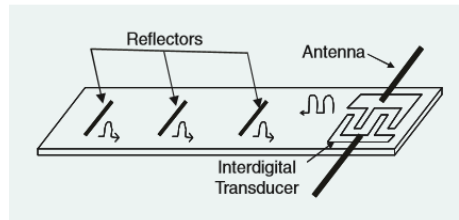
- printable RFID technology based on high speed time-domain reflections. In Conference on High Density Microsystem Design and Packaging and Component Failure Analysis, 2006. HDP'06. (pp. 166-170). IEEE. (2006, June). doi:10.1109/HDP.2006.1707587
- Shao, B., Chen, Q., Amin, Y., David, S. M., Liu, R., Zheng, L. R. An ultra-low-cost RFID tag with 1.67 Gbps data rate by ink-jet printing on paper substrate. In 2010 IEEE Asian Solid-State Circuits Conference (pp. 1-4). IEEE. (2010, November). doi:10.1109/ASSCC.2010.5716569
- Shao, B., Chen, Q., Liu, R., Zheng, L. R. Configurable ink-jet-printed RFID tag on paper substrate for low cost and green applications. Microwave and Optical Technology Letters, 53(12), 2781-2786. (2011). doi:10.1002/mop.26412
- Herrojo, C., Paredes, F., Mata-Contreras, J., Mart'ın, F. Chipless-RFID: A review and recent developments. Sensors, 19(15), 3385. (2019). doi:10.3390/s19153385
- Babaeian, F., Karmakar, N. C. Hybrid chipless RFID tags-A pathway to EPC global standard. IEEE Access, 6, 67415-67426.(2018). doi:10.1109/ACCESS.2018.2879050
- Babaeian, F., Karmakar, N. C. Development of cross-polar orientation-insensitive chipless RFID tags. IEEE Transactions on Antennas and Propagation, 68(7), 5159-5170.(2020). doi:10.1109/TAP.2020.2975639
- Preradovic, S., Balbin, I., Karmakar, N. C., Swiegers, G. F. Multiresonator-based chipless RFID system for low-cost item tracking. IEEE Transactions on Microwave Theory and Techniques, 57(5), 1411-1419.(2009). doi:10.1109/TMTT.2009.2017323
- Preradovic, S., Karmakar, N. C.. Design of fully printable planar chipless RFID transponder with 35-bit data capacity. In 2009 European Microwave Conference (EuMC) (pp. 013-016). IEEE.(2009, September) doi:10.23919/EUMC.2009.5296182
- Weng, Y. F., Cheung, S. W., Yuk, T. I., Liu, L. Design of chipless UWB RFID system using a CPW multi-resonator. IEEE Antennas and Propagation Magazine, 55(1), 13-31.(2013). doi:10.1109/MAP.2013.6474480
- Jalil, M. E., Rahim, M. K. A., Samsuri, N. A., Dewan, R. Flexible printed chip-less RFID tag using metamaterial-split ring resonator. Applied Physics A, 122(4), 348.(2016).
- Ma, Z. H., Yang, J. H., Chen, C. C., Yang, C. F. A re-transmitted chipless tag using CSRR coupled structure. Microsystem Technologies, 24(10), 4373-4382.(2018).
- Bhuiyan, M. S., Azad, A. K. M., Karmakar, N. Dual-band modified complementary split ring resonator (MCSRR) based multi-resonator circuit for chipless RFID tag. In 2013 IEEE Eighth International Conference on Intelligent Sensors, Sensor Networks and Information Processing (pp. 277-281). IEEE.(2013, April). doi:10.1109/ISSNIP.2013.6529802
- Al-Nuaimi, M. K. T., Whittow, W. G. Compact microstrip band stop filter using SRR and CSSR: Design,

- simulation and results. In Proceedings of the Fourth European Conference on Antennas and Propagation (pp. 1-5). IEEE.(2010, April).
- Bhuiyan, M. S., Karmakar, N. C. An efficient coplanar retransmission type chipless RFID tag based on dual-band McSrr. Progress In Electromagnetics Research, 54, 133-141.(2014). doi:10.2528/PIERC14061403
- Girbau, D., Lorenzo, J., Lazaro, A., Ferrater, C., Villarino, R. Frequency-coded chipless RFID tag based on dual-band resonators. IEEE Antennas and Wireless Propagation Letters, 11, 126-128.(2012). doi:10.1109/LAWP.2012.2185032
- Sumi, M., Dinesh, R., Nijas, C. M., Mridula, S., Mohanan, P. High bit encoding chipless RFID tag using multiple E shaped microstrip resonators. Progress In Electromagnetics Research, 61, 185-196.(2014). doi:10.2528/PIERB14081301
- Abdulkawi, W. M., Sheta, A. F. A. Four-state coupled-line resonator for chipless RFID tags application. Electronics, 8(5), 581.(2019). doi:10.3390/ELECTRONICS8050581
- Abdulkawi, W. M., Sheta, A. F. A. K-State Resonators for High-Coding-Capacity Chipless RFID Applications. IEEE Access, 7, 185868-185878.(2019). doi:10.1109/ACCESS.2019.2961565
- Babaeian, F., Karmakar, N. C. Time and Frequency Domains Analysis of Chipless RFID Back-Scattered Tag Reflection. IoT, 1(1), 109-127.(2020). doi:10.3390/iot1010007
- Islam, M. A., Karmakar, N. C. A novel compact printable dual-polarized chipless RFID system. IEEE Transactions on Microwave Theory and Techniques, 60(7), 2142-2151.(2012). doi:10.1109/TMTT.2012.2195021
- Islam, M. A., Karmakar, N. A compact printable dual-polarized chipless RFID tag using slot length variation in l'slot resonators. In 2015 European Microwave Conference (EuMC) (pp. 96-99). IEEE.(2015, September). doi:10.1109/EuMC.2015.7345708
- Habib, A., Azam, M. A., Amin, Y., Tenhunen, H. Chipless slot resonators for IoT system identification. In 2016 IEEE International Conference on Electro Information Technology (EIT) (pp. 0341-0344). IEEE.(2016, May). doi:10.1109/EIT.2016.7535262
- Martinez, M., van der Weide, D. Compact slot-based chipless RFID tag. In 2014 IEEE RFID Technology and Applications Conference (RFID-TA) (pp. 233-236). IEEE.(2014, September). doi:10.1109/RFID-TA.2014.6934234
- Jabeen, I., Ejaz, A., Akram, A., Amin, Y., Tenhunen, H. Miniaturized Slot Based Chipless RFID Tag for IoT Applications. In 2019 International Symposium on Recent Advances in Electrical Engineering (RAEE) (Vol. 4, pp. 1-4). IEEE.(2019, August). doi:10.1109/RAEE.2019.8887068
- Vena, A., Perret, E., Tedjini, S. A fully printable chipless RFID tag with detuning correction technique. IEEE Microwave and Wireless Components Letters, 22(4), 209-

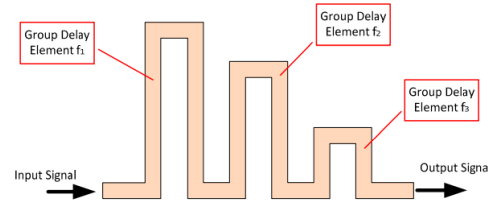
- 211.(2012).  
doi:10.1109/LMWC.2012.2188785
- Babaeian, F., Karmakar, N.. A cross-polar orientation insensitive chipless RFID tag. In 2019 IEEE International Conference on RFID Technology and Applications (RFID-TA) (pp. 116-119). IEEE.(2019, September) doi:10.1109/RFID-TA.2019.8892193
- Sharma, V., Malhotra, S., Hashmi, M. Slot resonator based novel orientation independent chipless RFID tag configurations. IEEE Sensors Journal, 19(13), 5153-5160.(2019).  
doi:10.1109/JSEN.2019.2902622
- Issa, K., Alshoudokhi, Y. A., Ashraf, M. A., AlShareef, M. R., Behairy, H. M., Alshebeili, S., Fathallah, H. A high-density L-shaped backscattering chipless tag for RFID bistatic systems. International Journal of Antennas and Propagation, 2018.(2018).  
doi:10.1155/2018/1542520
- Abdulkawi, W. M., Sheta, A. F. A., Issa, K., Alshebeili, S. A. Compact printable inverted-M shaped chipless RFID tag using dual-polarized excitation. Electronics, 8(5), 580.(2019).
- Costa, F., Genovesi, S., Monorchio, A. A chipless RFID based on multiresonant high-impedance surfaces. IEEE transactions on microwave theory and techniques, 61(1), 146-153.(2012).  
doi:10.1109/TMTT.2012.2227777
- Babaeian, F., Feng, J., Karmakar, N. Realisation of a high spectral efficient chip- less RFID tag using hairpin resonators. In 2019 IEEE Asia-Pacific Microwave Conference (APMC) (pp. 114-116). IEEE.(2019, December).  
doi:10.1109/APMC46564.2019.9038844
- Liu, Y., Yang, X. Chipless radio frequency identification tag design with modified interdigital hairpin resonators. In 2018 International Conference on Intelligent Transportation, Big Data Smart City (ICITBS) (pp. 645-648). IEEE.(2018, January).  
doi:10.1109/ICITBS.2018.00168
- Anam, H., Habib, A., Jafri, S. I., Amin, Y., Tenhunen, H. (2017). Directly print- able frequency signed chipless RFID tag for IoT applications. Radioengineering, 26(1), 139-146.  
doi:10.13164/re.2017.0139
- Vena, A., Perret, E., Tedjini, S. High-capacity chipless RFID tag insensitive to the polarization. IEEE Transactions on Antennas and Propagation, 60(10), 4509-4515.(2012).  
doi:10.13164/re.2017.0139
- Vena, A., Perret, E., Tedjini, S. Design of compact and auto-compensated single- layer chipless RFID tag. IEEE Transactions on Microwave Theory and Techniques, 60(9), 2913-2924.(2012).  
doi:10.1109/TMTT.2012.2203927
- Chen, Y. S., Jiang, T. Y., Lai, F. P. Automatic topology generation of 21 bit chip- less radio frequency identification tags using a noniterative technique. IEEE Antennas and Wireless Propagation Letters, 18(2), 293-297.(2018). doi:10.1109/LAWP.2018.2889322
- Herrojo, C., Paredes, F., Mata-Contreras, J., Zuffanelli, S., Mart'ın, F. Multistate multiresonator spectral signature barcodes implemented by means of S-shaped split ring



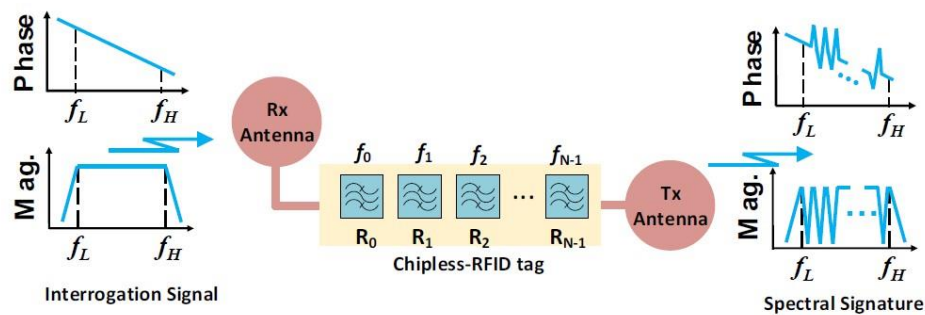
- resonators (S-SRRs). IEEE Transactions on Microwave Theory and Techniques, 65(7), 2341-2352.(2017).  
doi:10.1109/TMTT.2017.2672547
- Vena, A., Babar, A. A., Syd"anheimo, L., Tentzeris, M. M., Ukkonen, L. A novel near-transparent ASK-reconfigurable inkjet-printed chipless RFID tag. IEEE Antennas and Wireless Propagation Letters, 12, 753-756.(2013).  
doi:10.1109/LAWP.2013.2270932
- Vena, A., Perret, E., Tedjini, S. Chipless RFID tag using hybrid coding technique. IEEE Transactions on Microwave Theory and Techniques, 59(12), 3356-3364.(2011).  
doi:10.1109/TMTT.2011.2171001
- El-Awamry, A., Khaliel, M., Fawky, A., El-Hadidy, M., Kaiser, T. Novel notch modulation algorithm for enhancing the chipless RFID tags coding capacity. In 2015 IEEE International Conference on RFID (RFID) (pp. 25-31). IEEE.(2015, April).  
doi:10.1109/RFID.2015.7113069



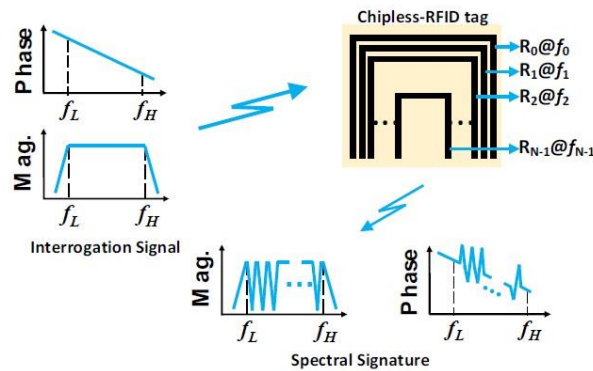
**Fig. 1: Surface acoustic wave tags-Adapted from Reference [8]**



**Fig. 2: Group delay based tags-Adapted from Reference [15]**



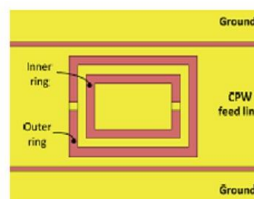
**Fig. 3: Retransmission based chipless RFID tags-Adapted from Reference [24]**



**Fig. 4: Backscatter based chipless RFID tags-Adapted from Reference [24]**



**Fig. 5: Spiral shaped resonator**



**Fig. 6: Conventional CSRR-Adapted from Reference [33]**

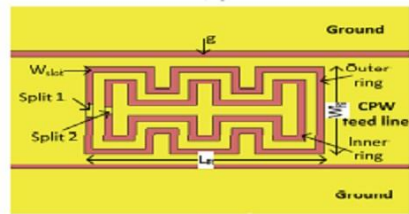


Fig. 7: Modified CSRR-Adapted from Reference [34]

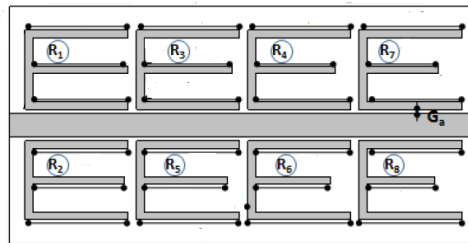


Fig. 8: E shape resonator-Adapted from Reference [36]

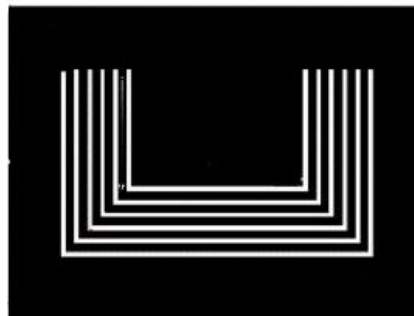


Fig. 9: U shape resonator-Adapted from Reference [39]

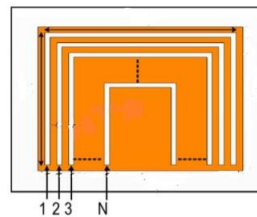


Fig. 10: Slot resonator-Adapted from Reference [40]

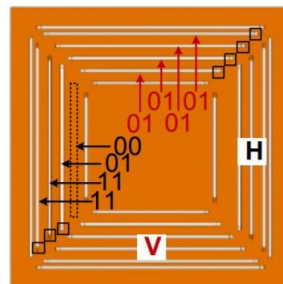
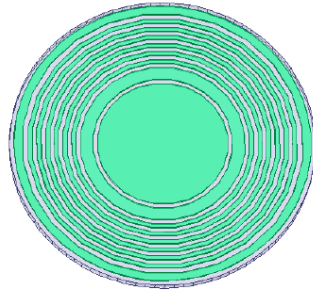
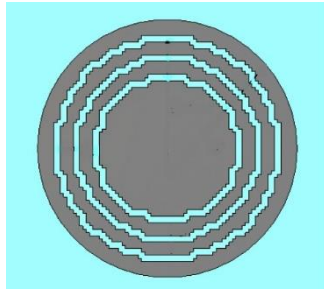


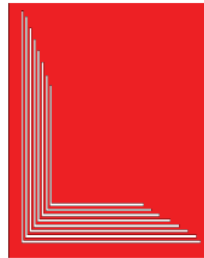
Fig. 11: I slot resonator -Adapted from Reference [44]



**Fig. 12: Circular slot resonator -Adapted from Reference [42]**



**Fig. 13: Discretized circular slot resonator-Adapted from Reference [43]**



**Fig. 14: L slot resonator-Adapted from Reference [47]**



**Fig. 15: M slot resonator-Adapted from Reference [49]**

# Biodiesel: Review on Production Techniques & Raw Material Process Economic Aspects

**J. Srinithi**

Research Scholar, Department of  
Chemical Engineering, Coimbatore  
Institute of Technology

**Dr. M. Thirumarimurugan**

Professor & Head, Department of  
Chemical Engineering, Coimbatore  
Institute of Technology

**D. Gokul**

Student, Department of Chemical  
Engineering, Kalasalingam Academy of  
Research and Education

## Abstract

Biodiesel is found to be one of the promising alternatives for conventional fuels since lot of researches and steps for practical implementation has been started by numerous countries to meet out the futuristic demands of switching towards new energy sources due to less toxicity and eco-friendly aspects. Diverse feedstock's are being used to produce by means of blending/direct use, micro-emulsion, thermal cracking/pyrolysis and transesterification. Parameters like type of alcohol, type of catalyst & its quantity, alcohol to oil ratio, stirring speed, temperature, pressure, time of reaction and type of source oil plays a major role in the contribution of yield, efficiency and cost. It is really important to study the process economics to understand the aspects in practical implementation. This study entirely deals with biodiesel production methods, parameters associated and process economics behind selection of raw materials.

**Keywords:** Biodiesel, Production, Process Economics, Raw materials, Feedstock

## INTRODUCTION

Decrease in availability of mineral oils is becoming a biggest concern in terms of energy crisis. Mineral oil also leads a way for global warming, environmental degradation and pollution, green house effect etc.[1] Few statistics reveals that oil and gas will not be available for use after 63 years if it is used consistently in the same pace.[2] Though scientists are working hard in doing researches on the areas of wind, geothermal and solar technologies, there is a huge need of alternative renewable energy sources termed as bio fuels which is an emerging technique in the field of energy sector.

In recent trends, world is stepping forward for a renewable production source of alternative fuel for diesel which is beneficial to environment, non-toxic and bio-degradable.

In the vision of deficiency towards fossil fuels and a hike in demand of diesel for generation of power, agriculture and

transportation [3] in very near future tends to identification and implementation of new alternative to avoid the crisis and an alternative is necessary and unavoidable in current scenario.

Biodiesel is produced from various biological resources which are renewable and non- toxic to environment such as fats and non-edible oils etc. which can be a best alternative for diesel. Biodiesel literally defined as a fuel with long chain fatty acids with mono-alkyl esters from oils and fats.[4] Numerous research studies prove that biodiesel can be a suitable alternative and substitute. Production techniques undergo speedy and comprehensive techno- revolution in academic and industries. Efficiency majorly deals with feedstock nature, catalyst, reaction time, temperature, alcohol type and economic aspects.[5]

In case of switching towards fuel of biodiesel, there records a neutral carbon since the quantity of emitted carbon will be same as adsorbed by

plant/animal during its life time during combustion process makes a evidence of minimal emission during green combustion. In recent trends, domination of diesel may be high but for an alternative is truly need when we think in a futuristic approach and we can believe that biodiesel can be such a boon for the cause.

### Key Characteristics of Pure Biodiesel

Certain key observation has to be done during the examination of pure biodiesel and the observations are being listed in the Table 1. [6]

### Classification of Bio-fuel

Bio-fuels are broadly classified into three major categories based on their feedstock selection for production of bio-fuel named as first, second and third generation bio-fuels. The classification criteria and example of feed-stock is listed in Table 2. [7]

### Production of Biodiesel

The four main approaches for production of bio-diesel are [8]

- 1) Direct use and Blending
- 2) Transesterification Process
- 3) Thermal Cracking/Pyrolysis
- 4) Microemulsion

#### Direct use and Blending:

Usage of vegetable oils directly to engines as a fuel consists of numerous practical implementation issues with it. Considering those conditions, an alternative method of blending technique has been adopted and the method helps in obtaining the properties of a fuel to a considerable extent. This method helps us in overcoming the faced issues in practical approach. Blending help in improving quality and reducing consumption thereby play a promising role in approaching the alternatives.

Successful ratio of 1:10 to 2:10 is preferred for running in a short period. Also there is a need of modifications in engine and customized running system for energy production since on usage without modifications lead to high risk and even danger of failure too. [16]

### Transesterification Process

Glycerol and Biodiesel produced by combination of alcohol and triglycerides in vegetables leads to a reaction called as transesterification. The process takes place in the presence or absence of the catalyst which is determined by the quantity of feed stock free fatty acid which is directly related to important parameters like efficiency & production. It is a reversible process where reaction takes place usually under temperature/pressure. [17] The following equation depicts the simple transesterification reaction.



Generally transesterification takes place in different steps like acid, base, heterogeneous, lipase, supercritical, nano and ionic liquid catalysed process. [18] All the transesterification process looks similar but the change in catalyst plays a primary role in it.

#### Acid Catalysed

The reaction requires longer time and higher temperature. Sulphonic, hydrochloric and sulphuric acid are commonly used acid in the process.

#### Base Catalysed

The reaction is faster over here and corrosion is less but the process economics is higher due to catalyst consumption and issues in separation process. NaOH and KOH are commonly used catalyst in the process.

#### Heterogeneous catalysed

The reaction holds a great advantage of simpler separation and

lower contamination enabling catalyst reusability. Potassium zirconias, Titanium and Amp. zirconia are few of the heterogeneous catalysts.

### **Lipase catalysed**

Though the cost and reaction time are quite more, utilizing enzymes become a recent trend as it help to produce a high purity product and supporting quite easier separation. *Pseudomonas* species, *Rhizopus oryza*, Novozym 435, Lipozyme TL are few enzymes utilized in the process.

### **Supercritical Reaction**

Considering immiscibility constraints, this type of reaction takes place under high temperature and pressure. It is non catalytic but takes very lesser time for reaction. Though methanol consumption and cost are higher, purity is good, separation is easier and it an eco friendly process.

### **Nano Catalysed**

This type of advanced catalyst enhances the catalytic activity due to its enormous advantages. It can be concluded as a promising one for effective production. Few of the nano catalysts are CaO/CaN, CaO/SS, CaO-Al<sub>2</sub>O<sub>3</sub> etc.

### **Onic Liquid Catalysed**

This type of catalyst helps us in formation of biphasic product at the end enabling quick separation. The process takes very less time compared to others and also helps us in reusability. 1-n-butyl-3-methylimidazolium is one of the ionic liquid studied by many researchers.

### **Thermal Cracking/ Pyrolysis**

Numerous small molecules formed due to breakage of bonds using heat between 400 – 600°C with/without oxygen or with/without catalyst named as a chemical change called Pyrolysis. Among the different classes of production, fast pyrolysis is found to be best suited

one for the production of bio-diesel due to its simplicity and efficiency. The process should be made with at most care since small deviations may lead to different products and uncertainty in purity of the product. Also separation technique in post production is yet a challenging milestone in this type of process. Zeolites, Red-mud and Alumina are the commonly used catalyst in pyrolysis process.

### **Micro emulsions**

Certain oil cannot be directly used as a fuel and viscosity might be one of the reasons for the particular cause. In this regard, micro-emulsions can be a best suitable one to overcome the cause. It really consists of oil, water and a surfactant which helps in incrementing the Cetane number and lowering the viscosity. This type of biodiesel cannot be used for a long time in a engine because it may cause damage to the engines. But literally this type of fuel possesses best spray property when compared to others.

### **Discussion of Key Variables involved in Biodiesel Characteristics**

Key variables associate with Biodiesel production are selection of type of alcohol needed, Alcohol to Oil Ratio, Time of the reaction, Temperature needed, Necessity of mixing, type of catalyst and its quantity, pressure etc. Each variable has its own characteristic contribution towards the economical, simple and quicker process for biodiesel production.

### **Selection of Oil**

The most important entity required for the biodiesel production is Oil source. Selection of oil is done based on analyzing its physicochemical characteristics like viscosity, calorific value etc. which help us to identify the suitable oil which as a primary base raw material for biodiesel production. Also

few parameters like iodine index, acidity, phosphorous index and oxidation stability are quality based parameters studied before selection of oil source. Also fatty acid content deals with the production process in a major extent since catalyst selection greatly deals with it. [71] Jatropha, rapeseed, sunflower, palm, soybean, cotton etc. are the most commonly used raw material for producing oil.

### **Type of Alcohol**

As we are aware that alcohol reacts with triglycerides to form free fatty acids. Thus alcohol is a major raw material required for the process to complete the reaction.[72] Ethanol and Methanol are most commonly used alcohols in the production process due to its availability physical & chemical advantages and low cost. There are other few alcohols used in process like butanol, octanol, branched alcohols etc. but they are costly. Also few co-solvent with alcohol for better yield purpose has been reported in few researches but majorly Methanol is using by extensive researchers in their research.

### **Alcohol to Oil Ratio**

An important parameter associated with yield, cost and conversion is alcohol to oil ratio. Literally when conversion needs to occur in a shorter time, alcohol to oil ratio should be higher and it may lead to higher purity of biodiesel.[73] The alcohol to oil ratio reported in various literatures vary from 1:1 to 45:1 in different methods of production of biodiesel. This ratio selection makes a huge impact until the biodiesel refining process.

### **Time of reaction, Stirring speed, Temperature and Pressure**

All the parameters are interlinked with each other and we can infer that the above parameters deal with overall

production time, quantity and cost. Reaction time is one which deals with quantity of production and cost of production. Only few process required stirring when viscosity variance occurs during the reaction. Temperature and Pressure is varied only when the reaction is too low and this type of reaction occurs under special category only. Also all these parameters deal with yield, conversion efficiency & purity of production. [74]

### **Type of Catalyst and Quantity**

Quantity of catalyst and the type of the catalyst used for the reaction is directly proportional to biodiesel yield and conversion efficiency since the catalyst increase the speed of the reaction thereby enabling increase in yield. There are several type of catalyst available like acid, basic, ionic, nano etc. and the catalyst is selected for the reaction on the basis of oil source characteristics. [75]

### **Other parameters**

Selection of appropriate blend quantity and the selection of required quantity of emulsions for the preparation of biodiesel play a major role in blending and micro-emulsions techniques respectively in which those parameters meant to deal with yield and efficiency aspects.

### **Process Economics dealing with Raw Material**

Process Economics is one of the important aspects to be studied in all the areas of engineering, science and technology as it paves a successful way for the practical implementation of the idea or research aspects. [76] World due to its adverse effects facing in the areas of environment protection and its related health hazards taking a joint initiative to save the earth. Also Government has started using blending



technique as a miniature alternative for this futuristic idea. But a prominent alternative really needed and Biodiesel found to be a boon for the conventional fossil fuels. In this regard, it should be economical to bring out for human consumption in daily needs.

Oil, Alcohol and Catalyst are the primary raw materials involved in this process. As discussed earlier in this study, Methanol is commonly used as an alcohol due to its availability and low cost in several processes.[72] Though co-solvents used in few studies, it is added in a very minimal amount and it does not make a much variation. Catalyst is another challenge but numerous studies worked up in biodiesel production consumes very less amount of catalyst and also the most of the catalyst used as easily available and of considerable cost.[75]

The only thing we need to study is the oil source and its availability for its implementation in practical applications. Jatropha, rapeseed, cottonseed, palm, vegetable, sunflower, soybean and waste cooking oil are commonly used source for oil.[77] In this area, cottonseed, palm, sunflower, vegetable, rapeseed and soybean oil are being used in the areas of cooking and wide extensive use of those oils in production of biodiesel may make a huge impact on the food market chain and oil price may reach a hike. Also collection of waste cooking oil is really a challenging task in preparing biodiesel. Thus we can infer that Jatropha oil, non edible oil found to be a boon for the biodiesel production industry. Also statistics says that Jatropha cultivation has been increased gradually to a great extent in past 10 years giving a hope towards switching an alternative fuel for usage.

Jatropha oil cost around Rs. 8-10 per litre and NaOH can be used a

catalyst since the research stated the highest yield using the same in adding methanol in the ratio of 5:1. We can conclude in the aspects of raw material process economics that Jatropha Oil found to be a boon to biodiesel production.

## CONCLUSION

The following points were inferred during this study in the process economic aspects of biodiesel production:

- 1) As we are aware, Methanol can be used a alcohol in the process considering availability and low cost
- 2) Base Catalyst is preferred due to its low cost and availability
- 3) Jatropha Oil is economical for this process and can be used in biodiesel production to meet out the problems which we are going to face in our future.
- 4) Since methanol to oil ratio is low while using base catalysts, overall process cost is also low enabling the public to change their mind towards quick shift for the biodiesel usage as an alternative fuel.
- 5) Also there is no need of making quite huge modifications in engine system while implementation for practical use.
- 6) Production process in simpler proving high purity and easier separation of the components.

## REFERENCES

- Bünger, J., et al. "Cytotoxic and mutagenic effects, particle size and concentration analysis of diesel engine emissions using biodiesel and petrol diesel as fuel." Archives of toxicology 74.8 (2000): 490-498.

- Global Reports and Publications. Statistical review of world energy; June 2007.
- Birol F (2014) world energy outlook 2013–2035. Rotterdam: International Energy Agency, IEA.
- Pinto, Angelo C., et al. "Biodiesel: an overview." *Journal of the Brazilian Chemical Society* 16.6B (2005): 1313-1330.
- Van Gerpen, Jon. "Biodiesel processing and production." *Fuel processing technology* 86.10 (2005): 1097-1107.
- Atabani, Abdelaziz E., et al. "A comprehensive review on biodiesel as an alternative energy resource and its characteristics." *Renewable and sustainable energy reviews* 16.4 (2012): 2070-2093.
- Hao, Han, et al. "Biofuel for vehicle use in China: Current status, future potential and policy implications." *Renewable and Sustainable Energy Reviews* 82 (2018): 645-653.
- Oh, Pin Pin, et al. "A review on conventional technologies and emerging process intensification (PI) methods for biodiesel production." *Renewable and Sustainable Energy Reviews* 16.7 (2012): 5131-5145.
- Papu, Nabam Hina, Pradip Lingfa, and Santosh Kumar Dash. "Euglena Sanguinea algal biodiesel and its various diesel blends as diesel engine fuels: a study on the performance and emission characteristics." *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects* (2020): 1-13.
- Chauhan, Bhupendra Singh, Naveen Kumar, and Haeng Muk Cho. "A study on the performance and emission of a diesel engine fueled with Jatropha biodiesel oil and its blends." *Energy* 37.1 (2012): 616-622.
- Venkata Subbaiah, G., and K. Raja Gopal. "An experimental investigation on the performance and emission characteristics of a diesel engine fuelled with rice bran biodiesel and ethanol blends." *International Journal of Green Energy* 8.2 (2011): 197-208.
- Manigandan, S., et al. "Emission and injection characteristics of corn biodiesel blends in diesel engine." *Fuel* 235 (2019): 723-735.
- Candeia, R. A., et al. "Influence of soybean biodiesel content on basic properties of biodiesel–diesel blends." *Fuel* 88.4 (2009): 738-743.
- Aydın, Selman. "Detailed evaluation of combustion, performance and emissions of ethyl proxitol and methyl proxitol-safflower biodiesel blends in a power generator diesel engine." *Fuel* 270 (2020): 117492.
- Acharya, N., et al. "Analysis of properties and estimation of optimum blending ratio of blended mahua biodiesel." *Engineering Science and Technology, an International Journal* 20.2 (2017): 511-517.
- Ghazali, Wan Nor Maawa Wan, et al. "Effects of biodiesel from different feedstocks on engine performance and emissions: A review." *Renewable and Sustainable Energy Reviews* 51 (2015): 585-602.

- Fukuda, Hideki, Akihiko Kondo, and Hideo Noda. "Biodiesel fuel production by transesterification of oils." *Journal of bioscience and bioengineering* 92.5 (2001): 405-416.
- Ma, Fangrui, and Milford A. Hanna. "Biodiesel production: a review." *Bioresource technology* 70.1 (1999): 1-15.
- Miao, Xiaoling, Rongxiu Li, and Hongyan Yao. "Effective acid-catalyzed transesterification for biodiesel production." *Energy Conversion and Management* 50.10 (2009): 2680-2684.
- Patil, Prafulla D., Veera Gnanaswar Gude, and Shuguang Deng. "Biodiesel production from *Jatropha curcas*, waste cooking, and *Camelina sativa* oils." *Industrial & Engineering Chemistry Research* 48.24 (2009): 10850-10856.
- Patle, Dipesh S., and Zainal Ahmad. "Techno-economic analysis of an alkali catalyzed biodiesel production using waste palm oil." *Applied Mechanics and Materials*. Vol. 465. Trans Tech Publications Ltd, 2014.
- Guan, Guoqing, et al. "Transesterification of vegetable oil to biodiesel fuel using acid catalysts in the presence of dimethyl ether." *Fuel* 88.1 (2009): 81-86.
- Gebremariam, Shemelis Nigatu, and Jorge Mario Marchetti. "Biodiesel production through sulfuric acid catalyzed transesterification of acidic oil: Techno economic feasibility of different process alternatives." *Energy Conversion and Management* 174 (2018): 639-648.
- Ojolo SJ OBS, Adelaja AO, Ogbonnaya M (2011) Study of an effective technique for the production of biodiesel. *JETEAS* 2: 79–86.
- Keera ST, El Sabagh SM, Taman AR (2011) Transesterification of vegetable oil to biodiesel fuel using alkaline catalyst. *Fuel* 90: 42–47.
- Kusumaningtyas, Ratna Dewi, et al. "Synthesis of biodiesel from kapok (*Ceiba pentandra* L.) seed oil through ultrasound-enhanced transesterification reaction." *AIP Conference Proceedings*. Vol. 2217. No. 1. AIP Publishing LLC, 2020.
- Meher L, Dharmagadda VS, Naik S (2006) Optimization of alkali-catalyzed transesterification of *Pongamia pinnata* oil for production of biodiesel. *Bioresource technol* 97: 1392–1397
- Boyce ABMSHaAN (2009) Biodiesel Production from Waste Sunflower Cooking Oil as an Environmental Recycling Process and Renewable Energy. *Bulgarian J Agricul Sci* 15: 312– 317.
- Ouanji F, Kacimi M, Ziyad M, et al. (2016) Production of biodiesel at small-scale (10 L) for local power generation. *Int J Hydrogen Energ* 42: 8914–8921.
- Furuta S, Matsushashi H, Arata K (2006) Biodiesel fuel production with solid amorphous zirconia catalysis in fixed bed reactor. *Biomass Bioenerg* 30: 870–873.
- Zhu H, Wu Z, Chen Y, et al. (2006) Preparation of Biodiesel Catalyzed by Solid Super Base of Calcium Oxide and Its Refining Process. *Chinese J Catal* 27: 391–396.

- Sánchez M, Avhad MR, Marchetti JM, et al. (2016) Enhancement of the jojobyl alcohols and biodiesel production using a renewable catalyst in a pressurized reactor. *Energ Convers Manage* 126: 1047–1053.
- Zhou, Hou Bo, Yang Cao, and Jin Li. "Research of Preparation of SO<sub>4</sub><sup>2-</sup>/TiO<sub>2</sub>-ZrO<sub>2</sub> and its Application on Synthesis of Biodiesel from Waste Cooking Oil." *Applied Mechanics and Materials*. Vol. 316. Trans Tech Publications Ltd, 2013.
- Syazwani, Osman Nur, et al. "Esterification of palm fatty acid distillate (PFAD) to biodiesel using Bi-functional catalyst synthesized from waste angel wing shell (*Cyrtopleura costata*)." *Renewable Energy* 131 (2019): 187-196.
- Hindryawati, Noor, Erwin, and Gaanty Pragas Maniam. "Esterification of oil adsorbed on palm decanter cake into methyl ester using sulfonated rice husk ash as heterogeneous acid catalyst." *AIP Conference Proceedings*. Vol. 1813. No. 1. AIP Publishing LLC, 2017.
- Devanesan, M. G., T. Viruthagiri, and N. Sugumar. "Transesterification of Jatropha oil using immobilized *Pseudomonas fluorescens*." *African Journal of biotechnology* 6.21 (2007).
- Zeng, Jing, et al. "Study on the effect of cultivation parameters and pretreatment on *Rhizopus oryzae* cell-catalyzed transesterification of vegetable oils for biodiesel production." *Journal of Molecular Catalysis B: Enzymatic* 43.1-4 (2006): 15-18.
- Lopresto, C. G., et al. "Enzymatic transesterification of waste vegetable oil to produce biodiesel." *Ecotoxicology and environmental safety* 121 (2015): 229-235.
- Hama, Shinji, et al. "Biodiesel-fuel production in a packed-bed reactor using lipase- producing *Rhizopus oryzae* cells immobilized within biomass support particles." *Biochemical Engineering Journal* 34.3 (2007): 273-278.
- Li L, Du W, Liu D, et al. (2006) Lipase-catalyzed transesterification of rapeseed oils for biodiesel production with a novel organic solvent as the reaction medium. *J Mol Catal B Enzym* 43: 58–62.
- Shah, Shweta, Shweta Sharma, and M. N. Gupta. "Biodiesel preparation by lipase-catalyzed transesterification of Jatropha oil." *Energy & Fuels* 18.1 (2004): 154-159.
- Tan, Tianwei, et al. "Biodiesel production with immobilized lipase: a review." *Biotechnology advances* 28.5 (2010): 628-634.
- Kusdiana D, Saka S (2001) Kinetics of transesterification in rapeseed oil to biodiesel fuel as treated in supercritical methanol. *Fuel* 80: 693–698.
- Bunyakiat K, Makmee S, Sawangkeaw R, et al. (2006) Continuous Production of Biodiesel via Transesterification from Vegetable Oils in Supercritical Methanol. *Energ Fuel* 20: 812– 817.
- Demirbas A (2007) Biodiesel from sunflower oil in supercritical methanol with calcium oxide. *Energ Convers Manage* 48: 937–941.

- Santana A, Maçaira J, Larrayoz MA (2012) Continuous production of biodiesel using supercritical fluids: A comparative study between methanol and ethanol. *Fuel Process Technol* 102: 110–115.
- Song ES, Lim JW, Lee HS, et al. (2008) Transesterification of RBD palm oil using supercritical methanol. *J Supercrit Fluid* 44: 356–363
- Hawash S, Kamal N, Zaher F, et al. (2009) Biodiesel fuel from Jatropha oil via non-catalytic supercritical methanol transesterification. *Fuel* 88: 579–582.
- Zhang, Yujiao, et al. "Synthesis of the SrO–CaO–Al<sub>2</sub>O<sub>3</sub> trimetallic oxide catalyst for transesterification to produce biodiesel." *Renewable Energy* 168 (2021): 981-990.
- Gupta J, Agarwal M (2016) Preparation and characterization of CaO nanoparticle for biodiesel production. 2nd International Conference on Emerging Technologies. Jaipur, 302017, India: American Institute of Physics
- Tahvildari K, Anaraki YN, Fazaeli R, et al. (2015) The study of CaO and MgO heterogenic nano-catalyst coupling on transesterification reaction efficacy in the production of biodiesel from recycled cooking oil. *J Environ Health Sci Eng* 13: 73–81.
- Hu S, Guan Y, Wang Y, et al. (2011) Nano-magnetic catalyst KF/CaO–Fe<sub>3</sub>O<sub>4</sub> for biodiesel production. *Appl Energy* 88: 2685–2690.
- Wen L, Wang Y, Lu D, et al. (2010) Preparation of KF/CaO nanocatalyst and its application in biodiesel production from Chinese tallow seed oil. *Fuel* 89: 2267–2271.
- Fan P, Xing S, Wang J, et al. (2017) Sulfonated imidazolium ionic liquid-catalyzed transesterification for biodiesel synthesis. *Fuel* 188: 483–488.
- Fan, Mingming, et al. "Biodiesel production by transesterification catalyzed by an efficient choline ionic liquid catalyst." *Applied energy* 108 (2013): 333-339.
- Wu Q, Chen H, Han M, et al. (2007) Transesterification of cottonseed oil catalyzed by brønsted acidic ionic liquids. *Ind Eng Chem Res* 46: 7955–7960.
- Yanfei, He, et al. "Transesterification of soybean oil to biodiesel by brønsted-type ionic liquid acid catalysts." *Chemical Engineering & Technology* 36.9 (2013): 1559-1567.
- Ullah, Zahoor, Mohamad Azmi Bustam, and Zakaria Man. "Biodiesel production from waste cooking oil by acidic ionic liquid as a catalyst." *Renewable Energy* 77 (2015): 521-526.
- Encinar, J. M., et al. "Catalytic pyrolysis of exhausted olive oil waste." *Journal of Analytical and Applied Pyrolysis* 85.1-2 (2009): 197-203.
- Omar, Rozita, and John P. Robinson. "Conventional and microwave-assisted pyrolysis of rapeseed oil for bio-fuel production." *Journal of analytical and applied pyrolysis* 105 (2014): 131-142.
- Laksmono, Nino, et al. "Biodiesel production from biomass gasification tar via thermal/catalytic cracking." *Fuel processing technology* 106 (2013): 776-783.

- Prado, Cinara MR, and Nelson R. Antoniosi Filho. "Production and characterization of the biofuels obtained by thermal cracking and thermal catalytic cracking of vegetable oils." *Journal of Analytical and Applied Pyrolysis* 86.2 (2009): 338-347.
- Dehghani, Sahar, and Mohammad Haghighi. "Sono-sulfated zirconia nanocatalyst supported on MCM-41 for biodiesel production from sunflower oil: influence of ultrasound irradiation power on catalytic properties and performance." *Ultrasonics sonochemistry* 35 (2017): 142-151.
- Chaihad, Nichaboon, et al. "In-situ catalytic upgrading of bio-oil derived from fast pyrolysis of sunflower stalk to aromatic hydrocarbons over bifunctional Cu-loaded HZSM-5." *Journal of Analytical and Applied Pyrolysis* 155 (2021): 105079.
- Xu, Junming, et al. "Biofuel production from catalytic cracking of woody oils." *Bioresource technology* 101.14 (2010): 5586-5591.
- Attaphong, Chodchanok, and David A. Sabatini. "Phase behaviors of vegetable oil-based microemulsion fuels: the effects of temperatures, surfactants, oils, and water in ethanol." *Energy & fuels* 27.11 (2013): 6773-6780.
- Arpornpong, Noulkamol, et al. "Ethanol-in-palm oil/diesel microemulsion-based biofuel: Phase behavior, viscosity, and droplet size." *Fuel* 132 (2014): 101-106.
- Sankumgon, Akechai, et al. "Properties and performance of microemulsion fuel: blending of jatropha oil, diesel, and ethanol-surfactant." *Renewable Energy Focus* 24 (2018): 28-32.
- Patidar, Vivek, et al. "Physiochemical and phase behaviour study of jatropha curcus oil– ethanol microemulsion fuels using sorbitane fatty esters." *Int J Renewable Sustainable Energy* 3 (2014): 13-19.
- Leng, Lijian, et al. "Rhamnolipid based glycerol-in-diesel microemulsion fuel: Formation and characterization." *Fuel* 147 (2015): 76-81.
- Sharma, Mahendra Pal. "Selection of potential oils for biodiesel production." *Renewable and Sustainable Energy Reviews* 56 (2016): 1129-1138.
- Verma, Puneet, M. P. Sharma, and Gaurav Dwivedi. "Impact of alcohol on biodiesel production and properties." *Renewable and Sustainable Energy Reviews* 56 (2016): 319-333.
- Musa, Idris Atadashi. "The effects of alcohol to oil molar ratios and the type of alcohol on biodiesel production using transesterification process." *Egyptian Journal of Petroleum* 25.1 (2016): 21-31.
- Günay, M. Erdem, Lemi Türker, and N. Alper Tapan. "Significant parameters and technological advancements in biodiesel production systems." *Fuel* 250 (2019): 27-41.

Math, M. C., Sudheer Prem Kumar, and Soma V. Chetty. "Technologies for biodiesel production from used cooking oil-A review." *Energy for sustainable Development* 14.4 (2010): 339-345.

Towler, Gavin, and Ray Sinnott. *Chemical engineering design: principles, practice and economics of plant and process design*. Elsevier, 2012.

Barnwal, B. K., and M. P. Sharma. "Prospects of biodiesel production from vegetable oils in India." *Renewable and sustainable energy reviews* 9.4 (2005): 363-378.

## Appendices

**Table 1**

### Biodiesel Characteristics

S. No	Property	Observations
1	Anti-Foaming	Excellent
2	Cetane Number	45 & 70
3	Chemical Structure	Ester of fatty acids C22, C16, C12, C14 & C18.
4	Oxygen content	11%
5	Cold flow properties	Solidification become difficult to control and more rapid
6	Conductivity	500 pico S/m
7	Corrosion	Oxygen presence may contribute towards corrosion

**Table 2**

### Biodiesel Classification

Generation	Definition	Feed-stock
First	Produced from food-crop or cultivated bio-energy crops	Direct usage of wheat, sorghum etc.
Second	Produced from Non-food feedstock such as agro and forestry stocks	Residues from agro and food stock
Third	Produced from aquatic cultivated feedstock	Algae

**Table 3**

### Blending

S.NO	Biodiesel	Blender	Key Notes	References
1	E. sanguinea	Diesel	40% ES	[9]
2	Jatropha seeds	Diesel	20% JS	[10]
3	Rice bran	Ethanol	2.5 % E	[11]
4	Corn	Diesel	20% C	[12]
5	Soyabean	Diesel	20% S	[13]
6	Safflower oil	ULSD	50% B	[14]
7	Mahua fruit	Mineral diesel	30% MD	[15]

**Table 4**

### Acid Catalysed Transesterification

Raw Material	Acid Used	Yield %	References
Refined soybean oil	Trifluoroacetic acid	98.4	[19]
Jatropha curcas oil	H <sub>2</sub> SO <sub>4</sub>	95	[20]
Waste cooking oil	H <sub>2</sub> SO <sub>4</sub>	89.6	[20]
Palm oil	CH <sub>3</sub> OH-H <sub>2</sub> SO <sub>4</sub>	83.72	[21]
Corn Oil	p-toluenesulfonic acid	100	[22]
Sunflower and Soyabean oil	H <sub>2</sub> SO <sub>4</sub>	96.6	[23]



**Table 5**  
**Base Catalysed Transesterification**

Raw material	Base used	Yield%	Reference
Jatropha Oil	NaOH	95.5	[24]
Soyabean Oil	NaOH	90	[25]
Cotton seed Oil	NaOH	98.5	[25]
Ceiba pentandra oil	KOH	96.2	[26]
Karanja oil	KOH	98	[27]
Sunflower cooking oil	KOH	99.5	[28]
Waste cooking oil	KOH	93.2	[29]

**Table 6**  
**Heterogeneous Catalysed Transesterification**

Raw material	Catalyst used	Yield%	Reference
Soyabean Oil	Titanium	95	[30]
Soyabean oil	Al doped Zirconias	95	[30]
Jatropha curcas oil	Solid Super Base CaO	93	[31]
Jojoba oil	CaO	96.3	[32]
Waste Cooking Oil	SO <sub>4</sub> <sup>2-</sup> /TiO <sub>2</sub> -ZrO <sub>2</sub>	96.7	[33]
PFAD	SO <sub>4</sub> <sup>2-</sup> /TiO <sub>2</sub> -ZrO <sub>2</sub>	98.9	[34]
Decanter Cake	SO <sub>4</sub> <sup>2-</sup> /TiO <sub>2</sub> -ZrO <sub>2</sub>	91	[35]

**Table 7**  
**Lipase Catalysed Transesterification**

Raw material	Catalyst used	Yield%	Reference
Jatropha oil	Pseudomonas fluorescens	72	[36]
Virgin Oil	Rhizopus oryzae	75	[37]
Waste vegetable oil	Rhizopus oryzae	80	[38]
Soyabean Oil	Rhizopus oryzae	92	[39]
Rapeseed Oil	Lipozyme TL	95	[40]
Jatropha Oil	Chromobacterium viscosum	71	[41]
Soyabean Oil	Candida antarctica	80	[42]

**Table 8**  
**Supercritical Catalysed Transesterification**

Raw material	Optimum Conditions	Yield%	Reference
Rapeseed Oil	350°C & 14 MPa	95	[43]
Coconut Oil	350°C & 19 MPa	95	[44]
Palm Kernel Oil	350°C & 19 MPa	96	[44]
Sunflower seed oil	252°C & 24 MPa	95	[45]
Vegetable Oil	200°C & 20 MPa	80	[46]
RBD Palm oil	350°C & 40 MPa	95	[47]
Jatropha Oil	320°C & 8.4 MPa	100	[48]

**Table 9**  
**Nano Catalysed Transesterification**

Raw material	Catalyst used	Yield%	Reference
Palm Oil	SrO–CaO–Al <sub>2</sub> O <sub>3</sub>	98.16	[49]
Soyabean Oil	CaO/CaN	93	[50]
Soyabean Oil	CaO/SS	96	[50]
Waste Cooking Oil	CaO	94.4	[51]
Waste Cooking Oil	CaO & MgO	98.95	[51]
Stillingia oil	KF/CaO–Fe <sub>3</sub> O <sub>4</sub>	95	[52]
Chinese tallow seed oil	KF/CaO	96.8	[53]

**Table 10**  
**Ionic Catalysed Transesterification**

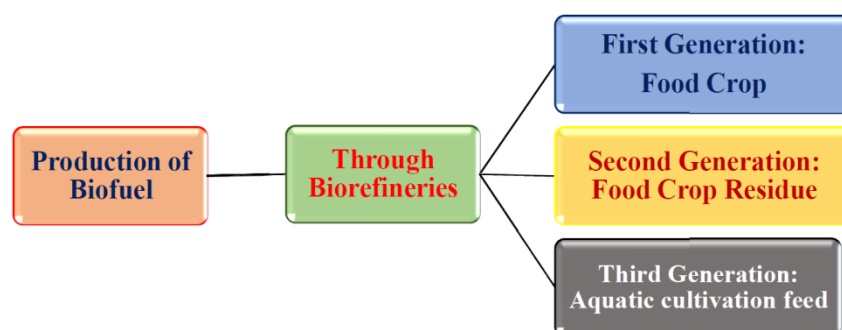
Raw Material	Catalyst Used	Yield %	Reference
Rapeseed oil	1-butyl-3-methylimidazolium hydrogen sulfate	8.89	[54]
Soyabean Oil	Chloroaluminate	98.5	[55]
Cottonseed Oil	1-(4-Sulfonic acid) butylpyridinium hydrogen sulfate	92	[56]
Rapeseed oil	1-butylsulfonate-3-methyl imidazolium hydrogen sulfate	100	[54]
Soyabean Oil	Brønsted acidic ionic liquid	93.2	[57]
Waste Palm Cooking Oil	butyl-methyl imidazolium hydrogensulfate	95.7	[58]

**Table 11**  
**Thermal Cracking/Pyrolysis**

Raw Material	Catalyst Used	Yield %	Reference
Waste olive oil	Dolomite	93	[59]
Rapeseed oil	ZSM-5	95	[60]
Biomass tar	ZSM-5	75.56	[61]
Soybean oil	Bauxite	93	[62]
Vegetables oil	Sulfated zirconia	97.08	[63]
Sunflower oil	HZSM-5	83.13	[64]
Woody oil	Al <sub>2</sub> O <sub>3</sub> /MCM-41/CaO	90.1	[65]

**Table 12**  
**Micro emulsions**

S.No	Micro-emulsions	Reference
1	Ethanol – Vegetable Oil - Carboxylate	[66]
2	Ethanol – Palm Oil - Diesel	[67]
3	Ethanol – Jatropha Oil – Diesel	[68]
4	Ethanol – Jatropha Oil – Sorbitane Fatty esters	[69]
5	Rhamnolipid – Crude Glycerine - Diesel	[70]



**Figure 1: Classification of Biodiesel**

# Gesture Controlled AI-Robot Using Kinect

<b>Jayasurya B,</b>	<b>Jino Justin,</b>	<b>Kharat Pooja C,</b>	<b>Mrutyunjay A,</b>	<b>A Hasaraddi,</b>	<b>Dr. T Kavitha</b>
Dept. of Electronics and Communication Engineering AMC Engineering College Bengaluru,India	Dept. of Electronics and Communication Engineering AMC Engineering College Bengaluru,India	Dept. of Electronics and Communication Engineering AMC Engineering College Bengaluru,India	Dept. of Electronics and Communication Engineering AMC Engineering College Bengaluru,India	Dept. of Electronics and Communication Engineering AMC Engineering College Bengaluru,India	Dept. of Electronics and Communication Engineering AMC Engineering College Bengaluru,India

## Abstract

Gesture recognition for human computer interaction is an area of active research in artificial intelligence and computer vision. To estimate gesture recognition performance in a real-life environment, we collect the gesture data that takes into account cluttered backgrounds, various poses and movement of robots, and then we evaluate the performance of robot. This involves skeleton tracking, where the skeleton data is produced from the depth images obtained via Microsoft Kinect sensor. The human gestures in 3 D space is captured by the kinect processed and replicated by the robot. An Arduino controller is used to govern the motion of robot which takes the input as joint angles from the kinect sensor and feeds it back to robot circuit and thus controls the robot actions. The primary goal of gesture recognition research is to create a system, which can identify specific human gestures and use them for device control. The gesture control robot will save huge cost of labour in future. The basic advantage of this robot is that it will be cost effective and no remote control is required.

**Keywords:** *Gesture, kinect, robotic movements.*

## INTRODUCTION

Gestures are visible body actions used for non-verbal communications to convey important messages. Gesture recognition is a technology for the extraction of human's meaningful expressions with mathematical interpretations through computing devices.

Gestures are usually divided into two types: static and dynamic gestures. A static gesture is a steady posture, represented by a single image which is captured. A dynamic gesture is a moving gesture, represented by a sequence of various images which are captured continuously. Algorithms on static gesture recognition have developed rapidly in recent years, such as gesture recognition based on artificial neural network and computer vision. However, simple static gesture cannot meet the requirements of the industry application and methods on dynamic gesture recognition have become

a focus in the area of research instead. Owing to the diversity and complexity of gestures and flexible positions and shapes of hands, it makes gesture recognition a multi-discipline and challenging project.

Human-Computer-Interaction technology has become very important over the last years. The desire to provide a natural interaction between humans and machines has become a focus on gesture recognition. With the development of computer vision technology and depth cameras, the ways people interact with the electrical devices are being improved. In this project, Microsoft Kinect sensor is applied in a remote robot control system to recognize different gestures and generate visual Human-Robot interaction interface without calculating complex inverse kinematics to make the robot follow the posture of human. This kind of system aims to enrich the interactive way between human and robots which help

non-expert users to control the robot freely, making human-robot interaction much easier.

### RELATED WORKS

Gesture Recognition or Sign Language Recognition (SLR) has been studied for decades since human computer interaction stepped into people's lives. Computational interpretation and translation systems can facilitate daily communication for speech and hearing challenged people. Understanding the structure of sign languages is the starting point to further solve the problems in developing hand motion tracking method. Literature on SLR, especially about 2D video-based recognition, is reviewed in Section 2.2.1

Studies aiming at tracking information of hands, including shape, position, and motion, can be traced back to the 1970's. Optical, magnetic, or acoustic sensing devices were attached to hands to report their positions. Later on, a glove-based system was described and implemented, which became a common and matured approach in the field of hand tracking. Throughout the past 20 years, a large variety of glove devices as input media for HCI have been built, of which some have remained in research labs and others have reached the marketplace. Literature about recent glove-based hand tracking research is reviewed in Section 2.2.2.

A more recent technology for gesture recognition is to incorporate the information of object distances, or depths, normally captured by a 3D camera, or a set of cameras that produce 3D images. It is also a contact-less user interface, in contrast to glove-based devices or handheld remote sensors. Different algorithms are proposed to separate objects from the background and to extract features of the objects, such as the body skeleton or hands, in order to track

their motion. Literature related to depth-based recognition is reviewed in Section 2.2.3.

Some researchers were done with Kinect since its first launch in 2010. Among them there are several systems focusing on hand gesture recognition, most of which were making use of depth-based techniques. Literature about most related work on using Kinect is reviewed in Section 2.2.4.

#### A. Sign Language Recognition

Starner et al. presented two vision-based SLR systems using hidden Markov models (HMM): one used a second-person view with a desk mounted camera and the other was the first-person view with a camera mounted on a hat worn by the user. HMM was used for training and continuous motion tracking. Both systems used a skin color matching algorithm for hand tracking. Once a pixel of skin color was found. They checked the eight nearest pixels to search for similar color areas. The facial area was discounted based on the assumption that its position is almost fixed while hands are always moving. They were not able to separate two hands when they overlap each other due to the 2D video limitation. Therefore, they simply assigned the whole area to each hand whenever occlusion happened. Both systems were trained to recognize American Sign Language (ASL) sentences randomly chosen from the form of "personal pronoun, verb, noun, adjective, (the same) personal pronoun" for a 40-word lexicon; four hundred sentences were used for training and one hundred sentences were used for testing. In comparison, the second-person view system had a word accuracy of 92% while the first-person view system had a word accuracy of 98%. The high accuracy indicated that HMM is good for the purpose of continuous motion tracking. However, neither of these two systems

has provided a feedback view for the signer himself. In addition, there is no good solution to compensate for head and hand rotations, especially for the first-person view system, in which the rotation of the head may significantly affect the quality of recognition. As lexicon grows large, it requires defining and extracting additional features to maintain the accuracy. Furthermore, no finger-spelling recognition was attempted in this project.

### **B. Glove-Based Gesture Recognition**

Kenn *et al.* came up with a way to integrate glove-based devices into multiple applications with the help of a context framework. The textile glove with integrated electronic device was cool in appearance, and was able to perform in at least three applications as demonstrated: to move/zoom/select parts of a map, to navigate to a remote control in presentation, and to direct a toy robot to move left/right, forward/backward. Gestures were chosen to be simple but sufficient in interacting with applications. One problem was that this device can only detect gestures in the X and Y axes, without the ability to detect motion in the Z axis such as the so-called "yaw". In addition to achieve wearability, light weight, and cool appearance, the accuracy of recognition was sacrificed.

The glove systems described so far mainly work with information. However, real life applications involve gestures in the 3D space. More recently, the trend of glove-based systems is pointing to 3D recognition and the reduction of price without sacrificing accuracy.

Kim *et al.* Developed a 3D hand motion tracking and gesture recognition system using a data glove called KHU-I. The data glove interacted with a PC via a Bluetooth device. It successfully performed hand motion tracking such as fist clenching, hand stretching and bending. A rule-based algorithm was used

in simple HGR at two different angular positions: horizontal and vertical. Three gestures (scissor, rock, and paper) were tested with an accuracy of 100% for 50 trials each. The recognition in 3D and the wireless transmission were good improvements, but they incurred time delay. However, the tested gestures were too simple and too few to prove the robustness of this system.

### **C. Gesture Recognition using Depth data**

Van den Bergh *et al.* used a ToF camera instead of stereoscopic cameras to enhance recognition. A ToF camera with a low resolution (176 x 144 pixels) was used to get depth image for segmentation, and it was paired with an RGB camera with a high resolution (640 x 480 pixels) for hand detection. The ToF camera and RGB camera were calibrated at the beginning, and a threshold distance was defined to discard background images according to the depth data. The remaining pixels were passed through a skin color detection to get hand data. The skin color used for detection was decided by a pre-trained, adaptive skin color model, which was updated with color information taken from the face. Three situations were evaluated in hand detection: the hand was next to the face, the hand overlapped with the face, and a second person was behind the tester. Depth-based detection achieved more than 98% accuracy in all three situations, while the accuracy of color-based detection decreased dramatically from 92% of the first situation to 19.8% of the third situation. Average Neighborhood Margin Maximization transformation was used to build the classifier for gesture recognition, where the Haarlet coefficients were calculated to match hand gestures stored in a database. The RGB-based recognition showed an accuracy of 99.54%, and the depth-based recognition

showed an accuracy of 99.07%, while the combination of the two methods showed 99.54%. This suggests that depth-based recognition may be good enough to form the basis of a recognition system especially in hand segmentation.

#### **D. Most related work using Kinect**

After the launch of Microsoft Kinect in November 2010, several exciting recognition systems based on this device were developed in less than 18 months. The resolution of its RGB camera and depth camera are both 640 x 480 pixels, which are fairly sufficient under many situations.

Yang *et al.* proposed a gesture recognition system using depth information provided by Kinect, and implemented in a media player application. It was able to recognize eight gestures to control the media player, with a maximum confusion rate of 8.0%. The algorithm for hand tracking is to first find the hand waving motion based on the assumption that a user tends to start an interaction session with such a motion. A continuously adaptive mean shift algorithm was applied to track the hand by using the depth probability and updating the depth histogram at each frame. The hand trajectory was examined by a 3D feature vector, and the gesture was recognized by an HMM. This system demonstrates the applicability of using Kinect for gesture recognition in a contact-less UI.

### **DESIGN AND METHODOLOGY**

Gesture recognition refers to the positioning of certain characteristic motions of the human body, target detection, extraction, recognition and tracking, and obtaining the state of human motion such as position, velocity and motion trajectory, thereby completing processing and analysis, and obtaining a certain amount of Valuable practical

parameters to achieve automatic processing and analysis of human motion to complete the task of motion tracking, and apply to other aspects. This chapter consists of overall block diagram of our project work and the design flowchart. This system uses the Kinect visual image sensor to identify human bone data and complete the recognition of the operator's movements. Through the filtering process of real-time data by the host computer platform with computer software as the core, the algorithm is programmed to realize the conversion from data to control signals. The system transmits the signal to the lower computer platform with microcontroller as the core through the transmission mode of the wireless communication, thereby completing the control of the robot. The block diagram includes process like Input Gestures, Kinect, Skeleton Tracking, wireless communication module, hardware processing module and finally Robot control module. The respective flowchart of both transmitter and receiver side is also included, along with its stepwise explanation. The different methods and technologies used in our project of controlling a robot wirelessly through gesture recognition is also mentioned and explained in the following section.

#### **E. Block diagram**

Figure describes the parts of the project in the form of block diagram. The overall block diagram of the control system consists of four main parts: A visual image processing sensor (input gestures & Kinect), a skeletal tracker, a hardware processor, and a robotic control platform (executive component). The sensor used here is Kinect visual image processing sensor, the data processor/skeleton tracking is controlled by computer platform, the hardware processor is completed by Microcontroller and related electronic modules, and the

robotic control platform completes the actually expected action. The computer platform receives the real-time joint state and information returned from the Kinect visual image sensor in real time, and transmits it to the computer in the form of data stream. The data is processed in real time by the programmed algorithm, and then sent to the lower computer microcontroller in real time by wireless communication also can display the real-time joint angle in the software operation interface if needed.

- Gestures are given as input commands by the user. The body movements of the user are captured using the Kinect sensor, which consists of a depth sensor and RGB camera, obtains the skeletal data from the user. The information is acquired in the form of positions of the various joints using the 3 dimensional Cartesian co-ordinate spaces.
- The captured image data is sent serially through the USB port to a computer machine where the captured skeleton is displayed and the co-ordinates of the joints are processed. Processing of the gestures requires a program compatible with the Software Development Kit (SDK) of the Kinect. Thus the skeleton tracking is done. Using mathematical calculation, it calculates the angle deviation between the different joints based on the movements.
- After the recognition of the gestures is completed, the data is processed in real time by the programmed algorithm and the corresponding angle deviation data measured by the Kinect sensor is transmitted from the computer to the robot through any wireless transmitter. In this project we are using Bluetooth for

this operation. The use of the wireless communication module will increase mobility.

- The transmitted data is received in the buffer of the Bluetooth module connected to the robot and given to microcontroller for further processing.
- The received information of the gesture via Bluetooth is processed in the microcontroller for various tasks to perform in real time. We are using Arduino board for performing this operation which will convert the received angle deviations values and generates the equivalent PWM. Thus the robotic control platform completes the actually expected action.

## F. Methodology

Our system is divided into two sections: Transmitter and Receiver section. Fig 1(a) is a flowchart for Transmitter section (Gesture recognition) and Fig 1(b) Receiver section (Robot control). After the start, the initialization object operation is needed to determine the tracking target, open the sensor, and start collecting the depth data and joint data using Kinect's image acquisition function. After filtering, display current image and data information in the software operation interface.

### 1) Transmitter section

*a) Data Acquisition:* In the data acquisition process, the gestures are captured in the form of video. The user has to stand in front of the device that is used to capture the input. Here Microsoft Kinect is used as an input capturing device. The Kinect can capture the RGB data as well as depth data. Using the Kinect sensor's visual perception technology, in principle, it automatically tracks the human joints within the target range before output, and displays a real-



time dynamic map showing the position of the human joint. The coordinates acquired by Kinect's depth data acquisition are depth image coordinates, but in order to make the human motion vector calculation in the actual realistic three-dimensional coordinates, it is necessary to pre-process the data, complete the coordinate conversion, and thus calculate the subsequent joint angle

**b) Skeleton Tracking:** The significant innovation in Kinect is its skeleton tracking ability. The sensor can elegantly track the skeleton of the person standing in front of it. Locate and trace person's major joints and provide helpful content of its locations which can be processed by computer. This is done by the sensor in following manner:

**i) Depth sensor:** The depth sensor is a combination of IR projector (laser) and IR camera. Depth values are coded in gray values the closer the object the darker will be its depth image pixels. The objects distance from the sensor is flawlessly coded into gray values depending on the time taken by the IR lights to return back to the sensor.

**ii) Joint Tracking:** The joints are classified it to various categories like (head, hand, neck, shoulder etc.). The sensor in all track 20 major joints of human body. These joints are effectively located by the sensor and tracked continuously. Based on the coordinates of the joints a vector is drawn between two joints which represent the bone of a skeleton. The combination of the joints and vectors is represented as the skeleton of the user. The joints are interconnected to obtain the person's skeleton. This result is optimized by tracking the joints at a rate of 5ms per frame. The sensor also provides the 3-D co-ordinates of the tracked joints.

**c) Feature extraction:** Once we have the skeleton data of the user, we use

basic trigonometric functions to calculate the angle between the vectors. The algorithm of the system is based on the feature recognition of the target operator's joints, and the depth coordinates are converted into three-dimensional real coordinates, thereby utilizing the nature of the space vector and the relative position between different joints to calculate the inter-bones. The angle, so that the computer completes the processing of the data returned by the Kinect sensor and sends out real-time control signals.

**d) Data Filtering:** Because Kinect has a fast refresh rate of 30 frames/s, it may cause the coordinates to change continuously during the same minute time period in the bone recognition process. Therefore, some means are needed to process the data collected in real time. This process is called "data filtering". In order to reduce the negative stability of its calculation, we adopt the average method which is easier to implement. We continuously use a fixed set of N real-time values as a set of data once, arranged in group, the group leader is fixed to N unchanged, the new data at the next moment is stored in the end of the group, and the data at the head of the group is removed, and so on, so that different values at different times are obtained, and the N data in the obtained group are taken average value. You can expect a more stable result.

$$y_k = \sum_{j=m}^n p_i y_{k+j}$$

$$k = m+1, m+2, \dots, N-n$$

In the formula, pi is the weight coefficient, and  $\sum_{i=m}^n p_i = 1$ , the system goes to  $n = 10$ , that is, every 10 sets of data is processed as a group,  $m = 0$ ,  $n = 9$ , the first 10 data from the above formula cannot participate in the calculation, because it can measure 30

times per second, there will be 30 sets of data within 1 second, that is  $y_1 - y_{20}$  are valid. Every 10 numbers take the arithmetic mean to get 2 data, and finally 2 data values are returned. By averaging the joints corresponding to the degrees of freedom, actual three-dimensional coordinate values of the groups returned within each second can be obtained.

**e) Angular Feature Calculation:**

After the filtered stable value is obtained, the angular feature calculation can be performed. For example, if a system operates with only 4 bones of one of the identified bones. First, the vector between the four bones is obtained from the actual three-dimensional coordinates, and a total of three sets of vector values are obtained,  $\vec{a}, \vec{b}, \vec{c}$ . According to the correspondence, the shoulder angle is,  $\theta = \langle \vec{a}, \vec{b} \rangle$ . The elbow angle is,  $\beta = \langle \vec{b}, \vec{c} \rangle$  using these actual vectors to map the angular features.

Therefore, the angle is the angle characteristic value of the current two bones. Based on this, it can be extended to 20 bone recognitions of the human body. The angle between any two bones joint can be extracted. This identification method has a series of benefits, which not only is only operability and also eliminates interference from disturbances such as lighting, background and operator position. In summary, in order to obtain accurate and stable target return value, a large amount of real-time data must be filtered to improve system performance and reduce fault tolerance.

**f) Wireless Serial Transmitter:**

Once we have the angle deviation values, we transfer the angle deviation through wireless communication module to receiver side. The wireless communication module allows us to increase the mobility

of the robots by eliminating the connection of the robot to the computer. On the receiver side, we use the data uploaded through the wireless communication module to control the robot actions.

**2) Receiver section**

**a) Wireless Serial Receiver:** The wireless receiver will fetch the data from the wireless transmitter module. The receiver is linked to the robot's control system.

**b) Processing of the data received using microcontroller:** The programming of robot flows the similar way as that of Kinect sensor. Fig. 4 shows the flow chart of the same. The robot when initialized, the Bluetooth module scans for the devices for connection from the remote computer machine. Once the connection between the two is established, the gesture information is received to the microcontroller. The microcontroller processes the received data and scans for the relevant operation to be performed. If the received information is for motion of the robot, the corresponding PWM signals are generated.

**c) Generation of PWM signals:** The PWM signals are Pulse Width Modulated Signals. They are analog signals generated from a digital source. If the PWM signals generated belong to the motor control, the received angles are first quantized and then the axel rotation of the motors takes place and the robot follows the commands of the user. The magnitude of the voltage determines the speed of the motor, and positive and negative represent the steering of the motor. When the voltage difference is 0, the motor stop rotating. The PWM square wave is the control signal of the robot, and the transient characteristics of the duty cycle are used to change the rotational characteristics of the robot. There's a provision for obstacle detection too using the ultrasonic sensor. It protects the robot

from getting damaged by continuously monitoring its environment and maintaining safe distance.

**d) Control operations of the robot:**

Robot can be controlled by simple gestures. The movements are processed by the computer in real-time and appropriate gesture is identified from the predefined feed.

**e) Motion Control:** In this project, we are designing a wheeled robot with four way motion. The robot is made self-equipped with collision detection. Furthermore we even make it more practical and portable by implementing it wirelessly using Bluetooth. However the use of 3Dimensional Gesture recognition used to operate the robot makes extremely easy to use. Any person can easily operate this robot on their own. The robot uses the microcontroller as the main controller, and completes the PWM square wave control of the robot motors. Before starting the start-up, the actual wireless connection is performed. Under different background environments and light intensities, identify the same actions of the operators and complete the corresponding requirements. The method to verify system stability and accuracy. The motors which are attached to the robot wheel control the further action of the robot. The primary work of this project is to create a user-friendly interface that recognizes different kind of gestures performed by the user. So, here are defined five types of gestures that should be associated with the robot movements. One of them is combined gesture; it means that it is combination of two different gestures associated with one robot movement. These kinds of gestures are as follows,

- Right Hand Vertical up, which is associated with movements of the robot for moving forward

- Right Hand Horizontal up is associated with the movements of the robot for moving on the right
- Left Hand Horizontal up is associated with the movements of the robot for moving on the left
- Left Hand Vertical up associated with the movements of the robots for moving its motors backward
- Both hands down means that robot does not move in any direction.

## EXPERIMENTAL RESULTS

The experimental results prove that our system has a good performance for recognizing gestures. Our system defines recognizable gestures strictly. When the tested gesture is not in standard, this gesture may not be recognized. In addition, our system sets the time between two consecutive gesture recognition must be more than 0.5 seconds. If the gestures are made frequently, they may not be recognized correctly. In summary, four dynamic gestures' recognition is as follows:

- 1) Right Hand vertically Up, which is associated with movements of the robot for moving forward.
- 2) Right Hand Horizontally Up is associated with the movements of the robot for moving on the right.
- 3) Left Hand Vertically Up is associated with the movements of the robots for moving its motors backward
- 4) Both hands down means that robot does not move in any direction.

After assembling and implementing the hardware components, the final output transmitter and receiver side would look like as shown in the Figure 4.

So, the overall project is viewed and thus it gives the expected results (i.e.) for the pre-defined gestures to produce

specific robotic movements .Figure 5 (a) and (b) shows the snapshot of the project, where the robot is interacting to the human's gesture.

### CONCLUSION

In this paper we have used a Kinect device for building a system that recognizes upper body gestures and then associates these gestures to the robot movements. The developed system can be referred as the application of human machine interface. The important part in our project is the skeletal tracking; this makes the human robot interaction more effective and innovative. The experimental results show that the proposed human motion capture system can achieve stable human motion measurement, which can meet the needs of human-robot collaboration scenarios. This interactive way between human and robots helps new users to control the robot freely, making human robot interaction much easier.

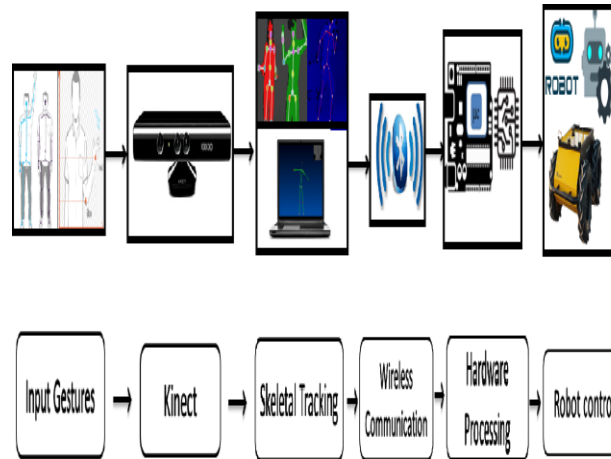
Our future work will be carried out to design more robust and efficient algorithms to recognize bi-manual gestures. Besides, more gestures will be defined, which will make our system more practical. After developing a mature method, we plan to connect the system with intelligent appliances in houses and make it easier to control the appliances. Not only for home automation, it can be further improved to design a system for industrial purpose too.

### REFERENCES

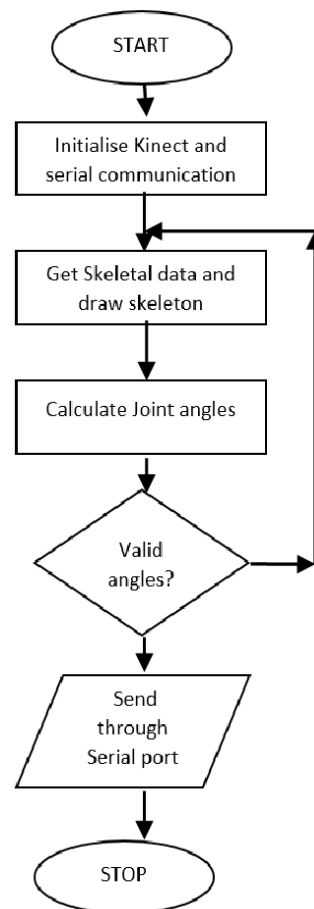
- M. Cho and Y. Jeong, "**Human gesture recognition performance evaluation for service robots**," 2017 19<sup>th</sup> International Conference on Advanced Communication Technology (ICACT), Bongpyeong, 2017, pp. 847-851, doi: 10.23919/ICACT.2017.7890213.
- Y. Liu, M. Dong, S. Bi, Dakui Gao, Y. Jing and L. Li, "**Gesture recognition based on Kinect**," 2016 IEEE International Conference on Cyber Technology in Automation, Control, and Intelligent Systems (CYBER), Chengdu, 2016, pp. 343-347, doi: 10.1109/CYBER.2016.7574847.
- D. Maraj, A. Maraj and A. Hajzeraj, "**Application interface for gesture recognition with Kinect sensor**," 2016 IEEE International Conference on Knowledge Engineering and Applications (ICKEA), Singapore, 2016, pp. 98-102, doi: 10.1109/ICKEA.2016.7803000.
- E. Yavşan and A. Uçar, "**Teaching human gestures to humanoid robots by using Kinect sensor**," 2015 23rd Signal Processing and Communications Applications Conference (SIU), Malatya, 2015, pp. 1208-1211, doi: 10.1109/SIU.2015.7130053.
- Y. GU, H. Do, Y. Ou and W. Sheng, "**Human gesture recognition through a Kinect sensor**," 2012 IEEE International Conference on Robotics and Biomimetic (ROBIO), Guangzhou, 2012, pp. 1379-1384, doi: 10.1109/ROBIO.2012.6491161.
- T. Starner, J. Weaver and A. Pentland, "**Real-time American sign language recognition using desk and wearable computer based video**," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 20, no. 12, pp. 1371-1375, Dec. 1998, doi: 10.1109/34.735811.
- H. Kenn, F. V. Megen and R. Sugar, "**A glove-based gesture interface for wearable computing**

- applications,"** 4th International Forum on Applied Wearable Computing 2007, Tel Aviv, Israel, 2007, pp. 1-10.
- C. Yang, Yujeong Jang, J. Beh, D. Han and H. Ko, "**Gesture recognition using depth-based hand tracking for contactless controller application,**" 2012 IEEE International Conference on Consumer Electronics (ICCE), Las Vegas, NV, 2012, pp. 297-298, doi: 10.1109/ICCE.2012.6161876.
- J. Kim, N. D. Thang and T. Kim, "**3-D hand motion tracking and gesture recognition using a data glove,**" 2009 IEEE International Symposium on Industrial Electronics, Seoul, 2009, pp. 1013-1018, doi: 10.1109/ISIE.2009.5221998.
- Guan-Feng He, Sun-Kyung Kang, Won-Chang Song and Sung-Tae Jung, "**Real-time gesture recognition using 3D depth camera,**" 2011 IEEE 2nd International Conference on Software Engineering and Service Science, Beijing, 2011, pp. 187-190, doi: 10.1109/ICSESS.2011.5982286.
- J. L. Hernandez-Rebollar, R. W. Lindeman and N. Kyriakopoulos, "**A multi-class pattern recognition system for practical finger spelling translation,**" Proceedings. Fourth IEEE International Conference on Multimodal Interfaces, Pittsburgh, PA, USA, 2002, pp. 185-190, doi: 10.1109/ICMI.2002.1166990.
- Han J., Jang W., Jung D., Lee E.C. (2017), "**Human Robot Interaction Method by Using Hand Gesture Recognition**". In: Park J., Chen SC., Raymond Choo KK. (eds) Advanced Multimedia and Ubiquitous Engineering. FutureTech 2017, MUE 2017. Lecture Notes in Electrical Engineering, vol 448. Springer, Singapore.  
[https://doi.org/10.1007/978-981-10-5041-1\\_17](https://doi.org/10.1007/978-981-10-5041-1_17)
- Cekova, Katerina & Koceska, Natasa & Koceski, Saso. (2016). "**Gesture Control of a Mobile Robot using Kinect Sensor**". International Conference On Applied Internet And Information Technologies. doi:251-258.  
10.20544/AIIT2016.31.
- Ahmad, Abdel-Mehsen & Bazzal, Zouhair & Al Youssef, Hiba. (2017). "**Kinect-Based Moving Human Tracking System with Obstacle Avoidance**". Advances in Science, Technology and Engineering Systems Journal. Doi:2. 191-197.  
10.25046/aj020325.
- J. A. Tumialán Borja, E. Bernal Alzate and D. L. Mariño Lizarazo, "**Motion control of a mobile robot using kinect sensor,**" 2017 IEEE 3rd Colombian Conference on Automatic Control (CCAC), Cartagena, 2017, pp. 1-6, Doi: 10.1109/CCAC.2017.8276474.
- Monika Jain, Aditi, Ashwani Lohiya, Mohammad Fahad Khan, Abhishek Maurya, "**Wireless Gesture Control Robot: An Analysis**", International Journal of Advanced Research in Computer and Communication Engineering Vol. 1, Issue 10, December 2012.
- Love Aggarwal, Varnika Gaur, Puneet Verma, "**Design and Implementation of a Wireless Gesture Controlled Robotic Arm with Vision**", International Journal of Computer Applications (0975 – 8887) Volume 79 – No 13, October 2013.
- Harish Kumar Kaura, Vipul Honrao, Sayali Patil, Pravish Shetty, "**Gesture**

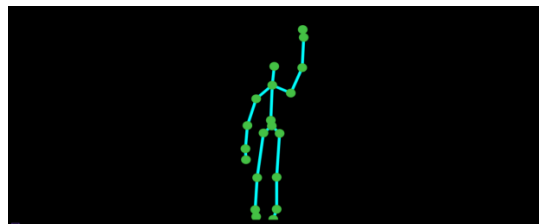
- Controlled Robot using Image Processing**", International Journal of Advanced Research in Artificial Intelligence, Vol. 2, No. 5, 2013.
- Mohammed A. Hussein, Ahmed S. Ali, F.A. Elmisery, R. Mostafa, "**Motion Control of Robot by using Kinect Sensor**", Research Journal of Applied Sciences, Engineering and Technology 8(11): 1384-1388, 2014 ISSN: 2040- 7459; e-ISSN: 2040-7467
- Swati A. Deshmukh, Karishma A. Matte, Rashmi A. Pandhare, "**Wireless Fire Fighting Robot**", International Journal For Research In Emerging Science And Technology Volume-2, Special Issue-1, March-2015.
- Ankit Multanmal Oswal, Gagan Shivarama Shetty, Mridul Anil Hiwarkar, Sanjeev Kumar Malik, Mrs. Hemangi Shinde, "**REAL - TIME ROBOT CAR CONTROL USING HAND SIGN RECOGNITION** ", International Journal For Technological Research In Engineering Volume 1, Issue 8, April-2014.
- K.R. Konda, A. Königs, H. Schulz, D. Schulz, "**Real time interaction with mobile robots using hand gestures**", in: Proc. of the 7th ACM/IEEE International Conference on Human-Robot Interaction, Boston, USA, 2012, pp. 177–178.



**Figure 1: Block diagram**



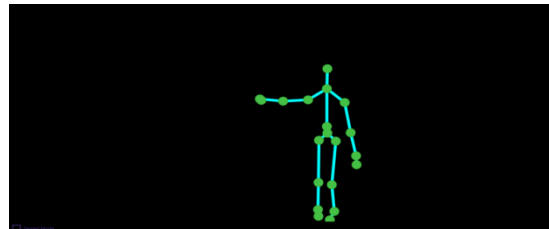
**Fig 2: Flow chart for data processing in receiver side.**



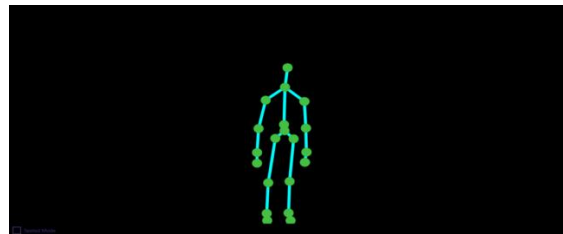
**Figure 3(a): Gesture for the robot to move forward**



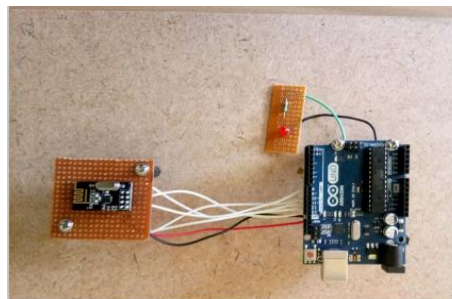
**Figure 3(b): Gesture for the robot to turn right**



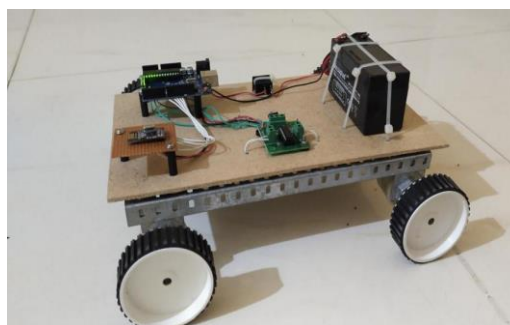
**Figure 3(c): Gesture for the robot to move backward**



**Figure 3(d): Gesture for the robot to stop**



**Figure 4(a): Final Hardware transmitter**



**Figure 4(b): Final Hardware receiver (wheeled robot).**



(a)



(b)



**Figure 5: A snapshots of the working project model**

# ECG Watermarking Technique for Telemedicine Applications using Deep Learning

Busharath P V

Department of Electronics and Communication  
Engineering  
NSS College of Engineering, Palakkad  
Kerala, India

Nandakumar Paramparambath

Department of Electronics and Communication  
Engineering  
NSS College of Engineering, Palakkad  
Kerala, India

## Abstract

The telemedicine sector is rapidly transforming medical facilities; it starts with simple duties like appointment scheduling and progresses to more difficult tasks like diagnosis and surgery. A large volume of patient data is transmitted via the internet in the telemedicine industry. It is critical to protect the integrity and security of medical data in such a situation. The use of digital watermarking to ensure the authenticity and integrity of medical information is a promising method. Authenticity refers to the ability to trace information back to its source and demonstrate that the data belongs to the correct patient. Integrity refers to the ability to confirm that data has not been tampered without permission. A high-capacity reversible data concealing mechanism is presented in this paper. Deep neural networks are employed in the suggested approach for better error prediction, and prediction error expansion (PEE) is integrated with it to assure reversibility. Percentage residual difference (PRD), signal to noise ratio (SNR), normalized cross correlation (NCC), tamper detection rate (TDR), false positive rate (FPR), and false negative rate (FNR) are used to assess the performance of the planned work. The significant contribution of the proposed work is the multipurpose features of ECG watermarking scheme like ownership detection, tamper detection, and tamper localization. The addition of a threshold increases the quality of watermarked signals while also allowing for bps management.

**Keywords:** Telemedicine, Digital Watermarking, Integrity, Authenticity, ANN.

## INTRODUCTION

Conventional diagnosis has generally moved to a technology-enabled e-diagnostic as a result of the exponential expansion of current technologies in the areas of communication and computer networks. Medical image transmission between hospitals in different locations and administrative organizations has become common practise for a variety of reasons, including diagnosis, treatment, distance learning, training, clinician teleconferences, and medical consultation between physicians and radiologists [1].

Medical data security is a major concern in the telemedicine sector [2]. Acts and laws such as HIPAA (Health Insurance Portability and Accountability Act of the United States) exist to ensure that medical data is protected and secure. Even in the

presence of such legislation, there is a risk that medical data will be compromised owing to a variety of factors such as noise, hacking, data corruption, and so on. Technology plays an essential part in the management of health-care services; hospitals are also equipped with a hospital information system (HIS), a network-based management system that ensures that hospitals run smoothly. Patient information is also available in the form of an electronic patient record (EPR) [3]. The patient's medical history and numerous medical reports are contained in the EPR. All of these technology improvements make healthcare more accessible, but they also raise concerns about medical data security.

Medical information security requirements are primarily drawn from

legal rules and strict security policies that professionals and concerned patients must adhere to [4]. This necessitates three requirements: confidentiality, dependability, and availability. Only permitted personnel have access to the data in routinely planned scenarios, according to confidentiality. The concept of reliability can be broken down into two parts: 1) Integrity, which ensures that the data hasn't been altered with; and 2) Authentication, which verifies that the data belongs to the correct patient and comes from a reliable source. Authorized users capacity to use the information system in regularly scheduled access and practice situations is referred to as availability [5].

Watermarking can be seen as a viable alternative in this circumstance for enhancing the security of medical data. As previously stated, watermarking is applied to many multimedia signals for a variety of objectives. The data of a patient can be used as a watermark to secure medical signals. In the telemedicine industry, patient data concealing is quite useful since it accomplishes two goals. First, the signal conceals the patient's personal information; second, it serves as a watermark and aids in the verification of the signal's integrity. A separate signal called a watermark is placed in the original signal during watermarking. Depending on the technique, this watermark can be used to determine ownership or identify signal tampering. When a watermark's sole function is to authenticate ownership or identity, it's reasonable to believe that the watermark will remain intact even after attacks. Robust watermarking is the name given to this type of watermarking system. When watermarking is used to identify tampering, it is believed that if there is even a minor modification, the watermark will be obliterated, signalling to tamper. Fragile watermarking is the name given to this type of watermarking system. The multipurpose

watermarking scheme [6] is a scheme that provides both features.

This project implements a multifunctional electrocardiogram (ECG) watermarking technique with a large capacity. It is versatile in the sense that it can detect and locate tampering as well as detect ownership. Two different watermarks are created for this purpose, one for recognizing ownership and the other for storing patient information. The other watermark is used to detect tampering by detecting the location of the tampering. The tamper detection watermark is created using the hashing approach. The method proposed is based on an artificial neural network (ANN). During the watermark embedding phase, a threshold introduces to increase watermarked signal quality.

The remainder of the paper is laid out as follows: The second section briefly reviews relevant works and what other researchers have done in this field. The background knowledge of relevant technologies is introduced in Section III. In Section IV, we go through the fundamentals of system architecture, watermark production, embedding, and extraction. The experimental results are presented in Section V. Finally, Section VI brings the paper to a close.

## RELATED WORKS

Several ECG data concealing strategies with a variety of properties have been developed in the past. Engin [7] presented one of the earliest approaches of ECG watermarking based on discrete wavelet transform. It was a non-blind technique, and the original ECG signal was required for detection. A pseudo-random sequence based on Gaussian noise was created and incorporated in wavelet subbands (DWT coefficient) of the ECG signal in their technique. The major goal of this research was to detect signal manipulation. In the event of tampering, the

retrieved watermark in the form of Gaussian noise will differ from the injected watermark. For performance evaluation, signals from the MIT-BIH arrhythmia database were employed.

Chen [8] suggested a transform domain watermarking technique, in which several transforms were examined on the MIT-BIH arrhythmia database. Their method employs the discrete wavelet transform (DWT), discrete cosine transform (DCT), and discrete Fourier transform (DFT). The RMSE (root mean square error), RRMSE (relative RMSE), SNR, and BER are used to evaluate performance (bit error rate). These two methods have the drawback of being non-reversible watermarking. Only data integrity is guaranteed in non-reversible watermarking systems, but the original ECG signal cannot be reconstructed properly from the watermarked signal. Use of the reversible watermarking algorithm [9] as an alternative to the above approaches. The original signal is perfectly recovered from the watermarked signal in reversible watermarking; this is a crucial parameter in the medical area because irreversible approaches generate permanent distortions in the signal that may render it worthless. Despite the fact that these distortions are not noticeable and visually indistinguishable, they might lead to incorrect diagnosis [10]. Kaur [11] proposed a simple reversible watermarking technique. Patients' confidential data was employed as a watermark in their algorithm, and the system was able to detect signal tampering. First, a low-frequency chirp signal is modulated according to the patient's privacy, and then it is added to the original ECG signal. The patient ID is recovered from the chirp signal and compared to the embedded ID during the extraction procedure. This approach is a blind recovery method, but it is reversible

for low values of the signal to chirp signal ratio.

For photographs, reversible watermarking or reversible data hiding (RDH) is commonly utilized. Reversible watermarking approaches include data compression, histogram shifting (HS), and difference expansion (DE) [12]. Tian [13] introduced the first watermarking technique based on difference expansion. The picture signal is split into low-pass average and high-pass difference components in their technique. The watermark information is then stored in the pixel difference component. These techniques can be used on a variety of signals. Thodi [14] presented Prediction Error Expansion, an improved difference expansion approach. The primary idea behind this approach was to create reversible image watermarking. In their method, the value of a single-pixel is predicted using its neighbours, and the difference between the actual and expected value is calculated. Watermark bits are then added to this estimated error, resulting in an enhanced or expanded error; thus, prediction error expansion is the name given to this technique (PEE). Based on prediction error expansion, a number of watermarking approaches are offered. All of these systems rely on the same basic concept but employ various prediction methodologies.

In [15] and [16], reversible image watermarking approaches based on PEE was described. An approach termed efficient adaptive prediction (EAP) is developed by Jaiswal for pixel prediction. For effective prediction, EAP considers the attributes of nearby pixels. Walsh-Hadamard transform is used in Pakdaman to ensure reversibility of watermarking scheme and for prediction Adaline neural network was used.

Based on histogram shifting and PEE, Wenchao [17] developed a reversible data hiding approach for ECG signals. To

deconstruct the ECG signal, they used an invertible integer-to-integer Haar wavelet technique. Watermarks were embedded in high-frequency coefficients using prediction error expansion (PEE), and side information related to watermarks was incorporated in low-frequency coefficients. The MIT-BIH arrhythmia database was used to test their method.

Wang [18] presented a reversible ECG data hiding strategy based on PEE and histogram shifting for ECG signal watermarking. The ECG data was separated into three sections in this technique, and various predictors were utilized for each part. If there is sufficient neighbors are available then a local linear prediction method is used for prediction and a simple average is used as the predicted value for samples in which enough neighboring samples are not present. ECG signals from the MIT-BIH arrhythmia database are used to evaluate the performance.

In [19], a reversible ECG data concealing technique is created. For sample prediction, a deep artificial neural network called DNN is used in this method. A reversible data hiding strategy for ECG (electrocardiogram) signals was explored in another study [20], as well as performance analysis of random forest (RF) regression, regression SVM (support vector machine), and artificial neural network (ANN). The watermark embedding and extraction mechanism used in their technique is the same as that used in [19]. The watermark is incorporated using prediction error expansion (PEE), and the ECG samples are predicted using RF, SVM, and ANN. When the models are tested for different embedding strengths, the ANN model outperforms the SVM and RF models. For performance evaluation, both of these systems used ECG signals from the MIT-BIH arrhythmia database.

## RELATED TECHNOLOGY

To create reversible ECG watermarking with tamper localization capability, the proposed work employs an artificial neural network (ANN) and prediction error expansion. This part covers the fundamental principles of both topics to familiarise readers with them. Artificial neural networks (ANN) are highly efficient algorithms that can predict output data from a complex set of input data that is dependent on several parameters [21]. In picture identification and recognition applications, artificial neural networks are frequently utilized [22]. The neural network finds a variety of applications in medical domain [23],[24]. The architecture of ANN is inspired by the human mind, and it learns in the same way as a human mind does. An ANN is a feed-forward layered architecture that typically consists of three layers: input layer, hidden layer, and output layer.

The basic unit of an ANN termed a neuron, is shown in FIG.1; these are the processing units that process data. Depending on the architecture, each layer may have numerous neurons. Each neuron has a weight and bias associated with it; given known training data, an ANN will attempt to learn it and determine appropriate weights and biases in the process. Guided learning, unsupervised learning, and reinforcement learning are the three types of learning mechanisms connected with neural networks. During the training phase of supervised learning, a target output for the input data is already known. For recognition, identification, and classification tasks, supervised learning is utilized. Unsupervised learning is used for clustering problems, where neural networks conduct clustering by categorizing input, and the aim is unknown during training. Reinforcement learning is a feedback based award-based learning process that is widely utilized in robotics.

Each neuron performs a basic procedure in which weighted input values are multiplied by bias and then passed to the next layer via the activation function.

The expression at each neuron's output is shown below.

$$y_j = f\left(\sum a_j \cdot w_{ij} + b_j\right) \quad (1)$$

Where  $f(\cdot)$  represents the activation function,  $a_j$  represents the input,  $w_{ij}$  represents the weight, and  $b_j$  represents the bias. The activation function is employed for two purposes: first, to add non-linearity in the output, and second, to guarantee that the output of the neuron is within acceptable boundaries. An error is calculated at the output layer of a neural network to measure learning performance. Mean square error is a popular error function used in ANN. Every neuron's weights and biases are modified based on the mistake at the output layer. Back propagation is a process in which error flows from the output layer to the input layer, updating all weights and biases in the process.

## B. Prediction error expansion

Tian [13] provided one of the earliest methods of reversible data concealment, which is called difference expansion. [14] presented a difference expansion enhancement known as prediction error expansion (PEE). An ECG sample is predicted for a batch of samples, and the batch is unique for each sample, it is a local prediction based approach [25]. Because the prediction error is dependent on unique data points, a locality constraint is imposed. PEE predicts a specified ECG value in the original signal based on its neighboring values. To detect the error, the difference between the predicted and original values is computed. After that, a watermark bit is incorporated into the error, resulting in a changed error. The original data is then supplemented with the adjusted error. Consider  $x$  as the original

value at a specific ECG data point, and  $\hat{x}$  as the anticipated value based on its neighbors. The error  $e$  is then calculated using the following formula:

$$e = x - \hat{x} \quad (2)$$

The bit binary representation of  $e$  is constructed to embed the watermark. The watermark bit is inserted into its LSB after left shifting  $e$  once. This causes an increase in error, which is denoted by the symbol  $e'$  and is referred to as enlarged error. To produce a watermarked ECG result, the expanded error is added to the projected value.

$$x' = \hat{x} + e' = x - e + e' \quad (3)$$

As a result of the shifting and the insertion of the watermark bit:

$$e' = 2 * e + b \quad (4)$$

Where  $b$  stands for the watermark bit. As a result,

$$x' = x + e + b \quad (5)$$

The data point acquired during extraction and recovery will be  $x'$ . The same method is used to estimate its worth. Because the same nearby points are used, the projected value will be the same, i.e.  $\hat{x}$ . First, the difference between the two values is calculated, and the watermark bit is taken from it.

The extraction error ( $e_r$ ) is as follows:

$$e_r = x' - \hat{x} \quad (6)$$

Using the values of  $x'$  from Equation (5) and  $\hat{x}$  from Equation (2), we get the following error at extraction:

$$e_r = 2 * e + b \quad (7)$$

The following equation can be used to retrieve the watermark bit.

$$b = e_r - 2 * \left[ \frac{e_r}{2} \right] \quad (8)$$

Finally, the original value  $x$  can be computed using the following formula:

$$x = x' - \left[ \frac{e_r}{2} \right] - b \quad (9)$$

## PROPOSED WATERMARKING SCHEME

For detection of signal tampering with tamper localization ability and ownership establishment, a powerful and high capacity reversible ECG watermarking system is designed. The proposed work begins with a discussion of the deep ANN architecture, which is followed by a discussion of the embedding and extraction strategy, as well as the watermark production approach.

### A. Deep neural network

For the prediction of ECG samples, a deep neural network was developed. A deep neural network is a feed-forward artificial neural network with multiple hidden layers (DNN). The deep neural network employed in the proposed strategy is shown in FIG.2. The configuration of the neural network is highlighted by the numbers written along with the boxes. It features three hidden layers: the first and third hidden layers each contain 20 neurons, while the middle hidden layer contains 30 neurons. It has four neurons in the input layer that hold four nearby sample values of the sample to be predicted, and a single neuron in the output layer that holds the anticipated output value. The activation function in all layers is the hyperbolic tangent sigmoid transfer function. The sigmoid function is an S-shaped curve that is defined as if  $y$  is the net, then sigmoid is defined as:

$$f(y) = \frac{1}{1 + e^{-y}} \quad (10)$$

The training of the ANN is done using stochastic gradient descent (SGD) with back propagation, and the performance is measured using mean square error (MSE). To get the lowest error at the output, various structures and settings were studied. The chosen structure yielded the best results. Although a larger number of layers outperformed a smaller layer architecture, increasing the number of layers and neurons beyond the recommended number did not improve the network's performance. The embedding and extraction processes use the same ANN design.

A high-capacity data embedding system is proposed. Through prediction error expansion, equations (2)–(5) explain the embedding process for a certain sample. The next sections detail the entire embedding and extraction process. The embedding process is divided into three stages. A middle sample from a unique batch of three ECG samples is chosen for watermark embedding in each embedding step. An ANN generates the forecast or the middle sample. As during training, two predecessors and two successive samples are supplied to the ANN, and the middle sample value is predicted. As a result, any sample's prediction is predicated on its four nearby ECG samples. Each group's watermark is placed in the middle sample. In the current phase, the points input to the ANN for prediction are not taken into account for data embedding.

Consider FIG.3 (a), which is a 12-sample ECG signal (A to L). FIG.3 (b) depicts the first embedding phase, with red coloured dots indicating the samples in which the watermark bit is implanted. Samples A, B, D, and E are input to ANN to predict sample C, which is unique to the group (B, C, D). Similarly, samples D, E, G, and H are used to predict sample F, which is unique to the group (E, F, and G). As a result, by the end of the first phase, C', F',

and I' have been modified samples with inserted watermark bits. As mentioned in Section 2.2, the procedure used for bit embedding is PEE. Phases II and III can be completed by repeating the embedding process on the remaining samples. In the next step, sample values that have been adjusted in earlier phases are taken into account for making predictions. Phase II is depicted in FIG.3 (c), with blue colored dots representing modified samples D', G', and J'. Sample D is predicted by feeding its four neighbors, B, C', E, and F', to ANN. C' and F' are changed values from phase 1 that were used for prediction. The technique is then repeated in phase 3 with the values from the previous phases adjusted. When the value of E is predicted using C', D', F', and G', the result is E'. Because there aren't enough surrounding samples for prediction, two samples from the beginning of the signal and two samples from the end aren't considered for embedding (samples A, B, and K, L in our case). Watermark extraction is performed in reverse order. Phase 3 watermark is extracted initial, followed by phase 2 and phase 1 watermarks throughout extraction. The number of samples in a 10 second ECG signal sampled at 360 Hz is 3600. After phase 1, the above procedure will result in the embedding of 1199 watermark bits. Variable bps could be achieved by setting a maximum permitted error threshold.

## B. Watermark generation

This work allows for tamper detection as well as tamper localization. This is accomplished by embedding two separate watermarks, one for tamper detection/ localization and the other for detecting ownership. The watermark generating block diagram is shown in FIG.4.

A hashing algorithm is used to create the tamper detection watermark on the ECG signal. Even if watermarking is done in all three steps, the tamper

detection watermark can be embedded only in the first. As a result, during step one, a tamper detection watermark is implanted. The entire signal size will be 3600 samples if the signal is sampled at 360 Hz for 10 seconds. As a result, the maximum permissible watermark size in the first phase is 1199 bits, of which 600 bits are utilized for tamper detection and the remaining bits are used for ownership detection. The SHA-1 (Secure hash algorithms-1) hashing algorithm is used to create the tamper detection watermark. To create this watermark, a 10-second ECG signal is first separated into 20 equal-sized pieces. As a result, each segment contains 180 samples. The SHA-1 hashing method is used to generate a unique hash for each segment. The created hash for each segment is then binarized, with bits removed from each hash until the total size of the generated hash for all segments equals 600 bits. The tamper detection watermark is created as a result of this.

The patient data is contained in the ownership watermark. The ownership watermark is likewise broken into 20 segments to merge the two watermarks, and each segment of the tamper detection watermark is implanted in the corresponding segment of the ownership watermark. Watermark and ECG signals are retrieved throughout the extraction process. Tamper detection watermark is extracted from the recovered watermark to detect tampering. The recovered ECG signal is split and subjected to the same technique in order to generate a hash. After that, the hash is binarized and bits are removed to make it the right length. In the absence of tampering, the generated tamper detection watermark at extraction will be equal to the embedded tamper detection watermark. In the event of tampering, a hash mismatch will occur. The position of the hash mismatch can be used



to pinpoint the segment where tampering occurred.

If tampered samples are limited to a single segment, the number of tampered samples discovered is 180, which is the same as one segment's size. Tampered signals will be equal to 360 if tampered samples are spread over two segments. As a result, there is some false positive samples. In Section V, the tamper localization scheme is examined.

### C. Watermark embedding procedure

- The value of the middle sample  $x$  is calculated by dividing the ECG signal into overlapping segments of 5 samples.
- Using pre-trained ANN, predict the value of a specified data point  $x$  using its four neighbors.
- The Equation (2) is used to calculate the error  $e$  between the corresponding predicted value and the original value.
- By adding a watermark bit to the once left shifted value of error as indicated in Equation (4), you may find the changed error  $e'$ .
- When the extended error is added to the anticipated value as shown in Equation (3), the resulting value will be used to replace the original value.

This is the first phase of embedding. Steps 2 and 3 are the same as the first. FIG.5 illustrates the watermark embedding process.

### D. Watermark extraction procedure

Prior to extraction, the number of stages in which embedding is performed should be known. The phase 3 watermark is extracted initial, then the phase 2 watermark, and finally the phase 1 watermark is removed. At the very end, the original signal is recovered.

- As in the embedding step, divide the watermarked ECG signal into overlapping segments of 5 samples.

- Predict the value of a single data point for each segment, then calculate the error by subtracting the predicted value from the received value, as shown in Equation (6). Equation (8) can be used to recover the watermark bit from the estimated error.
- The Equation (8) can be used to recover the watermark bit from the estimated error.
- The Equation (9) can be used to recover the original sample.
- To identify signal manipulation, extract the entire watermark and check the tamper detection watermark.
- Validate the results by extracting patient information from the ownership watermark.

Figure 6 depicts the watermark extraction procedure.

### E. Watermark embedding considering a threshold

By introducing a threshold during embedding, the bps of the resulting watermarked signal might be changed. As a result, watermark bits are not included in samples where the inaccuracy exceeds the threshold. The addition of a threshold increases the quality of watermarked signals while also allowing for bps management. Equation (11) is utilized to generate a modified error in place of the watermark bit. [30] discusses an embedding and extraction situation using a threshold. When the error exceeds the threshold, the modified error is calculated using the equations below.

$$e' = \begin{cases} e + T; & e > 0 \\ e - T + 1; & e < 0 \end{cases} \quad (11)$$

The threshold is  $T$ . Equation is used to calculate the modified signal value (5). FIG.7 depicts the embedding process in the presence of a threshold.

In the existence of a threshold, the extraction process is influenced by the computed error. If the sample contains a watermark bit, the error determined by Equation (6) during extraction will always be between  $2T + 1$  and  $2T$ . If the computed error is between  $2T + 1$  and  $2T$ , the watermark bits are extracted in the same way as if there is no threshold limit. If the error exceeds the above range, the extraction procedure is regulated by the equations below.

$$x = \begin{cases} x' - T; & e \geq 2T \\ x' + T - 1; & e \leq -2T + 1 \end{cases} \quad (12)$$

Prior to extraction, the threshold should be determined. The threshold has been set at 2 in this project.

## V. EXPERIMENTAL RESULTS

ECG signals from the MIT-BIH arrhythmia databases [26] and [27] are utilized to assess the performance of the proposed work. It's a well-known database that's mentioned in a number of ECG-related studies. Each database signal is around 30 minutes long and sampled at 360 Hz. In the MIT-BIH arrhythmia database, there are a total of 48 ECG signals. ECG values from two separate leads are included in all signals. In most circumstances, one of the signals is ML II (modified limb lead II, which is a standard nomenclature) and the other is modified lead V1. Electrodes placed on the chest collect ML II impulses.

Each of these 46 signals has a signal length of 10 seconds, which is utilized to train the ANN. The proposed approach was evaluated on 10 s ECG signals taken from the same database at different locations. As a result, testing and training signals are distinct. The ANN used to forecast the middle ECG sample is shown in FIG.8, and the performance plot is shown in FIG.9. It has the best validation performance with 1.0806 MSE at the eighth epoch.

The input ECG signal and the required patient information are shown in FIG.10 and FIG.11, respectively, for the development of ownership detection watermark. The owner is the one who enters these patient details. The first fragmented component, which is the first phase in the watermarking process, is shown in FIG.12. FIG.13 shows the error versus time graph, while FIG.14 shows the extended error vs time plot.

The watermarked signal is shown in red color above the original ECG signal in FIG.15 to highlight the difference between the two.

A. Watermarking performance evaluation Signal to noise ratio (SNR), normalized cross correlation (NCC), and percentage residual difference are three measures used to evaluate the algorithm's performance (PRD).

### 1. Signal to Noise Ratio (SNR)

SNR is commonly used to determine the original and watermarked ECG signal quality. A higher SNR value suggests that the two signals are more comparable. [28] Equation (15) is used to calculate this metric in decibels (dB):

$$SNR(X, Y) = 10 \log_{10} \sqrt{\frac{\sum_{i=1}^N x_i^2}{\sum_{i=1}^N (x_i - y_i)^2}} \quad (13)$$

FIG.16 depicts the distribution of SNR in relation to BPS.

### 2. Normalized Cross Correlation (NCC)

The Normalized Cross Correlation (NCC) method is used to compare the original and retrieved ECG signals [29]. Equation (14) can be used to calculate its value, which ranges from 0 to 1.

$$NCC(X, Y) = \frac{\sum x_i x_{ori} y_i}{N * N} \quad (14)$$

### 3. Percentage Residual Difference (PRD)

The distortion between the original ECG host signal and the watermarked ECG signal is measured using the percentage residual difference [18]. The expression is what defines PRD.

$$PRD(X, Y) = \sqrt{\frac{\sum_{i=1}^N (x_i - y_i)^2}{\sum_{i=1}^N x_i^2}} \times 100\% \quad (15)$$

The fluctuation in PRD with regard to BPS is seen in FIG.19. FIG.18 depicts the patient information derived from the watermarked ECG signal entered by the user in the initial state. The average PRD, CC, SNR, and Time of the proposed system are also shown in FIG.18.

### B. Tamper Localization Performance Evaluation

As illustrated in FIG.20, the proposed technique can detect signal tampering with the help of SHA1-based tamper detection watermark. The suggested method's tamper detection capacity is tested for modification attacks.

The attack value of a signal at a certain point is altered to a different value during modification. The suggested algorithm's capacity to identify tampering is shown in FIG.19. The original signal is blue in hue, and it overlaps the tampered watermarked signal on the graph. The signal has been tampered with, as indicated by the red color. The technique can detect signal tampering since the original signal completely covers the watermarked signal except at the tampered spot.

The following parameters are calculated to evaluate the performance of the proposed technique for tamper localization: [30]:

#### 1. False positive rate (FPR)

The suggested research will pinpoint the area where manipulation has been identified. Each tamper detection

segment consists of 180 ECG samples, as explained in the watermark production section. As a result, if the number of tampered bits is less than 180 and they all come from the same segment, the algorithm recognizes the tampered segment and flags all 180 samples in that segment as manipulated. If altered samples are spread across two segments, the algorithm will flag both segments as manipulated. As a result, 360 samples will be flagged as manipulated.

The ratio of the number of identified tampered samples that are actually not manipulated to the total number of samples in the tampered zone is known as the false positive rate (FPR).

FIG.21 shows the average false positive rate. The plot was created by randomly messing with a watermarked ECG signal. The average FPR found in most situations is nearer to zero, indicating that the system can always identify tampering for given tampering.

#### 2. False negative rate (FNR)

The rate at which tampered samples are mistakenly identified as non-tampered is known as the false negative rate (FNR). The ratio of the number of detected untampered samples that are not actually tampered with to the total number of samples in the untampered zone is known as the FNR. The average FNR plot is given by FIG.22.

#### 3. Tamper detection rate (TDR)

The rate at which tampered signals are actually recognized as tempered is known as the tamper detection rate (TDR). The term TDR refers to the ratio of the number of tampered samples found to the total number of manipulated samples. The average TDR plot of the proposed system is shown in FIG.23.

### C. Timing and complexity

The suggested algorithm's results and simulations are run on a Windows 7, 64-bit system with an Intel Pentium 3556U CPU running at 1.70GHz and 4 GB of

RAM. MATLAB was used to implement the algorithm. For any phase, watermark embedding and extraction require a single loop execution with a complexity of  $O(N)$ , where  $N$  is the number of bits implanted. The embedding and extraction of the watermark take roughly 0.45 seconds on average (rounded to two decimal places). The numerous parameters derived for distinct ECG signals from the MIT-BIH arrhythmia database are displayed in TABLE. I. Each signal is a 10 second ECG signal produced

from the MIT-BIH database of arrhythmias. These signals were taken from various portions of the original 30- minute transmission.

### CONCLUSIONS

A reversible ECG watermarking has been created and evaluated in this study to protect against ownership and manipulation assaults. To improve prediction, a deep neural network-based prediction model was deployed. The suggested algorithm's multifunctional nature has been discovered to be particularly effective in hiding patient's data in the form of ownership watermark and tampering location. The development of stronger prediction methods will be the focus in the future. Furthermore, better embedding approaches will be investigated in order to increase the embedding capacity without compromising the scheme's reversibility.

### REFERENCES

- N. A. Memon, A. Chaudhry, M. Ahmad, and Z. A. Keerio, International Journal of Computer Mathematics 88, 2057 (2011).
- J. Zain and M. Clarke, Sciences of Electronic, Technologies of Information and Telecommunications, Tunisia (2005).
- N. Rao and V. M. Kumari, Information Security Journal: A Global Perspective 20, 148 (2011).
- H. Nyeem, W. Boles, and C. Boyd, Journal of digital imaging 26, 326 (2013).
- G. Coatrieux, J. Puentes, C. Roux, M. Lamard, and W. Daccache, in 2005 IEEE Engineering in Medicine and Biology 27th Annual Conference (IEEE, 2006) pp. 2224–2227.
- I. A. Ansari and M. Pant, Pattern Recognition Letters 94, 228 (2017).
- M. Engin, O. C. Idam, and E. Z. Engin, Journal of medical systems 29, 589 (2005).
- S.-T. Chen, Y.-J. Guo, H.-N. Huang, W.-M. Kung, K.-K. Tseng, and S.-Y. Tu, Journal of medical systems 38, 1 (2014).
- N. Narawade and R. Kanphade, International Journal of Computer Science and Telecommunications 2, 46 (2011).
- R. Caldelli, F. Filippini, and R. Becarelli, EURASIP Journal on Information Security 2010, 1 (2010).
- S. Kaur, R. Singhal, O. Farooq, and B. S. Ahuja, in 2010 International Conference on Recent Trends in Information, Telecommunication and Computing (IEEE, 2010) pp. 140–144.
- S. P. Jaiswal, O. Au, V. Jakhetiya, A. Y. Guo, and A. K. Tiwari, in International Workshop on Digital Watermarking (Springer, 2014) pp. 276–288.
- J. Tian, IEEE transactions on circuits and systems for video technology 13, 890 (2003).
- D. M. Thodi and J. J. Rodríguez, IEEE transactions on image processing 16, 721 (2007).

- S. P. Jaiswal, O. C. Au, V. Jakhetiya, Y. Guo, A. K. Tiwari, and K. Yue, in 2013 IEEE International Conference on Image Processing (IEEE, 2013) pp. 4540–4544.
- Z. Pakdaman, S. Saryazdi, and H. Nezamabadi-Pour, *Multimedia Tools and Applications* 76, 8517 (2017).
- W. Wu, B. Liu, W. Zhang, and C. Chen, in 2015 2nd International Symposium on Future Information and Communication Technologies for Ubiquitous HealthCare (Ubi-HealthTech) (IEEE, 2015) pp. 1–5.
- H. Wang, W. Zhang, and N. Yu, *Multimedia Tools and Applications* 75, 13733 (2016).
- S. Bhalerao, I. A. Ansari, A. Kumar, and D. K. Jain, *Pattern Recognition Letters* 125, 463 (2019).
- S. Bhalerao, I. A. Ansari, and A. Kumar, in 2020 International Conference on Communication and Signal Processing (ICCSP) (IEEE, 2020) pp. 0667–0671.
- S. S. Haykin et al., “Neural networks and learning machines/simon haykin.” (2009).
- D. K. Jain, Z. Zhang, and K. Huang, *Pattern Recognition Letters* 115, 92 (2018).
- O. Faust, Y. Hagiwara, T. J. Hong, O. S. Lih, and U. R. Acharya, *Computer methods and programs in biomedicine* 161, 1 (2018).
- S. Ren, D. K. Jain, K. Guo, T. Xu, and T. Chi, *Signal Processing: Image Communication* 75, 1 (2019).
- I.-C. Dragoi and D. Coltuc, *IEEE Transactions on image processing* 23, 1779 (2014).
- A. L. Goldberger, L. A. Amaral, L. Glass, J. M. Hausdorff, P. C. Ivanov, R. G. Mark, J. E. Mietus, G. B. Moody, C.-K. Peng, and H. E. Stanley, *circulation* 101, e215 (2000).
- G. B. Moody and R. G. Mark, *IEEE Engineering in Medicine and Biology Magazine* 20, 45 (2001).
- K. Heylen and T. Dams, in *Mathematics of Data/Image Pattern Recognition, Compression, and Encryption with Applications XI*, Vol. 7075 (International Society for Optics and Photonics, 2008) p. 70750D.
- V. S. Jabade and S. R. Gengaje, *International Journal of Computer Applications* 31 (2011).
- I. A. Ansari, M. Pant, and C. W. Ahn, *International Journal of Machine Learning and Cybernetics* 7, 1225 (2016).

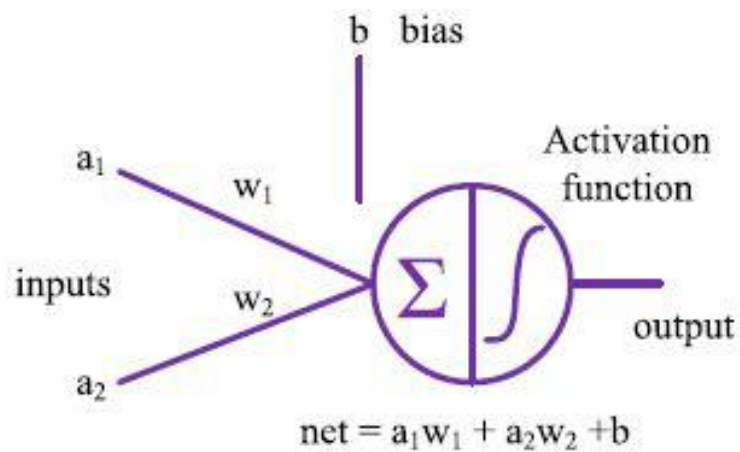


FIG. 1. An ANN's single neuron.

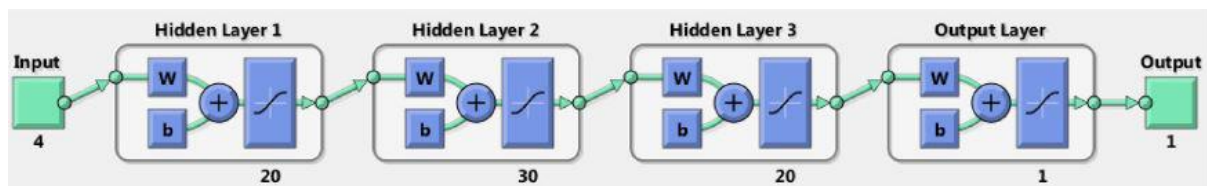


FIG. 2. DNN used in the proposed method.

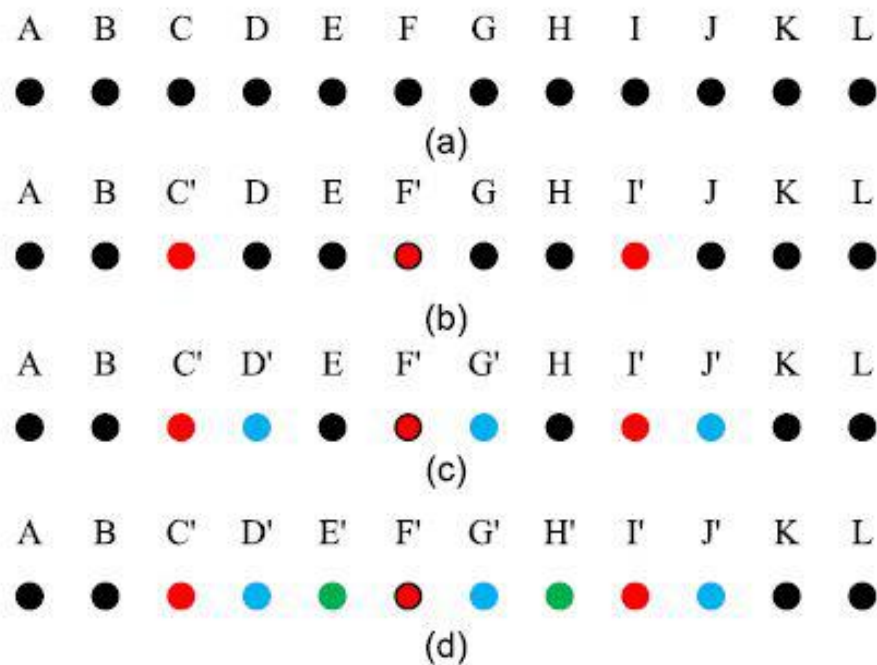
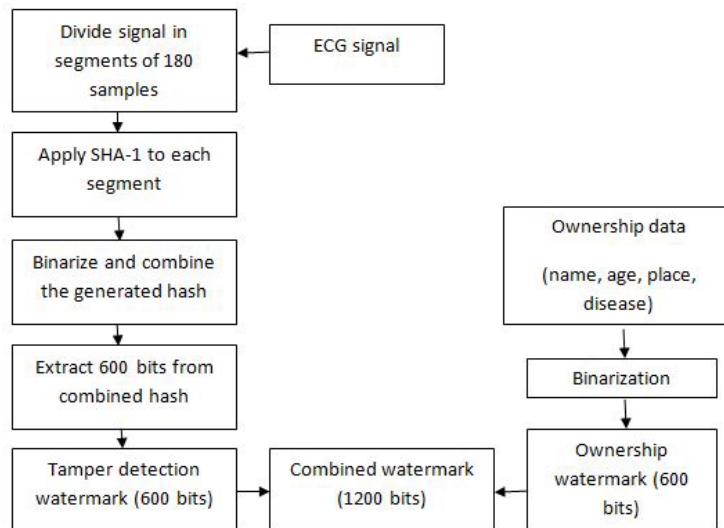
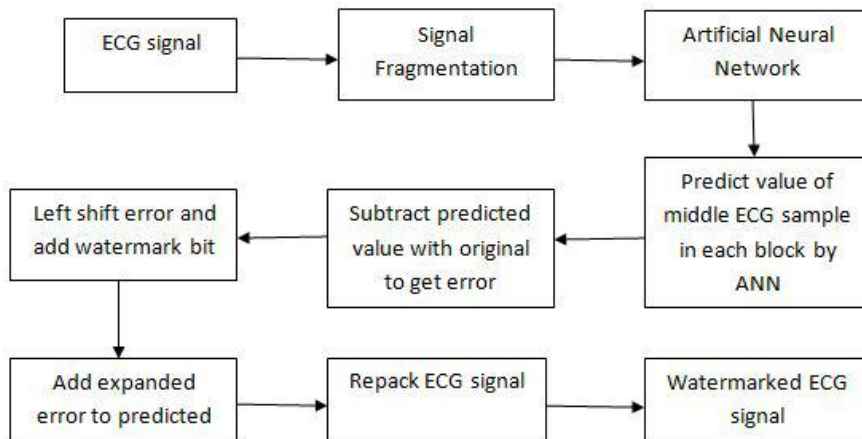


FIG. 3. Watermark embedding in ECG samples.

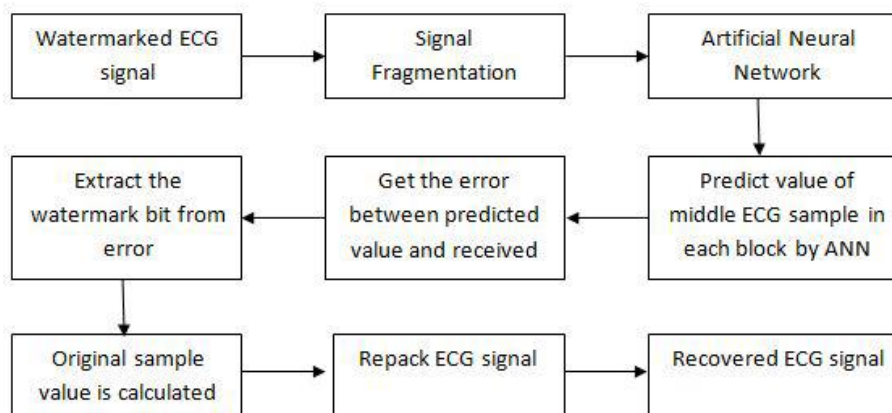




**FIG. 4. Block diagram of Watermark generation.**



**FIG. 5. Block diagram of Watermark embedding.**



**FIG. 6. Block diagram of Watermark extraction.**

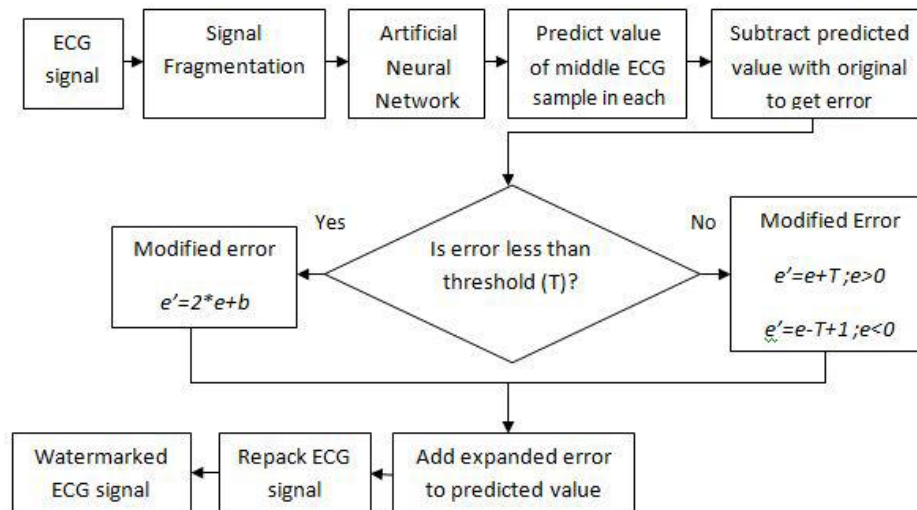


FIG. 7. Block diagram of Watermark embedding process considering threshold.

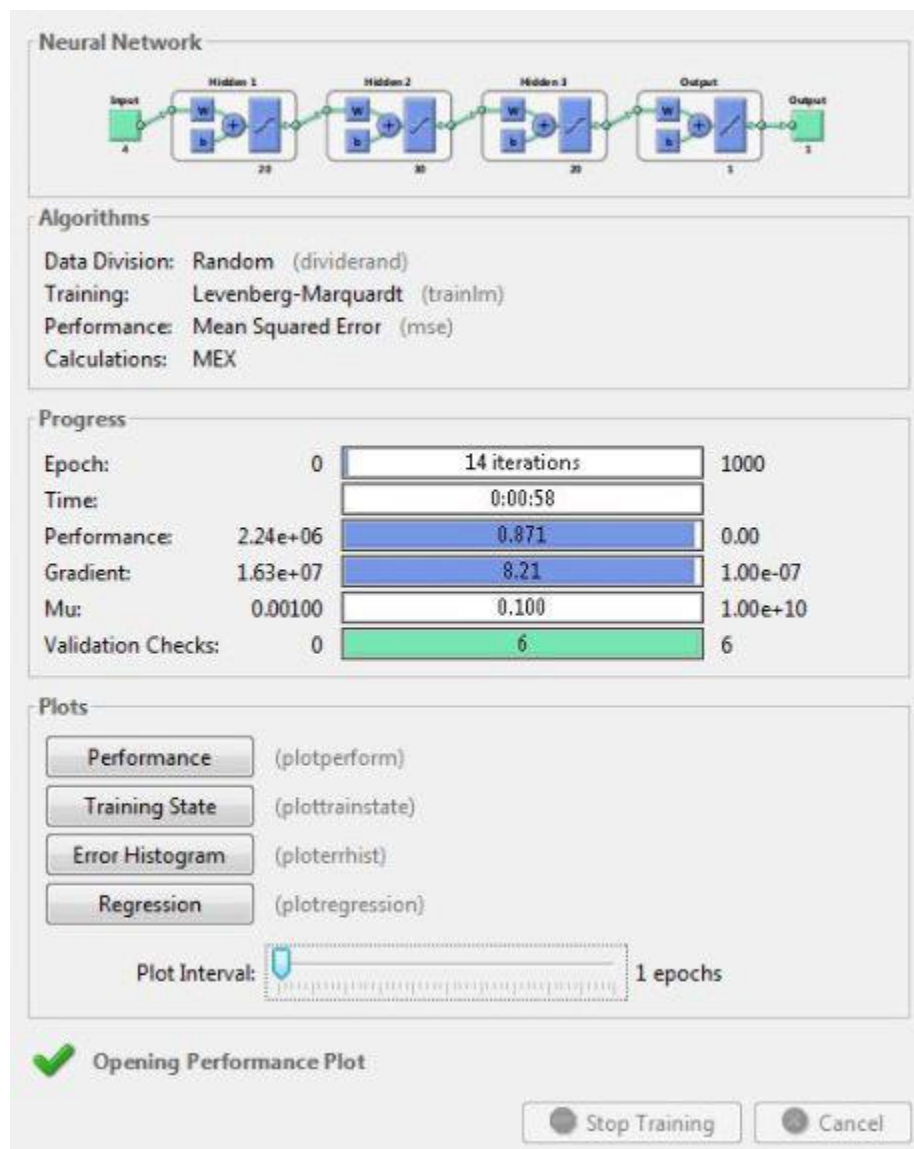
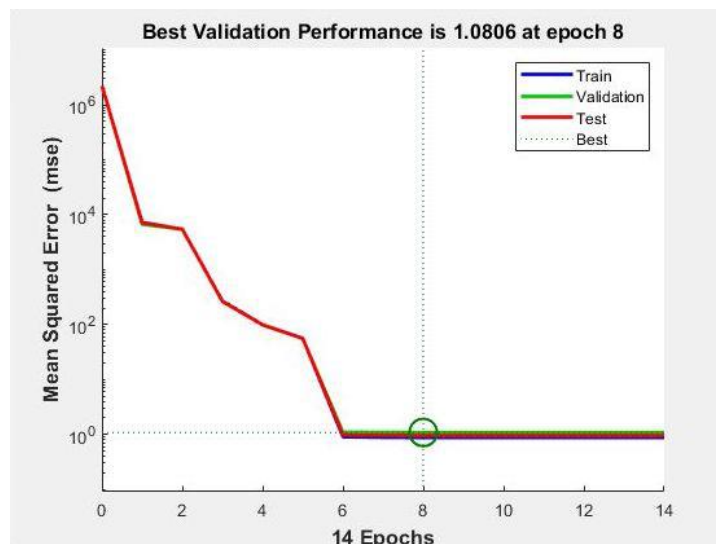
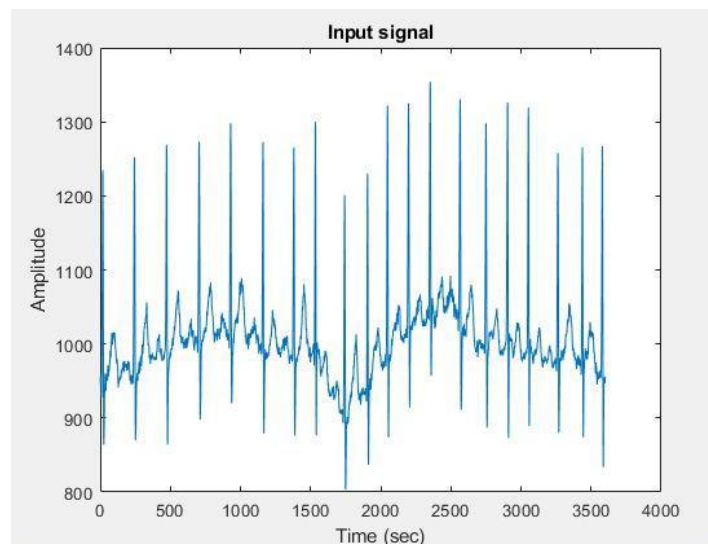


FIG. 8. Neural network training.



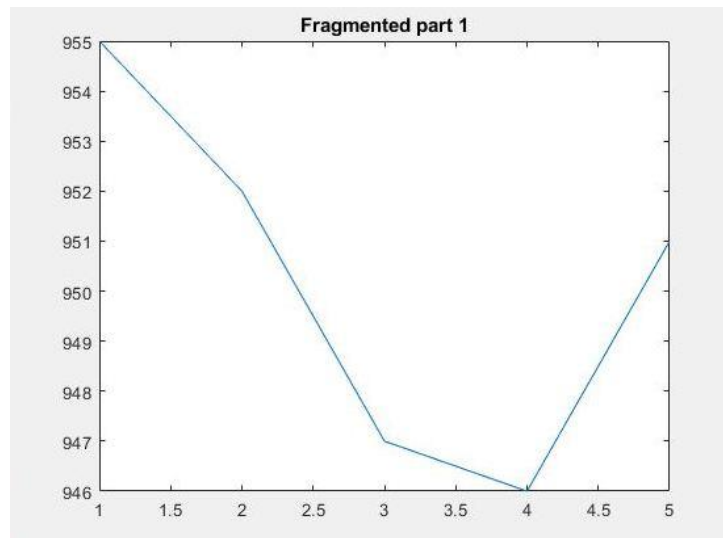
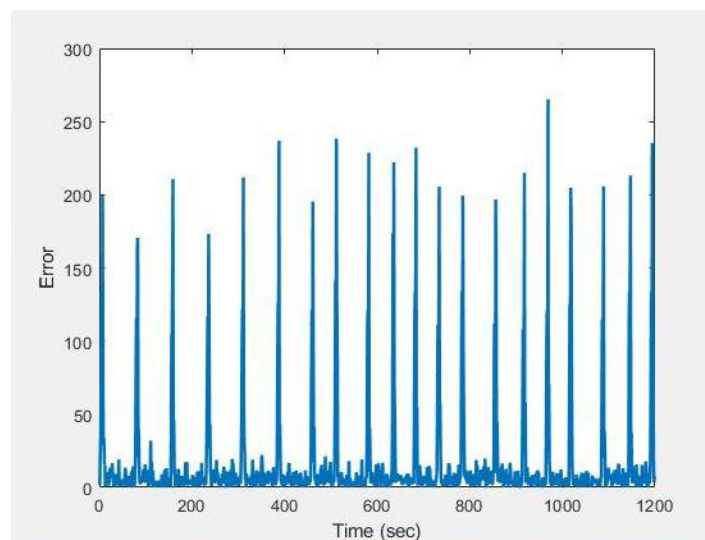
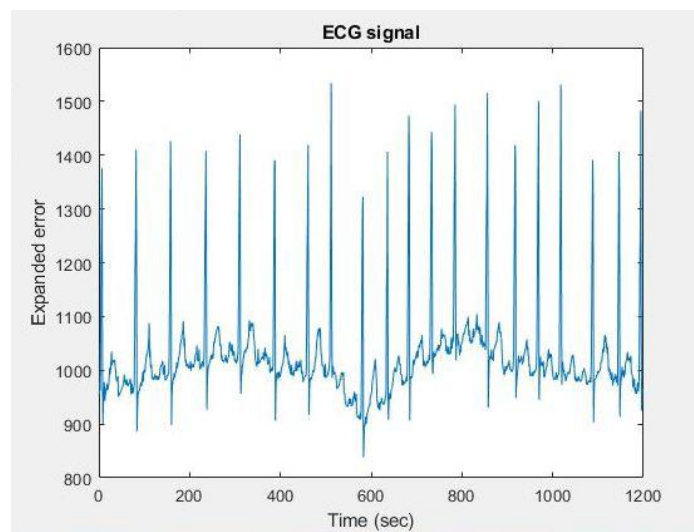
**FIG. 9. ANN performance plot.****FIG. 10. Input ECG signal.**

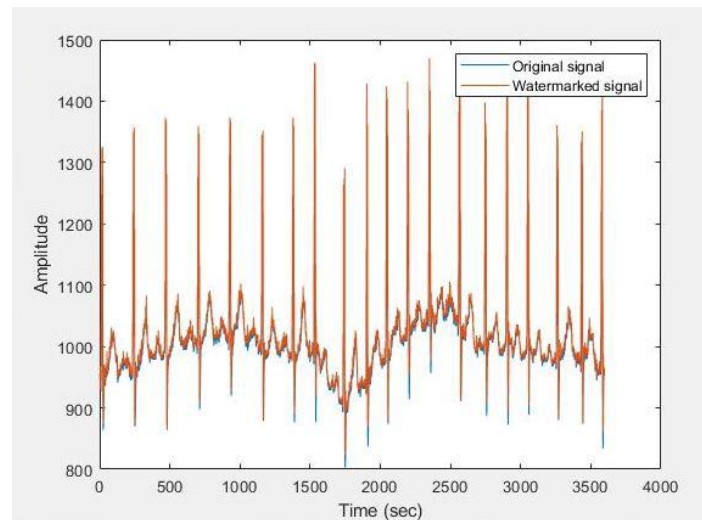
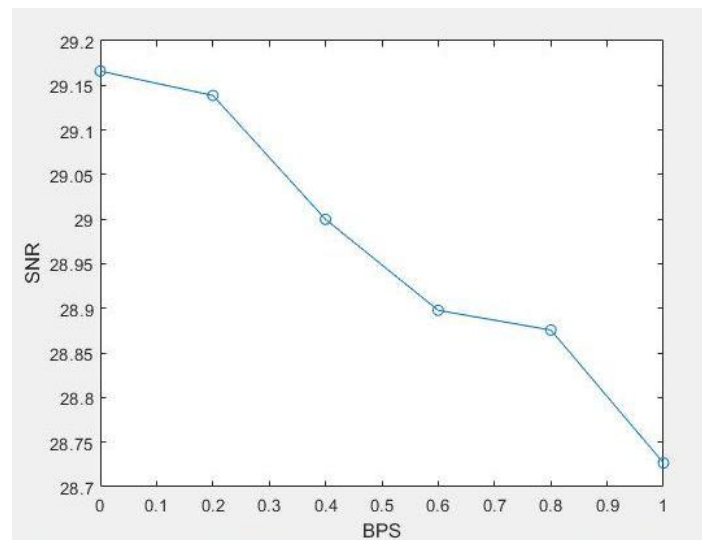
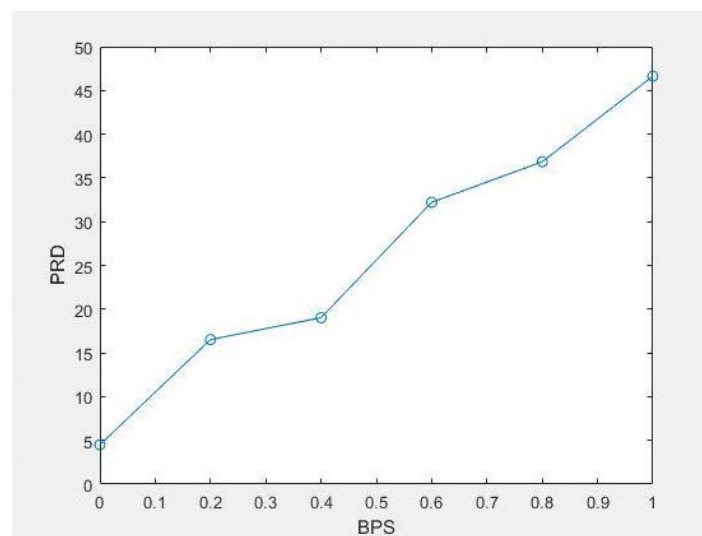
The figure shows a patient information input form. The form has the following fields and values:

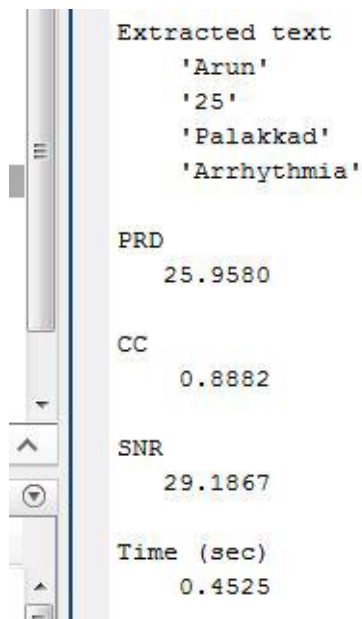
Field	Value
Patient name	Arun
Age	25
City/Town	Palakkad
Problem	Arrhythmia

At the bottom of the form are two buttons: "OK" and "Cancel".

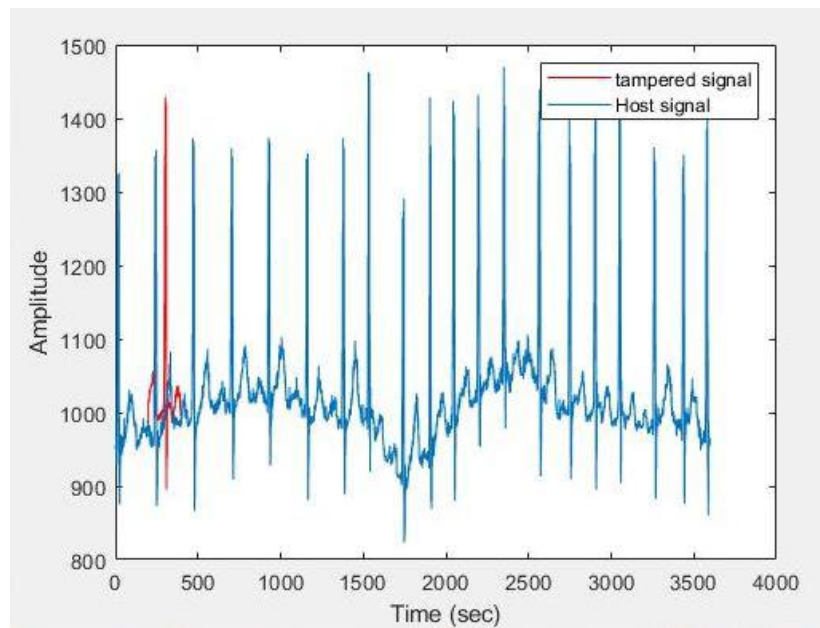
**FIG. 11. Input patient information.**

**FIG. 12. Fragmented part 1.****FIG. 13. Error versus Time.****FIG. 14. Expanded error versus Time.**

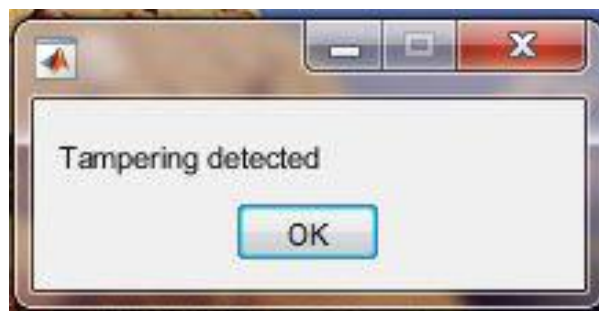
**FIG. 15. Watermarked ECG signal.****FIG. 16. SNR versus BPS.****FIG. 17. PRD versus BPS.**



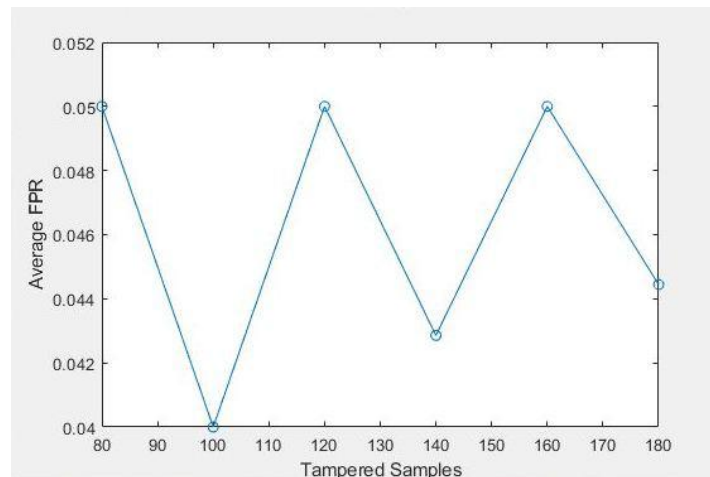
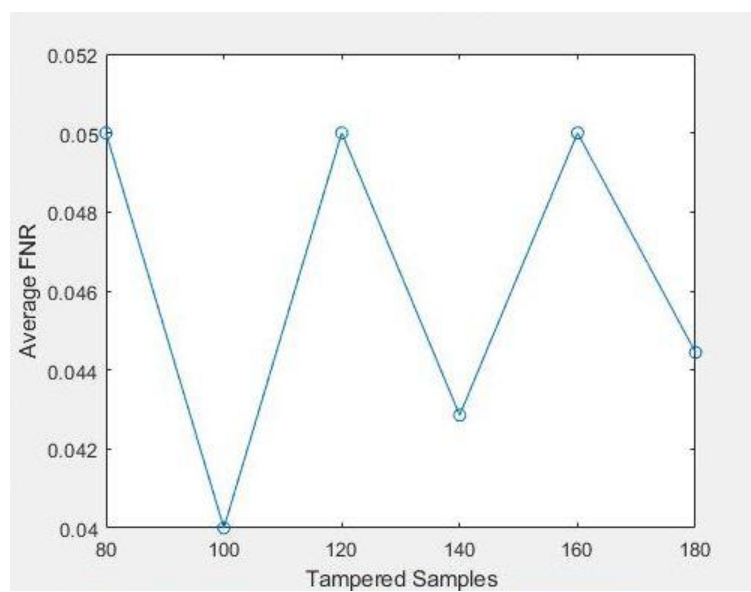
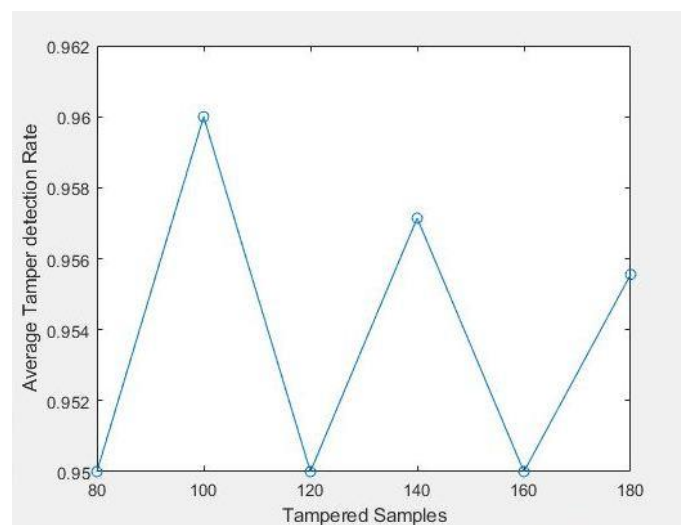
**FIG. 18. Watermarking performance evaluation**



**FIG. 19. Original signal and Modified tampered signal.**



**FIG. 20. Tamper detection ability.**

**FIG. 21. Average FPR plot.****FIG. 22. Average FNR plot.****FIG. 23. Average TDR plot.**

**TABLE I. Performance evaluation for different ECG signals.**

SL. No.	Record No.	CC	PRD	SNR	Time	TDR	FPR	FNR
1.	209	0.888	25.958	29.186	0.452	0.953	0.046	0.046
2.	105	0.962	18.988	33.692	0.295	0.953	0.043	0.044
3.	106	0.849	21.892	24.425	0.290	0.945	0.046	0.045
4.	207	0.978	27.481	35.277	0.516	0.947	0.047	0.046
5.	210	0.900	32.567	29.71	0.510	0.954	0.043	0.041
6.	234	0.951	32.235	32.008	0.586	0.943	0.045	0.046

# A Novel Approach to Mems Based Wideband Energy Harvesting for Sensing Applications

V Amirtha Raj,  
Research Scholar,

Dr.M Manivannan  
Associate Professor,  
Electronics and Instrumentation Department,  
Annamalai University, Tamil Nadu, India

## Abstract

*The ambient energy coming out of radiations can be harvested by activating MEMS devices, a single or multiple array of Nano mechanical Sensing, wireless sensor networks together with very low power electronic devices for several applications. The batteries used in the sensing system becomes failure due to expensive in replacement of batteries intermittently, consequently the sensor's lifespan will be declined. So the energy harvesting technologies from ambient radiations is a keen and promising solution to make the system monitoring self-supportable in micro as well as macro scale sensing and other applications. Due to advanced growth in Micro-Electro-Mechanical Systems, this one is appropriate to utilize MEMS devices. RF-MEMS components are mostly used in switches, adjustable capacitors, inductors, in resonators, VCOs and, MEMS supercapacitor, MEMS based converter circuits etc. Wireless applications based on MEMS switches include reconfigurable antennas, band-mode selection, transmit/receive duplexers and phased-array antennas. MEMS devices has least insertion loss and better isolation, nil power consumption, small dimension and light weightiness and low intermodulation bias. By integrating RF-MEMS in this system, it will improve the complete operation of the harvester and the dimensions and weight will be compact. It can be embedded easily with any micro or Nano scale systems for sensing applications.*

**Keywords:** Energy harvesting, RF MEMS, CNT supercapacitor, Sensing applications, Wireless Sensor Networks

## INTRODUCTION

The Energy harvesting from radiation is one of the interested areas of researchers in recent years. Due to widespread and great increase in application of wireless technologies, energy transmitted from cellular stations, broadcast locations and Wi-Fi nodes is harvested by working less consuming micro electronic sensors and devices. This can be accomplished by having MEMS based reconfigurable smart antennas, MEMS based tuned converter

circuits for rectifying RF power into DC, MEMS supercapacitor, MEMS DC-DC converters and sensors for various applications. A power sensor is attached into the reconfigurable smart antenna, to hunt a band having maximum energy then dynamically tune the matching network. Since it is operating under various frequencies, the tuned rectifier is designed by MEMS based variable components instead of using fixed one. The rectified signal passes to versatile planar MEMS supercapacitor. It uses

porous CNT forests as electrodes with low contact resistance. In the field of MEMS, supercapacitors could find very promising usages as an energy source with no chemical reactions involving in it and are perfectly suited for the energy source for pulse-power devices such as solid-state sensors (Jiang et al., 2009). The MEMS DC-DC (boost) converter consists of a variable capacitor which is coupled mechanically to the micro-actuator. The potential across charged and electrically isolated capacitor can be improved by decreasing the capacitance while storing its charge. This variation in capacitance can be mechanically accomplished by moving one of the electrodes with an electrostatic micro-actuator (Haas & Kraft, 2004). The boosted DC output is sufficient for driving sensors for various sensing applications.

### **ENERGY HARVESTING SYSTEM**

The harvesting system is deliberately made to actuate an ultra-low power sensor node by accumulating energy from ambient RF radiations. Few tasks in transforming these ambient energy into useful energy includes a) small voltage levels and power density which is inadequate for conventional alteration steps b) To attain high voltages at rectifier terminals, output impedance must be maintained high c) using boost converters causes low input resistance and power requirements for continuous operation is much higher d) the use of many rectifiers attached with individual antennas would take more space and so the cost increases (V. A. Raj, 2016). These issues are overcome by means of a) fixing accumulate-and-use design b) usage of a power sensor to hunt for a band with a higher energy and tune the network dynamically c) using adjustable components in its place of fixed one in the tuned rectifier. The design consists of rectenna. The need for almost all micro

systems is the capacity to sense and or transmit electromagnetic energy for communications or remote sensing. With the possibility to enable wide working frequency range, eradicate off-chip passive elements in order to reduce the interconnection losses into negligible, and make ideal switches and resonators in circumstance of planar assembly well-suited with available IC and MMIC methods, RF-MEMS is extensively supposed to that advancement. The complete device is integration of converting circuit including rectenna, supercapacitor, power gating circuit, boost converter etc (A. Raj, 2016).

This energy so attained is either used directly or transformed to necessitate form to energize micro power electronic devices and sensors. This signal is sent to WSN for small power programmable applications etc. Owing to the technical growth in wireless communication, least cost and very low power WSN is developed. So this collected energy is used for sensing applications.

### **MEMS BASED ANTENNA SYSTEM**

A single multiband antenna is designed by means of a power sensor, hence it search for the frequency range having higher energy and accordingly adjust the tuning circuit by using Radio Frequency (RF) Microwave antennas composed of electrical/ mechanical components. To obtain multi-band operation reconfigurable antennas is developed with self-tuning beam forming, jamming/ Nosiness easing, low observability (V. A. Raj, 2016). Upon integrating less loss, higher isolation RF-MEMS switches with resonant/micro strip or fractal antennas, fundamentally constituted rectennas are obtained (V. A. Raj, 2016). The MEMS switches are sequentially interconnected or insulated on the planar antenna to make a separate



radiator of switch positions. The topmost view of assembled MEMS antenna array is shown in the figure. (Qazi, 2010)

In addition MEMS phase-shifters is interconnected along many antenna elements to know most economic Electronically Steerable Arrays (ESAs) (Christodoulou, 2003). These ESAs enables integration of dynamic device and signal processor in order to realize 'smart' antenna's capability to autonomous tuning of frequency band and radiation arrangement adaptation. RF-MEMS integrated along fractal rectenna assemblies is fundamental of advanced smart rectenna. This feature allows virtual separation of intruding RF energy through binary search process.

The figure above shows the close-up view at the center of assembled RF MEMS antenna array. This keenness helps for adaptations in rectenna output to comprise modifications in assignment, condition; acceptance to deficiencies and errors; and entrusting novel approaches through digital synthesis.

### **MEMS BASED CONVERTER**

The Energy received from the antenna is generally in the range of very high frequency and also not sufficient to drive the sensors or any low-power devices. Subsequently the energy harvested is insufficient to drive these continuously, collect and drive design is developed to overcome this issue (Singh et al., 2013). In order to convert the signals into convenient and useable form, the converter circuit is used. The converter circuit comprises of a) MEMS based tuned rectifier, b) MEMS supercapacitor, c) MEMS based DC-DC converter. The purpose of MEMS based tuned circuit is to convert the RF signals into DC signals. The tuned rectifier can be designed by MEMS components such as MEMS based inductors, RF MEMS switches, tunable capacitors etc. Since it

is operating under various frequencies, the tuned rectifier is designed by usage of adjustable components in its place of fixed one. This tuned rectifier drives a viable small powered DC-DC boost converter.

The supercapacitor is attached to the terminal of the rectifier circuit to stock sufficient energy. This supercapacitor has been used as charge storing device consists of electrolyte in between two-layered electrodes. This supercapacitor involve no chemical reaction either its charging or discharging action to promptly collect or release energy. As a power source without any chemical reactions, supercapacitor is well suited in pulse power applications like solid state sensors. Supercapacitors has simple structure and steady output. Supercapacitor stores energy temporarily from harvester and energizes the system for communication and WSN applications. A simple and adaptable planar MEMS supercapacitor with low contact resistance architecture made of porous CNT forests as electrodes is proposed in the various research articles. These planar MEMS supercapacitor is applicable in many systems such as harvesters, pulse power supplies, pioneering microelectronics and acts as on-chip capacitors (Jiang et al., 2009). The figure below shows the planar MEMS supercapacitor.

The boost converter efficiency fluctuates with the input voltage and hence the supercapacitor operative voltage range is stable such that it exploits the collective efficiency of RF-DC and the boost converter stage (Singh et al., 2013). The MEMS based voltage converter is made of a variable capacitor mechanically coupled to a micro-actuator. The charged and electrically isolated capacitor's voltage is improved by decreasing the capacitance while conserving. The variation in capacitance

is done mechanically by moving one electrode with an electrostatic micro-actuator. Promising areas of applications are self-powered, standalone sensors, aerospace and various types of piezoelectric or electrostatic MEMS devices. The figure shows the MEMS DC-DC converter circuit.

Owing to innovative technologies, it is desirable to use MEMS switches as a gating and leakage controlling circuits. MEMS switches have low insertion loss and high isolation, no power consumption, small size and weightless and low intermodulation distortion. It improves complete operation of the harvester. Hence the low power high frequency RF signal is converted into useable DC power. The usage of MEMS components in the converter circuits enables to integrate with micro-chip.

### **DISCUSSIONS AND APPLICATIONS**

The yield hence harvested is directly or transformed in to necessitate form is used for low power sensors and devices. The signal can also transmitted in to WSN and processed for low power programmable applications etc. Due to the developments in wireless communication technologies, low power and cheap WSNs can be made. This system has wide applications in strategic and sensitive zones where a large number of various sensors need to be employed. This signal is more enough for actuating temperature sensor, chemical sensor, GPRS data logger etc. The Wireless Sensor Networks are extensively used in devices related to monitoring, tracing and regulatory control. Few specific uses accounts fire detection, nuclear reactor control and traffic monitoring. Additional usages includes sensors based personal health monitoring, sensor networks based location detection and movement detection. Few of the wireless sensing

applications include

- a) Environmental monitoring.
- b) Military
- c) Vehicle Detection
- d) Greenhouse Monitoring
- e) Flame Monitoring
- f) Area monitoring
- g) Level Monitoring in well
- h) Medical/ Health
- i) Physical world
- j) Pump Counter

This energy harvesting device can also be used in single or array of Micro/ Nano mechanical sensing applications. Various MEMS and NEMs applications include Air bag accelerometer, Gyroscopes, MEMS for automotive pressure sensors, Consumer products, MEMS in safety and Control systems etc.

### **CONCLUSIONS**

The extremely competent wirelessly powered wireless terminal is attained with advanced development for faster, miniaturized, dynamically adjustable and least cost communication devices which takes low power with widespread range of frequencies for improved data rates and latest areas of application. Some examples of innovative constituents like less loss with huge isolation MEMS switches, resonators, reconfigurable antennas, filters and tuners, high-Q passives and low loss planar waveguide components and low loss phase shifters. Encompassing all, the most effective, miniaturized and least cost energy harvester is created. The complete system is designed in small size by using MEMS components, so that it can be integrated into micro-chip and can also be united with various Nano-mechanical sensors. It can also be mounted and incorporated with various Wireless sensing networks. This devices can also be integrated with few physical

transducers like motion, light, heat, EM field etc., thus the power unit will be strengthened and this arrangement is made effective and capable along with other physical sensing applications. The usage of Wireless Sensor Networks is expanded in defense and space crafts by comprising the latest technology in the design of constituents and power converting circuits. Due to this the problem related to power requirement for micro devices, periodic replacement of batteries for sensors can be overcome. Moreover, the size and weight of the device is much small so it can be mounted easily to any system. Once the technologies in integration of these components are improved in near future, the overall system can be more efficient.

## REFERENCES

- Christodoulou, C. G. (2003). RF-MEMS and its applications to microwave systems, antennas and wireless communications. Proceedings of the 2003 SBMO/IEEE MTT-S International Microwave and Optoelectronics Conference - IMOC 2003. (Cat. No.03TH8678).
- Haas, C. H., & Kraft, M. (2004). Modelling and analysis of a MEMS approach to dc voltage step-up conversion. *Journal of Micromechanics and Microengineering*, 14(9). <https://doi.org/10.1088/0960-1317/14/9/020>
- Jiang, Y. Q., Zhou, Q., & Lin, L. (2009). Planar mems supercapacitor using carbon nanotube forests. Proceedings of the IEEE International Conference on Micro Electro Mechanical Systems (MEMS), 587–590. <https://doi.org/10.1109/MEMSYS.2009.4805450>
- Jose, N., John, N., Jain, P., Raja, P., Prabhakar, T. V., & Vinoy, K. J. (2015). RF powered integrated system for IoT applications. Conference Proceedings - 13th IEEE International NEW Circuits and Systems Conference, NEWCAS 2015. <https://doi.org/10.1109/NEWCAS.2015.7182100>
- Jusoh, M., Jamlos, M. F., Nawawi, N. M., Alomainy, A., Kamarudin, M. R., & Hamid, M. R. (2013). Switchable parasitic antenna using PIN Diode- and MEMS-switches. RFM 2013 - 2013 IEEE International RF and Microwave Conference, Proceedings, 353–355. <https://doi.org/10.1109/RFM.2013.6757283>
- Qazi, S. (2010). MEMS-Based Wireless Communications. *Nanotechnology for Telecommunications*.
- Raj, A. (2016). Wideband Energy Harvesting Using MEMS for WSN Applications. *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (An ISO, 5(3), 1534–1538)*. <https://doi.org/10.15662/IJAREEIE.2016.0503070>
- Raj, V. A. (2016). MEMS based multi-band Energy Harvesting for Wireless Sensor Network applications. 2016 International Conference on Energy Efficient Technologies for Sustainability, ICEETS 2016, 573–576. <https://doi.org/10.1109/ICEETS.2016.7583819>
- Singh, G., Ponnaganti, R., Prabhakar, T. V., & Vinoy, K. J. (2013). A tuned rectifier for RF energy harvesting from ambient radiations. *AEU - International Journal of Electronics and Communications*, 67(7), 564–569. <https://doi.org/10.1016/j.aeue.2012.12.004>

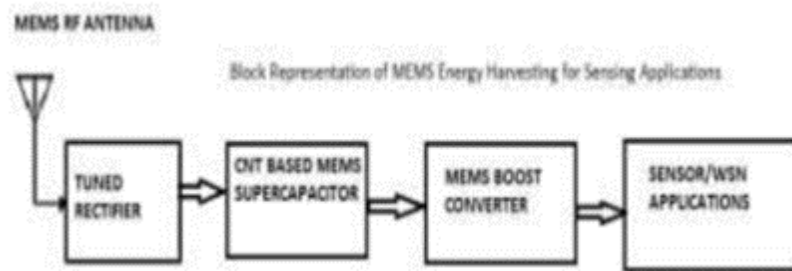


Figure.1 Block representation of Energy Harvesting System

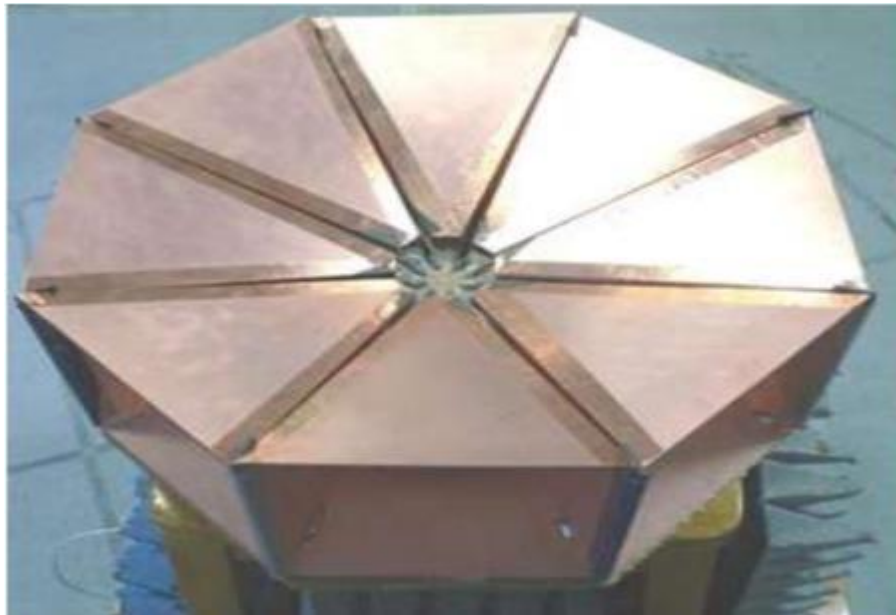


Figure 2. Top view of MEMS antenna array

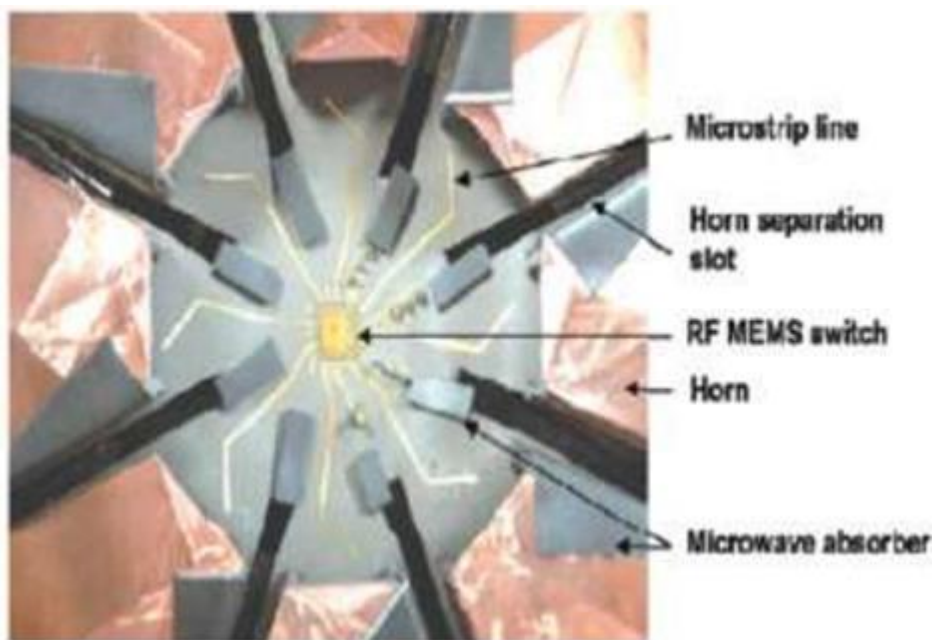
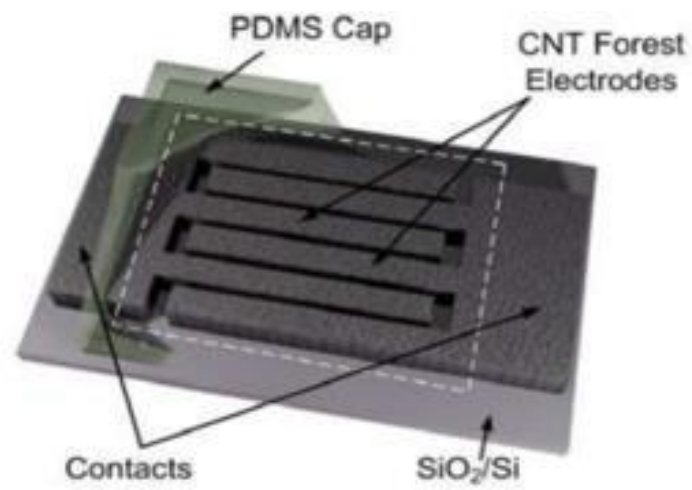
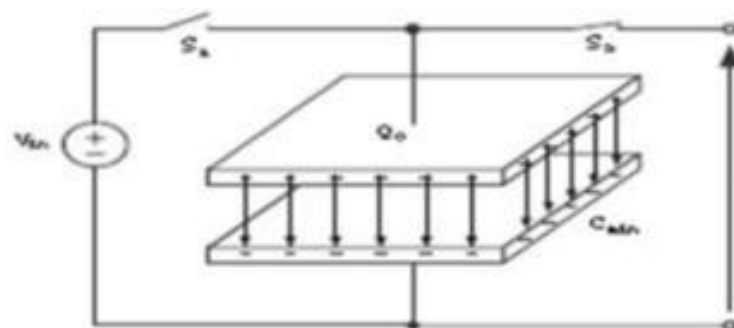


Figure.3 Close view of MEMS antenna array



**Figure.4 Planar MEMS Supercapacitor**



**Figure 5 MEMS DC-DC Converter**

# “Development of Toolkits and Checklists for Design of Public Transport Infrastructure - A Case Study of Raichur and Kalburgi Bus Terminal”

**Rohan N Ramaiya**

Infrastructure Engineering and Technology,  
B.V.M Engineering College,  
V.V Nagar, Gujarat, India,

**Prof. Jagruti Shah**

Asst. Prof. Structural Engineering Department,  
B.V.M Engineering College,  
V.V Nagar, Gujarat, India,

## **Abstract**

Due to the high income lifestyle, the Buses in India are facing a large reduction in passengers. For the system to function smoothly and Efficiently, the construction of bus terminals requires adequate planning, management and control systems. The study provides different sets of toolkits and checklists for transportation agencies and funding agencies. The toolkit and checklist include the main factors, namely the planning, design, monitoring and evaluation of the bus terminal, and further include: 1) Accessibility; 2) Safety and Security; 3) Civil / Structural components; 4) facilities and infrastructure; 5) Way findings and information system; 6) Financing for the bus terminal when the bus terminal is developed.

**Keywords:** Bus Depot, Bus Terminal, Checklists, Toolkits

## **INTRODUCTION**

Public transport means the carriage of a passenger using a public transport passenger vehicle by a public passenger service. Both public transport, either on highways, rail, airways or seaways, operates on infrastructure.

Population and urban growth have an effect on the production and expansion of public transport services. It was done to meet the rising needs of humans and to avoid the problems created by the increasing flow of traffic. The increase of the population's living standards poses a challenge to the public transport priority, i.e. more people prefer private transport, which is quicker, more convenient. The nation is working hard to transform itself over the next few decades, with an increasing population too. Strong on the agenda is developing public transport.

## **OBJECTIVE**

The main objective of the study is to prepare the toolkits and checklists for

the designing and Funding of the Public transport infrastructure mainly focused on Bus Terminal.

## **NEED FOR THE STUDY**

Development of toolkits provides the ability to create a tailored solution – for the best integration with other systems, and the ability to build in customized functionality that may more directly meet the needs of the enterprise.

The main objective of developing the toolkit is to do a quick assessment of the new public transport infrastructure proposal by the agencies before submitting the proposal to State Urban Transport Funding Agency.

## **METHODOLOGY**

The Toolkits and checklist were prepared for four processes i.e. 1) Designing; 2) Funding 3) Monitoring and 4) Evaluation and Further Sub Divisions were done i.e. 1) Accessibility; 2) Safety and Security; 3) Civil/Structural components; 4) Amenities and

Infrastructure; 5) Way findings and Information system; 6) Financing

### COMPARISON OF GUIDELINES

Majorly 4 guidelines were studied for the Bus Terminal Design 1) "Bus Terminal Design Guidelines" by Shakti Sustainable Energy Foundation, 2) "Public Transport Infrastructure Manual (PTIM)" by The State of Queensland (Department of Transport and Main Roads) 2015. 3) "RTD Bus Infrastructure Design Guidelines and Criteria" Denver, Colorado (2016). 4) "Guidelines for the Development of Public Transport Interchange Facilities" NSW ministry of Transport (2008).

It was found that the Shakti Bus Terminal Design Guidelines contains all the important and common information for development of Checklist and Toolkits

### CASE STUDY

For the Case Study Raichur Bus Terminal and Kalburgi Bus Terminal was taken and was studied with compared to the standard Shakti Guidelines.

### RESULTS

#### Toolkits

Various toolkits were created in the excel file for the help of transport agency.

#### Checklists

Checklists are prepared as per the guidelines for designing and funding process. There is the list of parameters that has to be checked whether construction process (i.e. design, fund, monitor and evaluation) going on according to the toolkit provided.

### CONCLUSION

In construction of Bus terminal, the Design, Funding, Monitoring and evaluation are the process to follow. Toolkit was prepared for the Designing, Funding, Monitoring and Evaluation of the Bus Terminal for the Transport Agency and Users

The toolkits were prepared in Excel file, to take into further study toolkit can be prepared as a software by following the same procedure as mentioned. Software of toolkit will be more useful in the process of construction.

### REFERENCES

- A. Jahic, M. E. (2019). Bus Depot Simulator: Steady-State Python and DigSilent Co-simulation for Large Scale Electric Bus Depots.
- Anastasia Caroline Sutandi, W. S. (2018). ITS Design Priority at Large Bus Terminal in Indonesia in Supporting Sustainable Transportation.
- Bismi M Buhari, A. V. (2020). Planning of New Municipal Bus Terminal, Pandalam.
- Chakib.Kara-Zaitri, & Derek.J.Howarth. (1999). Fire safety management at passenger terminals. Disaster Prevention and Management: An International Journal, 362-369.
- Dr.K.Krishnaiah, D. B., & R.Baskaran. (2010). Performance Evaluation of Bus Depots Using AHP. International Journal of Industrial Engineering Research and Development (IJIERD), 49-63.
- G.B.Bhaskar, & N.T.Wadhai. (2017). Analysis and Design of Advanced Bus Stand. IJSTE - International Journal of Science Technology & Engineering, 88-98.
- Jay.S.Pandya, & Prof.Yogesh.Patel. (2018). Redesign of Gandhinagar bus terminal a Case study. International Research Journal of Engineering and Technology (IRJET), 1150-1152.
- John.Pucher, Nisha.Korattyswaropama, Neha.Mittal, & Nennu.Itteyerah. (2004). Urban transport crisis in India.

- Khosyiatillah Hakima, B. J. (2016). A Japan compact bus terminal; Review on Hakata bus terminal.
- Lee Yin Mun, W. K. (2019). A study on the Barriers in Accessibility for the Disabled at Bus Terminal.
- Markus.Dietmannsberger, Marc. Schumann, Marc. Meyer, & Detlef. Schulz. (2017). Modelling the Electrification of Bus Depots using Real Data: Consequences for the Distribution Grid and Operational Requirements. 1st E-Mobility Power System Integration Symposium.
- MD.Anamul.Hasan. (n.d.). Structural Design of a Bus Terminal. Asia Pacific Rail, 1-5.
- Mohammad Faysal, N. Z. (2018). Assessing Social and Environmental sustainability of Sonadanga Bus Terminal, Khulna.
- Moka.Eshwar, A.Titus.Manohar, & Akshay.Mani. (2018). Fleet Management of Public Transportation using Internet of Things. International Journal of Engineering & Technology, 388.
- Nils den Hartog, A. A. (2017). Structuring private sector participation in the Dammam, Saudi Arabia,public transport project.
- S.Logeswaran. (2017). Design Standards for Planning a Bus Terminus. International Journal of Advanced Research in Basic Engineering Sciences and Technology (IJARBEST), 411-414.
- SGA.Architects. (2017). Bus Depot Design Guidelines. Delhi.
- Syed Muhammad Arif, T. T. (2020). Plug-In Electric Bus Depot Charging with PV and ESS and Their Impact on LV Feeder.
- (2006). The BRT planning Guide. New York.
- Vitor E. M. Cardoso, N. M. (2018). A discussion about thermal comfort evaluation in a bus terminal.
- Wrold bank Group and PPIAF. (n.d.). Retrieved from Urban Bus Toolkit: [https://ppiaf.org/sites/ppiaf.org/files/documents/toolkits/UrbanBusToolkit/assets/3/3.1/35\(vii\)b.html](https://ppiaf.org/sites/ppiaf.org/files/documents/toolkits/UrbanBusToolkit/assets/3/3.1/35(vii)b.html)



## Appendices

### Table 1

#### Design Checklists

SR NO	PARAMETERS		YES/NO
<b>A</b>	<b>INFRASTRUCTURE AND AMENITIES</b>		
1	Passenger areas	Drinking water	
		Toilets	
		Seating facilities	
		Help desk	
		Cloak Room	
		Canteen	
		lockers	
		Ticket Collector room	
2	Availability of Passenger amenities facilities	Free Wi-Fi facility in waiting area	
		Baggage trolleys	
		ATM	
		Phone Booth	
		Electric Plug points	
		Dust bins	
3	Areas for terminal staff	Revenue office	
		Security and information	
		Ticketing booth	
		Resting room	
		drinking water	
		toilets	
		Canteen	
		lockers	
		Control room	
		Resting areas	
		Dormitories	
4	Designated Parking area	2-wheelers & 4-wheelers	
		Drop Off Zone	
		Bicycle Stands	
		Auto rickshaws	
		Structured	
		At Grade	
5	Bus bay allocation	Saw tooth bays	
		Angular bays	
		Perpendicular bays	
		Drive through	
		Linear/parallel bays	
<b>B</b>	<b>CIVIL/STRUCTURAL COMPONENTS</b>		
1	Availability of design basis report		
2	Drainage system		
3	Rainwater harvesting		
4	Solar panels on roof top		
5	Water management		
6	Materials used in construction		
<b>C</b>	<b>SAFETY AND SECURITY</b>		
1	Fire Fighting		

2	Safety from any dangerous/hazardous items if any (e.g. transformers/Electric Pole/Well/Open nala, etc) (Within the proposed site)		
3	Provision of lighting facility		
4	Provision of alternative entrance for emergency vehicles, in case of emergency		
<b>D</b>	<b>ACCESSIBILITY</b>		
1	Feeder infrastructure		
2	Entrance for the Commuters / Passengers	Dedicated Entrance	
		Provision of a footpath network within the Bus Terminal	
3	Entrance for universal accessibility	Presence of ramp	
		width of Passage / Corridor	
		Presence of street braille	
4	Connectivity between the platforms	At grade pedestrian crossing	
		Stairs/Lift/Ramp/Escalator	
<b>E</b>	<b>INFORMATION AND SIGNAGE</b>		
1	Marking on pavement for bus bays		
3	Schedule information		
4	Printed guided material (i.e. Route and Terminal layout information)		
5	Telephone enquiry (operator)		
6	Website information		
7	Customer offices		
8	Appropriate signage inside the terminal:	a) Variable message signs	
		b) Display boards	

Table 2 Funding Checklists for Transport Agency

FOR TRANSPORT AGENCY		
Sr. No.	Particulars	AMOUNT
<b>1</b>	<b>Estimation</b>	
a	Basement area	
b	Ground Floor area	
c	First Floor area	
d	Second Floor area	
e	Third Floor area	
f	Parking area	
g	Toilet Blocks	
h	Compound Wall	
i	Sewage Treatment Plant	
j	Electrical Systems	
k	Miscellaneous	
<b>2</b>	<b>Agencies</b>	
2.1	Funding By Transport Agency	
2.2	Funding By Other Agency	
	<b>Total</b>	

**Table 3 Monitoring Checklists for Transport Agency**

SR.NO.	ACTIVITY	Y/N
<b>A</b>	<b>GENERAL CHECKS</b>	
1	Availability of all the latest relevant GFC drawings.	
2	Availability of measurement batch boxes on site.	
3	Concreting carried out in the presence of an engineer.	
4	Checking of vibrators done before concreting.	
5	Are stand by vibrators and vibrator needles available at site.	
6	Are the shuttering and the reinforcement works complete before concreting	
7	Is the concrete placed and compacted within half an hour of its mixing	
8	Is the work executed in conformance with the drawings and details supplied by the structural consultant	
9	Approval from the quality engineer obtained regarding the	
10	satisfactory completion of formwork, reinforcement, cover	
11	block fixing and electrical conduit laying before concreting	
<b>B</b>	<b>SUBSTRUCTURE</b>	
1	<b>PLAIN CEMENT CONCRETE (PCC)</b>	
	Are polythene sheets spread properly before concreting ?	
	Is curing by sprinkling of water started as soon as the surface starts drying ?	
	Level of finish checked and concreted when concrete is fresh.	
	Uniform compaction with straight edge/ wooden runner done.	
	Are the laborers wearing gum boots, gloves etc. while concreting.	
	Slump checked at the site lab by the concerned personnel regularly.	
2	<b>FOOTING CHECKS</b>	
	Is layer wise concreting followed with the height of a single concrete layer	
	Level of finish checked and concreted when concrete is fresh.	
	Is rough finishing done in the footing-column interface.	
3	<b>COLUMN CHECKS</b>	
	Are column boxes aligned properly & to the required dimensions	
	Concreting of column done up to the beam bottom level.	
	Required number of concrete cubes for testing cast on site.	
	Concrete surfaces not damaged while deshuttering	
	Plumb of column box and checked before concreting.	
	Are PVC pipes for keeping the tie rods cut in flush with the finished surface	
4	<b>SLAB AND BEAM</b>	
	Is concreting being carried out only after plumbing and electrical clearance?	
	Is the beam line as per the drawings	
	Is the plumb of beam sides checked	
5	<b>REINFORCEMENT CHECKLIST</b>	
	Ensure that anchors are provided as per drawings at the edges of the footing	
	Check if the cover blocks are of correct sizes and at correct spacing	
	Are the development length and anchorage length that are provided as per drawing	
	Check if the main reinforcement provided for any member parallel and spaced is as per GFC drawings	
	Check If the secondary reinforcement provided for any member parallel and spaced is as per GFC drawings	
	Ensure that the spacing between the stirrups and the total number of stirrups along the length of the footing as per the drawings	

	Ensure that the reinforcement bars that are projecting out of the current area of concreting are parallel	
	check if stirrups for columns are provided up to the bottom of each footing and at the beam-column junction	
	Ensure that the provision of dowels for future extensions are done as per the drawings	
	ensure that the ends of the dowels for future extension are covered properly with polythene sheets	
	Ensure that the extra reinforcement in sleeves and pipes openings in the slabs are per the design and checked by the structural consultant	
	Check if all rods of the slabs and beams are cut according to the drawing and running visually parallel to each other	
	Check if the number of rods and their diameters, in beams and slabs and the provision of dowels are according to the drawings	
	Ensure that U-Hook are provided in the retaining walls	
6	<b>RAINWATER HARVESTING</b>	
	Placement of support base per plan.	
	Distribution system installed per plan.	
	All pipes from roof are directed to device	
	Mosquito screens and overflow device installed.	
7	<b>Drainage system constructed according to the plan.</b>	
8	<b>Plumbing works are done as per specifications</b>	
9	<b>electrical works are done as per specifications</b>	
C	<b>SUPER STRUCTURE</b>	
1	<b>MASONRY</b>	
	<b>STONE MASONRY</b>	
	Is mortar mix proportion maintained as per specifications using measurement boxes	
	Are the vertical keys & horizontal bonds staggered	
	Are the horizontal bond stones at 1m intervals in each course	
	Are the vertical keys kept at 1m intervals in each course	
	<b>BLOCK MASONRY &amp; BRICK MASONRY</b>	
	Is the course under the beam bottom built with full blocks	
	Is the gap between the beam bottom and the top most course thoroughly packed with mortar	
	A concrete band (1:2:4 concrete) of thickness 100mm, laid with 6 to 8mm steel rods embedded inside, after every 4 courses, for walls of width 100mm.	
	Are the sizes of the mortar joints uniform and not more than 10mm.	
	Compound wall constructed according to specified height and other specifications	
2	<b>PLASTERING</b>	
	Trowel finish for internal plastering	
	Using of L angles for external cladding, door and window mortar bands	
	Skirting top packing	
	Use of MS L- Angle	
3	<b>PAINTING WORK</b>	
	Scaffolding are properly fixed	
	Surface voids, pores and cracks are filled	
	Dry up priming coat for 48 hours	
	Electrical, water supply, sanitary pipes and door and window frames are fixed	

	ensure that the surface is wet before applying cement paint	
4	<b>FINISHERS</b>	
	Dedicated Entrance provided	
	Provision of a footpath network	
	Presence of Passage / Corridor, Stairs/Lift/Ramp/Escalator	
	Bus boarding bay arrangement (Saw tooth bays/Angular bays/Perpendicular bays/Drive through/Linear/parallel bays) are provided	
	Required number of toilet constructed according to the plan and specifications	
	Marking on pavement for bus bays	
	Cat box provided where ever required	

**Table 4**  
**Evaluation Checklists for Transport Agency**

EVALUATION CHECKLISTS FOR TRANSPORT AGENCY			
Sr. No.	SPECIFICATIONS	Y/N	
1	Civil/Structural components (each question carries 01 marks)		
1.1	Concrete/Paved Area at Terminal		
1.2	Paved parking Area inside/outside the terminal		
1.3	60°/45° Angled Bus Parking		
1.4	UCR/CR Masonary Compound Wall		
1.5	Doors/Windows/Entrance as per DPR		
1.6	Beams/Columns as per DPR		
2	Proper Linkage to bus terminal		
3	Proper Signage outside/inside terminal		
4	Sustainability (each question carries 01 marks)		
4.1	Rainwater harvesting system		
4.2	Roof top solar PV cells		
4.3	Proper Drainage system for the terminal		
4.4	Proper lighting in the terminal		
4.5	Noise/Air pollution under control		
5	Is cleanliness maintained while handing over terminal		
Total (14)			
* Each Yes carries 1 marks, No carries 0 marks			
Level of Service (LoS)			
Sr.No	Score	LoS	Description
1	Score (11-14)	A	Excellent
2	Score (7-10)	B	Good
3	Score (4-6)	C	Average
4	Score <=04	D	Poor

**Table 5**  
**Evaluation Checklists for Users**

EVALUATION CHECKLISTS FOR USERS		
Sr. No.	Specifications	Y/N
<b>COMFORT</b>		
1	Drinking water/Toilets	
2	Seating arrangement and Waiting Rooms	

3	Shops/canteen		
4	Air pollution and noise pollution under control		
5	Bus terminal is clean and dust bins provided where ever required		
CONVINIENCE			
6	Ticket counter/help desk		
7	Lifts/ escalators at terminals		
8	Transfers availability ( City bus service/IPT (auto/cab/ cycles)		
9	Parking facilities in the terminal (24/7)		
10	Announcements (Audio/ visual) and Availability of crew members for information		
11	Availability of Intelligent Transport System(ITS)		
12	Availability of 24/7 help counters for information		
SAFETY			
13	Availability of emergency services (first aid/ health room)		
14	Lighting facility and fire extinguishers		
TOTAL(14)			
* Each Yes carries 1 marks, No carries 0 marks			
Level of Service (LoS)			
Sr.No	Score	LoS	Description
1	Score (11-14)	A	Excellent
2	Score (7-10)	B	Good
3	Score (4-6)	C	Average
4	Score <=04	D	Poor

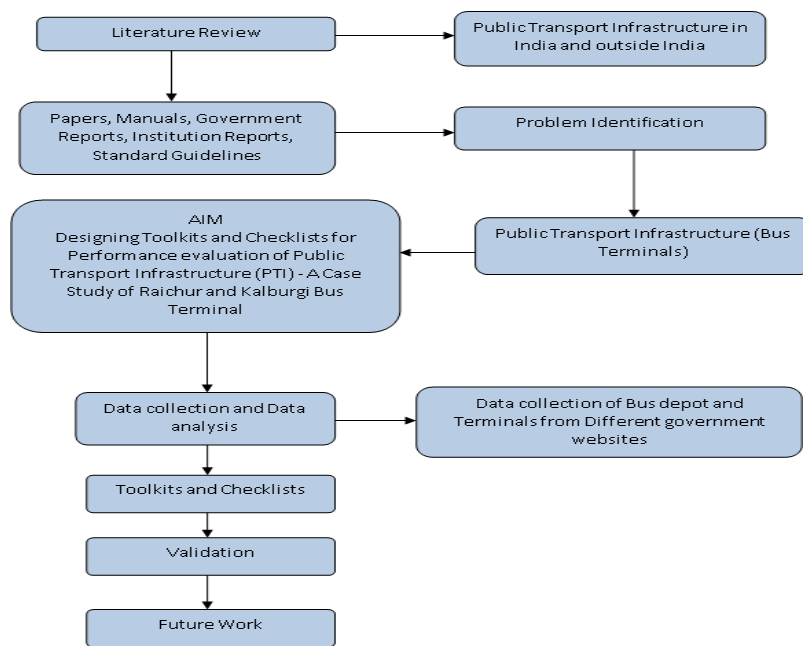


Figure 1 Process for Creation of Checklists and Toolkits

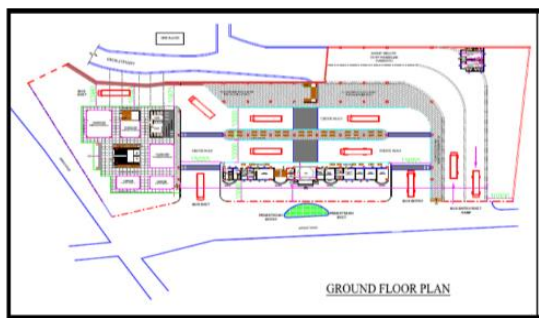


Figure 3 Kalburgi Bus Terminal

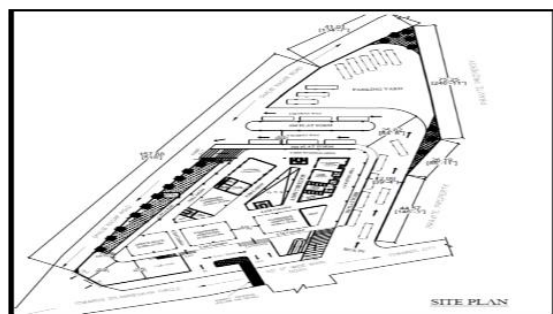


Figure 2 Raichur Bus Terminal

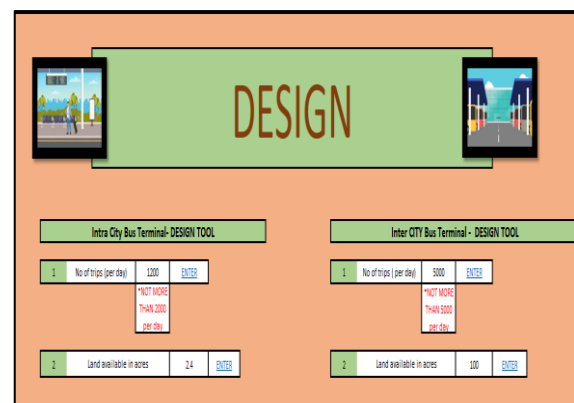
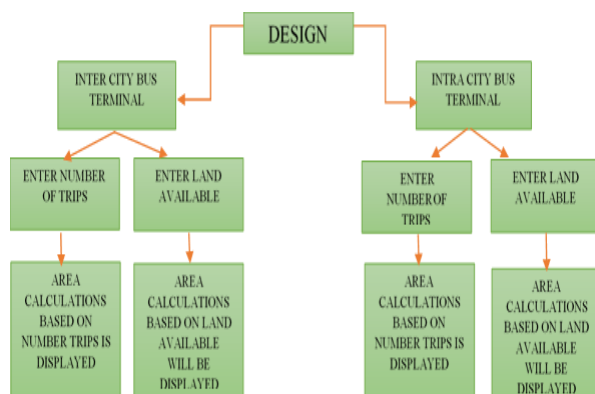


Figure 4 Toolkit for Designing of Bus Terminal

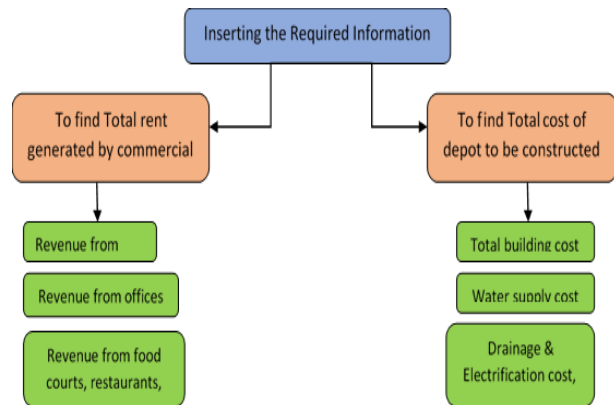


Figure 9 Working of Funding Toolkit

**FUNDING BY TRANSPORT AGENCY**

PLEASE ENTER THE INFORMATION BELOW

Total Terminal Area (Sq.mt.)	2000
Total Commercial Area (Sq.mt.)	3000
Construction Cost/Sq.mt	1000
Total Parking Area (Sq.mt.)	5000
Compound Wall (Mt.)	200

Total Commercial Rental:  ENTER

Total Terminal Cost:  ENTER

Figure 8 Toolkit for Funding of Bus Terminal

**MONITOR**

PROJECT NAME	PROJECT DURATION IN DAYS	PROJECT START DATE	PROJECT END DATE
BUS TERMINAL CONSTRUCTION	189	10-Aug	15-Feb

Enter project start date

MILESTONE 1		MILESTONE 2		MILESTONE 3	
SUBSTRUCTURE	TASK DURATION	SUPERSTRUCTURE	TASK DURATION	FINISHERS	TASK DURATION
<input type="text"/> ENTER		<input type="text"/> ENTER		<input type="text"/> ENTER	

Figure 7 Toolkit for Monitoring of Bus Terminal

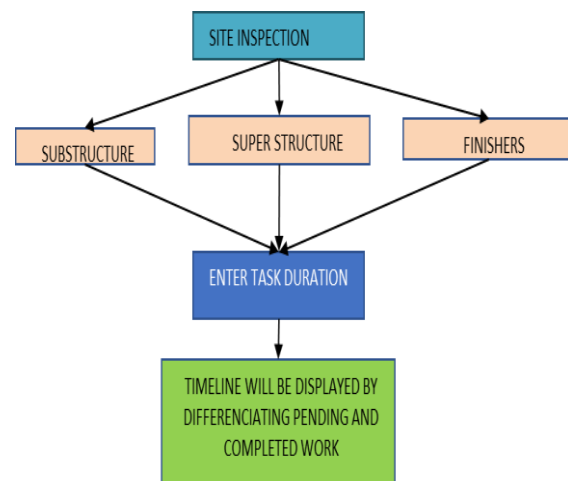


Figure 6 Working of Monitoring Toolkit

**EVALUATION**

**BUS TERMINAL**

STEP 1: TO ENTER SURVEY RESULTS  ENTER

STEP 2: TO CALCULATE LEVEL OF SERVICE

OUTSTANDING: Excellent, Very Good, Good, Fair, Poor

Figure 11 Working of Evaluation Toolkit

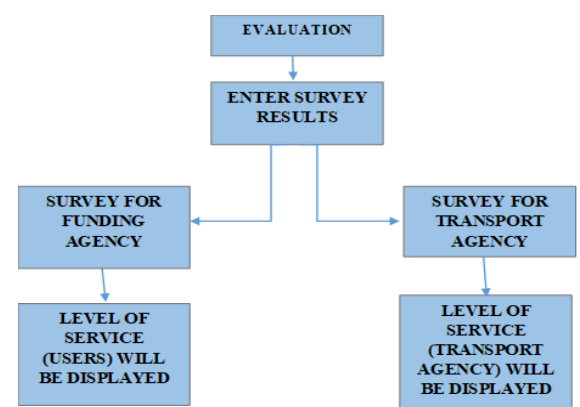


Figure 10 Toolkit for Evaluation of Bus Terminal



# Stabilization of Soil using Sewage Sludge as Admixture

BindhuLal

Professor, Dept. of Civil & Env. Engg.  
Birla Institute of Technology, Mesra, Ranchi, Jharkhand, India

Sukeerti Bansal

PG student, Dept. of Civil & Env. Engg.  
Birla Institute of Technology, Mesra, Ranchi, Jharkhand, India

## Abstract

The geotechnical properties of soils having poor strength characteristics are improved by stabilizing the soil with admixtures. Even though stabilization is carried out with different admixtures like cement, lime etc., now a days, more emphasis is given on using environmental pollutants as admixtures. In this paper, sewage sludge which is a waste product from domestic household is used for stabilizing the soil. The soil used for stabilization is silty sand having low strength characteristics. Soil is mixed with sewage sludge (SS) in different proportions (1% to 6%) by weight and studied the change in its strength properties such as Optimum Moisture Content (OMC), Maximum Dry Density (MDD), California Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS). Micro level investigations like Scanning Electron Microscope (SEM), Energy dispersive X-ray spectroscopy (EDS) test, Differential thermal analysis (DTA) and Thermo Gravimetric Analysis (TGA) is also performed to find the change in mass with respect to temperature and variation in chemical composition of soil with addition of sludge. Results show that the optimum value necessary for improving the strength properties of the soil considered is 2% of sludge by weight of soil.

**Keywords:** Soil stabilization, sludge, Unconfined Compressive strength, California Bearing Ratio, Micro level Investigations

## INTRODUCTION

Government of India has undertaken a programme known as 'Pradhan Mantra Gram Sadak Yojana (PMGSY)' to provide connectivity to all rural habitations under the Ministry of Rural Development. As rural roads mainly cater to the needs of village people in transporting agricultural products, they are designed as flexible pavements with low volume traffic. Flexible pavements are largely preferred for low volume roads because initial cost is low, construction can be done in stages, and can be easily opened to public. Hence in the strength characteristics and economic point of view these roads need not require the conditions to be satisfied by Highways and State Roadways. Locally available soil is used in sub grades of rural roads. Soil stabilization is one of the methods of improving the strength characteristics of in

situ soil. The two methods of soil stabilization are compaction and addition of admixtures. Several materials like cement, lime, polypropylene fibre, and bitumen are used as admixture. Even though addition of these admixtures increased the strength of soil, industrial and agricultural wastes are replacing the above admixtures as they are costly. [1] studied the changes in properties like atterberg limits, specific gravity, cohesion, maximum dry density and optimum moisture content of three different types of soil when mixed with waste of paper industry (WIP). Results show that WIP can be used as a stabilizer for soil stabilization for sub-base of forest roads. [2] studied the influence of using rice husk ash in soil stabilization with lime. The results generally indicate that adding lime and rice husk ash (RHA) causes a decrease in dry density, increase in optimum water content, a decreasing rate in liquid limit

and plastic limit, a decrease in deformability of soil samples and an increase in shear strength. The studies conducted by [3] on soil stabilization using rice husk ash and cement showed that the increase in RHA content increases the OMC but decrease in MDD. An optimum value of 10% RHA content with 6% cement increases the CBR and UCS of soil. Studies were also done on soil stabilization with rice husk ash and lime sludge [4], rice husk ash and cement [5], rice husk ash and fly ash [6], rice husk ash and cement kiln dust [7], rice husk ash and garlic skin [8] and soil-cement-lime-rice husk ash (soil-CLR) mixture [9] which showed satisfactory results. [10] studied soil stabilization by using ground pulp and coconut pulp as stabilizers and results show that MDD and CBR improved after the addition of admixtures to the soil. Recently, attempts are being made to use domestic waste/kitchen waste as stabilizers since their disposal is an environmental problem. One such pollutant is Sewage Sludge (SS). Sewage sludge (SS) is a by product of wastewater treatment. Wastewater and storm water enter the sewage system and flow into wastewater treatment facilities, where the solid wastes are separated from the liquid wastes through settling. This settled material is taken out and thrown in the nearby lands for drying. The chemical constituents in sewage sludge depend on the treated wastes and processes used. Sewage sludge basically contains biodegradable organic matter with macro nutrients such as nitrogen and phosphorus and micro nutrient as zinc. [11] conducted studies on treatment of soft subgrade soil by sewage sludge ash and cement. In this study, Incinerated Sewage Sludge Ash (ISSA) is mixed with cement in a fixed ratio of 4:1 for use as a stabilizer to improve the strength of soft, cohesive, subgrade soil. Five different ratios in weight percentage (0%, 2%, 4%,

8%, and 16%) of ISSA/cement admixture are mixed with cohesive soil to make soil samples. To understand the influences of admixtures on the soil properties, pH value, Atterberg limits, compaction, CBR, UCS, and triaxial compression tests were performed on those samples. The study shows that the UCS of specimens with the ISSA/cement addition was improved to approximately 3–7 times better than that of the untreated soil. In the above study, sewage sludge is converted to ash by burning which is wastage of resources like coal and petroleum as it is again costly. The sludge may lose its properties while burning. In this study SS is used in the raw form. The product from waste water treatment plant was first dried in air and then oven dried. Dried sludge is then converted to fine power by grinding in pulveriser and used as admixture.

## **MATERIAL AND METHODOLOGY**

### **Material characterization**

#### **Soil**

The soil used for the study is collected from district Faizabad in Uttar Pradesh, India (Fig.1). Soil characterization is done by conducting tests as per Indian Standard Specifications. The tests for index properties like Atterberg limits, grain size analysis, specific gravity and tests for strength characteristics like Proctor Compaction, CBR (soaked and unsoaked) and UCS were performed and the results are summarized (Table 1 and Fig.2). The quality of sub grade based on UCS and CBR values is categorized by the Indian Road Congress Guidelines IRC SP: 72-2007 *Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads* (Table 2 and Table 3). It is seen from the grain size analysis the soil is silty sand which is non-plastic and is of poor quality as the CBR values (soaked and unsoaked) are between 3-4 and UCS value is 60 KPS.

## **Sewage sludge (SS)**

Sewage Sludge is a semi-solid material which is the end product from the waste water treatment plant of industry or municipality. When wastewater enters a primary settling tank, approximately 50% of the suspended solid matter will settle down. This collection of solids is known as raw sludge or primary solids and is said to be "fresh" before anaerobic processes become active. The sludge will become putrescent in a short time once anaerobic action starts. Hence digestion of sludge has to be done to convert the organic matter present in the settled sludge of the primary and final sedimentation tanks to aerobic condition. Digested sludge will be free from pathogens, have less volume and water content and also its organic matter will be stabilized and industrial value recovered. This is disposed by drying and then land filling.

In this study the digested sewage sludge from Waste Water Treatment Plant, MECON, Ranchi is used as admixture. Sludge which is semi-dry at the collection point is air dried, oven dried for 24 hrs and grinded in the pulveriser into fine powder. This fine powder is mixed with soil for stabilization. The physical and chemical properties of sewage sludge is shown in Table 4

## **Methodology**

The various laboratory tests conducted to know the change in properties of the soil when mixed with sewage sludge are Specific Gravity test, Proctor Compaction, CBR (unsoaked and soaked) and UCS. The tests are performed on soil by mixing various percentages of sewage sludge. To verify the test result and to substantiate the results, micro level studies have done with the help of Scanning Electron Microscope (SEM), Energy Dispersive X-ray Spectroscopy (EDS), Differential Thermal

Analysis (DTA) and Thermo Gravimetric Analysis (TGA) [12].

## **RESULTS AND DISCUSSION**

### **Effect of stabilisation on strength characteristics of soil**

Standard compaction test is done to get the OMC for conducting UCS and CBR. The soil is mixed with varying proportions of SS from 1% to 6% with increments of 1% and the OMC and MDD for different proportions are tabulated in Table 5. It is seen from the results that there is slight variation of OMC and MDD up to 2%. But at 3% the OMC has increased which may be due to the fact that, SS being finer than soil sample, the treated soil sample tends to be finer and have bigger voids ratio which results in an increase in OMC. The decrease in specific gravity with the addition of SS is due to the replacement of soil by SS which is having very low specific gravity.

UCS tests are conducted to know the compressive strength of treated soil when it is used as subgrade.

The results (Table 6) show that the value of UCS increased up to 2% and then started decreasing. Since the specific gravity of SS is very less, the size of the particles will be very fine and it blends well with soil by occupying the pore space of soil sample. Hence the compressibility increases. But as the percentage of SS increase, voids decrease and there is a chance of decrease in compressibility. The value of UCS at 2% has improved from 60% to 91 % and it can be considered as a stiff subgrade.

One of the design parameters to calculate pavement thickness is CBR. Tests are done to determine the CBR (soaked and unsoaked) of soil sample treated with SS and results are tabulated (Table 6, Fig.3, Fig.4). The results show that the values of CBR

(soaked and unsoaked) started decreasing as the percentage of SS added increased from 2% to 3%. Hence 2% by weight of soil can be considered as optimum value for this silty sand. The increase in fineness of treated soil sample as the percentage of SS increases may be the reason for decrease in strength values. An increase in strength up to 2% may be due to the organic matter present in SS which tries to bond the soil particles. Even though soaked CBR for soil treated with 1% SS is more than that mixed with 2%, since UCS is more in the latter case, 2% of SS is considered as optimum value.

### Microlevel Investigation

In a scanning electron microscope a focused beam of high-energy electrons is used to generate a variety of signals at the surface of solid specimens. A lot of information about the sample including external morphology (texture), chemical composition, and crystalline structure and orientation of materials making up the sample is revealed from the signals derived from interactions. The virgin soil, SS and soil mixed with varying percentages (1%, 2%, 3%, 4%, 5% and 6%) of SS are analyzed using SEM images (Fig.5 – Fig.12). The SEM image of soil + 2% SS shows that, when compared to other images, SS has occupied the voids of soil sample wholly.

Energy Dispersive X-Ray Spectroscopy (EDS or EDX) is used in conjunction with scanning electron microscopy (SEM). It is a chemical microanalysis technique done to identify the micro structural developments in the matrix of any sample and to qualitatively determine the minerals present in the sample. EDS graphs represent the peak value of each element present in soil sample. The EDS graphs show a change in chemical composition of soil with the addition of admixtures. EDS graphs are

plotted for virgin soil and soil treated with SS (Fig.13 -Fig.20). The mineral composition (Table7-Table14) shows that soil treated with 2% SS contains more minerals, mainly presence of calcium, than other combinations which may be the reason for increase in strength characteristics at 2% as calcium is a binding material.

DTA is a thermo analytical technique which measures the energy changes when a sample is heated or cooled. The data on the transformations like glass transitions, crystallization, melting and sublimation can be obtained from DTA curves. In TGA the sample is heated at controlled rising temperature condition and changes are recorded and charts which shows the thermal characteristics are obtained. DTA and TGA are performed for virgin soil, SS and soil mixed with varying percentages (1%, 2%, 3%, 4%, 5% and 6%) of SS (Fig.21- Fig.28). The DTA and TGA graphs of virgin soil and soil sample treated with SS is not showing any variation even at higher temperatures which is an indication that SS is not influencing the soil index properties

### CONCLUSIONS

In this study, SS which is an environmental pollutant is used as admixture to stabilize the soil. The soil used is silty sand which is weak in strength characteristics.

Based upon the above study, results can be concluded as follows:-

1. Soaked CBR value of the soil for the optimum mix proportion has increased from 2.935% to 6.67% which shows that SS is enhancing the strength of soil.
2. On stabilization of soil, result shows that UCS value has increased from 60.51KN/m<sup>2</sup> to 90.99KN/m<sup>2</sup>.

3. SEM results show that with the addition of sludge void's ratio is decreasing.
4. EDS results show the presence of calcium with 2% addition of sludge to the soil which may be one of the reasons for increasing the strength of stabilized soil.
5. DTA and TGA analysis shows that at high temperatures SS will not influence the index properties of soil  
Since the strength characteristics of soil (UCS and CBR) have improved and index properties have changed, SS can be considered as a good admixture for soil stabilization.

### REFERENCES

- Habip Eroglu, H. Hulusi Acar, Osman Ucuncu (2003), "Soil Stabilization with waste of paper industry for Sub-Base of Forest Roads", Austro2003: High Tech Forest Operations for Mountainous Terrain, 1-8.
- A.J. Choobbasti, H. Ghodrati, M. J. Vahdatirad, S. Firouzian, A. Barari, M. Torabi, A. Bagherian (2010), "Influence of using Rice husk ash in soil stabilisation method with lime", *Frontiers*, 4(4) : 471-480
- Aparna Roy (2014), "Soil stabilization using rice husk ash and cement", *International Journal of Civil Engineering Research*, 5, (1): 49-54
- Chandra S, Kumar S, Kumar Anand R (2005), "Soil stabilization with rice husk ash and lime sludge", *Indian Highways*, 33(5) : 87-98
- E A Basha, R Hashim, H B Mahmud, A S Muntoha (2005), "Stabilization of Residual soil with Rice husk ash and cement", *Construction and Building materials*, 19(6): 448-453
- Robert M. Brooks (2009), "Soil Stabilization with flyash and Rice husk ash", *International Journal of Research and Reviews in Applied Sciences*, 1(3): 209-217
- Khandaker, M. and Hossain, A., 2011, "Stabilized Soils Incorporating Combinations of Rice Husk Ash and Cement Kiln Dust," *Journal of Materials in Civil Engineering*, 23(9): 1,320-1,327
- M. Jaiswal and B. Lal (2017), "Stabilization of Clayey Soil with Garlic Skin and Rice Husk Ash for Flexible Pavement Construction," *Geotechnical Testing Journal* 40 (6): 1071-1082
- Younes Bagheri, Fauziah Ahmad, Mohd Ashraf Mohamad Ismail (2014), "Strength and Mechanical behaviour of Soil – Cement – Lime – Rice husk ash(soil – CLR) mixture" *Materials and Structures*, 47(1-2) : 55-56
- Kumar, M.R. and Bhuvanika, Y. and Kumari, A. and DivyaSree, G. (2015) "Soil stabilization by groundnut pulp and coconut pulp". *International Journal of Engineering Technology, Management and Applied Sciences*, 3 (6). : 278-282
- Li Chen, Deng-Fong Lin (2009), "Stabilization treatment of Soft Subgrade Soil by Sewage Sludge ash and cement", *Journal of Hazardous materials*, 162(1): 321-327
- Neeraj Kumar Sharma, S. K. Swain, Umesh C. Sahoo (2012), "Stabilization of clayey soil with fly ash and lime: A Micro level Investigation", *Geotechnical and geological Engineering*, 30(5) : 1197-1205

### Appendices

**Table. 1. Properties of Soil**

Properties of Soil Sample	Value
Specific Gravity	2.66
Unconfined Compressive strength	60.51KPa
Unsoaked CBR	3.94
Soaked CBR	2.94
Consistency	Non-Plastic
Gravel	0%
Sand	25%
Silt	55%
Clay	20%
Soil Classification	SM

**Table.2. Sub-grade classification based on CBR**

Quality of Subgrade	Class	Range (CBR%)
Very poor	S1	2 or less
Poor	S2	3-4
Fair	S3	5-6
Good	S4	7-9
Very good	S5	10-15

**Table.3. Sub-grade classification based on UCS**

UCS(KPA)	Quality of Subgrade
25-50	Soft subgrade
50-100	Medium subgrade
100-200	Stiff subgrade
200-380	Very stiff subgrade
>380	Hard subgrade

**Table.4. Properties of sewage sludge**

Specific Gravity	1.39
pH value	7.8
Organic Carbon	5.532%
Organic matter	9.54%

**Table. 5. MDD, OMC and Specific Gravity of treated soil sample**

<b>Sewage Sludge (%)</b>	<b>Optimum Moisture Content (OMC) %</b>	<b>Maximum Dry Density (MDD) g/cc</b>	<b>Specific Gravity</b>
0	13.5	1.81	2.66
1	13.3	1.83	2.47
2	13.2	1.84	2.40
3	15	1.76	2.40
4	15.75	1.76	2.40
5	15.76	1.77	2.39
6	15.79	1.77	2.35

**Table. 6. Unconfined compressive strength, CBR (soaked and unsoaked) of treated soil**

<b>Sewage Sludge (%)</b>	<b>Unconfined Compressive strength(KPa)</b>	<b>Soaked CBR(%)</b>	<b>Unsoaked CBR(%)</b>
0	60.51	2.935	3.94
1	84.68	8.34	10.203
2	90.99	6.67	10.988
3	86.71	1.766	2.55
4	84.23	3.04	5.199
5	80.59	5.886	8.248
6	81.45	1.217	3.14

**Table.7. Chemical Constituents of Soil**

<b>Element</b>	<b>Weight%</b>	<b>Atomic%</b>
Al K	15.65	18.13
Si K	54.24	60.35
K K	29.68	15.60
Fe K	10.59	5.93
Totals	100.0	

**Table.8. Chemical Constituents of Sludge**

<b>Element</b>	<b>Weight%</b>	<b>Atomic%</b>
Al K	12.64	16.30
Si K	48.03	59.51
K K	4.86	4.32
Ca K	8.38	7.27
Fe K	10.92	6.81
Zr K	15.17	5.79
Totals	100.0	

**Table.9 .Chemical Constituents of Soil+1% Sludge**

Element	Weight%	Atomic%
Al K	9.82	12.58
Si K	54.14	66.59
K K	4.01	3.55
Fe K	21.49	13.29
Zr K	10.54	3.99
Totals	100.0	

**Table.10. Chemical Constituents of Soil+2% Sludge**

Element	Weight%	Atomic%
N K	48.92	73.10
Al K	6.72	5.21
Si K	16.88	12.58
K K	2.02	1.08
Ca K	1.62	0.84
Fe K	15.60	5.85
Zr K	2.64	0.61
Dy K	5.59	0.72
Totals	100.0	

**Table.11. Chemical Constituents of Soil+3% Sludge**

Element	Weight%	Atomic%
Al K	25.05	28.64
Si K	47.01	51.63
K K	18.20	14.36
Fe K	9.74	5.38
Totals	100.0	

**Table.12. Chemical Constituents of Soil+4% Sludge**

Element	Weight%	Atomic%
N K	78.15	88.78
Al K	2.04	1.20
Si K	15.06	8.53
K K	1.06	0.43
Fe K	3.70	1.05
Totals	100.0	

**Table.13. Chemical Constituents of Soil+5% Sludge**

Element	Weight%	Atomic%
Al K	15.33	18.02
Si K	56.98	64.37
K K	7.60	6.17
Ti K	4.80	3.18
Fe K	10.15	5.77
Zn K	5.14	2.50
Totals	100.0	

**Table.14. Chemical Constituents of Soil+6% Sludge**

Element	Weight%	Atomic%
Al K	8.84	9.94
Si K	73.68	79.60
K K	4.14	3.21
Fe K	13.34	7.25
Totals	100.0	



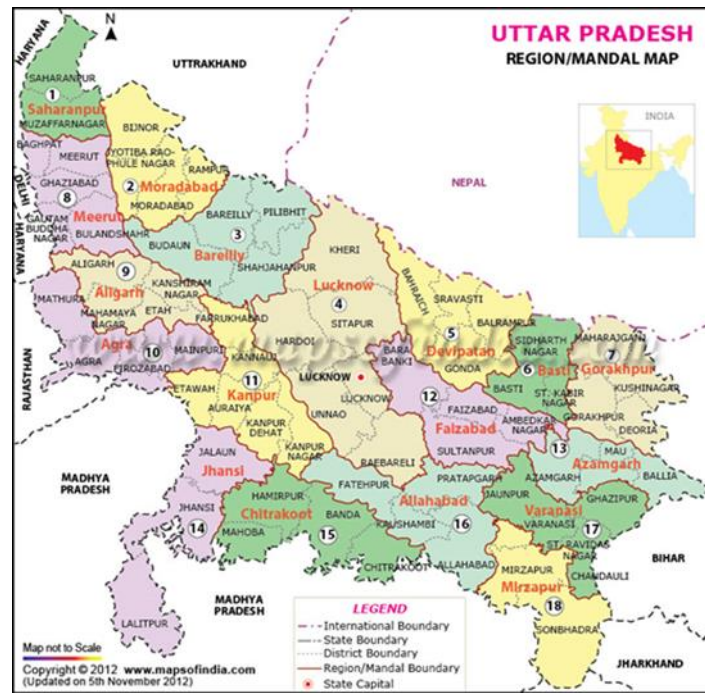


Fig.1. Location from where soil sample collected

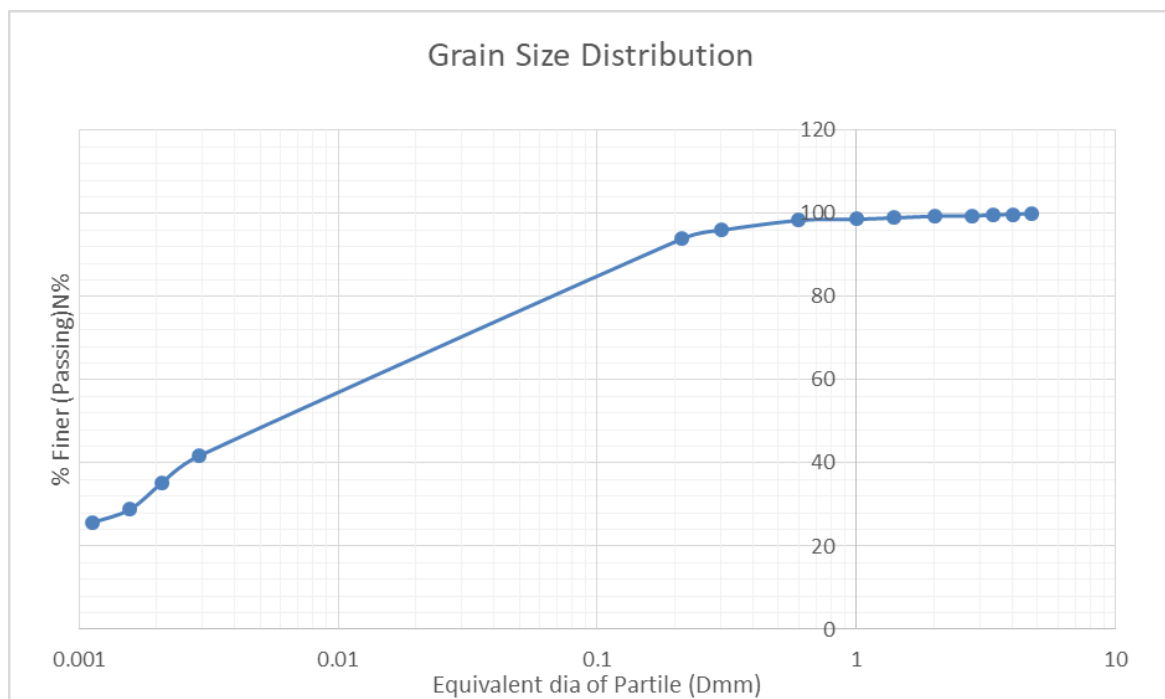
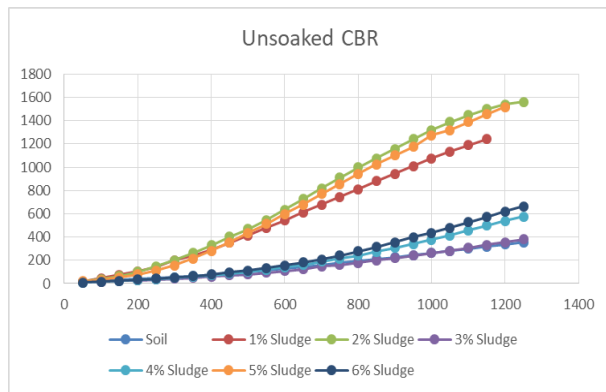
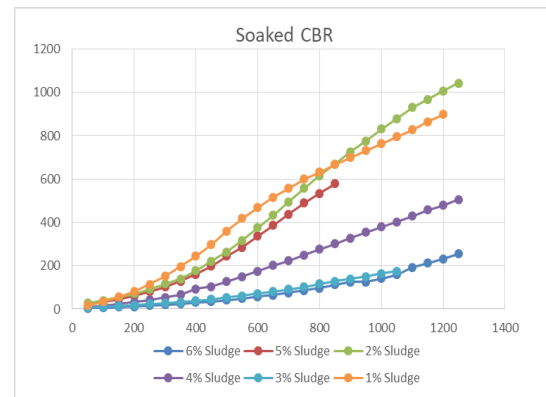


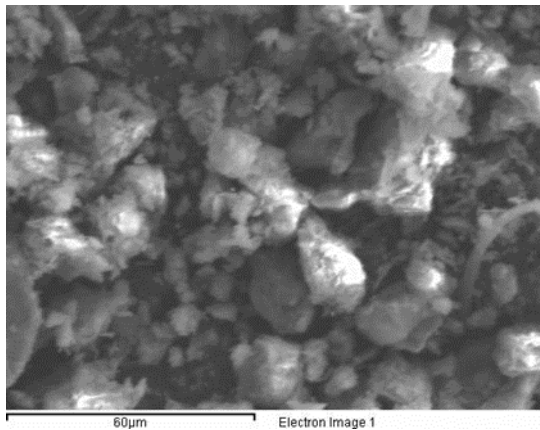
Fig.2. Grain size distribution graph of soil sample



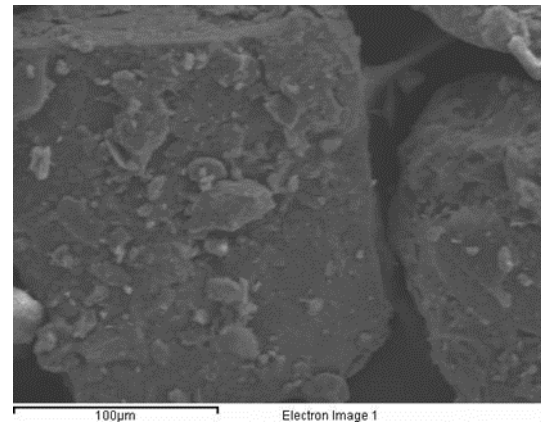
**Fig.3. Unsoaked CBR graph of soil with different admixture ratio**



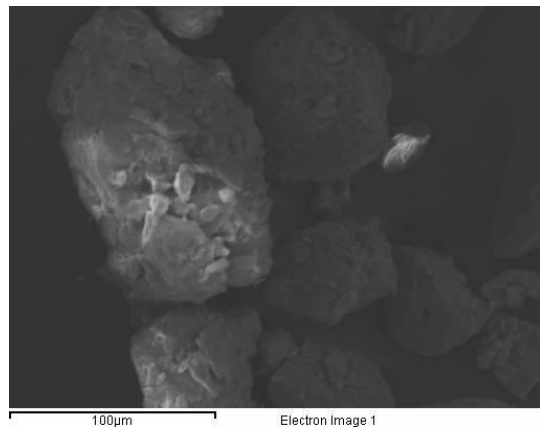
**Fig.4. Soaked CBR graph of soil with different admixture ratio**



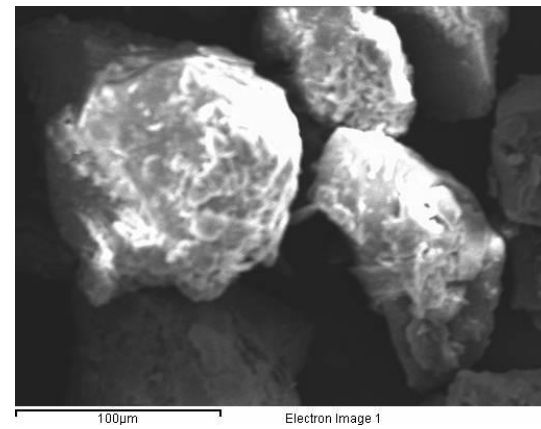
**Fig.5. Sludge under SEM**



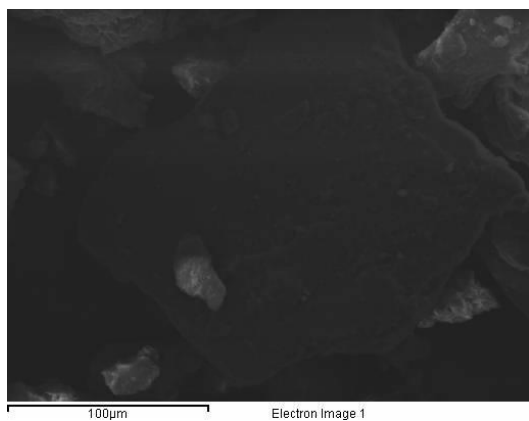
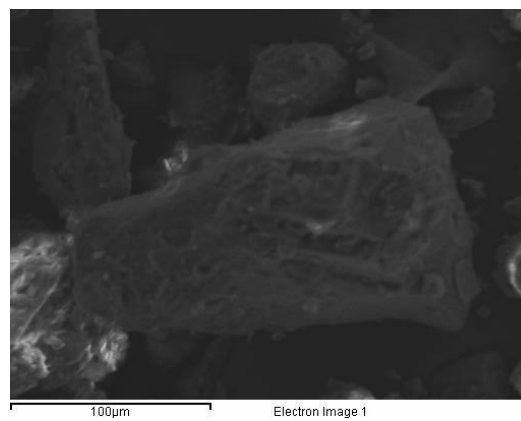
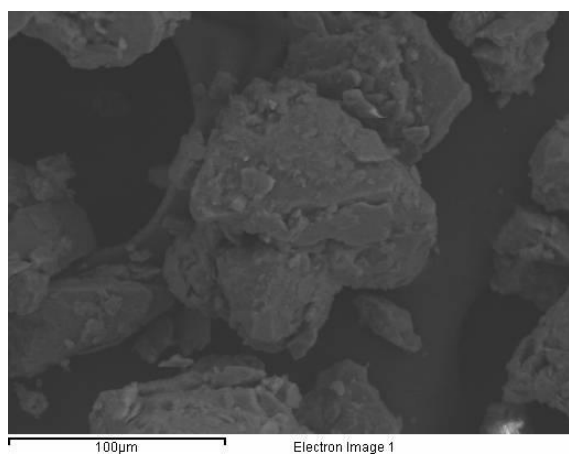
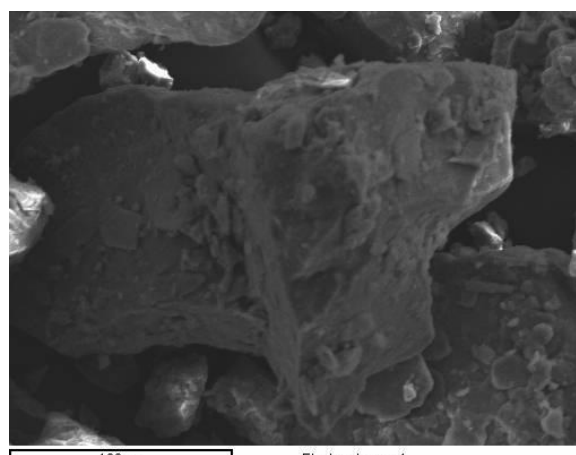
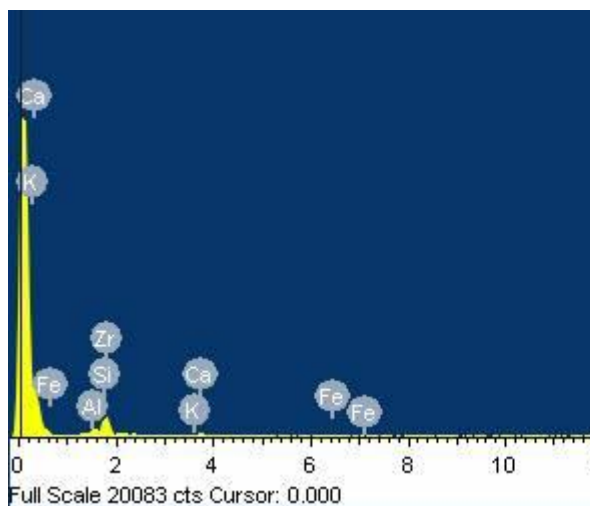
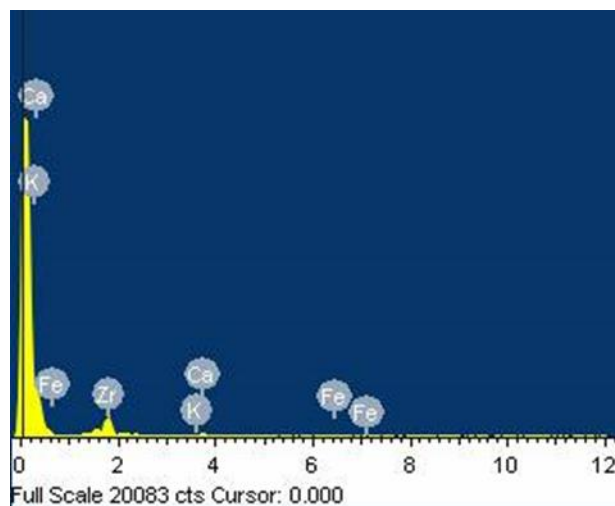
**Fig.6. SEM view of Soil sample**

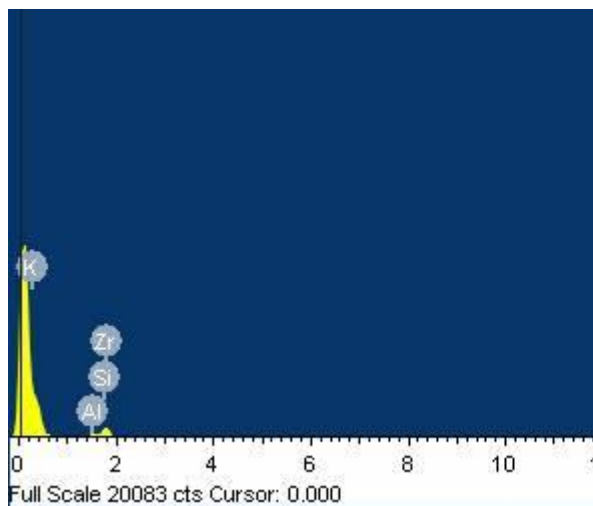
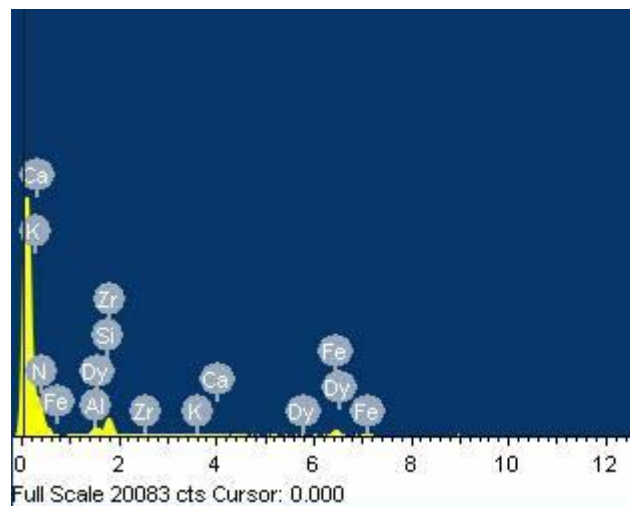
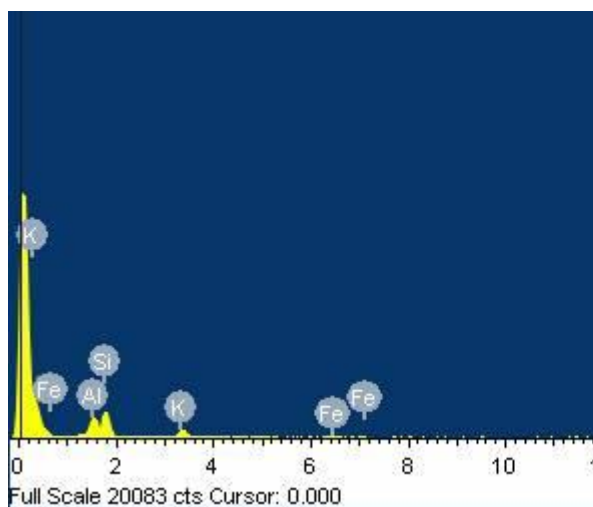
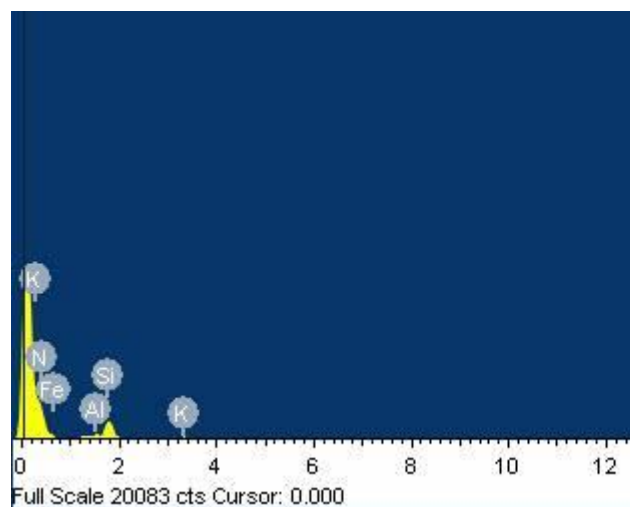
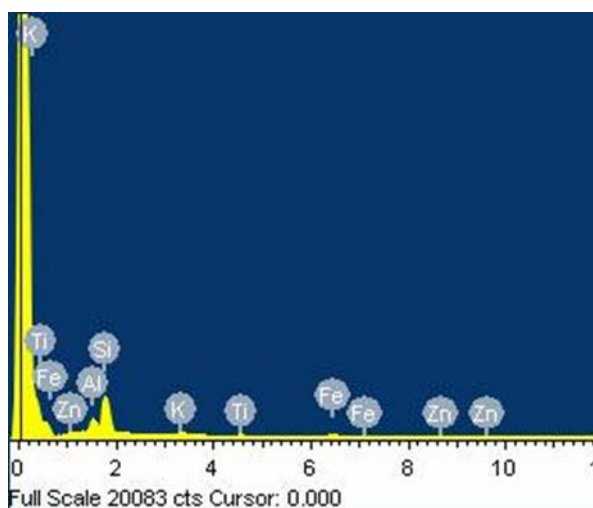
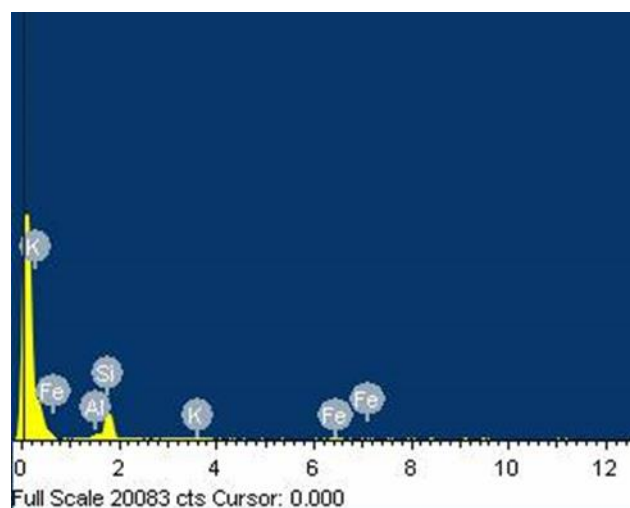


**Fig.7. Soil with 1% sludge, Under SEM**



**Fig.8. Soil with 2% sludge, under SEM**

**Fig.9. SEM view of soil with 3% sludge****Fig.10. SEM image of soil with 4% sludge****Fig.11. SEM view of soil with 5% sludge****Fig.12. SEM view of soil with 6% sludge****Fig.13. EDS result of Sludge****Fig.14. EDS result of Soil**

**Fig.15. EDS result of soil +1% Sludge****Fig.16. EDS result of soil +2% Sludge****Fig.17. EDS result of soil +3% Sludge****Fig.18. EDS result of soil +4% Sludge****Fig.19. EDS result of soil +5% Sludge****Fig.20. EDS result of soil +6% Sludge**

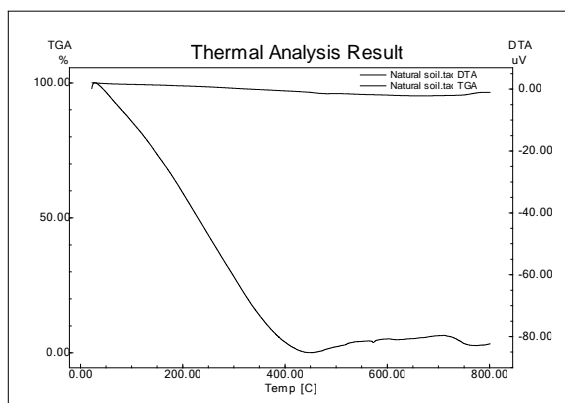


Fig.21. TGA &amp; DTA of soil

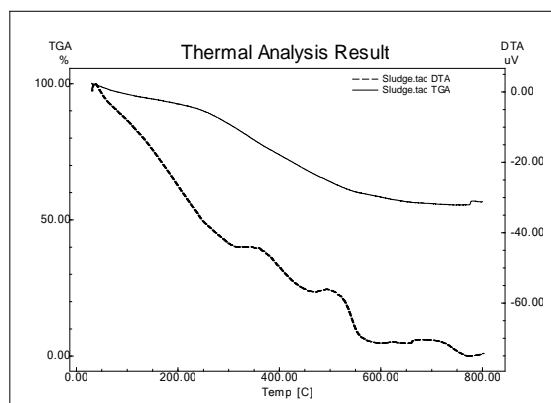


Fig.22. TGA &amp; DTA of Sludge

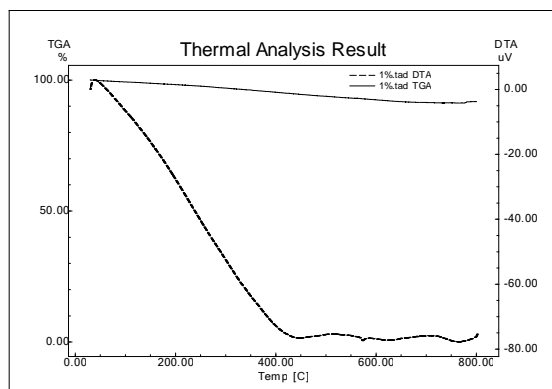


Fig.23. TGA &amp; DTA of soil + 1% sludge

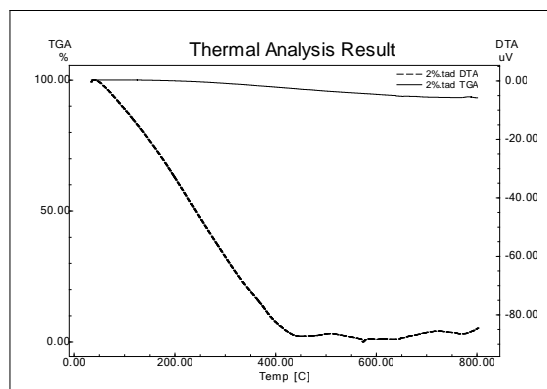


Fig.24. TGA &amp; DTA of soil + 2% sludge

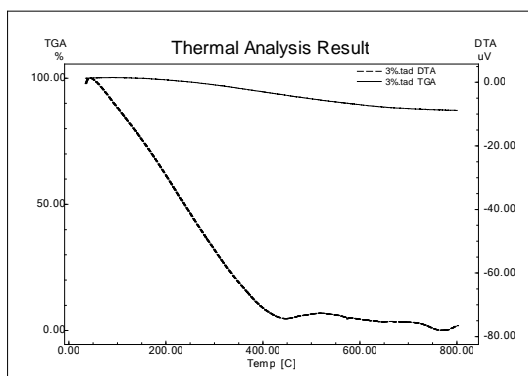


Fig.25. TGA &amp; DTA of soil +3% sludge

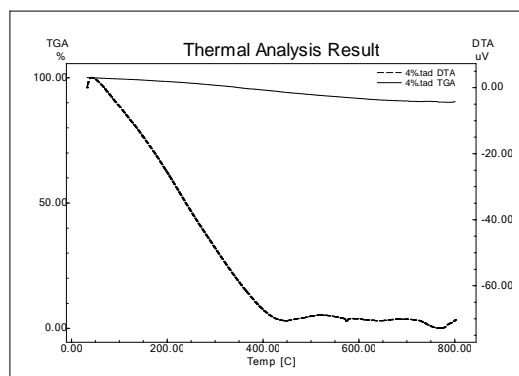


Fig.26. TGA &amp; DTA of soil+ 4% sludge

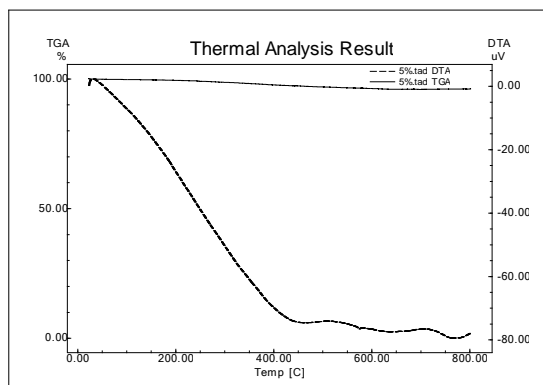


Fig.27. TGA &amp; DTA of soil + 5% sludge

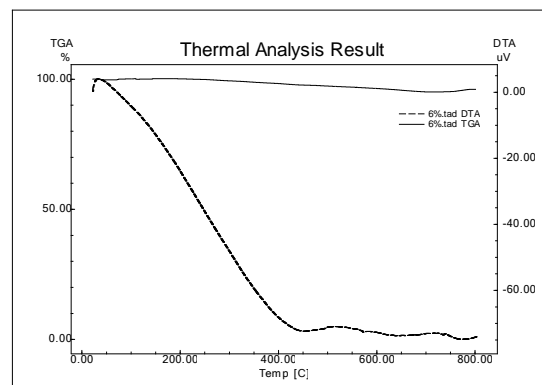


Fig.28. TGA &amp; DTA of soil + 6% sludge