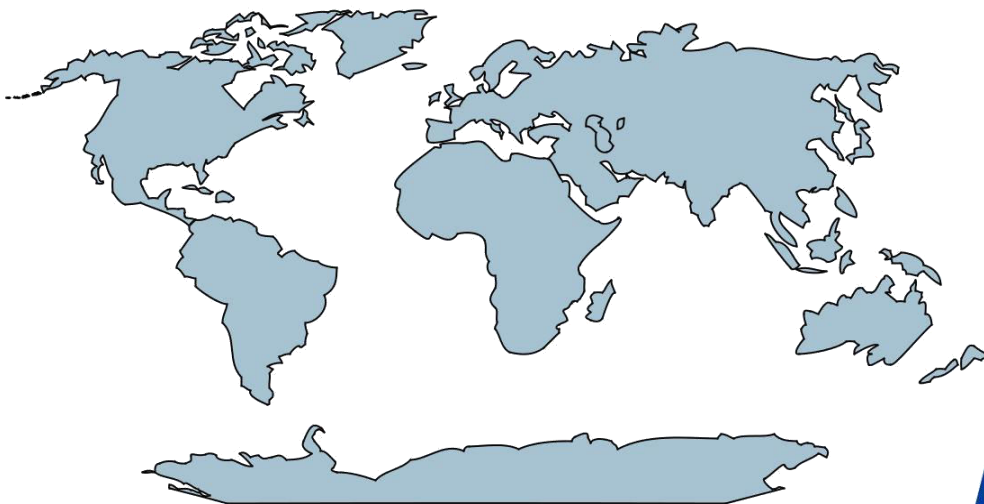


ISSN 2322 - 0899

# **INTERNATIONAL JOURNAL OF RESEARCH IN MANAGEMENT & SOCIAL SCIENCE**



**Volume 10, Issue 2**  
April - June 2022

# International Journal of Research in Management & Social Science

---

Volume 10, Issue 2: April - June 2022

---

Chief Patron

**Mr. Zahirul Alam Ahmed**

Director, Empyreal Institute of Higher Education.  
President , Bhramaputra Welfare Organization

Editor- In-Chief

**Dr. Tazyn Rahman**

## Members of Editorial Advisory Board

**Mr. Nakibur Rahman**

Ex. General Manager ( Project )  
Bongaioan Refinery, IOC Ltd, Assam

**Dr. Mukesh Saxena**

Pro Vice Chancellor,  
University of Technology and Management, Shillong

**Dr. Alka Agarwal**

Director,  
Mewar Institute of Management, Ghaziabad

**Dr. Archana A. Ghatule**

Director,  
SKN Sinhgad Business School, Pandharpur

**Prof. (Dr.) Sudhansu Ranjan Mohapatra**

Dean, Faculty of Law,  
Sambalpur University, Sambalpur

**Prof.(Dr.) Sharad Kumar Goel**

Director,  
Indirapuram Institute of Higher Studies, Ghaziabad

**Dr. P. Malyadri**

Principal,  
Government Degree College, Hyderabad

**Prof. (Dr.) Monoj Kumar Chowdhury**

Professor, Department of Business Administration,  
Guahati University, Guwahati

**Prof.(Dr.) Shareef Hoque**

Professor,  
North South University, Bangladesh

**Prof. (Dr.) Baljeet Singh Hothi**

Professor,  
Gitarattan International Business School, Delhi

**Prof.(Dr.) Michael J. Riordan**

Professor,  
Sanda University, Jiashan, China

**Prof. (Dr.) Badiuddin Ahmed**

Professor & Head, Department of Commerce,  
Maulana Azad National Urdu University, Hyderabad

**Prof.(Dr.) James Steve**

Professor,  
Fresno Pacific University, California, USA

**Dr. Anindita Sharma**

Dean & Associate Professor,  
Jaipuria School of Business, Indirapuram, Ghaziabad

**Prof.(Dr.) Chris Wilson**

Professor,  
Curtin University, Singapore

**Prof. (Dr.) Jose Vargas Hernandez**

Research Professor,  
University of Guadalajara, Jalisco, México

**Prof. (Dr.) Amer A. Taqa**

Professor, DBS Department,  
University of Mosul, Iraq

**Prof. (Dr.) Himanshu Pandey**

Professor, Department of Mathematics and Statistics  
Gorakhpur University, Gorakhpur

**Dr. Nurul Fadly Habidin**

Faculty of Management and Economics,  
Universiti Pendidikan Sultan Idris, Malaysia

**Prof. (Dr.) Agbo Johnson Madaki**

Faculty, Faculty of Law,  
Catholic University of Eastern Africa, Nairobi, Kenya

**Dr. Neetu Singh**

HOD, Department of Biotechnology,  
Mewar Institute, Vasundhara, Ghaziabad

**Prof. (Dr.) D. Durga Bhavani**

Professor,  
CVR College of Engineering, Hyderabad, Telangana

**Prof. (Dr.) Shashi Singhal**

Professor,  
Amity University, Jaipur

**Prof. (Dr.) Alireza Heidari**

Professor, Faculty of Chemistry,  
California South University, California, USA

**Prof. (Dr.) Badar Alam Iqbal**

Adjunct Professor,  
Monarch University, Switzerland

**Dr. Dhananjay Prabhakar Awasarikar**

Associate Professor,  
Suryadutta Institute, Pune

**Dr. Mohammad Younis**

Associate Professor,  
King Abdullah University, Saudi Arabia

**Dr. Kavita Gidwani**

Associate Professor,  
Chanakya Technical Campus, Jaipur

**Dr. Vijit Chaturvedi**

Associate Professor,  
Amity University, Noida

**Dr. Marwan Mustafa Shammot**

Associate Professor,  
King Saud University, Saudi Arabia

**Dr. Juhab Hussain**

Assistant Professor,  
King Abdulaziz University, Saudi Arabia

**Dr. V. Tulasi Das**

Assistant Professor,  
Acharya Nagarjuna University, Guntur, A.P.

**Dr. Urmila Yadav**

Assistant Professor,  
Sharda University, Greater Noida

**Prof. (Dr.) Aradhna Yadav**

Professor,  
Krupanidhi School of Management, Bengaluru

**Prof.(Dr.) Robert Allen**

Professor  
Carnegie Mellon University, Australia

**Prof. (Dr.) S. Nallusamy**

Professor & Dean,  
Dr. M.G.R. Educational & Research Institute, Chennai

**Dr. Sarmistha Sarma**

Associate Professor,  
Institute of Innovation in Technology and Management

**Dr. Pranjal Sharma**

Associate Professor, Department of Management  
Mile Stone Institute of Higher Management, Ghaziabad

**Dr. Lalata K Pani**

Reader,  
Bhadrak Autonomous College, Bhadrak, Odisha

**Dr. Sunita Dwivedi**

Associate Professor,  
Symbiosis Center for Management Studies, Noida

**Dr. R. Navaneeth Krishnan**

Associate Professor,  
Bharathiyar College of Engg & Tech, Puducherry

**Dr. Namita Dixit**

Assistant Professor,  
ITS Institute of Management, Ghaziabad

**Mr. Sukhvinder Singh**

Assistant Professor,  
Institute of Innovation in Technology & Management

**Dr. Nidhi Agrawal**

Assistant Professor,  
Institute of Technology & Science, Ghaziabad

Copyright @ 2022 Empyreal Institute of Higher Education, Guwahati  
All rights reserved.

No part of this publication may be reproduced or transmitted in any form or by any means, or stored in any retrieval system of any nature without prior written permission. Application for permission for other use of copyright material including permission to reproduce extracts in other published works shall be made to the publishers. Full acknowledgment of author, publishers and source must be given.

The views expressed in the articles are those of the contributors and not necessarily of the Editorial Board or the Institute. Although every care has been taken to avoid errors or omissions, this publication is being published on the condition and understanding that information given in this journal is merely for reference and must not be taken as having authority of or binding in any way on the authors, editors and publishers, who do not owe any responsibility for any damage or loss to any person, for the result of any action taken on the basis of this work. All disputes are subject to Guwahati jurisdiction only.

 THOMSON REUTERS	 INDEX COPERNICUS INTERNATIONAL	 University Grants Commission	 Journal Seeker Research Bible	 OAJ Open Academic .net Journals Index
 INNO SPACE SJIF Scientific Journal Impact Factor	 CiteFactor Academic Scientific Journals	 JOURNAL INDEX .net	 Google scholar	 ResearchGATE scientific network
 SciSeek	 I2OR	 Scribd.	 ADVANCED SCIENCE INDEX	 AcademicKeys UNLOCKING ACADEMIC CAREERS
 bing	 iseek	 entireweb Beta	 Scholarsteer Scholarly Information	 WZB Berlin Social Science Center
 SJIF	 JISRA JIF	 DIIF	 GENERAL IMPACT FACTOR Universal Digital Object Information	 Research Impact Factor
 GIF GLOBAL IMPACT FACTOR	 Cosmos COSMOS IMPACT FACTOR		 iis	 JIF JIFACTOR
 SIS Scientific Indexing Services	 Pak Academic Search GROWING KNOWLEDGE FOR FUTURE	 ZB MED Wissen für Mensch & Umwelt www.zbmed.de	 Open Access Library Search Engine, Journal, Index, Repository	 EZB Electronic Journals Library
 Journal Seek	 JOUR INFORMATICS	 INTERNATIONAL Scientific Indexing	 UMS UNIVERSITI MALAYSIA SABAH	 OCLC WorldCat®
 International Innovative Journal Impact Factor (IIJIF)	 bibliothek WISSENSCHAFTSPARK ALBERT EINSTEIN	 ESJI Eurasian Scientific Journal Index www.ESJIndex.org	 JOURNAL FACTOR	 INFOBASE INDEX
 DocSlide	 SJIFactor Scientific Journal Impact Factor	 UNIVERSIDAD DE GUADALAJARA Red Universitaria de Jalisco		 www.irmgm.ir
 ACADEMIA	 Yumpu	 STUDYLIB	 docshare.tips	 BASE Bielefeld Academic Search Engine
 International Institute For Research Impact Factor Journals (IFIJ)	 SSRN SOCIAL SCIENCE RESEARCH NETWORK	 Xactseek RELEVANT WEB SEARCH	 GIGA BLAST The Search Engine	 NSD ERIH PLUS EUROPEAN REFERENCE INDEX FOR THE HUMANITIES AND SOCIAL SCIENCES
 Baidu 学术	 FWS FreeWebSubmission.com	 ISIFI INTERNATIONAL SERVICES FOR IMPACT FACTOR AND INDEXING	 beta refseek	 zenodo



# Certificate IC Journal Master List



Certificates that journal  
**International Journal of Research in  
Management & Social Science**

ISSN: 2322 - 0899

has been indexed in the  
IC Journal Master List in 2014.

**ICV: 6.35**

1 May 2014

Date

A handwritten signature in black ink, appearing to read "Risto Wapato".

Signature:

## CONTENTS

---

### ***Research Papers***

- REDEFINING MEN-WOMEN RELATIONSHIP WITHIN THE FEMINIST PARADIGM** 1 – 7  
Sumedha Sharma
- A STUDY OF DIFFERENT FORMATS OF BIG DATA MANAGEMENT SYSTEM AND USE OF ITS APPLICATIONS IN VARIOUS SECTORS** 8 – 18  
Dr. Archana
- A STUDY ON IMPACT AND APPLICATIONS OF ENVIRONMENTAL ACCOUNTING AND AUDITING PRACTICES OF INDIAN COMPANIES** 19 – 28  
Mr. Pratik A. Shah, Prof. (Dr.) Sandip K. Bhatt and Dr. Kamini Shah
- A SURVEY OF COLLEGE GIRLS' OPINION ON KAFTANS AND GOTHIC ARCHITECTURAL MOTIFS** 29 – 32  
Shivangi Agarwal
- SMART HOME ENRGY MANAGEMENT USING MATALAB** 33 – 39  
Dr. J. Vijaya Kumar, K. Saiharini, B. Usharani, J. Jayateja and P. Priyanka Reddy
- ATTACHED GROWTH SYSTEM - IMPROVED OPTION FOR DOMESTIC WASTE WATER TREATMENT: A REVIEW** 40 – 45  
Ms. Pallavi S. Chakole and Mr. Neeraj Deshmush
- BROWN SEAWEEDS MEDIATED SYNTHESIZATION OF AG-NPS AND THEIR ANTIBACTERIAL EFFECT AGAINST PATHOGENIC MICROBES** 46 - 55  
Nithyas S, Shweta K. Pal and Subhashini S
- CLOUD LEARNING TECHNOLOGY IN EDUCATION** 56 – 59  
Sasikala P and Dr. Nachimuthu K
- CONSUMER'S RESPONSE AND SATISFACTION TOWARD ONLINE FOOD DELIVERY SERVICES: A CASE OF AHMEDABAD CITY** 60 – 64  
Dr. Ankitaben D. Kathiriya
- DESIGN & STRENGTH ENHANCEMENT METHOD FOR COMPOSITE GEARS** 65 – 70  
Harshal Rajaram Tambave and Prof. (Dr.) B. S. Rathod
- EFFECT OF MILK MIXTURES ON MILK COAGULATION PROPERTIES FROM DIFFENT SPECIES GROWN ON ALBANIA REGIONS** 71 – 76  
Migena Hoxha, Suada Muca and Vlash Mara

<b>EXAMINATION OF PHYSIOLOGICAL PROFILES OF JUDO AND WRESTLING PLAYERS</b>	77 – 79
Sanjeevkumar K. S and Ravindra Gouda S. M	
<b>FACTORS INCLUDING LOAN REPAYMENT CAPACITY OF FARMERS AFFECTING ON MONSOON PADDY PRODUCTION IN MYANMAR</b>	80 – 86
Nilar Aung, Theingi Myint, Yu Yu Tun and Nyein Nyein Htwe	
<b>MAGNETIC NANOPARTICLE BASED APPROACHES IN CANCER THERAPY – A CRITICAL REVIEW</b>	87 – 95
Dr. R. Karthikeyan, V. Velmurugan, V. Abishek and K. Lakshmi	
<b>PC BASED POWER GRID CONTROL USING WIRELESS COMMUNICATION</b>	96 – 100
Mr. C. Ganesh, P. Nagaveni, A. Hari Priya, P. Manikanteswar Reddy and A. Arun Kumar	
<b>ROBOTIC PROCESS AUTOMATION: LITERATURE REVIEW, CHALLENGES AND OPPORTUNITIES</b>	101 – 113
Neelam Yadav and Dr. Supriya P. Panda	
<b>SIGNIFICANCE OF SWARM INTELLIGENCE AND ROUTING CHALLENGES IN VANET</b>	114 – 120
Gagan Deep Singh	
<b>POTENTIOMETRIC SENSOR FOR MEASURING AMMONIA AND AMMONIUM IONS IN LIQUID AND GASEOUS MEDIA</b>	121 – 126
Sergey D. Aronbaev Charos A. Raimkulova, Dmitry M. Aronbaev and Kodirbek M. Narbaev	
<b>A SURVEY ON MARKET STATUS OF KNEE SLEEVE</b>	127 – 130
Shivangi Agarwal, Dr. Shalini Juneja and Dr. Sumit Nathani	
<b>A STUDY ON IMPACT OF BEHAVIOURAL FINANCE ON INVESTMENT DECISION OF INDIVIDUAL INVESTORS IN HIMACHAL PRADESH</b>	131
Sunil Kumar	
<b>CLINICAL STUDY ON THE EFFECT OF SIRAVYADHANA ALONG WITH TRISHOTHADI LEPAM ON VENOUS FOOT ULCERS</b>	132
Dr. Devyani Dasar (Jaiswal)	
<b>EVALUATION OF EFFECTIVENESS OF MICROLEARNING METHOD AMONG UNDERGRADUATE STUDENTS- A WAY OF MINDFUL EDUCATION STYLE IN STRESS MANAGEMENT</b>	133
Dr. Reena Jaiswal	
<b>IN VITRO PROPAGATION THROUGH THE INDUCTION OF MULTIPLE PROTOCOLORM LIKE BODY (MPLB) AND PLANT REGENERATION IN A RARE ORCHID <i>AERIDES CRISPUM</i> LINDL (ORCHIDACEAE)</b>	134
Ashok N. Pyati	

<b>LEARNING: AN INSIGHT</b>	135
Dr. Debabrata Bhattacharjee	
<b>MILITARY LOGISTICS OUTSOURCING PRACTICES IN USA &amp; UK: A CASE STUDY</b>	136
Satya Tripathi	
<b>PERFORMANCE APPRAISAL OF INDIAN EQUITY MUTUAL FUNDS</b>	137
Sunil Kumar	
<b>TIBETAN BUDDHISM AND SCIENCE: EXPLORING PERSPECTIVES OF THE DALAI LAMA TOWARDS SCIENCE AND TECHNOLOGY</b>	138
Duggirala Srikrishna	
<b>DIAGNOSIS AND CLASSIFICATION OF COVID-19 FROM X-RAY IMAGES USING MACHINE LEARNING</b>	139
R. Chandrasekaran, Dr. S. Vijayaraj and M. K. Soundarya	
<b>BUILDING CULTURE FROM WITHIN: HR STRATEGIES FOR FOSTERING ORGANIZATIONAL VALUES</b>	140 – 151
Dr. Charu Sharma	
<b>SYMBOLS OF JUSTICE IN TAMIL JUDICIAL TRADITION: MANU NEEDHI CHOLAN</b>	152 – 159
Dr. Tushita Sharma	



---

**REDEFINING MEN-WOMEN RELATIONSHIP WITHIN THE FEMINIST PARADIGM**

---

**Sumedha Sharma**Research Scholar, Department of English and Modern European Languages, Gautam Buddha University,  
Greater Noida**ABSTRACT**

*Indian women have been suffering for thousands of years due to patriarchal mindset of the society in which all decisions related to the lives of women were taken by men. Even important decisions like education, marriage of women was decided by father or elders of the family in ancient times. They did not had independence in small matters like wearing clothes of their choice. So, relations between woman and man were not equal in any way, in fact, women were treated as lesser human beings. They were confined to the four walls of their homes before and after marriage. Image of Indian women had been restricted to that of a beautiful daughter, obedient wife and self negating mother.*

**INTRODUCTION**

In 20<sup>th</sup> century new age authors like Anita Desai, Kamala Markandaya, Nayantara Sehgal, Shashi Deshpande, Shobha De and Manju Kapoor started writing women-centric novels, challenging the established roles for woman in the Indian patriarchal society, breaking the silence of their suffering and trying to move out of the suffocating existence in their families & societies and asserting their individual self. These feminist authors have been questioning the absence of female authors in the Indian literary field for quite a long time. These women scholars grew intolerant of the old age subjugation of women to men and sketched realistic women characters who revolt against the paradoxes of the stereotypical Indian society and express their desires and aspirations and try to live their lives on their own. Initially, such literary creations by Indian women writers were dismissed as sensational or plagiarized but later their works were recognized for the realistic portrayal of Indian women not only in India but in foreign countries too.

Manju Kapur and Shobha De, both have written literary masterpieces on women emancipation, their desires, longings and yearning to live their lives on their own, breaking free their bondages from men. These women characters do not consider themselves at a lower pedestal than men. To achieve this, they understand the value of education, financial freedom and so try to stand on their feet by doing service or business. Once they get financial freedom, they take independent decisions about their marriage, men in their lives. But at the same time, women characters of Manju Kapur try to fit within image of traditional Indian women and do not wish to break up the family ties. The women's question today is, therefore, no longer an issue confined to the position of women within the family or their rights to equality with men in different aspects of social life. It is part of the far broader question regarding the direction of change that our society is taking, economic, social, political and intellectual perception of that process. It is in this context that the role of women is discussed in the novels of Manju Kapur. As a writer of new generation in an atmosphere of the nation's socio-political flux, Kapur has recorded the truth in her fictive narrative. With zeal to change the Indian male perception, she describes the traumas of her female protagonists from which they suffer, and perish in for their triumph. The idea, that all women were meant to get married and be submissive to their husbands, was given a second look in her novels. While Manju Kapur's first novel, '*Difficult Daughters*', (1998) is a family saga set against the historical backdrop of partition of India in 1947, her second novel '*A Married Woman*' (2002) is a work of investigative reporting on the most controversial and political issue of demolition of Babri Masjid at Ayodhya and a woman's obsession with love and lesbianism. The novel is a narrative on a woman's incompatible marriage and her resultant frustration. Her third novel '*Home*' (2006) explores the complex terrain of the Indian family and reveals many issues that are deep rooted within the family, the revolt against the age-old traditions, quest for identity, the problems of marriage; and lastly the women's struggle for her survival.

Shobha De, as a writer, portrays her feminist mindset while sketching women characters in her novels. Evaluation of her works reveals her protest against the good old image of woman who can't live the way she wants to but is forced to set herself in the roles set for women by the society. Instead, women characters, in her novels are represented as sexually liberated and free thinkers who take decisions of their lives independently and try to live their lives promiscuously, imitating the playboy image of modern men. These so-called new women are much more physically active than earlier generations of women. They are quite opposite from the sexually ignorant Indian woman. Shobha De's women characters challenge this traditional role set for them by the society. Women in her novels are far more assertive, dominating and bold in comparison to men. They are not submissive and guilty of their affairs. The relation between man and woman is one of the cardinal themes

that are exemplified perceptibly in her creative works. She discusses this theme in almost all of her novels in an objective mode.

Shobha De creates such female dominated scenario in her novels in which the males are subsided and are compelled to live a life very much as liked and expected by their dominant counterparts. Taken on the literary side, the critics believe that women had to create a literature of their own, in which the feminine sensibility could consider and confront the peculiarity of feminine issues and experiences. It is essential to do so because a larger part of the feminine experience is out of the reach of the male psyche and, therefore, an authentic and sensitive portrayal of the conflicts and traumas, in all their nuances, ambiguities and contradictions, could be achieved only by women writers.

**Manju Kapur's** *'Difficult Daughters'* is written in the backdrop of freedom struggle of India. While India fights for freedom from the British Raj, Virmati fights for the freedom to live life on her terms. Like so many other Indian girls, she wants to decide what to study and when & whom to marry. In the end, it appears that she might have achieved all that but it ceases to be important. Through the struggle to live life on her own, taking decisions of her lives independently, she loses a part of herself. She is torn in two halves, one of which is on the side she is fighting against. This also symbolizes the fact that one gets something important at a price like India attained freedom but at the cost of partition of the country. Virmati also attains independence but at the cost of losing half of her soul as India achieve independence at the cost of hundreds of thousands of innocent lives, lost in the fire of communal hatred. In her quest of independence, Virmati the central character of the novel *'Difficult Daughters'*, rebels against tradition. She is impelled by the inner need to feel loved as an individual rather than as a responsible daughter.

*'Difficult Daughters'* is a feminist discourse not because she is a woman writing about women but because, as Jaidev puts it she has understood a woman both as a woman and as a person pressurised by all kinds of visible and invisible contexts. It is a skilful, enticing first novel by an Indian writer who prefers reality to magic realism. Manju Kapur's realism re-creates an intimate world where family groups sleep in the open air on the roof and wash themselves in the yard in the dewy cool of morning, where love-making is furtive and urgent because another wife may be listening and women's lives move to a complex choreography of cooking, washing, weaving, mending, growing, picking, chopping and blending. The author presents the yearning for autonomy and separate identity in her lead women characters. Virmati finds it impossible to accept a physical relationship only without marriage. So, she is haunted by a deep sense of guilt. The formal marriage, a social and public statement, is a must for her. It is this which will establish her identity even if it is as the Professor's second wife. Marriage, thus for her means being free from the fear of being socially condemned, a possibility which will perhaps bring her back into the fold of insecurity and uncertainty. Additionally, her focus on solemnising marriage to continue physical relationship can be understood from the fact that the novel is set in middle of the 20<sup>th</sup> century when women were not so advanced that they could have physical relations without entering matrimony, unlike present times. The earlier generation of women, like her mother, saw no reason to rebel. There was complete acceptance in their lives. Kasturi, mother of Virmati, is an example of typical feminine attitude who thinks that main aim of her life is to procreate in order to bring about life and pleasure and to keep her husband and in-laws happy. She procreates six daughters and five sons against her wishes. Giving birth to so many children even affect her health and she has to live at Dalhousie, a hill station, to recuperate. After procreation, her priorities are to run her home, first a joint family and later her own, as is expected in a patriarchal society. Since her school days, Kasturi is not allowed to forget that marriage is her destiny and after she graduates, her education of homely work like cooking, cleaning, sewing etc continues at home so that she could become a perfect wife and daughter-in-law. Kasturi represents traditional Indian woman who has molded herself according to the norms of the male dominated society. Like Kasturi, for Ganga, the Professor's wife, marriage is a religious and a social institution, where love is not the basis of marriage. She too has a superb domestic sensibility. Her cooking is enjoyed by her educated husband, anglicised to a point and who is otherwise very aloof from her emotionally. For Ganga, just living with her husband and bearing his children is enough. However, in Virmati, there is a struggle between her brain and heart, the physical and moral; Virmati gives way to her heart and body. She becomes a loser whose acts totally alienate her from her own family and she fails to create a space for herself for which she had been striving all along. Rollason (2004) comments, "In the micro-state to which her destiny leads her, she has no family or close friends. She attains a near-exemplary level of female autonomy. For the first and only time, she has her own place to live, Virginia Woolf's famous *'A Room of One's Own'*: and yet she falls." Today is but the day following yesterday. Things might have changed, but how much really? Even today thousands of girls sit within the four walls of their houses and wonder why they do not have the right to choose their own lives, decides for themselves whether they want to be homemakers or more. Marriage is still the reason for their birth. Freedom is more than just

being aloud out for shopping with friends. Manju Kapur presented her women character's emancipation and striving for some space in such a manner that we read not just with our eyes but also with our heart.

In her novel '*A Married Woman*', Manju Kapur has taken writing as a mark of protest, a way of mapping about struggles and experiences from the point of view of a woman. In the backdrop of the novel, Kapur negotiates different issues emerging out of a socio-political upheaval in her country. The novel is a sincere confession of a woman about her personality cult in the personal allegory of a bad marriage. In a realistic way, she has described the Indian male perception of woman as a holy cow even though women are not very interested in history and those in power trying to twist and turn historical facts to serve their own purposes. '*A Married Woman*' deals with women's issues in the present context. It is an honest and seductive story of love, passion and attachment set at the time of political and religious turmoil in India. Driven by a powerful physical relationship with a much younger woman, the main character of the novel risks losing the acquisitions and comforts of her conventional marriage. The novel raises the controversial issue of homosexual relationship in a challenging way. After all gay and lesbian relationships are not mere fancies. This is getting more and more visible in modern societies though we may or may not accept it. When Astha was in college, her mother began to search for a good husband without even asking Astha about it.

When Astha learnt about it, she got shocked and locked herself in the bathroom with sorrow in her heart. "The mother finally gave up, leaving Astha collapsed against the bathroom door, tears falling, crying, crying for Bunty, crying for the lack of love in her barren life, crying because she did not want to see dull stolid man in the drawing room who advertised for a wife and ask about sports".

As a married woman Astha, the protagonist, becomes an enduring wife and sacrificing mother. Her temperamental incompatibility with her corporate thinking husband Hemant compels her to play the role of "mother and father" for her children but denies her the fulfillment, a soul partner brings to life and it leads to the collapse of the institution of marriage. Discontentment leads her to defiance and restlessness. Her anxiety, discomfort, loneliness and isolation do not encourage her to give voice to her unhappiness over her troubled relationship, rather it prompts her to develop the feelings of guilt, negativity and lack of self-esteem in facing the challenges of her life.

The novel exposes the domestic relationship. The author has remained truthful and realistic in presenting the women and the challenges they face in their personal, professional, religious and socio-political lives. Manju Kapur presents in her novel the changing image of women moving away from traditional portrayals of enduring, self sacrificing women towards self assured assertive and ambitious women making society aware of their demands and in this way providing a medium for self expression.

Manju Kapur's third novel '*Home*' (2006) quite fascinatingly, if not very eloquently, shows the choking closeness and destructive limitations of Indian family values. It is a closet dark world where any hint of individual expression is swiftly trampled to death, to be substituted with deadened conformity. This novel is about the family of Banwari Lal. The shop owner Banwari Lal, his sons Yashpal and Pyarelal and their wives and children and it explores the world of joint families. This world of joint families is not the large happy make-believe families of films. It is a world trying to grapple with complexities of adjusting your aspirations and individualities with those of the others inside closed walls of the house, facing challenges of generational changes, trying to accommodate growing children in narrow personal spaces and even narrower working spaces. This world of joint families does have altruistic, elders, a mutual support system and intimacy that makes joint family living such a pleasure and pain, but the novel does not dwell much on these aspects, it rather focuses on tensions and rivalries, almost a Darwinian struggle of finding your own space for catching the sunlight and growing up, escaping the shadows of the others, who came before you or who have more rights than you. In the novel, male characters are shown as stereotypical role of earning money while the women characters remain busy in doing work associated with females in a patriarchal society like cooking food, washing clothes, maintaining house and providing emotional support to their male counterparts within the confines of four walls of the home. In the joint family, all the marriages are fixed keeping in mind the amount of dowry that the dowry will bring but turning point in the novel comes when Banwari Lal's eldest son, Yashpal defies this mode of selection of wife and declares his love for Sona, a girl from humble background. After lot of resistance to the marriage, both Yashpal and Sona are married. Banwari Lal's married daughter Sunita, dies under mysterious circumstances and their responsibility of orphaned son Vicky is given to Sona because she was childless till then. But after lot of fasting and visits to holy temples, Sona gives birth to a daughter, Nisha and a son Raju. Vicky who was now 15 years of age seduces his younger cousin Nisha because of which she becomes alienated from her family. Though the family elders had an inkling of incestuous behavior of Vicky but they do nothing about it owing to their family honour. When Nisha grows up, she starts going to college and

have an unsuccessful affair with a boy. Her affair restlessness in her family because according to her family Suresh belonged to low caste family so he was not eligible to marry her. Nisha defended Suresh by saying that "Who cares about caste these days? What you really want is to sell me in the market."

In Manju Kapur's novel, *'Immigrant'* (2008), protagonist is Nina, the only child of her parents, her father was an IFS officer, dies at the young age of 45 years and her mother is a homemaker. At that time, Nina was 15 years old. After the death of father of Nina, both daughter and her mother become financially dependent on grandfather of Nina. Then she studies in Delhi University and after completing her education, she starts teaching at a college. In the opening chapter Manju Kapur shows, pressure of marriage on Nina and her mother because Nina had attained the age of 30 years and both used to remain depressed as they could not find a suitable groom for Nina till now. The author describes the 30th birthday of Nina vividly,

"Nina's skin knew it was 30 broadcasting the fact at certain angles in front of the mirror. Her spirit felt 60 as she walked from the bus stop to the single room where she lived with her mother. Her heart felt a hundred as it surveyed the many years of hopeless longing it had known."

The author has discussed two main aspects of man-woman relationship, sexual aspect and physiological in the novel. But sexual aspect of the novel overpowers the psychological aspect. The author has shown pre-marital and extramarital relationship in the novel. I pre-marital sex Rahul the boyfriend of Nina ignites the fire of sex in Nina. Rahul was fifteen years older than her and a teacher in English Department at the Art Faculty. In extra-marital relationship Nina finds a partner in Anton, a US national of Russian origin who was studying Library Science with her at Halifax, Canada. Through the author shows that female do not have conservative mindset and are ready to enter pre-marital sex and extra-marital with different men at different times.

Nina devoted herself physically and emotionally to Rahul even after knowing that he was a serial lover in hope that her combined forces of youth and devotion would persuade him into commitment. But Rahul moved on after leaving her in despair. The author shows that Nina is a modern woman as she willingly allows her future husband Ananda to touch her sexually. After their marriage consummation night proved to be a turning point in their newly married relationship. It was the night of fulfillment of Ananda's sexual desires but for Nina the night proved to be a thunderclap on her expectations. Ananda's sexual dysfunction left bad impression on her. Initially Nina did not give importance to Ananda's sexual dysfunction assuming that with time and proper environment it would fade away. She also thought he was providing a luxurious and affluent life to her like staying in 5-star hotels and enjoying food there. The penetrative orgasm can be ignored. But when Ananda's sexual dysfunction persists even after many months of marriage, distances start developing in their relationship. All her desire and aspiration of warm and happy married life were shattered. Ananda's assessment that worldly possessions and comforts are the basis of successful relationship proves wrong. Ananda decided to marry an Indian lady as he knew about his sexual dysfunction and hoped that Indian lady would not be more demanding and adjust according to the realities after marriage. Ananda is a man of cold sensuousness while Nina is a lover seeker so her desire of a husband according to her wish is not fulfilled. Her efforts for taking medical help to conceive a baby are thwarted by Ananda as he does not want to accept her sexual dysfunction in front of her. From the starting of their relationship after her migrating to Canada, a sense of alienation from Ananda was dawning on her. As for Ananda, his sexual dysfunction is at the center of their shattered relationship that gave no delight at all. Aware of this problem Ananda was now engrossed only in his performance rather than in loving his wife and giving her the love of a husband. He only concentrated on his timing ignoring Nina's craving for love and its pleasure.

Eventually gone is the warmth of love, the hot passion of affection after they have got married. Here in Canada Ananda is more indulged in his clinic than in his wife without realizing that she could not adjust in Canada so easily without his love and care which in turn left Nina a forlorn figure.

**Shobha De** is concerned with the urban woman, one doesn't take it into consideration that the urban woman would, undoubtedly, be weak. Rather she is an incarnation of liberty, competence and self-sufficiency. She knows how to get the things on her own terms and conditions. The mythical woman and the urban modern woman are contradictory to each other. De's women characters are bold, courageous and ambitious. They have got victory over their families. They use their sexuality against the male dominance. The world of Shobha De's women seems to be dominated by the females only. It would not be wrong to say that Shobha De has female heroes in her novels.

*'Socialite Evenings'* is Shobha De's first novel published in 1988. The novel portrays Mumbai high society and explores the lives of bored rich housewives trapped in loveless marriages and engaging in ill-fated, extra-marital

affairs, smug selfish husbands, fashionable parties, false spiritual leaders and a portrait of general moral, spiritual and intellectual bankruptcy of the elite who have traded their traditional culture for westernisation and modernisation. The novel presents the institutions of family and marriage existing in the wealthy class of the Indian society. This portrayal is authentic, being an inside story, because the narrator herself belongs to this class. The novel is a romantic tale, suffused with feminist traits. An enduring theme in the novel is the image of new women, search for identity and selfhood.

Karuna, the protagonist of '*Socialite Evenings*', is the perfect example of misery of women in India. Karuna is presented as a prominent Bombay socialite in '*Socialite Evenings*' and the novel is in the form of her memoirs. Karuna's life starts only when they migrate to Bombay because of her father's official transfer. She meets Anjali, a prominent socialite and wife of a wealthy playboy. Her whole world changes as Karuna starts dreaming of a career in films and holidays abroad. When she enters the college and gets married to Bunty, a rich businessman, the family accepts him because of his social status. She suffers due to the callous and non-responsive attitude of her husband. Her husband treats her as a mere object subjected to his will, as a result there is a complete loss of her identity. Similarly, Anjali, a young socialite, also suffers much because of her incompatible marriage and her husband's oppressive attitude. Here, in presenting the picture of subordination and marginalization of Indian women, Shobha De's attack is not against the individuals, it is against the system that favours men and causes women's subjugation and marginalization. There occurs a sense of dichotomy in the perception of male as perceived by Karuna in relation to her father and her husband. It is Charlie, her friend at college, who creates in her awareness of her sexual identity and it is through Charlie that Karuna has been introduced to the world of modeling. Through modeling and in the company of Anjali, Karuna learns how to spread her wings to go beyond. Karuna's father reacts violently to her modeling profession and at the same time he doesn't like Anjali as her role-model. But she is thankful to her father's transfer to Bombay as she is able to get the opportunity to give altogether a different identity to her personality.

'*Sultry Days*' the fifth novel written by Shobha De, published in 1994, is a tale of struggle and freedom. With '*Sultry Days*', Shobha De has explored a different approach in her characters which was not seen in her previous novels. The author writes in the front page of this novel;

'For my children... finally a book by me that they can read. L. Sonia Ningthoujam writes; "*Sultry Days*, takes us into the world of power, sex and guns, the shady side of Mumbai upper class society."

The protagonist in this novel is also a female like other novels of Shobha De, but unlike her other novels, '*Sultry Days*' also revolves around a male character. Nisha, the protagonist of the novel is a strong headed and career-oriented female although the novel also deals with a very realistic male character who also becomes the central character as the novel unfolds. God or Deb is the central male character and Nisha is the narrator. It is through Deb that Nisha discovers herself. Nisha is a young college student who is sharp and focused towards studies, she comes from an upper middle class. Nisha's parents do not have a very loving relationship. She always feels tense that father has no time for her mother and neglects his daughter. Nisha is a shy girl and she always hated the frown birthmark on her forehead which made her look tensed all the time. Nisha thought that she may appear to Deb as a,

"A prissy little good girl who carried far too many books around. Pretty enough, I suppose. But not special."

Shobha De portrayed the unfocused picture of women psyche dexterously when the extramarital relations of parents cause distress in the minds of children. Nisha's parents always celebrate their wedding anniversary with grand dinner. When Nisha gets home, she finds her mother weeping in the bedroom. When Nisha asks about it, she tells her that her marriage-life is in danger as her husband is fascinated towards a Sindhi woman from his office. This shows that homemaker woman is first affected by the disturbance in marital relationships, because they are not economically independent.

De shows two different faces of the working woman in the novel. One is working for glamour and the other is a business professional. The main motive behind the working of the women under both the categories is the same. They want to come out of the old sphere of traditional role of the women. De wants to lighten the dark feminine sphere with important issues related to matrimony and gender bias. The basis of marriage is the basic requirement of love and safety. The author shows that males are too self-absorbed and at times they behave. Sometimes, it becomes far more offensive. They pride their professional competency and expect their female counterpart to recognize it. But, when they fling mocking sneers at their wives' behavior to attend a hobby class or to some charity, it smacks more of malice than of discourtesy.

In novel '*Second Thoughts*' published in 1996, Shobha De explores the hollowness of marriage system of India. It is an expression of female consciousness against male ego, the domineering mother-in-law, the obedient wife, public semblance and the social charade. The novel is the realistic representation of the psyche of the traditional Indian men and women. The most important social issue discussed by Shobha De in this novel is treachery in the institution of marriage. Normally when a woman gets ready for marriage, she has dreams of love and pleasures of life. But when she gets trapped in marriage, all her colorful dreams melt steadily. The condition becomes worst when there is a mismatch which always directs to deterioration in family life. The woman starts feeling loneliness and develops aloofness from her partner.

Maya, Ranjan and Nikhil are the main characters around whom the story in the novel revolves. The other insignificant characters, Maya's mother, father, uncle, Nikhil's mother and Ranjan's mother just help in the development of the storyline. The noteworthy feature of Shobha De's characters is that her male characters are weaker protagonist in the novel. Maya, is charming with "gleaming jet-black hair" and "large dark eyes". She "a trained textile designer" is depicted in the novel as a non-conformist. It creates disturbance and dislodgement in their relations. In this novel, marital life of Ranjan and Maya is disrupted due to the conjugal indifferences. Being a Bengali, Maya leads her life in a world of allurements and fantasy in Bombay (Mumbai) far from the realities of life. Later on, she is unable to sustain the equilibrium between the reality and fantasy. Maya expects Ranjan to comprehend her desires. She loiters for Ranjan to respond to her biological needs, her demands and urges. But he fails to fulfill her needs, which makes her unhappy. She becomes sexually frustrated and leisurely estranged from her husband. As a result, Maya feels haven in the company of Nikhil as she realises that her emotional longings are fulfilled by him. She then strikes a friendship and love affair with Nikhil, her charming college going neighbour. Maya, the central protagonist of novel, as per the meaning of her name is used to travel in the world of fantasy. But she fails to recognize that dreams never come true and unfortunately, she is obligated by the conditions to accept her seclusion as her companion. As truly depicted, Maya was fascinated by Bombay but was taken aback when she sensed that Bombay smelt of desperation and deceit. Since beginning Ranjan seems to be dominating her. She is a graduate in textile designing. When her mother motivates her to pursue her career but Ranjan rejects it. He announces that he is earning well and the duty of woman is only to look after the home. After marriage when Maya asks him for doing a job, he bursts:

"In our families, the only sort of work ladies do is social work. Our relatives criticize us if you suddenly take up a job".

This incident is one of the examples of male dominance and crushing the talent of women in the novel. When Maya reacts furiously that she has no one else to converse in the house, Ranjan suggests to her that there is television, music and cleaning the house in order to pass the time. He even does not give any liberty to Maya to enjoy her life in her own ways. Once when she says that she wants to attend a few pottery classes as she has much leisure, Ranjan replies,

"Housewives don't have extra time as there is so much to be done around the home. Take Ma's example, she is busy round the clock".

Like a typical Indian man, Ranjan keeps on reminding Maya about her duties as a wife and a married woman. He is scarcely aware of her existence in his home and never discusses anything with her. He never allows her to participate in decision making process.

In '*Starry Nights*' published in 1992, Shobha De has anticipated the shattering of human esteems in this sparkling universe of Mumbai silver screen through the practical depiction of Aasha Rani, Geeta Devi, Malini and Rita. In Indian society, women abuse and ill-treat women as opposed to indicating adoration, regard and comprehension for their own sex. In actuality, Shobha De draws out the general mental truth that the woman is the adversary of woman. The women in this novel are identified with the universe of movies. Aasha Rani, 'sweetheart of the millions', breaks every single social standard by her strange and freak conduct. Nothing controls her willingness to carry on with her own existence. Her sexual experiences with various men call attention to her sexual animosity. She overcomes men unexpectedly and devastates the legendary picture of lady forced by male centric society. As indicated by the writer, 'sex is the bedrock of all connections'. Her characters in this novel honestly talk and have sex. They are intense and rebellious who secure against their abuse and endeavor to state their identity. However, women in this literary masterpiece are sufficiently tolerant to proceed with their indulgences and issues without their partner. These women are sure and are sufficiently sensible to legitimise their relationship. This relationship is best shown in the connection between Aasha Rani and Akshay Arora in '*Starry Nights*'. Shobha De has graphically delineated the Mumbai film world and how could Bollywood be finished without sex and beefy joys. De has anticipated the quick breaking down of human



esteems in the glitzy universe of Mumbai silver screen. Aasha Rani, Geetha Devi, Malini and Rita encounter abuse and misuse in film industry. The novel overwhelmed the artistic world for its straight to the point depiction of sex and sexploitation. Bollywood industry is known for marvelous movies depicting desires, longings and known as mirror of the society; it entices numerous young ladies and men, rising with desire and desire for power and fame. Young ladies like Aasha Rani needs to go through the dim passages of sexploitation dejection and fiasco.

Shobha De attracts thoughtfulness regarding woman's misuse, separation and commodification. In the books of Shobha De the shifted universe of characters are imaginatively depicted. Her women are much more unique when contrasted with any customary provincial women. They carry on with their life minus all potential limitations. They favor living without any confinements and liberating from a wide range of control of male centric guidelines uncontrolled in the provincial society.

## CONCLUSION

The significant topic of Kapur's and De's anecdotal works is the man-women relationship. They depict their new women characters as the individuals who are not prepared to respect the ordinary and hierarchal universe of hetro-sexuality. From one perspective, these women dismiss the overbearing and shallow man-women connections, and on the other, they request closeness and relationship absolutely dependent on equity, equity, shared regard, warmth and adoration between man. The new women characters of De and Kapur encase the women's activist suspicion of a perfect man-women relationship. They ask men and in addition women to adopt positive and innovative strategy to the ideas of developing women's activist waves that feature the premise privileges of women. They admonish men to have versatility and adaptability to the ideal models of new womanhood and women. This paper endeavors to make an investigation into the new women idea utilized by two driving female creators, Manju Kapur and Shobha De in their works.

## REFERENCES

- 1- Kapur, Manju. *A Married Woman*, New Delhi: India In, 2002
- 2- Kapur, Manju. *Difficult Daughters*, London: Faber and Faber, 1998.
- 3- Kapur, Manju. *Home*, Random House India, 2006.
- 4- De, Shobha. *Second Thoughts*. New Delhi: Penguin Books India, 1996.
- 5- *Socialite Evenings*. New Delhi: Penguin Books India, 1989.
- 6- *Starry Nights*. New Delhi: Penguin Books India, 1994.
- 7- *Sultry Days*. New Delhi: Penguin Books India, 1994.
- 8- The Study of Feminism in Selected Works of Shobha De, Shibani Ghai, Krantipal Singh, Vikramjit Singh. *IJSOS Journal*.
- 9- Jaidev "Problematizing Feminism", *Gender and Literature*, ed., Iqbal Kaur, Delhi: B.R. Publishing Corporation, 1992.
- 10- Kumar, Gajendra. *Indian English Literature: A New Perspective*. New Delhi: Sarup and Sons, 2001.
- 11- Mishra, Vandita. comments in *The Pioneer: The Pioneer*. New Delhi: 1 August, 1998.
- 12- Rollason, Christopher. *Women On the Margins: Reflections on Manju Kapur's 'Difficult Daughters'*. January 2004. 26 June 2010.
- 13- *Feministic Voices in Manju Kapoor's 'A Married Woman'* By. Dr. Ram Sharma
- 14- V. V. N. R. Prasad, "Anita Desai and the wounded self," *Indian Women Novelists*, Ed. R. K. Dhawan, New Delhi: Prestige Books, Set. 1, vol. 11, 1991.
- 15- A. Kumar, *Novels of Manju Kapur*, New Delhi: Sarup Book Publishers, 2010.
- 16- N. Kumar, *The Road to Baghdad, or Travelling Biculturalism: Theorizing a Bicultural Washington*, Washington: New Academia, 2005.
- 17- Bharat, Meenakshi. *Desert in Bloom: Contemporary Indian Women's Fiction in English*, New Delhi: Pencraft International, 2004.

## WORK CITED

1. De, Shobha. *Sultry Days* (New Delhi: Penguin India, 1994)
2. Phyllis, Chubb. "Famous or Infamous", *The Jyotish Digest* (Vol. I June 2002) issue 3.

---

**A STUDY OF DIFFERENT FORMATS OF BIG DATA MANAGEMENT SYSTEM AND USE OF ITS APPLICATIONS IN VARIOUS SECTORS**

---

**Dr. Archana**

Extension Lecturer, Computer Science Department, G.P.G.C.W College, Rohtak- 124001

**ABSTRACT**

*Today, we produce massive amounts of data that is largely unstructured and transient. It comes from a variety of sources and types: text, video, geospatial data, information captured by a sensor in a plant or a vehicle or from social interactions via the web. This is often being referred to as big data. Hence, Big Data is the data that, in addition to being massive in size, is of a greater variety and complexity, and is generated at a high velocity. Collectively, these are referred to as the three Vs of Big Data. The emergence of Big Data is closely linked to advances in Information and Communication Technology (ICT). One indicator of such a link is the digital footprints that are left by people and things in forms like sensor data, commercial transactions, public and private records stored by companies, photos, videos, tweets, etc. which are considered the main sources of Big Data. This is perhaps the single most entity which forms the backbone of any major transformation within any large global corporation across industries. Data is no longer being looked and used as a tactical medium for storage or operations; on the contrary, it becomes extremely strategic in nature. The data element acts as a central aspect to strategic decisions whether it comes to new product/service development or behavior of customer or user data, appreciation or acknowledgement of revenue. With big data being so strategic in nature a large part of the focus has now shifted to data extraction and normalization to ensure meaningful information is extracted and utilized for business benefits by customers. Industry influencers, academicians, and other prominent stakeholders certainly agree that big data has become a big game changer in most, if not all, types of modern industries over the last few years. As big data continues to permeate our day-to-day lives, there has been a significant shift of focus from the hype surrounding it to finding real value in its use. Generally, most organizations have several goals for adopting big data projects. While the primary goal for most organizations is to enhance customer experience, other goals include cost reduction, better targeted marketing and making existing processes more efficient. In recent times, data breaches have also made enhanced security an important goal that big data projects seek to incorporate. In Brief, The extraction and transformation of data for key benefits will be very much a business, as usual, thing, without which survival will become questionable within ICT industry, especially whilst looking at the concept of digital explosion.*

*Keywords: Big data, ICT, Latest technologies, Big data in various areas, Applications of Big Data, New trends, New technologies in Agriculture and Production.*

**INTRODUCTION**

This paper has discussed require of big data in different applications. Big data could be referred as a field in that huge data sets are analyzed and managed. It has been utilized in multiple sectors such as healthcare, manufacturing, media & entertainment etc. In marketing field, big data sets are required but it is not easy to manage and analyzed such big data sets. Big Data utilization and acceptance is utilized in governmental processes also and it affects price, output, and technology etc. It is almost impossible for transport sector to handle this rapid growth of data. The information gathered by transport sector includes rich sources. Along with use of big data in different sectors, some challenges are also faced during dealing to huge data sets. There are scarcities of skilled employers. These skilled employers are required to evaluate such data. Along with this, a time period is required in process to analyze huge data sets. As it has been considered at starting, many companies want to be able to make evaluation of data in real time. The huge size of unstructured data is also growing as a basic challenge. In addition, lack of proper management to analyze Big Data in adequately method is also a hurdle. It is supposed to give enterprises better understanding moreover it has been found capable to handle a large quantity of independent data and inside a specific period. The Hadoop architecture has been frequently utilized to process big data. It is a well-known platform utilized to analyze and deal with big data. Several distributed programming frameworks are available to process big data using Map Reduce HDFS provided by Hadoop. Hadoop and its technologies are focus of this section. Map reduces and spark is explained with their features. HDFS, Hive and Pig are illustrated. Concept of web server that would be utilized to host python script has been also considered here. Web server would be installed on environment in order to host web application that would interact with database. Database might be HIVE, PIG, HDFS. On server-side python has been utilized in order to get data from operator end and transfer it to database. Python script is capable to perform decision making on server side.

**Big Data Management system**

In previous years, it has been analyzed that companies make use of only that information that is required for satisfactory execution of a proposal. But with passage of time it has become essential for a company to have record of all relative or irrelative data.

**Starting from capture, organize, integrate, analyze, and act**

It is extremely important to gain information regarding useful needs for big data ahead of its construction. First of all, in primary stage data is collected. After that this data is organized and combined. As soon as this stage is completed, in subsequent stage, data could be accessed on basis of issue being discussed. In last stage, on basis of assessment reports a desired step is taken by management.

**Series of big data management**

At same time, it considers that it is too much simple, but it is quite difficult to execute some operations. Authentication is one of basic needs to verify data. In circumstances where information sources have established links with organization, it is very important that organization must have ability to verify data. The information source includes secret information implementation. Thus, proper levels of safety as well as control are required.

**Setting architectural foundation**

In addition to support operational needs imposed efficiency should be taken in to account. On basis of assessment researchers are encouraging user's needs are calculated. One could constantly demand a high computational power and speed. It is possible to execute some of estimation in real time.

But still some amount of data is kept. The architecture must contain a correct amount of redundancy. The consideration of problems regarding to efficiency are considered here that vary according to organization and its need. Let us begin, by asking some questions:

1. Magnitude of information needed in an organization to control present and future
2. Number of times when one organization needs to manage data in actual time or almost in actual time
- 3 The amount of risk that is afforded by one organization affords. Industries focus on strict security, compliance, and governance requirement.
- 4 Influence of speed that is needed to control information
- 5 Nature of useful data

It is quite simple to realize big data once elements of its structure are formed. The management design must incorporated facilities. Such facility allows countless information sources to be utilized by organization. Utilization is made in a speedy and effective way. In order to provide assistance, elements are placed in to a diagram that would help operator to know relationship between components.

**Interfaces and feeds**

Before developing heart of big data technology heap personally, it is essential to remember that evidence of links and supplies are exist in each side of diagram and internally make management of data. In beginning one could realize require of big data. After those responsibilities of big data in original world is discovered. The big data depends upon collecting of large data from different sources. Therefore, foundation of any big data architecture is open application programming interfaces. Furthermore, it is also essential to remember that links exist at each level and between each layer of heap. The execution of big data is almost impossible in situation where integration of services is not present.

**Redundant physical infrastructure**

The physical foundation of big data formation is essential for its working and adaptively. It is illustrated that existence of big data is not a critical issue in absence of this strong physical foundation. It has been come in to notice that physical foundation of big data is separate in comparison to other established data. The reason behind this is that it provides support to extraordinary or inconsistent size of data. On basis of circulated calculation method physical foundation of big data is made. It means that it is quite possible to keep data in physical form in separate locations. By means of web, dispersed file system, and various big data logical tools and applications this data could be easily integrated. Redundancy is essential for reason that operator are dealing with so much data from so many different sources. It came in different shapes. Whenever a personal cloud is created by any organization it is necessary to form redundancy inside personal surrounding so that it could manage changing workloads. In situation where organization wants to involve interior IT growth, they have utilized external cloud facility for growth of its interior resources. In some situations, this redundancy might

come in shape of Software utilized as a service. It enables multiple associations to perform multiple data estimation as a service. Software as a Service method introduces cheaper, quicker start and complete development of fundamental technology.

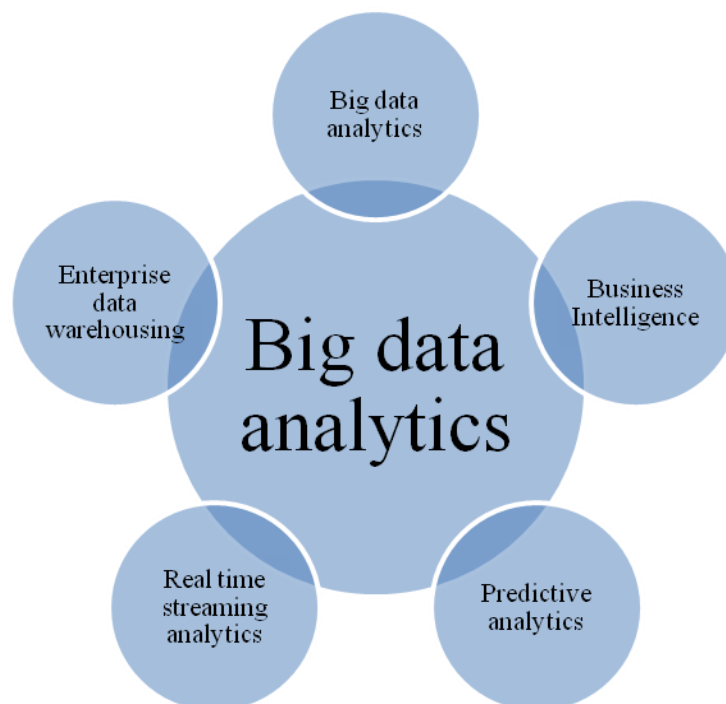
### Security infrastructure

In present scenario, assessment and safety of data becomes very important for organization. Analysis of big data becomes more important to companies, security of that data is also becomes more important. For example, in field of healthcare department, utilization of big data application is required to decide alteration in demographics. It has been utilized easily to recognize require of patient in order to maintain privacy of patient. The operator knows if anyone sees data. In specific situation they allow other to access their system. The security systems are capable to verify identity of users and guard identity of patients. It is essential that all these types of security requirements are considered in big data structure from beginning.

When studied all together these are known as nosql, or not only sql databases. In the real meaning a user needs to map data architectures to type of transactions. Working on it will help in ensuring right data has when a user wants it. Data architectures have been needed to hold complex unstructured content. User needs to include relational databases & no relational databases both in approach of user to harness big data. It has also been found very important to contain unstructured data sources. These sources are like management of content systems. The user could get closer to that 360-degree business view. This kind of operational data sources are having many features:

- These are systems to record the track of critical data that has been needed for real-time, day-to-day operation in business.
- These are updated regularly that has been based upon transactions that have been happening in business units & from web.
- The sources have provided an accurate presentation of business; data sources blend structured & unstructured data.

Such systems have also capable to scale and to support thousands of users on a regular basis. These may have included transactional e-commerce systems, customer relationship management systems, or call center applications.



**Fig 1.1** Big Data Analytics

### Characteristics of Big Data:

(i) **Volume** – it is well known thing that term Big Data is related to a huge data set. Size of data has an essential crucial role to determine data value. Also, specific data is considered as a Big Data according to volume of data.

It varies according to size of data. Therefore the, '**Volume**' has been known as characteristic required being determined at time to deal with Big Data.

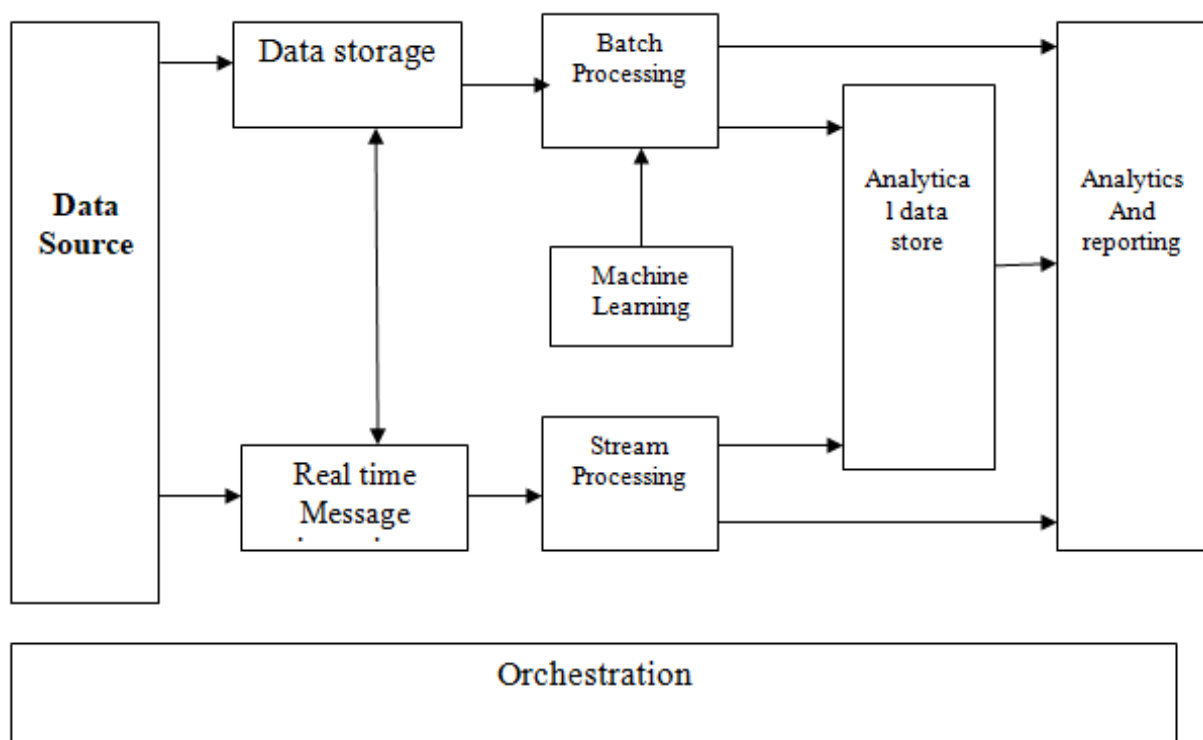
(ii) **Variety** – other feature related to Big Data is **variety of data**. In Variety of data there are two factor heterogeneous sources and data nature are considered. The data has been divided in two type structured and unstructured. in earlier days, spreadsheets and databases were considered as merely sources of data that are utilized in multiple applications. It has been analyzed that due to unstructured data, there may be different related to storage, mining and evaluating data.

(iii) **Velocity** – **Velocity** stands for speed related to generation of data. The speed of data generation and processed to get according to requirement are considered here. Such factors determine actual efficiency of data.

Velocity of Big Data shows speed of data flows. This data has been transferred in from sources for example business processes, application logs etc. The networks, and social media sites and sensors are also considered here. It has been seen that data flow is huge as well as continuous.

(iv) **Variability** – this term has been utilized to highlight inconsistency related to big data at times. It hampers to procedure that has been followed to deal with huge data set.

#### Architecture:



#### Types of Big Data Formats:

Big data could be structured, unstructured and multi structured. The development of big data facilitates several innovative transmissions between business professionals in a company. Two kinds of data are there in one conversation. These have been gathered for the completion of business deals. The first is structured and second is unstructured that can be type of big.

It is the fact that such kind of data has been used in modern digital enterprise. But it is essential to manage these kinds of data differently. Conversation are required that is defining significance of data set in enterprise. Data analysts as well as business stakeholders are based on information to produce actionable operations. These practices are performed during data collection, archiving, and data discovery.

#### Structured

Structured data is also considered as traditional data. It consists of several text files. These text file includes organized contents. Structured data has been collected in data warehouse. Here it might be pulled to perform analysis. In beginning of big data as well as emerging data sources it has been observed that structured data has prepared according to decisions related to business.

Structured data is organized properly. It is not difficult to digest. Legacy data mining application has been utilized to make analytics feasible. In this way structured data has been made up by data of customer. The data includes names, addresses, and contact data. In additionally, associations also make collection of transaction data. Source is consisting of financial data. It is required storage to fulfill compliance standards.

The Structured information is managed with legacy analytics results. These types of solutions are provided in manager pattern.

Structured data has been considered as data is organized in deigned storehouse. In data base elements are easily build addressable. Arranged data is normally reachable by primary algorithms sample. It includes the unrolsheets as well as the data from machine sensors. It is the fact that the structured data is well-organized. It has been formatted in a particular method so it is easy to search in relational .Structured data is organized properly. One can easily understand it via machine language. Implementation inside relational databases may input, make searching with modification in structured information rapidly. It has been considered most attractive characteristic of organized information. Programming tool that has been utilized for managing structured data has been known as structured query language. This language is considered SQL. This language has been launched by IBM in the starting of 1970s. it has been used to handle the relationships in databases.

### **Unstructured**

Unstructured data is not having pre-defined format. This makes it more complex to store, execute and verify. Such type of information has been found increasing and getting influenced in organization. This is because organization is trying to leverage latest. Same problem exist in case of emerging data set.

Such latest content sources have been developed by streaming data. Such information is got from social media platforms. These could be retrieved from mobile applications.

In some case, it has been known to location services and technologies of IOT devices. As variety between not structured data sources have lack of prevalent. There is solution to manage businesses with use of structured data formats. In form of result, it could be said that associations are able to deal with multiple challenge. They are ready to get creative for pulling relevant data to evaluate it.

Maturation & growth of information has been lacing. Thus Hadoop platform has found direct output of exploring unstructured data. Previous data warehouse environments have no match in case of many data types. Companies have been supposed to pour additional resources in human talent with software code to support.

Lack of simply defined structure inside an unstructured data store has presented a unique opportunity in an up-and-coming profession of the data scientist. Unstructured data required specialized skills & tools to work. They cannot be recorded normally in an Excel spreadsheet or data table. There has been a requirement of more Unstructured data just like human language. Unstructured data has been mostly categorized as qualitative data & could not be processed & analyzed by the use of conventional tools & methods.

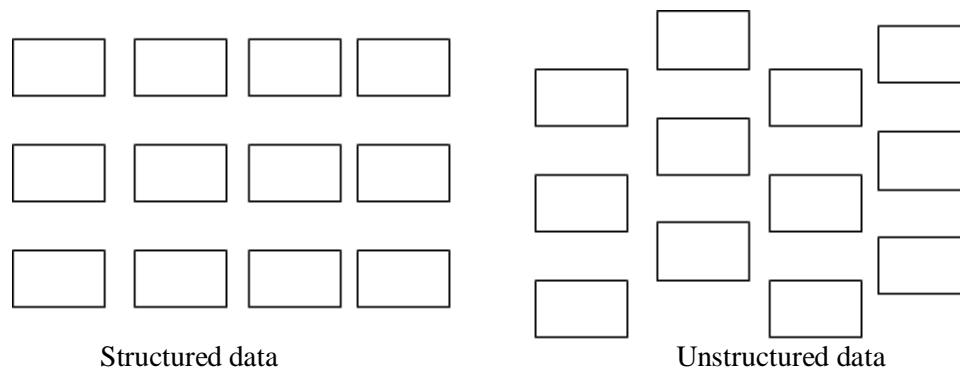
Examples of unstructured data consists of text, video. It also considers audio, mobile activity. It has been observed that social media activity along with satellite imagery and surveillance imagery also included in it. [11] Sample of unstructured data are consisting textual and graphical content.

It is not easy to deal with the unstructured data. The cause is that it has lack of pre-defined model. Mean to say that it is not able to organize the data in relational databases. It is observed that non-relational as well as NoSQL databases have been found best fit to manage unstructured information.

Different mechanism to deal with unstructured data, Data Lake has been used. It allows it to be in its raw unstructured format. More than 80% data that has been generated currently is unstructured. Number is providing the continuity to growth within prominence related to IOT.

It is not an easy task to find the insight buried in not structured data. It needs the advanced analytics with the height technical expertise for actually make a variance. It has been shifted for multiple associations.



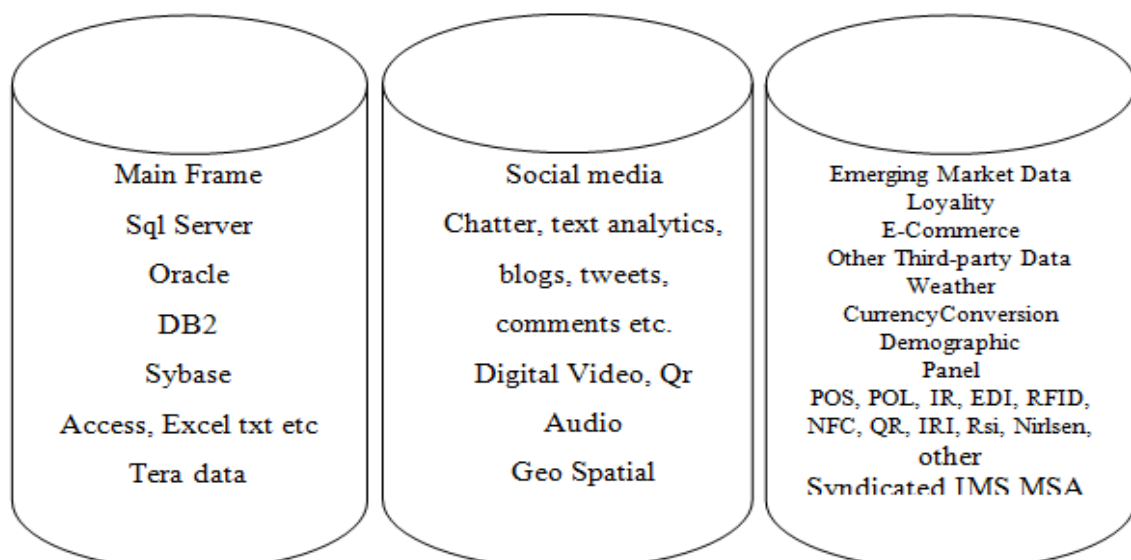


**Fig 1.3** Structured/unstructured Data

### Multi structured/Hybrid

This type of content is for diversity of content formats & types. Such contents might be inherited from users and systems. Samples of such content are web based applications as well as social networks. The Hybrid Data Warehouse is providing several benefits that are mentioned below:

- Content optimization during processing has several workloads such as content transformation. This is managed by hybrid data warehouse.
- New chances for organization using flexible Schema-on-Read are accessible. This done by multi use as well as multi-workload data processing. This is done over similar group of data. Batch to real-time procession has been used to implement it.
- It has been observed that flexible features are allowing quick loading of information. It also allows parallel processing. This is resulting in quick time to insight. Bulk of data is found effective as compare to data warehouse to process. It has raised quantity of unstructured & semi-structured information. It has been found significant for analytics in present time.
- A data warehouse has augmented with a data lake has made it possible to enterprise to employ more strategic use of the assets.
- Hybrid Data Warehouse has provided guarantee of best query performance. It has introduced agility & sound information architecture. This has performed by enabling using accessing with the integration logic across soft wares.
- It is minimizing cost of development. It is also providing solution in time. The reusable is also reducing cost of maintenance.
- Hybrid Data Warehouse assistance for information sources has been provided. It is specialized NoSQL content stores, public web content, cloud apps. It is exposing information to more consumers. It has linked content through Restful.



**Fig 1.4** Comparison between Structured, Unstructured and Multi structured/Hybrid data

**Table 1.1** Structured, Unstructured and Hybrid

	<b>STRUCTURED DATA</b>	<b>UNSTRUCTURED DATA</b>
<b>Features</b>	It is having predefined content models. Generally content that are textual are utilized. This has been found is simple to find structured information.	Such content type is not predefined content model. This could be textual, graphical, voice based or animated.
<b>Presents in in</b>	It is checked in relational databases with in warehouse of contents.	It could be found in software, No SQL databases, Information
<b>Produced by</b>	Structured data sets could be produced by humans or machines.	It could be developed by humans or machines.
<b>Typical Software's</b>	This is applicable in Airlines reservation systems. Inventory control and ERP systems are also considered here.	It has been used in Word processing along with presentation software.
<b>Examples</b>	Examples of structured data are phone numbers, Credit card numbers, and social security numbers. Here transaction information is considered.	Examples are unstructured Text files, Reports. It also consists of Email message, Audio files.

In above table, comparison of structured and unstructured data has been made. In this table it has become clear that structured data is predefined model. Generally, it has been observed that structured data are in text form and easy to search. On other hand, unstructured data could be referred as un- predefined model. It might be in form of text, graphic, sound, video or other formats. It is not easy that one can easily make searching in this data. Structured data resides in Relational databases as well as may be Data warehouses. On other hand, unstructured data could be seen in applications, No SQL databases, Data warehouses, Data lakes etc. There is one similarity in structured data and unstructured data that both are formulated by human being or machines. Examples of structured data are phone numbers, Credit card numbers, and social security numbers. Here transaction information is considered.

On other hand, unstructured data is available in Text files, Reports, Email message, Audio files, Video files, Images, Surveillance Imagery etc.

Have you ever thought of the amount of data created every day in this digital era by all of us? Every credit card transaction, every message sent, even every web page opened... It all sums up to a total of 2.5 quintillion bytes of data that the global population produces on a daily basis. And this data is called big data.

### **Importance of Big Data Analytics in Education**

Big data analytics assists organizations to effectively utilize their data to identify new fields in their institutions & businesses to create new opportunities. Schools, universities, colleges and other educational bodies hold huge amounts of data related to students and faculty. This data can be analyzed to get insight that can improve the operational efficiency of the educational institutions. Variables like student's behavior & performance, examination results, and the development of each student as well as their educational needs will be based on the changing educational requirements. Big data analytics monitors student's activity such as their favorite subjects, their classroom performance, extracurricular activities, the time they take to finish an exam and many other things within a student's educational environment. A report can be constructed which will indicate the interest areas of a student. Educators can also improve their teaching skills after receiving feedback for a better learning experience equally for all students.

We can summarize the influence of big data in education as:

- Big data in the education sector Customize programs for different students.
- It improves student result & thus reduces dropouts.
- In the future, the enhancement of big data systems in the classroom will make it even more essential that educators must understand how to work with the technology and use it to improve student learning outcomes.

**Big Data Analytics in Production:**

It has been observed that analytical manufacturing is providing near to zero downtime along with transparency. In order to implement it there is requirement of large amount of information. There is also require of advanced forecasting tool. All these are required to do a systematic process of information and change them in significant information. Benefits of utilizing Big Data in manufacturing organization has been discussed as follow:

1. Producing better quality and tracking of defects
2. Making use of scheduling
3. Defect tracking during production process
4. Predicating production
5. Enhancement of energy efficiency
6. Checking and imitation of recent and upcoming production processes
7. Assistance for bulk modification during production

**Big Data Analytics in e-Commerce**

The use of Big Data and analytics is helping e-commerce business stay one step ahead of the game. Big Data is a large collection of information that organizations can use to determine which product, price and advertising is best to maximize their profits. As we know, Big Data is a large collection of data that organizations can use to make better decisions. And e-commerce business can benefit the most from using it, because of all the information they collect during day-to-day operations.

Predictive analytics is used by e-commerce to predict what the particular consumer will buy. Today all e-commerce sites like Flipcart, Myntra, Amazon etc. use this with science and not just relying on their marketing ability. Personalization involves using Big Data to personalize emails and increase adaptation rates. This concept can be understood by even those customers who know nothing about technology but are using these e-commerce sites. Depending on their searching of products & buying habits, these sites send notifications & also allure them with discounts & other favors. Moreover, Pricing can be changed constantly to keep up with competition using real-time analytics.

**Big Data Analytics in Banking Sector**

Today, banking is one of the business domains that make the highest investment in big data as volume of data generated and handled in the banking and financial sector is enormous. While digital banking is used by almost half of the world's adult population, financial institutions have enough data at hand to think about big data rather than traditional methods for data handling to become more efficient, more customer-centric and hence, more profitable. Big data analytics can assist banks in understanding customer behavior based on the inputs received from their investment patterns, shopping trends, motivation to invest and personal or financial backgrounds. This data plays a vital role in winning customer loyalty and trust by designing personalized or customized banking solutions for them. Now, knowing the usual spending patterns of a customer helps raise a red flag if something offensive happens. If a careful investor who prefers to pay with his card, attempts to withdraw all the money from his account via an ATM, this might mean the card was stolen and used by fraudsters. At this, a phone call from a bank confirming to complete such transactions helps in understanding the genuine card –holder or a fraud.

We can summarize the role of big data in banking sector as:

- Identifying the spending patterns of the customers
- Identifying the main mode of transactions (ATM withdrawal, credit/debit card payments)
- Dividing the customers into segments according to their profiles
- Product cross-selling based on the customers' segmentation
- Fraud management & prevention
- Risk evaluation observance & reporting
- Customer feedback analysis and application

**Big Data Analytics in Healthcare**

Big Data has changed the way we manage, analyze and control data in any industry. One of the most promising fields where it can be applied to make a change is healthcare. The application of big data analytics in healthcare has a lot of optimistic and also life-saving results. Healthcare needs to catch up with other industries that have already moved from standard regression-based methods to more future-oriented like predictive analytics, machine learning, and graph analytics. Big data in healthcare refers to the rich health data combined from numerous sources including electronic health records (EHRs), medical imaging, genomic sequencing, payer records, pharmaceutical research, wearable, and medical devices etc.

For example: Consumer products like the Fitbit activity tracker and the Apple Watch and Samsung Gear keep tabs on the physical activity levels of individuals and can also report on specific health-related trends. Various Apps in mobile, when downloaded and used as described keep tracks of one's health thus, following the rule "Prevention is better than cure."

In short, Big data is just beginning to revolutionize healthcare and the industry is moving forward on many fronts.

In a nutshell, with big data analytics in healthcare, we can:

- Use Electronic Health Records (EHRs)
- Use real-time alerting for immediate care
- Use health data collected for a better-informed deliberate planning
- Research more extensively to cure cancer
- Use predictive analytics
- Reduce fraud and enhance data security
- Practice telemedicine or remote diagnosis and treatment of patients by means of telecommunication technology
- Integrate medical imaging for an broader diagnosis

**Big Data Analytics in Agriculture**

Different countries have different Agriculture requirements depending upon weather conditions, nature of soil and other atmospheric factors. Agriculture is the backbone of the Indian economy, but the industry presently needs more support than any other. In Agriculture, Smart Farming is a new term. Smart Farming is a farming management concept using modern technology to increase the quality & quantity of agricultural products. This is a new development in agriculture that emphasizes the use of information and communication technology. New technologies such as the Internet of Things and Cloud Computing are likely to power this development and introduce more robots and artificial intelligence in farming. This is incorporated by the phenomenon of Big Data, enormous volumes of data with a wide variety that can be captured, analyzed and used for decision-making. Both Big Data and Smart Farming are relatively new concepts, so it is expected that knowledge about their applications and their implications for research and development is not commonly spread. Besides From a business point of view, farmers are looking for ways to improve productivity and effectiveness by, on the one hand looking for ways to reduce their costs and on the other hand obtaining better prices for their products. Therefore, they must take best possible and precise decisions and hence improve management control.

**CONCLUSIONS**

Here first of all, use of big data in different sectors has been defined. After that challenges faced during dealing with big data in different sectors are also considered. Data safety and integrity is arguably the biggest concern about Big Data to regulatory authorities and education stakeholders. For one, the existing security protocols are not well equipped to handle the large volumes of data involved in Big Data analytics. What's more, it is very expensive, not to mention difficult, to effectively manage the dynamic or continuously updating type of data the technology brings about. Hackers, therefore, have an easy time getting to datasets, particularly those stored in the cloud without data owners noticing.

Keeping in view that, academic data may not be as sensitive as financial or health data, but still, there is fear that hackers and malicious people may use the weak security systems of Big Data to gain access to volumes of student data. Fortunately, further research is ongoing in this aspect, and hopefully, it results in better, more reliable data protection methods.

Moreover, limited supply of data scientists and people skilled of working with Big Data is also a limitation of working with Big Data. Noise is also present in Big data which must be dealt carefully. Also intelligent use of data need to be done for better decision making so that it can fulfill the purpose of using Big Data.

## REFERENCES

- Hilbert, Martin, and PriscilaLópez. "The world's technological capacity to store, communicate, and compute information.", Science 332.6025, pp. 60-65, April2019.
- "Big data as the bedrock of the future economy", January 11 2017, European Political Strategy Centre, [Online] [https://ec.europa.eu/epsc/publications/strategic-notes/enter-data- economy\\_en](https://ec.europa.eu/epsc/publications/strategic-notes/enter-data- economy_en), lastaccessed05-04-2017.
- Bell, Gordon, Tony Hey, and Alex Szalay. "Beyond the data deluge.", Science 323.5919, pp. 1297-1298, March2019.
- MarkusMaier, Master's Thesis, "Towards a Big data reference architecture", 13 Oct., 2013, Eindhoven University of Technology. last accessed 05-04-2017.
- Bernard Marr, Forbes, "How Big Data is Changing Healthcare", (2015), [Online] <http://www.forbes.com/sites/bernardmarr/2015/04/21/how-big-data-is-changing-healthcare/>, last accessed 05-04-2017.
- "What is Big Data", 2016 [Online] <http://www.ibm.com/bigdata/us/en/>, last accessed 05-04-17.
- "Big Data 3 V's: Volume, Variety, Velocity (Infographic)", 2021, [Online] <http://whatsthebigdata.com/2013/07/25/big-data-3-vs-volumevariety-velocity-infographic/>, last accessed 05-04-2017.
- "Big Data", 2016, [Online] [https://www.sas.com/en\\_us/insights/bigdata/what-is-big-data.html](https://www.sas.com/en_us/insights/bigdata/what-is-big-data.html), last accessed 05-04-2017.
- "What is the big data? 12 Definitions", 2017, [Online] <http://whatsthebigdata.com/2014/09/08/whats-the-big-data-12-definitions/>, last accessed 05-04-2017.
- James Manyika, Michael Chui, Brad Brown, Jacques Bughin, Richard Dobbs, Charles Roxburgh, Angela Hung Byers, "Big data: The next frontier for innovation, competition, and productivity", 2011, [Online] [http://www.mckinsey.com/insights/business\\_technology/big\\_data\\_the\\_next\\_frontier\\_for\\_innovation](http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation), last accessed 05-04-2017.
- EddDumbill. "What is big data?", 2012, [Online] <https://www.oreilly.com/ideas/what-is-big-data>, last accessed 05-04-2017.
- Carl W. Olofson & Dan Vesset, "Big Data : Trends, Strategies, and SAP Technology", 2012, [Online] <http://www.itexpocenter.nl/iec/sap/BigDataTrendsStrategiesandSAPTechnology.pdf>, last accessed 06-04-2018.
- A. Katal, M. Wazid and R.H. Goudar, "Big data: Issues, challenges, tools and good practices," Contemporary Computing (IC3), Sixth International Conference, pp. 404-409, IEEE 2013.
- Demchenko, Yuri, P. Grosso, C. Laat and P. Membrey, "Addressing big data issues in scientific data infrastructure," Collaboration Technologies and Systems (CTS), International Conference, pp. 8-55, IEEE 2013.
- Richard L. Villars, Carl W. Olofson, Matthew Eastwood, "Big Data: What It Is and Why You Should Care", 2011, [Online] [http://www.admin-magazine.com/HPC/content/download/5604/49345/file/IDC\\_](http://www.admin-magazine.com/HPC/content/download/5604/49345/file/IDC_)
- Big%20Data\_whitepaper\_final.pdf, last accessed 07-04-2017.
- James Manyika, Michael Chui, Brad Brown, Jacques Bughin, Richard Dobbs, Charles Roxburgh, Angela Hung Byers, "Big data: The Next Frontier for Innovation, Competition, and Productivity", May 2011, McKinsey Global Institute, last accessed 05-04-2017.
- Poonam Dabas, Anoop Arya, "Grid Computing: An Introduction", International Journal of Advanced Research in Computer Science and Software Engineering, vol. 3, issue 3, pp. 466- 470, March 2013.

- 
- Randal E. Bryant, “Data-intensive scalable computing for scientific applications”, Computer. Sci. Eng, vol.-13, issue-6, pp. 25–33, December2018.
  - N. Rajesh, V.Prana “Challenges associated with heterogeneity in Big Data using HACE theorem”,proceedingsofNationalLevelTechnicalConferenceonRecentTrendsInComputerScience Engineering and Technology (NCRTCSET), pp 21-26, September 2020..
  - Martin Hilbert, Priscila Lopez, “The world’s technological capacitytostore, communicate, and compute information”, Science, vol. 332, pp. 60–65, April 2011.
  - HaiyingShen, Lianyu Zhao, Ze Li, “A distributed spatial-temporal similarity data storage scheme in wireless sensor networks”, IEEE Trans. Mobile Computing, vol. 10, issue 7, pp. 982– 996, July2021.



## A STUDY ON IMPACT AND APPLICATIONS OF ENVIRONMENTAL ACCOUNTING AND AUDITING PRACTICES OF INDIAN COMPANIES

Mr. Pratik A. Shah<sup>1</sup>, Prof. (Dr.) Sandip K. Bhatt<sup>2</sup> and Dr. Kamini Shah<sup>3</sup>

<sup>1</sup>Research scholar and Assistant Professor, Shree Bhaikaka Government Arts and Commerce College

<sup>2</sup>Head and Research Guide and <sup>3</sup>Associate Professor, Sojitra, Department of Business Studies, Sardar Patel University, Vallabh Vidyanagar

### ABSTRACT

*Environmental accounting and auditing has been gaining its importance day by day. All stakeholders of companies have realised importance of it and started to evaluate companies on the basis of environmental performance of companies. In this research paper authors have compile opinions from experts through a structured questionnaire with respect to impact and applications of environmental accounting and auditing practices of Indian companies. Opinions for basic impact and application practices for environmental accounting practices, for environmental auditing practices and for better policy making suggestions have been collected from 109 experts in this research work. It has been observed from the responses that government and companies are moving in right direction for implementing environmental accounting and auditing but still the hurdles are to be removed for its efficient implementation.*

*Keywords: environmental accounting, environmental auditing, Environmental performance.*

### 1. INTRODUCTION

“Environ” a French word translating to “surrounding” is the origin of word ‘Environment’. Existence of human kind is possible because of environment only. Because of so much importance of environment, right from ancient times, protection of environment has been taken care of. However, rapid growth of industrialisation and lack of awareness about the damage to environment by certain deeds from human beings, environment got polluted and the entire eco cycle has got disturbed. We are already experiencing negative outcome of not taking care of environment in the form of global warming.

Luckily, this has been realised now and at international level, efforts have been made to protect environment. Industrial growth with sustainability has been introduced now. Our future generation must be given enough natural resources to live their life happily. Proper framework for environmental reporting will certainly create compulsory component on part of corporate to protect environment. There has been no specific accounting format for environmental reporting in India. Companies are disclosing some environmental matters in their annual reports as well as part of their sustainability report on the basis of some guidelines available with respect to environmental reporting in India. In this research paper, authors have tried to comprehend present disclosure practices by opinions from experts through a questionnaire which will be useful to policy makers also for better policy decisions in this regard.

### 2.1 LITERATURE REVIEW

Environmental accounting and auditing has been an emerging concept. Many Researchers have tried to study various areas related to this topic. Some of such research studies are as under:

(Shukla Bal, 2020) has undergone to study Environmental Accounting and Reporting Practices in Indian Manufacturing Companies With Special Reference to Select Cement Companies. The researcher has taken into account all 163 cement companies to analyse environmental information and reporting disclosure practices dividing into public and private sector. Output was also compared with environmental accounting practices. Primary data from five companies were also collected through research schedule. It was observed that there were 157 private and 6 public companies and performance of all companies were average with respect to environmental information and accounting disclosure. Most of companies were disclosing compulsory required information only. Global standards and voluntary disclosure were missing in most of companies. It was suggested to have training and awareness programmes with collaboration of experts in field of environmental accounting, industries and educational institutes for corporate houses. Also common accounting standards for environmental accounting was demanded by accountants of selected companies.

(Rusi, 2019) has focused on environmental disclosures practices among the select Indian companies with special reference to global reporting initiative GRI guidelines. The study has tried to observe extent of disclosure with reference to type of companies, size of company, foreign ownership, profitability, government ownership and financial leverage. The study has considered environmental disclosure index (EDI) based on Global Reporting Initiative – G4 guidelines consisting of 34 indicators. Constructing the disclosure index was

aided by content analysis method. To study whether difference in extent of environmental disclosure practices can be explained by Stakeholders theory and Legitimacy theory, the research design was based on two theories- Stakeholders Theory and Legitimacy Theory.

(Kumar, 2018) has focused on corporate environmental reporting in India. The researcher has considered Five major industries. From each of this sector, five public and five private sector companies were selected on the basis of ET Wealth 500 Index market capitalisation for the year 2014-15. To examine the data of environmental content, seven major areas of corporate environmental reporting were identified on the basis of the GRI G4 (2014) Guidelines. This research was based on a six-year content examination of fifty corporations' annual and sustainability reports. Most of the environmental disclosures were qualitative in nature and were located in the part of Directors Report of annual report. The highest priority area of the social reporting in Indian companies was Energy and least was the Material and Biodiversity Contribution. The overall trend of environmental reporting in annual and sustainability report of Indian companies was increasing but it was not very satisfactory.

(Omnamasivaya, 2017) studied environmental accounting and disclosure practices of Nifty companies. The study indicated that the environmental disclosures were flexible throughout the years. Size of the companies influenced the degree and quantity of environmental disclosures. The important reasons for low disclosures could be the no compulsory requirements for informing environment information.

(Rachchh & Gadade, 2015) Environmental reporting by Indian Hospitality Industry was considered. Disclosures were more general or theoretical (qualitative). It lacked consistency thus, disclosure standard were considered unacceptable.

(Jaganathan, 2007) has studied environmental accounting and reporting. He has taken into account 200 top companies for a single year. 20 environmental indicators were identified and grouped into Regulatory environmental Information (7), Accounting Environmental Information (4) and General Environmental Information (9). He has also taken opinion of 143 chartered accountants with respect to environmental accounting and reporting practices. Also six corporate characteristics were also identified to investigate the association between firm characteristics and the state of environmental disclosure. 'The' study concluded that disclosure practices for environmental matters were very poor among selected companies. They have provided detail at various places in annual reports. Strong standards for disclosures were also suggested by chartered accountants. Environmental disclosure was also found to be positively correlated with financial success, age, size, and foreign influence, while being adversely linked with systematic risk.

(Chauhan, 2006) in his study tried to explain the issue of environmental indicators which could be utilized by the corporate sector to adjudge the sustainable administration of environment for better disclosure of actualities identified with environment.

## **2.2 Research Gap**

From the above review literature, it can be observed that at present corporate world has been forced by various stakeholders to consider environmental accounting and auditing as their part of social responsibility. Still there has been no universally accepted model to disclose environmental accounting and auditing aspect in books of account. Considering this research gap, in this research paper impact and applications of environmental accounting - auditing practices at India level has been tried to be touched up on.

## **3. RESEARCH METHODOLOGY**

### **3.1 Research design**

For this research work, survey method has been utilised and, authors have framed a questionnaire to compile opinions from experts with respect to impact and applications of environmental accounting and auditing practices of Indian companies. The questionnaire has four sections- 1) Basic opinions with respect to impact and applications of environmental disclosure practices of companies 2) Environmental accounting practices 3) Environmental auditing practices and 4) Important opinions of experts for better policy decisions

### **3.2 Scope of the study**

Most of developed countries have already started practicing environmental accounting and auditing in a systematic way as compared to developing countries. Indian companies have been voluntarily discloses environmental related matters. But it has been observed that Indian companies discloses only positive matters related to their contribution to environment and also that too descriptively. By observing opinions of experts, the current scenario with respect to environmental accounting and auditing can be known. This will also help policy makers and future researchers to understand real existing picture.

### 3.3 Research objectives

- 1) To understand various aspects of environmental accounting and auditing framework.
- 2) To compile opinions of experts for basic environmental disclosure matters of Indian companies
- 3) To collect opinions of experts for current impact and applications of environmental accounting practices of Indian companies
- 4) To compile opinions for existing impact and applications of environmental auditing practices of Indian companies
- 5) To have opinions from experts to suggest better impact and applications of environmental accounting and auditing practices of Indian companies.

### 3.4 Sampling techniques

For analysis for this research work, 109 responses from experts have been considered as a pilot study. Experts for this purpose will mean CA, CS, CWA, Teaching professionals and concerned company representatives from all over India.

### 3.5 Limitation of the study

Limitations of survey method can be limitation of this research work. However, due care has been taken to carry out this research work in the best possible manner.

### 3.6 Further scope of the study

Environmental accounting and auditing has been a developing concept and hence there are many areas for future researchers. Future researchers can study companies with certain identified environmental parameters, various stakeholders can be involved other than considered here for the purpose of environmental accounting and auditing practices etc.

### 3.7 Usefulness of the study

To understand concept of environmental accounting and auditing more properly and to be aware about its existing disclosure practice among various companies can benefit all stakeholders of companies. Suggestions received for better impact and applications of environmental accounting and auditing practices of Indian companies will also be helpful to future researchers and policy makers.

## 4 ENVIRONMENTAL ACCOUNTING AND AUDITING

### 4.1 Environmental accounting

The identification, collection, prediction and examination of costs related to environment in order to facilitate decision-making within the organisation can be considered as environmental accounting. Identification of environmental cost and separation of non-environmental costs of each process is its primary goal. Inclusion of environmental information in accounting system of the entity is the step towards inclusion of sustainable development in routine business decisions.

### 4.2 Scope of Environment Accounting

Corporate, National & International level areas are covered under its extensive scope.

#### Viewpoints:

1. **Internal:** Informal in nature and comprising of investment made for reducing losses to environment by the corporate like funds spent on equipment - devices for environmental protection.
2. **External:** It deals with all indirect measures by which the harm to the environment is done due to operations of the entity including:
  - a. **Degradation and demolition:** i.e. soil erosion, air pollution, water pollution, loss of bio diversity, Noise pollution, solid waste problem, coastal & marine pollution.
  - b. **Depletion of non-renewable natural resources** i.e. Over exploitation of non-renewable natural resources like minerals, gas, water etc.
  - c. **Deforestation and Land uses**

There are difficulties in dealing with such type of accounting method as the value of precious natural resources cannot be easily and directly defined and measured in money, also it is difficult to ascertain the amount or percentage of loss occurred to the environment by that industry, hence to address this issue tentative amounts or comparative estimates using historical data can be deployed.

### **4.3 Environmental auditing**

It is a tool primarily used for measurement of the effects of some activities on the environment by comparison against determined criteria and standards.

Types of environmental audit are bifurcated as per standards and its focus. Almost all types of firms are now giving importance to the environmental areas and activities as stakeholders have started to focus on it. It helps to improve the operations in a way that the adverse effects on the environment is curbed down for cleaner, better and healthier future.

Aspects of various activities of the companies' activities towards environment are noted and clearly and systematically disclosed in the audit report. Some of the reasons for EA is compliance with environmental regulation and meet the client requirements.

International Organization for Standardization (ISO) has given many standards in this area which are intended to guide organisations with compliance and auditors for the execution of environmental audits.

## **5. LEGAL FRAMEWORKS**

While manufacturing licensing for all real-world purposes has been terminated, the focus has now been on environmental clearance from various government authorities. With growing global concern about environmental conservation, India has also set up a Union Ministry of Environment to coordinate environmental protection and anti-pollution creativities among the various states and departments. Essential legislation has also been passed.

In July 2011, the Ministry of Corporate Affairs of India released the 'National Voluntary Guidelines on Corporate Social, Environmental and Economic Tasks. 'Such guidelines include detailed standards to be implemented by businesses as portion of their business practices, and a standardized company compliance reporting system involving such clear reports, showing the measures that companies have taken to enforce certain standards. These guidelines have been revised in the year 2018.

Under Business Responsibility Report format, Principle wise performance is to be disclosed by the company. Principle 2, 4 and Principle 6 pertains to the Environment related information.

(Markets, 2021) Recently, regulator Sebi on May 10, 2021 came out with disclosure requirements under business responsibility and sustainability reporting, covering environmental, social and governance perspectives, which will be applicable on the top 1,000 listed entities by market capitalisation. The new report -- Business Responsibility and Sustainability Report (BRSR) will replace the existing Business Responsibility Report (BRR).

Under BRSR, listed entities need to disclose about an overview of the entity's material ESG (environmental, social and governance) risks and opportunities, approach to mitigate or adapt to the risks along with financial implications of the same. In addition, sustainability related goals and targets and performance against the same need to mention in the report.

Environment related disclosures cover aspects such as resource usage (energy and water), air pollutant emissions, green-house (GHG) emissions, transitioning to circular economy, waste generated and waste management practices, bio-diversity.

The reporting would be on voluntary basis for financial year 2021-22 and on a mandatory basis from 2022-23.

## **6. RESULT AND DISCUSSION**

Authors have designed a questionnaire (enclosed herewith) which has been divided into four sections. The final respondents are 109 in number whose responses for each question has been summarised as under:

1. Should companies disclose environmental matters compulsorily? Out of 109 respondents, 106(98%) have agreed for this while 2% have disagreed.
2. How environmental matters should be disclosed? 31% of respondents have favoured Separate Environmental Report, 18% have favoured Annual Reports, 6% have favoured Website or any such platform and 45% have shown interest in combination of these options.
3. If environmental matters are to be disclosed in the annual reports where should it be mentioned in it? 41% of respondents have favoured Separate section for environmental disclosure, 6% have favoured notes to accounts, 12% have favoured Balance sheet, 1% have agreed for Directors report and 39% have favoured combination of these options.

4. Guidelines with respect to disclosure of environmental matters should be issued by whom? 9% of respondents have favoured Department of Company Affairs, 18% have agreed for Pollution control board, 7% felt SEBI, 7% wanted Professional accounting bodies and 58% preferred combination of these options

5.1 Is the disclosure of environmental matters an opportunity for the company in your opinion?

84% have favoured this while 9% have remained indifferent and 7% have not agreed with this.

5.2 40% have agreed with this, 17% have remained indifferent and 43% have not agreed with this.

5.3 Should environmental audit be carried out in the corporate entities?

84% have agreed for this, 7% have remained indifferent and 9% have disagreed with this.

5.4 Should environmental audit report be made public?

84% have agreed with this, 9% have remained indifferent and 7% have disagreed with this.

5.5 Should the companies have separate environment management department?

79% have felt its needed, 11% have remained indifferent and 10% have disagreed with this.

6. If disclosure of environmental matters is an opportunity for the company, please mark tick the appropriate following points as reasons for your answer

10% have found If performance is good, it will lead to good public image, 8% have felt Will give an indication that the company is a responsible corporate citizen, No one has agreed for Will help in ensuring effective use of natural resources only and 82% have felt all these options as reasons.

7. If disclosure of environmental information is a threat for the company, please mark tick the appropriate following points as reasons for your answer

6% have felt May give negative public image

As the reason, 8% have agreed for May effect competitiveness, community view sales etc., 5% felt May cause litigation, 8% felt There is a risk of consumer boycott, if poor performance

And 72% have felt all these reasons together.

8. If environmental audit is to be conducted, who should conduct it?

66% have favoured external auditors, 16% have agreed for internal auditors and 18% have favoured both auditors for this.

9. Have you come across the following Salient features of Environmental Accounting in the organizations?

9.1 It helps in planning the Cost Control and/or Cost Reduction

74% have agreed with this, 15% have remained indifferent and 11% have disagreed with this

9.2 It promotes designing several processes using the environment friendly technologies

83% have agreed with this reason, 9% have remained indifferent and 8% have not agreed with this.

9.3 It identifies the evaluation of Investments vis-à-vis savings on consumption or usage of resources

79% have felt this reason, 13% have remained indifferent and 8% have not agreed with this.

9.4 It evaluates the Impact of entity's Project on surrounding environment

82% have favoured this reason, 10% have remained indifferent and 8% have not favoured this.

10. Provide your opinion for the following with respect to environmental issues and environmental costs in the Financial Records by adopting Environmental Accounting Tool:

10.1 Do you agree with treatment of environmental costs as Expense with no future advantage(s)?

48% have agreed while 52% have not agreed with this.

10.2 Do you observe Capitalizing environmental costs incurred in preventing the air or water pollution and land contamination?

81% have favoured this while 19% have not favoured this.

10.3 Do you find Capitalizing environmental costs incurred in improving the efficiency and safety of present Asset?

81% have agreed while 19% have disagreed with this.

10.4 Do you agree with Amortisation of environmental costs within 5 years?

74% have favoured this while 26% have not favoured this.

11. Do you agree with the following Advantages emerging from adoption of Environmental Accounting Practices in entities:

11.1 Accounting for environmental outlays and performance recording can help in implementing Environmental policies framed.

93% have favoured this, 4% have remained indifferent and 3% have not agreed with this.

11.2 Collection and recording of environmental costs can further endorse precise costing.

89% have agreed for this, 6% have remained indifferent and 5% have not agreed with this.

11.3 Reasonable relationship with clients on basis of Green products/ services can reflect the environmental friendly attitude in economic development.

93% have favoured this, 4% have remained indifferent and 3% have not favoured this.

12. Do you think that the given Objectives of Environmental Auditing are useful in following ways?

12.1 As a replication of the belief that proficient environmental reporting is the basis of enduring profitability and decent economic progress

88% have agreed with this, 6% have remained indifferent and 6% have not agreed with this.

12.2 Improving competitiveness by making customers and society increasingly aware of environmental issues by addressing them

88% have agreed with this, 6% have remained indifferent and 6% have not agreed with this.

12.3 Updating personnel and clients about the entity's environmental work

84% have agreed with this, 9% have remained indifferent and 7% have not agreed with this.

12.4 Meeting demands of trade bodies viz. FICCI, ASSOCHAM, etc.

86% have favoured this, 10% have remained indifferent and 5% have not favoured this.

12.5 Acting as a significant tool in interactions with governmental authorities and other parties in the environmental field 87% have agreed with this, 8% have remained indifferent and 5% have not favoured this.

13. Have you observed the following Key Areas and Types of Environmental Auditing in organizations?

13.1 Nature conservation, Renewable Energy, Land use planning, Eco construction, etc

86% have agreed while 14% have not agreed with this.

13.2 Transport, Waste management, Eco-consumerism and Community awareness

76% have agreed while 24% have not agreed.

13.3 Management audit, Regulatory Compliance audit, Environmental Management System (EMS) audit and Waste audit

84% have favoured and 16% have not favoured this.

13.4 Waste Disposal-Treatment Storage & Disposal Facility audit, Waste Transport audit, Water audit, Energy audit, Material Balance audit, Environmental Review, Due Diligence audit, etc.

83% have favoured this and 17% have not agreed with this.

14. Do you observe that the following Advantages are the outcome of adopting Environmental Auditing Practices?



14.1 Increase in the management awareness on environmental issues

92% have agreed, 5% have remained indifferent and 3% have not agreed with this.

14.2 Avoiding of fines for noncompliance

81% have agreed, 12% have remained indifferent and 7% have not agreed with this.

14.3 Assurance of financial accruals for environmental liabilities

86% have favoured this, 9% have remained indifferent and 5% have not agreed with this.

14.4 Cost savings from waste minimization and avoiding environmental risks

85% have agreed with this, 9% have remained indifferent and 6% have not agreed with this.

14.5 Early identification of issues and problems before regulatory enforcement action.

87% have favoured this, 9% have remained indifferent and 5% have not favoured this.

14.6 Bagging any prestigious Award or Certification from Government or Non-government agencies

82% have agreed with this, 12% have remained indifferent and 6% have not agreed with this.

15. Do you agree that following are the Reasons leading to Non-adoption or Minimal adoption of Environmental Accounting and Auditing Practices

15.1 Voluntary Nature of Environmental Accounting and Auditing.

90% have agreed with this, 5% have remained indifferent and 5% have not agreed with this.

15.2 Lack of Specific policy on such Emerging issues.

91% have favoured this, 5% have remained indifferent and 4% have not favoured this.

15.3 Unawareness about the benefits of Environmental Accounting and Auditing.

88% have agreed with this, 8% have remained indifferent and 4% have not agreed with this.

15.4 Difficulty in measuring Cost-Benefit analysis from such practices.

86% have favoured this, 8% have remained indifferent and 6% have not agreed with this.

15.5 Absence of Environmental Auditing Standard.

90% have favoured this, 6% have remained indifferent and 4% have not agreed with this.

15.6 Lack of real will and commitment by the political wing/s towards addressing implementation of protective measures for conservation of environment.

80% have agreed with this, 16% have remained indifferent and 4% have not agreed with this.

15.7 In wake of achieving short term gains by corporates, long term challenges to environment are ignored

92% have agreed with this, 4% have remained indifferent and 4% have not agreed with this.

15.8 Unlimited consumerism has emerged as a threat to environment.

85% have agreed with this, 11% have remained indifferent and 4% have not agreed with this.

16. A list of parameters of environmental matters has been given below, please mark tick in appropriate column of each parameter of environmental matters according to the degree of importance that parameter carries to you.

16.1 Awards and accolades for environmental performance received by company

78% have felt its important, 15% have remained indifferent and 7% have felt its not important.

16.2 Global Reporting Initiatives (GRI) adoption

81% have felt its important, 15% have remained indifferent and 4% have felt its not important.

16.3 Environmental Policy framed by the company

83% have felt its important, 14% have remained indifferent and 3% have felt its not important.

---

**16.4 ISO 14001 certification**

83% have felt its important, 10% have remained indifferent and 7% have felt its not important.

**16.5 Renewable Energy usage in the company**

82% have felt its important, 13% have remained indifferent and 5% have felt its not important.

**16.6 Research and development in the environmental area by the company**

81% have felt its important, 12% have remained indifferent and 7% have felt its not important.

**16.7 Carbon disclosure**

83% have felt its important, 12% have remained indifferent and 5% have felt its not important.

**16.8 Materiality- Materiality Map**

80% have felt its important, 14% have remained indifferent and 6% have felt its not important.

**16.9 Environmental targets, standards and output measures**

83% have felt its important, 12% have remained indifferent and 5% have felt its not important.

**16.10 Information in notes to financial statements (accounts)**

84% have felt its important, 11% have remained indifferent and 5% have felt its not important.

**17. Should the disclosure of environmental matters be quantitative descriptive or both?****17.1 Renewable Energy usage in the company**

54% have felt it should be Quantitative, 15% have felt it should be Descriptive and 31% have felt it should be both Quantitative and descriptive.

**17.2 Awards and accolades for environmental performance received by company**

39% have felt it should be Quantitative, 34% have felt it should be Descriptive and 27% have felt it should be both Quantitative and descriptive.

**17.3 Research and development in the environmental area by the company**

38% have felt it should be Quantitative, 32% have felt it should be Descriptive and 30% have felt it should be both Quantitative and descriptive.

**17.4 Carbon disclosure**

43% have felt it should be Quantitative, 24% have felt it should be Descriptive and 33% have felt it should be both Quantitative and descriptive.

**17.5 Materiality- Materiality Map**

41% have felt it should be Quantitative, 31% have felt it should be Descriptive and 28% have felt it should be both Quantitative and descriptive.

**17.6 Environmental targets, standards and output measures**

38% have felt it should be Quantitative, 31% have felt it should be Descriptive and 31% have felt it should be both Quantitative and descriptive.

**17.7 Information in notes to financial statements(accounts)**

48% have felt it should be Quantitative, 19% have felt it should be Descriptive and 33% have felt it should be both Quantitative and descriptive.

**18. Do you think the new report Business Responsibility and SustainabilityReport (BRSR) issued by SEBI will bring any positive impact in reality?**

85% have agreed with this,13% have remained indifferent and 2% have not agreed with this.

**19. Provide your suggestion with respect to improvement in practices and implementation of environmental accounting and auditing for better policy making.**

Suggestions have been pointed out as under as provided by experts for this question:

- 
- Important is to get the norms which are mandate, properly framed and practically possible. Implementation, execution and review mechanism has to be strong, only then it's going to be effective.
  - Along with accounting and reporting, there has to be some mandate for companies to spend on environment protection or improvement like how CSR has been made mandate for corporates before few years and now it has started showing awareness among companies. There can be provision for companies to spend 1-2% of profit for renewable energy, adoption of green technology, adoption of area, cities, town to make it green on PPP model and so on. These all should be subject to audit and shall form part of disclosure.
  - Proper guidelines to be issued and measurement criteria should be defined properly.
  - Strong legal provisions in Companies Act and SEBI Guidelines will required to make companies follow all the norms
  - It should be done through own conscience, rather than compulsion from government rules
  - Reward through tax benefit
  - It is joint responsibilities as consumer & producers towards usage of Environmental resources available keeping in view of future generation.
  - Make environmental audit mandatory
  - Not to adopt western model in India
  - Government has to make special norms for the environmental accounting
  - Government should think about making of some accounting standards on environmental accounting practices.
  - Compulsory for company having a turnover or profit of some specific levels as per the corporate social responsibility contributions
  - Passionately pursue Environmental Ethics and sustainable development practices.
  - It should be recognised by stake holders and regulators...
  - GPCB, IPCB Must work without correction, for that also required policy.
  - Need for mandatory environmental audit.
  - It is compulsory for all types of business should follow and disclose the environmental accounting and auditing ... prepared by environmental departments and professionals.... and for that collaborate with that institute who has environmental courses...
  - Separate report is must and that should be implemented through rule. So that only way to implement environmental audit
  - The government will have to think to have separate accounting standard on that and it should be implemented by every company.
  - For every company must do Work on Environmental Accounting...
  - The cost can be considered for amortisation and also as deferred payment
  - Collection and recording of environmental costs can further endorse precise costing.
  - Mostly all aspects have been covered.
  - Transparency
  - Services of such professional is must. certificate in prescribed form, grade, cost/benefit, awards, to fix control points in raw-material, process, finished good, and incentive by tax-education etc
  - Policy implementation with the correct object of the existing law. Reduce the corruption in gov. Pollution control board so that implementation can be done with true spirit of the law.
  - Policy Should be based on equitable sustainable basis.
-

- It should be linked with the value of company which can impact its share value if it's a limited company. There must be a reward system which ultimately makes a country to be in good position w.r.t SDG of UN. The companies can also be categorised with labels like green= very good, blue= moderate and red= very bad practices.
- In p & l of sch 3 of co. Act there should be different head of the this cost
- Environmental accounts provide data which highlight both the contribution of natural resources to economic well-being and the costs imposed by pollution or resource degradation.
- Government policies and guidelines most important and public aspect for company behavior and public behavior roles
- Making better environmental policy
- It has to be compulsory.
- Some more practicing and improving of that environmental accounting area

## 7. FINDINGS AND CONCLUSION

It can be observed that basic opinions with respect to environmental accounting and auditing have been common of experts, impact and applications of environmental accounting and auditing have been evaluated from experts with positive signs and suggestions have also been received from experts to implement environmental accounting and auditing properly.

Thus, it can be said that experts have agreed to implement environmental accounting and auditing in a systematic way but still there is no perfect clarity on how to implement it. Experts have been agreeing on majority of aspects and that is a good sign. If all stakeholders will work together with clear agenda, within very near future, we can have a proper environmental accounting and auditing implementation system in India.

## 8. REFERENCES

- Chauhan, M. (2006). Environmental Indicators. *The Management Accountant*, 41(6):446-447.
- GOI. (2018). National Guidelines on the Economic, Social and Environmental Responsibilities of Business. Delhi: Central Government of India.
- Jaganathan, V. S. (2007). A study of environmental accounting and reporting an empirical analysis. Department of Commerce and Financial Studies, Bharathidasan University.
- Kumar, C. (2018). Corporate environmental reporting in India A comparative study of selected public and private companies. Department of Commerce, University of Lucknow.
- Markets, T. E. (2021, May 11). *The Economic Times ET Markets*. India.
- Omnamasivaya, B. (2017). A study on environmental accounting and disclosure practices of Nifty companies. Ph.D thesis, Department of Finance, GITAM University.
- Patel, S. (2017). Environmental audit impact and applications in India . Baroda: . Baroda: Ph.D thesis, Department of Accounting and Financial Management, Maharaja Sayajirao University of Baroda.
- Rachchh, M., & Gadade, S. (2015). Environmental Reporting by Indian hospitality industry. *IOSR Journal of Business and Management*, 17(4): 20-22.
- Rusi, M. F. (2019). A Study Of Environmental Disclosures Practices Among The Select Indian Companies With Special Reference To Global Reporting Initiative GRI Guidelines. Veer Narmad South Gujarat University.
- Shukla Bal, G. (2020). A Study of Environmental Accounting and Reporting Practices in Indian Manufacturing Companies With Special Reference to Select Cement Companies. Allahabad: University of Allahabad.

---

## A SURVEY OF COLLEGE GIRLS' OPINION ON KAFTANS AND GOTHIC ARCHITECTURAL MOTIFS

---

Shivangi Agarwal

Research Scholar, Banasthali Vidyapith, Rajasthan

### ABSTRACT

*The purpose of the present study was to determine the awareness of kaftans and Gothic architectural motifs in college going girls. The understanding of respondents with the term kaftan and Gothic architectural motifs, preferences while purchasing garment, kaftan's length, color and embellishment preferences, occasion to wear kaftans according to respondents were also studied. A survey research design was utilized to carry out this study. Findings indicated that majority of the respondents were aware about kaftans and Gothic architectural motifs. Majority of the respondents understand kaftans as gowns and Gothic architectural motifs as floral motifs. Majority of the respondents select garments on the basis of quality, followed by comfort, fashion, color, design, silhouette, price and aesthetic appeal respectively. In respect of occasion, party was chosen by majority of respondents to wear kaftans. Ankle length and pastel colors for kaftans were preferred by majority of the respondents. Majority of the respondents like to embellish kaftans with embroidery and like to have kaftans designed with Gothic architectural motifs in their wardrobe collection. Hence, it was concluded that the designing of kaftans with Gothic architectural motifs was accepted by majority of the respondents, which helped to reach the height of fashion even by keeping our feet on traditional ground.*

*Keywords: Garment style, Gothic architectural motifs, Kaftan, survey.*

### INTRODUCTION

Over the years "Kaftan" has become the blanket term in fashion for any kind of loose-fitting tunic or robe. Kaftan is a Persian word, while the garment style is believed to be originated in Ancient Mesopotamia. The kaftan lent itself well to the fashions of the next decade, providing a simple silhouette that could be beaded, heavily patterned or tidily marginal. Fashion designers such as Matthew Williamson and Temperley have reanimated the kaftans' Bohemian mystique and other designers such as Elie Saab and Naeem Khan have brought the kaftan to the red carpet with embroidered and ornately beaded versions (Helms, 2018).

In the present study, the awareness regarding kaftans and gothic architectural motifs among college going girls were observed. The term Gothic was first used during the Renaissance, by Italian painters and writers such as Giorgio Vasari and Raphael, to refer the art that flourishing throughout Christian Europe for more than three centuries, from about 1150 until 1500. Gothic architecture was represented by an explosion of monuments as early as the 12<sup>th</sup> century (Gozzoli, 1971). In the 13th century, Gothic sculpture attained classical perfection. It was modeled after nature, but forms were idealized and ennobled. Ornaments consisted of familiar plants-strawberry plant, wild rose, vine, water lily, fern, cress, maple and oak turned into decorative motifs (Toman, 1999). The ornamental feature reveals delight in the forms and the brilliance of color, in them is seen as an attempt to imitate nature, even to reproduce it exactly. In sculpture and painting realism was also sought. Figures were given expressive faces and lifelike poses. The specialty about gothic tracery drawing was its often extreme elaboration. Gothic is concerned with surface decoration of one kind or another (Gozzoli, 1971). The Gothic style in architecture inspired an outpouring of sculptural decoration (Sayre, 1997).

The research work had been carried out with objective to determine consumer preference for kaftans and Gothic motifs. The study was carried out to know about the consumer's preference and expectations for an innovative approach to use Gothic architectural motifs in designing Kaftans.

### RESEARCH METHODS

The present study was conducted at Banasthali Vidyapith, Rajasthan. The self-structured questionnaire was developed as tool for the market study. The research has been carried out with following methodology:

#### Selection of respondents

A sample of hundred college going girls of Banasthali Vidyapith between the age group 18-25 years was selected randomly for the study.

#### Construction of questionnaire

A self-structured questionnaire was developed consisting of close-ended and open ended questions. The information about kaftan and Gothic architecture's awareness, the understanding regarding kaftan and Gothic architectural motifs, their preference while garment selection, the kaftan's length preference, occasions suitable

to wear kaftans, color preference for kaftans, embellishment on kaftans and their preference for kaftans designed with gothic motifs forwardrobe collection.

### Data Collection

The data was collected by the investigator from the selected respondents in the selected place through questionnaire. The study was explained to all respondents in order to satisfy their curiosity and to obtain good responses.

### Data Analysis

Data was gathered and analyzed on the basis of the response given by the respondents to extract out the general preferences about the present study. Frequency and responses was calculated.

## RESULTS

The present study was done to know the awareness of kaftans and Gothic architectural motifs among college going girls and their preferences in respect of various parameters related to kaftans and Gothic architectural motifs. The findings of the study are presented below.

### Awareness about kaftans

Aware about kaftans	99%
Unaware about kaftans	1%

It was observed that maximum of the girls were aware about the kaftans, *i.e.*, 99 per cent and only 1 per cent of the girls were not aware about the kaftans.

### Wear kaftans

Worn kaftans	52%
Never worn kaftans	48%

It was found from the study that only 52 per cent of the respondents had worn kaftans and 48 percent had never worn kaftans in their life.

### Understanding of kaftans

Kurti	14%
Tunic	28%
Gown	57%

When surveyed it was found that most of the respondents understand kaftans as gown *viz.* 57 per cent and others understand kaftans as kurti and tunic in the per cent of 14 and 28 respectively.

### Awareness about Gothic architecture

Aware about Gothic architecture	95%
Unaware about Gothic architecture	5%

During study it was found that 95 per cent of the respondents were aware about the Gothic architecture and 5 per cent of the respondents did not have knowledge about Gothic architecture.

### Understanding of Gothic architecture motifs

Floral motif	61%
Geometrical motif	15%
Stylized motif	24%

It was observed that maximum respondents understand Gothic architectural motifs as floral motifs *viz.* 61 per cent and 24 per cent and 15 per cent respondents understand Gothic architectural motifs as stylized and geometrical motifs respectively.

### Preference for kaftans designed with Gothic motifs

Interested	86%
Not interested	14%

It was found that 86 per cent respondents showed interest in wearing kaftans designed with Gothic motifs and 14 per cent did not had any interest in kaftans designed with Gothic motifs.

**Factors for selection of garments**

Fashion	50%
Silhouette	9%
Design	30%
Color	36%
Price	24%
Aesthetic appeal	20%
Quality	55%
Comfort	50%

It was found that 55 per cent respondents prefer quality of the garment in respect to other aspects, followed by comfort and fashion by securing 50 per cent each. Color, design, silhouette, price and aesthetic appeal were preferred in the per cent of 36, 30, 9, 24 and 20 respectively.

**Occasion to wear kaftans**

Casual wear	22%
Party wear	45%
Formal wear	5%
Traditional	28%

The maximum respondents prefer parties to wear kaftans by 45 per cent, followed by traditional occasions by 28 per cent, the 22 per cent respondents preferred for casual occasions and least respondents preferred kaftans for formal occasions by 5 per cent.

**Kaftan's length preference**

Mid-thigh length	20%
Knee length	20%
Calf length	11%
Ankle length	49%

From the present study it was found that most of the respondents preferred ankle length for the kaftans, *i.e.*, 49 per cent. 20 per cent of the respondents preferred mid-thigh length and knee length individually and 11 per cent of the respondents preferred calf length for the kaftans.

**Color preference for kaftans**

Pastel color	34%
Light color	24%
Dark color	24%
Bright color	18%

The finding showed that 34 per cent respondents preferred pastel colors for kaftans, 24 per cent respondents preferred light colors and dark colors, each for kaftans. And 18 per cent respondents preferred bright colors for kaftans.

**Embellishment on kaftans**

Preference for embellishment	71%
Did not prefer embellishment	29%

During survey it was found that maximum respondents preferred embellishment on kaftans in the per cent of 71 and 29 per cent respondents did not prefer embellishment on kaftans.

**Type of embellishment**

Embroidery	25%
Bead work	14%
Sequence work	14%
Cut-dana work	18%

The type of embellishment was selected by the respondents who preferred embellishment on the kaftans. Those respondents preferred embroidery by 25 per cent, cut-dana work by 18 per cent, bead work and sequence work by 14 per cent each.

**Kaftans designed with Gothic motifs**

Willing to have Gothic motifs designed kaftans	92%
Unwilling to have Gothic motifs designed kaftans	8%

The study showed that 92 per cent of the respondents were willing to had kaftans designed with Gothic motifs in their wardrobe collection and 8 per cent of the respondents unlike to have it in their wardrobe collection.

**CONCLUSION**

Kaftans are nowadays being preferred for mostly occasion by the females. The present study provided innovative approach to add enthusiasm by adding some flamboyant spirit of kaftans designed with Gothic architectural motifs. Hence, the present study can be concluded that it adds a new zeal among the seeking consumer to satisfy their need to look fashionable.

**REFERENCES**

- Gozzoli, C. (1971). Pall Mall Encyclopedia of Art (vol. 2). Vikas Publication: Delhi, 784-785, 808.
- Helms, L. (2018). How the Kaftan went global, Vogue. Retrieved from: <https://en.vogue.me/fashion/how-the-kaftan-went-global>.
- Sayre, H.M. (1997). World of Art (2<sup>nd</sup> Ed.). Prentice Hall: New Jersey, 414.
- Toman, R. (1999). The Art of Gothic: Architecture. Sculpture. Painting. Good Fellow and Enga Publishing Management, Cambridge.



## SIGNIFICANCE OF SWARM INTELLIGENCE AND ROUTING CHALLENGES IN VANET

Gagan Deep Singh

Assistant Professor SS, School of Computer Science, University of Petroleum and Energy Studies UPES,  
Dehradun- 248007, Uttarakhand, India

### ABSTRACT

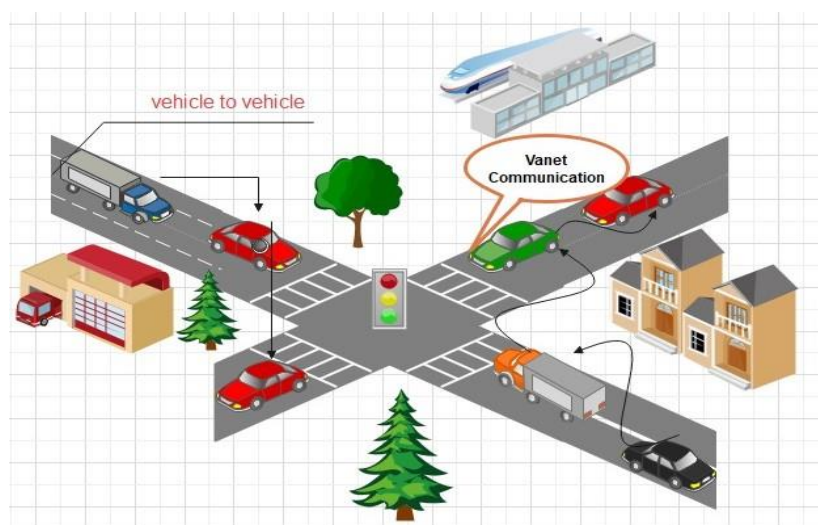
*Vehicular Adhoc Network (VANET) has emerged as a new domain of network routing. It has its own challenges and limitations. The paper provides the significance of VANET over the mobile ad-hoc network. Further, it highlights some of the major routing issues with its traditional routing protocols. The paper also presents the features of VANET routing protocols and their constraints at different aspects like bandwidth, security, network scalability, network topology, etc. Then research gap in VANET routing has been discussed and proposed Swarm Intelligence and Metaheuristics approach to fill this research gap. Then the paper has come up with a conclusion that Swarm Intelligence algorithms can be integrated with the traditional routing algorithm to achieve the efficient routing solution of VANET in various traffic network scenarios.*

*Keywords: VANET, routing protocols, Swarm Intelligence, Metaheuristics.*

### 1 THE VEHICULAR ADHOC NETWORK

The advancements in wireless communication technology and devices have opened a new dimension of research capable of repairing and organizing and rearranging the networks without any centralized authority or infrastructure. Recent enhancements in wireless communication technologies and devices have made vehicle-to-vehicle communications (V2V), and road vehicle communications (RVC) developed using Mobile Ad hoc Networks (MANET). A new network has evolved from this and is called a Vehicular Ad hoc Network (VANET). This newly new communication technology of VANET has emerged for Intelligent Transportation System (ITS) and is capable of improved road safety; optimize traffic flow, and even in lesser congestion of the vehicular nodes. VANETs is actually evolved from MANETs [1].

VANET can be used as a driver's assistance for communication and coordination among each other that will minimize the critical situation in V2V communication, e.g. random braking, obstacles, accidents on the road, bumper to bumper jams, random increase in speed, pathways for emergency vehicles like fire, police, and ambulance, etc. Along with these preventive applications, VANETs are also useful for comfort applications to drivers and passengers—for example, multimedia applications, internet connectivity, weather forecast, and infotainments during drives. The “Crash Avoidance Matrices Partnership (CAMP), Advance Driver Assistance System (ADASE), FLEETNET, and CARTALK” are some of the famous applications which was developed by various automobile manufacturers and governments through Public-Private Partnerships [2]. Figure 1 illustrates the typical VANET structure.



**Fig. 1.** A typical structure of Vehicular Adhoc Network.

The working and framework of VANET are entirely different from the MANET. This environment of VANET manipulates major factors and requirements of artificial road topology, traffic flow system, trip models, roadside obstacle, traffic rush, and drivers' behaviour. There are many points from which VANETs is not the same as of MANETs, such as a sudden change in the topology and random node mobility. It may vary with

other ad hoc networks by network architectures, unstable topology, suddenly disconnected networks, and communication [3].

There are many limitations in VANET, and these challenges need to be explored to achieve reliable and better services in a network. Hence, reliable and stable routing is one of the major issues in VANET. So, dedicated research in this field is required to implement accurate methods in realistic environments. Furthermore, the vehicles have dynamic behaviour, and high mobility speed makes routing in VANET even more challenging.

## **2 VANET FEATURES AND CHALLENGES**

The features and characteristics of VANET separate itself from many other Adhoc networks. Some characteristics of VANET, such as huge network size, high speed of nodes, and continuous mobility, make it difficult to stabilize node connectivity. Though, some of the various add-on features of entertainment, internet, payment, and updates are also integrated with the vehicles as a driver's comfort in addition to V2V communication and safety [4].

It is essential to describe the prime challenges that affect VANET. Some of the prime challenges from a technical perception are discussed below:

### **2.1 Bandwidth Limitation**

The big challenges of VANET are the absence of a central managing device like that of the router for the communication between nodes. Hence, productive use of bandwidth becomes essential in VANET [5]. Other objects like buildings and other vehicles may act as obstacles and cause deficiency in network signals.

### **2.2 Small Effective Diameter**

A VANETs small productive network diameter results in weak connectivity in communication among nodes. Therefore, sustaining a network topology for a node for a longer duration is not practical. Hence, the presently available routing algorithms of VANET are not suitable for the larger diameter of networks [6].

### **2.3 Security and Privacy**

As the nodes broadcast the information in VANET hence, receiving data from a trustworthy sender is a major concern [7].

All these bring new challenges to VANET communication. VANET-related research challenges need further research and innovative solutions to ensure satisfactory performance of VANET infrastructure, communication, security, applications, and services.

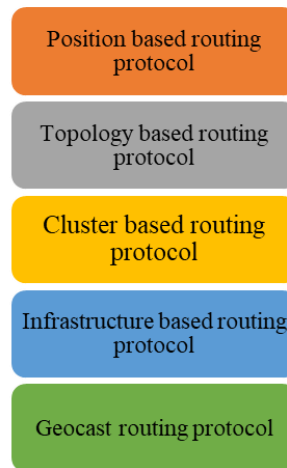
### **2.4 Autonomous and Infrastructure-less Network**

VANETs are formed by vehicular nodes of the autonomous system connected through wireless links without central management. This is an infrastructure-less network as networks vehicular nodes set up paths among themselves dynamically to transmit packets temporarily. Research on VANETs real-time communication improves routing performance in different mobility scenarios [8].

VANET security differs from wireless and wired networks because of its high mobility constraints, infrastructure-less framework, and the short duration link between nodes. In wired networks, infrastructure has specific functional components; for example, routers decide destination routes while network hosts send and receive messages.

### **2.5 Dynamic Changing Network Topology**

VANET works without infrastructure and has a dynamic topology. The packet transmission and routing in this environment are challenging due to the shortage of life span of communication link, random change in speed, variation in density, and characteristics of different network environments. Topology frequently changes due to speed and vehicle movement. High-speed mobility models and predictions have a significant role in VANETs dissemination and design. Disconnection chances are high due to its dynamic topology. High mobility in VANETs, leads to regular separation of network and route disconnection, the need for re-computation of topology information [9]. These routing protocols in VANETs has been categorized into five different types: as shown in figure 2.



**Fig. 2.** The categories of VANET routing protocols

Position-based routing, Topology based routing, Cluster-based routing, broadcast routing, Infrastructure based, and Geocast routing protocols [10].

High mobility and frequent network topology changes are the most challenging issues in VANET. Network topology varies in VANETS when vehicles change their velocity and lanes. These depend on drivers and road situations and are not scheduled in advance [11].

## 2.6 Network Scalability

Scalability is a very crucial characteristic in large and especially distributed networks and systems. The network scalability is the property to manage extra incoming nodes without altering or degrading the network performance and additional manageability. The number of active nodes (vehicles) affects the network connectivity and has the likelihood of congesting wireless channels. Protocol designs also impact scalability [12].

VANETs comprise potentially multiple vehicles, so protocol mechanisms should be scalable and efficient regarding mobility management-based overhead. Unfortunately, the feature common in topology protocols is degradation as link possibility grows, making scalability difficult.

Limited capacity also leads to scalability concerns for future VANETs. In addition, a V2V network with few nodes or low data traffic works well, but networks with many nodes or high data load breaks down. So, new strategies for VANETs data dissemination have to be designed, keeping scalability and capacity in mind [13].

## 2.7 Bandwidth Constraint

Position-based protocols, unlike topology protocols, do not need the route maintenance process. Instead, the route is established when needed, thereby reducing undue bandwidth constraints already low in VANETs. This approach results in huge control overheads restricting the use of limited wireless resources like available bandwidth. That ensures information delivery with extensive bandwidth usage.

Bandwidth constraints the wireless links, having lower capacity than wired links. Fading, noise, and interference affect wireless communication throughput. Inter-vehicular communication is at the core of many industries and academic research initiatives that aim to enhance transportation systems' safety and efficiency. The ranking is thus critical and enables the most significant data to be transmitted under bandwidth constraints [14].

## 2.8 Location-Dependent Contention

Data transmission rate has to be adaptive in VANETs as wireless channels are time-varying and location-dependent. When VANETs enter critical areas and become localization system dependent, GPS issues and problems like non - availability or may not be robust enough for some applications. So, there is a need to develop new localization techniques to overcome GPS limitations [15].

## 2.9 Security

The simple and effective security mechanism is a big issue for deploying VANETs in public since the security of the VANET system is susceptible to several attacks. These false warning propagation messages are similar to actual warning message suppression, thus leading to accidents. So, security is a major concern in such networks. Moreover, most nodes are vehicles that can form self-organizing networks without knowing each other whose security is very low and very vulnerable [16].

There are many security challenges in the vehicular network that are addressed with different areas of many known security primitives like symmetric and asymmetric cryptography, data aggregation, strong authentication, and cooperation enforcement. Hence, Security in VANETs is reliant on detecting and correcting malicious data [17].

### 2.10 Energy Efficiency

Reducing energy for data transmission and improving VANET's energy efficiency are accomplished using a two-tier data delivery mechanism. It also considers energy-efficient roadside access point scheduling. A scheduler capable of satisfying communication requirements of vehicles in the vicinity of an AP while minimizing energy needed using AP power control is considered [18].

As sensor nodes can disappear over time, Wireless Sensor Networks (WSNs) use such methods for replication, yet space and energy-efficient data storage. Also, monitored data has to be encrypted to protect it from any unauthorized access.

An optimal schedule of turning on/off the deployed RSUs at a given time is performed to minimize energy consumption while maintaining VANET connectivity [19].

So, researchers should shift back to security problems rather than paying attention to energy efficiency.

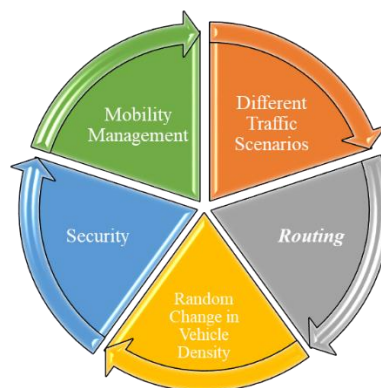
## 3 VANET ROUTING CHALLENGES

A major challenge in VANET design is developing a dynamic routing protocol to disseminate information from a node (vehicle) to another. The challenge is to reduce the delay associated with passing information from a node to another node. The other issue is to develop an efficient multicast and Geo-cast protocol over VANETs changeable topology. Mobility of a destined zone reveals dissemination of a protocol packet to static or mobile multicast or Geo-cast region. Current protocols consider static multicast or Geo-cast region except for mobicast routing protocols [20].

The survey performed over the VANET routing protocols shows the existing challenges and the open research issues in VANET routing. Today's important research area includes the analysis of driver's behaviour, signal loss, and the interferences that occur due to tunnels and high buildings [21]. Furthermore, designing an efficient VANET routing protocol is challenging due to its high node mobility and mobile node movement constraints.

During high mobility and rapid topology change, designing an efficient routing protocol to deliver a packet with minimum time duration having few dropped packets is critical in VANETs. Further, many researchers focusing more on designing and developing a routing protocol to suit rural and dense environments with high vehicle density and close distance between them. Designing an efficient routing protocol impacts many factors, out of which the first is to enhance system reliability by leveraging between them.

The next is to reduce the interference that occurs due to the existence of high buildings. So, there exist new challenges for VANET routing protocols as traditional routing protocols may be unsuitable for VANETs. Researchers are currently designing new VANETs routing protocols by comparing and improving current stimulation tests [22]. The major VANET routing challenges is depicted as per figure 3.



**Fig. 3.** The research challenges VANET routing protocols

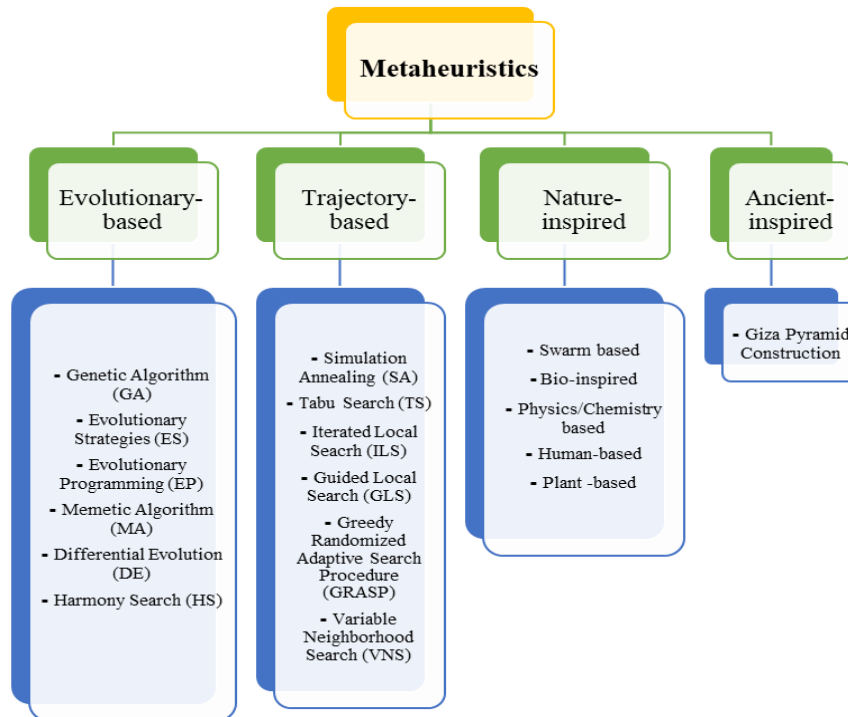
### 3.1 Research Gap

The existing routing algorithms for VANET routing are not that robust, which can meet the expectation of various routing scenarios. Many researchers have attained great success in various areas of VANET. But, many challenges are required to be overcome and a few issues that can be investigated [23]. Although, much research has been already available in the areas of VANET routing protocol and its performance [24]. However, due to

the emergence of Swarm Intelligence, many fact-findings have yet to be validated [25]. Integration of existing standard routing protocols with Swarm Intelligence has shown better results [26]. VANET performance depends on various simulation scenarios, and none of the routings is best suited for every scenario.

### 3.2 Swarm Optimization Approach for Efficient VANET Routing

These days Swarm Intelligence has come up with the solution to real-life hard problems. Hence, many of the metaheuristics algorithms are proposed to increase the efficiency of routing in multiple network environments. The classification of the metaheuristics algorithm is shown in figure 4. Some of them are Ant Colony Optimization, Particle Swarm Optimization, Bee Optimization, Firefly optimization, Bat optimization etc.



**Fig. 4.** The classification of metaheuristics algorithms

The Genetic Algorithm (GA) application in VANET is proposed by the researcher [27] and located the best generation of vehicles to be generated and managed a data flow while reducing the wireless network bandwidth consumption. Using random values of  $\lambda$ ,  $P$ , and  $z$ , the initial population size is reduced based on corresponding effect coefficients ( $a_1$ ,  $a_2$ ,  $a_3$ ).

In [26] researcher proposed a PSO approach for hybrid VANET-sensor networks for the two-lane placement problem is proposed and implemented. An Integer Linear Program (ILP) model for a 2-lane problem is first established. Then, a Center PSO approach is proposed for the problem, and theoretical analysis is also derived for the same. Results showed that this approach performed well for moderate problems. Future work must consider heterogeneity, other objective functions, constraints, and hybrid methods in practice. Another challenge dealt with is to propose a cross-layer design of the hybrid network.

With evolutionary-based routing being a predominant research theme, an efficient, trust-based, ant colony routing technique is used for a simple highway scenario-based VANET. Simulation results show that the new Trust dependent Ant Colony Routing (TACR) performed better than Mobility-aware Ant Colony Optimization Routing (MAR- DYMO) algorithm compared to routing overhead.

VANETs are unable to meet the exact needs and applications of all users. The VANET routing behaves differently in various traffic and network scenarios. None of the routings can provide the best results for all the network scenarios. Hence, in sparse and dense networks the "Minimum Calculated Desired Time (MCDT)" technique is suggested and data dissemination is performed using a context-aware congestion resolution protocol. Here, the MCDT determines the node connectivity through a peak-stable link [28] [29]. "Modified Lion Algorithm (LA)" is also used to compare with GA and performance analysis was done for cost, complexity and convergence.

#### 4 CONCLUSION

The efficient routing that is capable of supporting various realistic traffic scenarios is still under investigation. Many pre-existing standard routing protocols are presently available, but they have not integrated Swarm Intelligence for realistic city-based traffic scenarios. Hence, this problem must be the focus of the research work to integrate feasible best Swarm Intelligence-based routing algorithms. Then it can be tested on desired VANET traffic scenarios using realistic VANET simulation tools such as Veins. The performance can be calculated for traditional as well as real-city traffic scenarios taking two principle performance factors: Packet Data delivery Ratio (PDR) and throughput. The results gathered from simulation tests of PDR and throughput will be used to conclude the efficiency of the devised routing algorithms in VANET.

#### REFERENCES

- [1] R. J. Hall, "An improved geocast for mobile ad hoc networks," IEEE Transactions on Mobile Computing, Vol. 10, No. 2, pp. 254–266, 2011.
- [2] J. Luo and J. P. Hubaux, "A survey of research in inter-vehicle communications," in Embedded Security in Cars: Securing Current and Future Automotive IT Applications, Springer Berlin Heidelberg, 2006, pp. 111–122.
- [3] R. Tomar, M. Prateek, and G. H. Sastry, "Vehicular Adhoc Network (VANET)- An introduction," International Journal of Control Theory and Applications, Vol. 9, No. 18, pp. 8883–8888, 2016.
- [4] A. M. Vegni, "Smart Vehicles, Technologies and Main Applications in Vehicular Ad hoc Networks," M. Biagi, Ed. Rijeka: IntechOpen, 2013, p. Ch. 1-Ch. 1.
- [5] N. Haouari, S. Moussaoui, S. M. Senouci, A. Boualouache, and M. A. Messous, "An efficient management of the control channel bandwidth in VANETs," in IEEE International Conference on Communications, 2017.
- [6] L. Qiao, Y. Shi, and S. Chen, "An empirical study on the temporal structural characteristics of VANETs on a Taxi GPS Dataset," IEEE Access, Vol. 5, pp. 722–731, 2017.
- [7] F. Qu, Z. Wu, F. Wang, and W. Cho, "A Security and Privacy Review of VANETs," IEEE Transactions on Intelligent Transportation Systems, Vol. 16, No. 6. Institute of Electrical and Electronics Engineers Inc., pp. 2985–2996, 01-Dec-2015.
- [8] A. Vladyko, A. Khakimov, A. Muthanna, A. A. Ateya, and A. Koucheryavy, "Distributed Edge Computing to Assist Ultra-Low-Latency VANET Applications," Future Internet, Vol. 11, No. 6, p. 128, Jun. 2019.
- [9] S. S. Manvi and S. Tangade, "A survey on authentication schemes in VANETs for secured communication," Vehicular Communications, Vol. 9, pp. 19–30, 2017.
- [10] G. D. Singh, R. Tomar, H. G. Sastry, and M. Prateek, "A review on VANET routing protocols and wireless standards," in Smart Innovation, Systems and Technologies, Vol. 78, 2018, pp. 329–340.
- [11] M. H. Slovenská akadémia vied. Institute of Informatics., H. Abdy, and S. H. Zahiri, Computing and informatics., Vol. 35, No. 1. 2016.
- [12] M. Al-Rabayah and R. Malaney, "A new scalable hybrid routing protocol for VANETs," IEEE Transactions on Vehicular Technology, Vol. 61, No. 6, pp. 2625–2635, 2012.
- [13] M. Chaqfeh and A. Lakas, "A novel approach for scalable multi-hop data dissemination in vehicular ad hoc networks," Ad Hoc Networks, Vol. 37, pp. 228–239, Feb. 2016.
- [14] M. B. Wagh and N. Gomathi, "Route discovery for vehicular ad hoc networks using modified lion algorithm," Alexandria Engineering Journal, Vol. 57, No. 4, pp. 3075–3087, Dec. 2018.
- [15] K. Na Nakorn and K. Rojviboonchai, "Non-GPS data dissemination for VANET," International Journal of Distributed Sensor Networks, Vol. 2014, No. 1, p. 906084, Jan. 2014.
- [16] A.-S. K. Pathan, Security of Self-Organizing Networks: MANET, WSN, WMN, VANET, 1st ed. Auerbach Publications, 2019.
- [17] A. M. Malla and R. K. Sahu, "Security attacks with an effective solution for dos attacks in VANET," International Journal of Computer Applications, Vol. 66, No. 22, 2013.
- [18] P. Deshmukh, "Improving Energy and Efficiency in cluster based VANETs through AODV Protocol," Vol. 5, No. 3, pp. 4788–4792, 2014.



- 
- [19] M. Elhoseny and K. Shankar, "Energy Efficient Optimal Routing for Communication in VANETs via Clustering Model," in *Studies in Systems, Decision and Control*, Vol. 242, Springer International Publishing, 2020, pp. 1–14.
- [20] A. Ahamed and H. Vakilzadian, "Issues and Challenges in VANET Routing Protocols," in *IEEE International Conference on Electro Information Technology*, 2018, Vol. 2018-May, pp. 723–728.
- [21] E. R. Cavalcanti, J. A. R. de Souza, M. A. Spohn, R. C. de M. Gomes, and A. F. B. F. da Costa, "VANETs' Research over the Past Decade: Overview, Credibility, and Trends," *SIGCOMM Comput. Commun. Rev.*, Vol. 48, No. 2, pp. 31–39, May 2018.
- [22] H. Bello-Salau, A. M. Aibinu, Z. Wang, A. J. Onumanyi, E. N. Onwuka, and J. J. Dukiya, "An optimized routing algorithm for vehicle ad-hoc networks," *Engineering Science and Technology, an International Journal*, Vol. 22, No. 3, pp. 754–766, 2019.
- [23] J. A. Volpe, "The Smart/Connected City and Its Implications for Connected Transportation."
- [24] P. P. Rajendra, K. S. Santosh, K. K. N. Sunil, S. Majumdar, and Shivashankar, "An efficient routing algorithm based on ant colony optimisation for VANETs," in *2016 IEEE International Conference on Recent Trends in Electronics, Information and Communication Technology, RTEICT 2016 - Proceedings*, 2017, pp. 436–440.
- [25] G. D. Singh, M. Prateek, and H. S. G, "Swarm Intelligence Based Algorithm for Efficient Routing in VANET," *International Journal of Innovative Technology and Exploring Engineering*, Vol. 9, No. 5, pp. 1124–1136, 2020.
- [26] B. Ranjan Senapati and P. Mohan Khilar, "Optimization of performance parameter for vehicular ad-hoc NETWORK (VANET) using swarm intelligence," in *Studies in Computational Intelligence*, Vol. SCI 871, Springer, 2020, pp. 83–107.
- [27] M. Jafer, M. A. Khan, S. Ur Rehman, and T. A. Zia, "Optimizing Broadcasting Scheme for VANETs Using Genetic Algorithm," in *Proceedings - Conference on Local Computer Networks, LCN*, 2016, pp. 222–229.
- [28] M. L. Chiang, "Eventually Byzantine Agreement on CDS-based Mobile Ad hoc NETWORKs," *Ad Hoc Networks*, Vol. 10, No. 3, pp. 388–400, 2012.
- [29] R. Tomar, M. Prateek, and H. G. Sastry, "A novel approach to multicast in VANET using MQTT," *Ada User Journal*, Vol. 38, No. 4, pp. 231–235, Dec. 2017.
-

---

## ATTACHED GROWTH SYSTEM - IMPROVED OPTION FOR DOMESTIC WASTE WATER TREATMENT: A REVIEW

---

**Ms. Pallavi S. Chakole and Mr. Neeraj Deshmush**

Assistant Professors, Department of Civil Engineering, Yashwantrao Chavan College of Engineering, Nagpur,  
India

### ABSTRACT

*Many countries of the world are seeing an increase in the use of biofilm treatment technology for domestic wastewater. 'Fixed-film' wastewater treatment technologies take advantage of microorganisms' natural predilection for living in communities attached to surfaces. When compared to their suspended growth counterparts, attached growth systems are frequently far more efficient and resistant to shocks. Trickling filters, rotating biological contactors, and biologically active filters are all examples of connected growth systems. . This paper describes all attached growth systems out of which the rotating biological contactor technique is a one-of-a-kind adaption of the moving- medium biofilm system that makes oxygen transmission simple and efficient. Several huge flat or corrugated discs with biofilm clinging to the surface are attached on a shared shaft that is spun through shaped tanks while partially submerged in wastewater with constant wastewater flow. Although the rotating biological contactor is commonly utilized for wastewater treatment, there appears to be a lack of understanding concerning the rate of oxygen transfer.*

### INTRODUCTION

The challenge of sanitation in emerging countries is exacerbated by rising population density, which is accompanied by rising water usage. The discharge of residential wastewater into drainage systems without treatment is considered a source of pollution that poses a health risk to the public. One of the environmental issues that must be addressed is industrial effluent discharge into the environment. Biodegradable organic materials (BOD) are abundant in waste water from numerous sectors, making it one of the most polluting waste waters that must be cleaned before being discharged into the environment. Treatment technologies that are currently in use the cost of Sludge activation and nutrient removal at the tertiary level is prohibitive to be a viable residential wastewater treatment option.

Microorganisms re-move organic matter from wastewater, which is the basis for attached growth technologies. These microbes are primarily anaerobic, which means they need oxygen to survive. The Organic material that has been dissolved is regenerated into a film that grows on the filter medium (gravel, sand, peat, or a specially woven fabric or plastic). After a septic tank or other main treatment system, attached growth filters are utilised as secondary treatment devices. Because bigger solids and floating debris can clog the filter, raw wastewater must first be treated to eliminate them. Compared to activated sludge systems, connected growth techniques have lower energy requirements, are easier to operate, have fewer thickening issues, require less maintenance, and have greater shock load recovery. Attached growth processes are highly effective at reducing biochemical oxygen demand (BOD), nitrification, and denitrification from wastewater. The downsides include a larger area need, poor operation in cold weather, and potential scent issues.

### TYPES OF ATTACHED GROWTH SYSTEM

There are three types of Systems that retain the media in place while allowing wastewater to flow over the bed are known as attached growth or fixed film systems. (like trickling filters), in addition to those who transfer media in regard to wastewater (e.g., rotating biological disks).

Organic pollutants are removed using trickling filters (TFs) from wastewater. The TF is an aerobic treatment system that uses microorganisms attached to a substrate to remove organic pollutants from wastewater. Rotating biological contactors and packed bed reactors, for example, utilise this technique (bio- towers). Attached-growth processes are the name for these systems. Suspended-growth techniques, Allow a population of microorganisms (aerobic, anaerobic, and facultative bacteria; fungus; algae; and protozoa) a biological film or slime layer that adheres to the medium to absorb organic material in wastewater (approximately 0.1 to 0.2 mm thick). Microorganisms in the wastewater attach themselves to the surface as it travels over the rock, slag, or plastic surface, forming a film. Aerobic bacteria in the slime layer's outer layer then consume the organic material.

Allow a population of microbes to grow (aerobic, anaerobic, and facultative bacteria; fungus; algae; and protozoa) adhered to the medium as a biological film or slime layer to absorb organic material in wastewater (approximately 0.1 to 0.2 mm thick). In its most basic form, an RBC is made up of a succession of discs positioned on a horizontal shaft that rotates slowly. Typically, the discs are made of a polymer such as PVC,



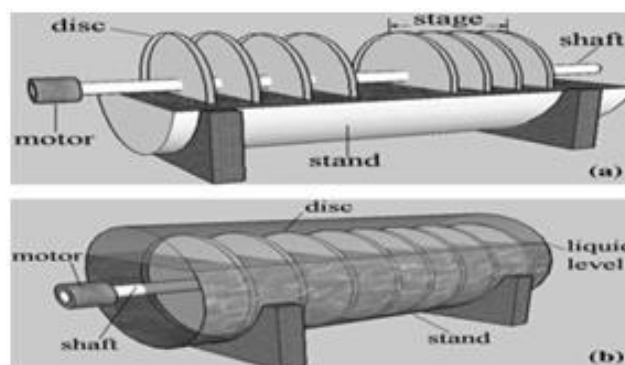
polystyrene, or polyethylene, and they are half submerged in a sewage sludge. Microorganisms proliferate on the discs and develop a biofilm when around the disc is submerged in waste water for 40% of its surface area.

Bio-towers are essentially deep trickling filter. In tower air and wastewater get thoroughly mixed while the wastewater trickles downward. The contact among the Wastewater, microorganisms, and air is improved due to the increase in the length of travel. Moreover, the velocity of air and wastewater through the tower trickling filter is increased, causing higher oxygen transfer to the flocs.

When all three systems are compared, the Rotating Biological Contactor (RBC) system emerges as the best alternative for sewage treatment. RBCs have significant early capital expenditures, but their low operating and maintenance expenses, as well as their simplicity of process control, make them economically viable. The RBC system is more efficient than any other system.

### ROTATING BIOLOGICAL CONTRACTOR

In its most basic form, an RBC is made up of a succession of discs positioned horizontally oriented that rotates slowly. The discs are normally made of a polymer such as PVC, polystyrene, or polyethylene and are immersed in a waste water stream to some extent. Microorganisms proliferate on the discs and develop a biofilm when around for 40 percent of the disc's surface area, it is submerged in waste water. Due to the rotation of the discs, the biofilm is immersed in the waste water flow and alternately exposed to air, as shown in Fig 1. The biofilm comes into touch with organic contaminants that have been mobilized in the waste water flow during the periodic submersion. A layer of waste water flows across the biofilm when exposed to air, collecting oxygen from the air and aerating the waste water. As a result, the bacteria in this process have consistent access to both organic matter and dissolved oxygen. As the discs spin through the waste water, shear stresses are applied to the biofilm. The discs' rotation also uniformly hydrates the surface of the biofilm and creates turbulence in the liquid phase. The existence of a bulk liquid phase also enables precise control of key operating parameters including pH, temperature, and nutrition.



**Fig. 1:** Schematic diagram of RBC units: (a) conventional RBC with two-stages; (b) single-stage closed RBC

The RBC (rotating biological contactor) system has been changed, the main benefits of the waste water RBC, which is extensively utilised and widely recognised as a very dependable technology, may be applied. The immediate biofilm growth control provided by shear forces acting on the film as a result of disc rotation allows for Long-term performance that is stable and requires little maintenance and precise control of critical process parameters like pH, temperature, and pressure, DO supply, and nutrient content.

RBCs are often formed in phases. Because the microorganisms that develop in each step are matched to the waste water from the previous stage, Organic removal and denitrification at a high degree is achieved because to the series design. In a multistage RBC, The residence time distribution resembles that of a plug-flow system, which improves BOD removal. As a result, developing a highly efficient and correctly built modified RBC system with diverse shaft configurations and spinning media can prove to be the most efficient in removing BOD and COD.

### Merits of RBC

- 1) Because of the huge active surface, short contact durations are required.
- 2) Modified RBCs that have been designed and built properly can handle a wide range of flows.
- 3) Sloughed biomass is easy to separate from waste due to its strong settling properties.
- 4) Plant operation requires little talent, therefore operating costs are low.
- 5) Retention time is short.

- 6) Elimination of channeling, which is a problem with traditional percolators.
- 7) Shock sensitivity is reduced, and shock loadings are recovered more quickly.
- 8) Low energy consumption and cost-effective operation and maintenance.
- 9) The amount of sludge produced is little, and process control is high.
- 10) It is simple to operate and maintain.

#### Demerits of RBC

- 1) In the early phases of the biofilm, a shortage of oxygen restricts the spectrum of rates and impacts of organic loading the establishment layers of anaerobic bacteria.
- 2) An excessive Rapid biomass growth is caused by a high rate of organic loading to the initial stage might lead to operational concerns (with shafts and media).
- 3) Shaft bearings and mechanical drive components need to be serviced on a regular basis

#### REVIEW OF RELATED LITERATURE

S. Syed Enayatdhali and Dr. V.Nehru Kumar (2008) [1] had created a A two-stage Rotating Biological Contactor is modelled in the lab (RBC) that could control the blades' rotational speed. The performance of the redesigned rotating biological contactor was investigated using grey wastewater. Each stage of the reactor had four rotating blades that were 300 mm x 100 mm x 10 mm in size and were mounted perpendicular to the shaft. The experiment was carried out with various influent COD loads and rotating blade speeds. When compared to the rotational speeds of 5 and 6 rpm, with a 3 rpm rotational speed had the highest percent elimination of COD at 95.07 percent, which had the lowest percent removal of COD.

Tawffik A. et al (2006) [2] at a temperature of 12-24°C, has undertaken an experimental examination in an RBC system on the treatment of municipal waste water. The RBC system was made up of two stages that were linked together in a sequence. To maximise RBC performance, the system was run at different rates of organic loading and hydraulic retention times. Total HRT was reduced from 10 to 24 hours, while OLR was increased from 11 to 47g/m<sup>2</sup>/d. COD removal effectiveness drops considerably. The effluent quality of soluble COD, on the other hand, is unaltered. In the first stage, the majority of the COD was eliminated, and the second stage involved nitrification.

Cortez S.,et al.( 2008) [3] studied Because of inherent practicality, design and operation simplicity, and rapid start-up, compact footprint, Low energy usage, low operating and maintenance costs, and excellent treatment efficiency are all advantages of this system, they are becoming increasingly popular. , RBCs (rotating biological contactors) are a one- of-a-kind and improved method of removing biodegradable waste and nitrogen. The RBC review looks at performance parameters Rotational speed, organic and hydraulic loading rates, and retention duration are all factors to consider. Support media for biofilms, staging, temperature, influent and effluent wastewater properties, biofilm characteristics, dissolved oxygen levels, solids recirculation, step feeding, and medium submergence are all factors to consider. are just a few of the variables to take into account, as well as design considerations, operational issues, and comparisons with other RBC treatment methods for wastewater.

Esen and R. A. Ashraf (1992) [4] had been founded on the notion of RBC stands for rotating biological contactor, where the unit rotated based based on the weight of recovered treated wastewater and influent sewage. The RBC system created intermittent raw sewage feeding at an 8-hour-per-day rate. The findings revealed a considerable reduction in biochemical oxygen demand. In comparison to a traditional RBC system, the concentration of dissolved oxygen was higher, and the energy requirements were lower.

Taiceong. R and Stenstrom. M (1979) [5] the performance of a Rotating At a loading rate of 0.2 gallon/ft<sup>2</sup>/day, the Biological Contactor (RBC) was investigated. . Domestic wastewater BOD<sub>5</sub> concentrations were reduced by 98 percent, from 140 mg/l to 2mg/l. Total suspended particles were cut in half, from 73 to 32 mg/l after ammonia was converted fully to nitrate. For applications that don't need to be serviced. or operating skills that may be lacking, the Treatment of wastewater with a low loading rate and its economics may be appealing. The RBC was also given a mathematical model, which included material balances in the biofilm and bulk solution for both oxygen and sub- strate. An implicit numerical technique akin to Crank-Nicolson was used to solve the resulting sets of non-linear, parabolic partial differential equations. The experimental results differed by only 10% from the model predictions. The model should be used as a starting point for further development.

Vinage et al. (2003) [6] For loadings less than 150 g/m<sup>3</sup>h, the revised RBC system is mass transfer limited. According to the results of a laboratory model, but becomes limited for increasing pollutant intake

concentrations. within the biofilm by a biodegradation process They claimed that the disc rotational speed had a significant impact on the system under investigation's process performance. Predictions were compared to experimental deterioration data using a time-independent mathematical model. At the time of the inquiry, there was a high level of agreement between the experimental data and modelling results.

Subrahmanyam, Y.V. et al [7] has been developing a lab the The fixed film horizontal flow RBC technique has a number of advantages. are combined with the anaerobic system's high strength and starch degrading capabilities in this type of an anaerobic RBC process. The anaerobic RBC reactor has a total disc surface area of 4.35 m<sup>2</sup> and a liquid volume of 70 litres. The reactor was run at a continuous rotational speed of 9 rev/min and with a submergence of 100% of the disc area. The synthetic sago wastewater had a COD value of 1086 mg/l and was subjected to a 42-hour hydraulic retention time (HRT) to achieve a maximum COD of 9522 mg/l. With a COD removal effectiveness of 97.2 percent, COD at its best load was discovered to be 6860 mg/l. Hydraulic loading rate (HLR) was 24 to 48 hours with the optimum COD load.

M .Dolores Coello et al. (2009) [8] Fixed biomass devices for wastewater depuration, such as spinning biological contactors or bio discs, have been studied in both large and small agglomerations. The composition of the biofilm and the activity of the microorganisms were both important factors in the systems' operation and control. Biofilm thickness and total dry weight had long been employed to characterize biofilms, but they weren't enough to explain biofilm activity. Biofilm activity has little to do with the amount of fixed biomass in the biofilm, but it does elevate the active thickness of the biofilm to a specific level. Nutrient diffusion through the film becomes a limiting factor once the active thickness is exceeded. As a result, stable, thin, and active biofilms offer several benefits in the treatment of water and wastewater. Biofilm activity was assessed using a variety of metrics. For that aim, the ratio of active/total cells, as well as the specific oxygen absorption rate and dehydrogenate activity, were employed. Not only was the approach easy and quick, but it was also sensitive, exact, and representational. The results show that microbial activity monitoring has the potential to be used for precise biofilm characterization, Estimating biomass activity in basic research, as well as the operation and control of fixed biomass depuration systems.

M. Wallis et al. (2000) [9] After a study on RBC was finished, the biofilms of a three-stage rotating biological contactor (RBC) were investigated for their ability to treat wastewater contaminated with cadmium, copper, and zinc. With removal capabilities of roughly 73, 42, and 33 percent, the elements Cu > Zn> Cd were successfully eliminated by the system. As indicated by the fact that Reactor 1 has a much higher metal Reactors 2 and 3 have a lower capacity for waste removal., metal removal was not constant across the reactors. All three metals were found on the biofilms' surfaces in all three reactors using energy dispersive X- ray spectroscopy. A detailed examination of the biofilms it was discovered the poor metal removal in Reactors 2 and 3 was most likely due to insufficient biofilm growth Compared to Reactor 1, these two reactors have a higher efficiency. The shabby biofilm formation was exacerbated by removing only a small amount of COD in the final two reactors.

Saikaly P. and Ayoub G. M. et al.(2003) [10] The impact of step- feeding on ammonia nitrogen (NH<sub>3</sub>-N) elimination in biological systems was investigated using a rotating biological reactor (RBR) system with Synthetic wastewater is treated two units with three stages (one control and one step-feed). The performance of the step-feed RBC in terms of NH<sub>3</sub>-N removals and stage-dissolved oxygen (DO) conditions was compared to that of a regularly fed RBC throughout a variety of hydraulic and organic loading rates. The results show that at high HLR and ORL, the step-feed unit had a higher removal efficiency (percent) than the control unit that is fed on a regular basis At all phases of the two units, DO decreased as the HLR and ORL were increased. In the step-feed system, the DO values, on the other hand, compared to those in the control system. The performance of the step- NH<sub>3</sub>-N removals and stage- dissolved oxygen (DO) conditions are given to the RBC was compared to that of a regularly fed RBC throughout a variety of hydraulic and organic loading rates. The results reveal that the step-feed unit had a greater removal efficiency (percentage) than the regularly fed control unit at high HLR and ORL. At all phases of the two units, DO decreased as the HLR and ORL were increased. The In a step-feed system, DO values are measured, on the other hand, were higher than those in the control system.

## CONCLUSIONS

- 1) Overall, the literature review illustrate that:
- 2) In the RBC system, several organic loading rates and hydraulic retention times were utilised. With a reduction of total HRT from ten to twenty-four hours and an increase in OLR from eleven to forty-seven grammes per square metre per day, , COD removal effectiveness drops considerably. The effluent quality of soluble COD, on the other hand, is unaltered. In the first stage, the majority of the COD was eliminated, and the second stage involved nitrification.

- 3) Rotating biological contactors (RBC) are a one-of-a-kind and superior option. Because of their practicality, ease of construction and operation, quick start-up, small footprint, reduced operating and maintenance costs, as well as low energy usage, and high treatment efficiency, they are ideal for the removal of biodegradable matter and nitrogen.
- 4) For loadings below 150 g/m<sup>3</sup>h, the modified RBC system had a mass transfer restriction, but biodegradation reaction inside the biofilm limits it for higher inlet pollutant concentrations.
- 5) The anaerobic RBC method, which combines the benefits of a horizontal flow RBC process with a fixed film with an anaerobic system's high strength and starch degrading capabilities. . The anaerobic RBC reactor has a total disc surface area of 4.25 m<sup>2</sup> and a liquid volume of 70 litres. With a COD elimination, you'll be able to save money effectiveness of 95.2 percent, the optimum COD load was discovered to be 6860 mg/l. Hydraulic loading rate (HLR) was 24 to 48 hours with the optimum COD load.
- 6) Fixed biomass technologies for the purification of wastewater in large and medium-sized agglomerations, such as spinning biological contactors or bio discs. For the systems to function and be controlled, the composition of the biofilm and the activity of the microorganisms were crucial criteria. For a long time, biofilm thickness and total dry weight were used to characterise biofilms, but they weren't enough to describe biofilm activity. Biofilm activity is related to the amount of fixed biomass present, rather than raising the thickness of the biofilm to a predetermined level known as the active thickness. Nutrient diffusion across the film becomes a limiting factor above the active thickness level. As a result, biofilms that are durable, thin, and active have a number of advantages in the treatment of water and wastewater.
- 7) After thorough evaluation of the related literature, it can be revealed that most of the work has been carried out on RBC. But very few literature available regarding the treatment of wastewater by different positions of shafts and by using different media. It has also shown some positive results. But very few work has been done on RBC with different arrangements. Hence the study is required to be undertaken to analyze the overall performance of RBC with horizontal and vertical arrangement of shafts fitted with box media under such by taking different combinations of different media, trials and errors.

#### ACKNOWLEDGMENTS

I am most grateful to the department of Civil Engineering, Yeshwantrao Chavan College of Engineering for providing facilities to undertake this research under the guidance of senior faculty member for their constant support for the research.

#### REFERENCES

1. Nehru Kumar, V. "Effect of speed of rotating discs in the modified RBC for treating sago wastewater", Poll. Res, 2005, pp. 823-825.
2. Tawfik, H Temmink , "Sewage Treatment in RBC System", Journal of water ,air and soil pollution 175, 2006, pp. 275-289.
3. S.Cortez and wallis RBC- A review. Indian Engg.Chem.Res.42, 2003, pp. 2035- 2051.
4. I.Esen and R.A.Ashraf, "Rotating Biological Contactors Operation with Water action", Journal Environmental International, vol.18, 1992,pp. 403-408.
5. Taiceong. R Stenstrom, I.K. Kapdan, "Biological Decolourization of Textile Dyestuff Containing Waste water by Rotating Biological Contactors". Journal of Enzyme and Microbial Technology, 1975,pp. 30-34.
6. I.Vintage, P.Rudolf, "Biological waste gas treatment with modified RBC" Journal Of Bioprocess Biosyt Engg.26, 2003, pp. 69-74.
7. Subrahmanyam, Y.V. Sastry C.A," Treatment of Sago Mill Wastewater Using Up Flow Anaerobic Filter", Indian J. Environ,1988,p. 8.
8. M. Dolores Coello , M.R. Rodriguez, "Use of Microbial Activity Measure- ments For Monitoring RBC biofilms", Environmental monitory assessment 2010, pp. 123-126
9. Costley S C, and F.M. Wallis., "Effect of Flow Rate On Heavy Metal Accu- mulation by Rotating Biological Contactor", RBC biofilms Journal, 2000, pp. 244-250.
10. P.saikaly,G.M Ayoub, "Ammonia Nitrogen Removal in Step Feed RBC", Journal of water, air and soil pollution150, 2000,pp. 177-191.

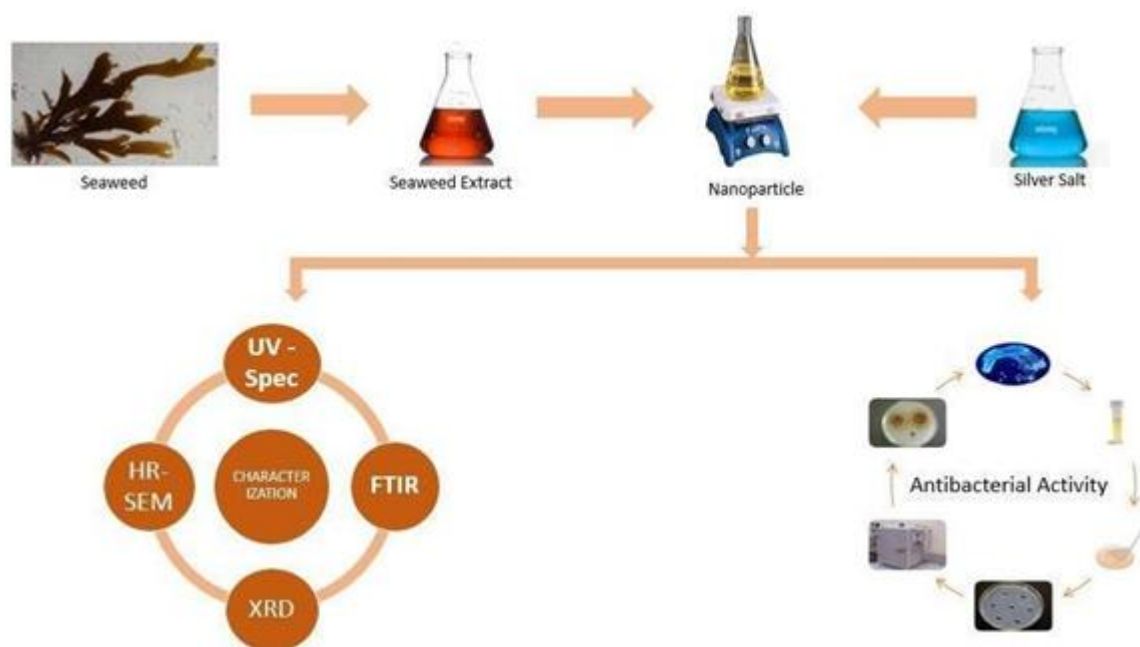
- 
11. Tsamir A. and Daigger, G. T. and Lim, H. C., “Biological Wastewater Treatment”, Marcel Dekker, New York, 2006.
  12. Janczukowicz, W. and Klimiuk, E.: 1992, “The Influence of Raw Wastes Dosing System on Technological Parameters of The Rotating Biological Disc (RBD) process’, Biores. Technol. 1992,pp. 42, 241–245.
  13. P.Rudolf, P. Pudiger, “Rotating Biological Contactors In kennes C.Veiga M C, Bioreactor for waste gas treatment”, Kluwer academic Dordrecht, 2001, pp.201- 204.

## BROWN SEAWEEDS MEDIATED SYNTHESIZATION OF AG-NPS AND THEIR ANTIBACTERIAL EFFECT AGAINST PATHOGENIC MICROBES

Nithyas S, Shweta K. Pal and Subhashini S\*

SRM Institute of Science and Technology, SRM Nagar, Potheri, Tamil Nadu- 603203

### GRAPHICAL ABSTRACT



### Highlights

- Green synthesis of metallic nanoparticle sized drugs via brown seaweeds by avoiding cons of physical & chemical methods.
- Characterization of synthesized Ag-NPs done by X-ray diffractometer (XRD), Ultraviolet-Visible (UV) spectroscopy, High Resolution Scanning Electron Microscopy (HRSEM), and Fourier Transform Infrared (FTIR) spectroscopy.
- AgNPs with the size of 10-100 nm showed strong antimicrobial effect against both Gram-positive and negative bacteria. The small particle size enables AgNPs to adhere to the cell wall and penetrate into the bacteria cell easily, which in turn improves their antimicrobial activity against bacteria.
- *Dictyopteris woodwardii* biological investigation revealed that it has the better antibacterial properties against *Pseudomonas aeruginosa* following *Enterococcus faecalis*, *Staphylococcus aureus* and finally *Klebsiella pneumoniae* that can be utilized in pharmaceutical companies.

### ABSTRACT

The present study was intended to standardize the protocol for the biological synthesis of silver nanoparticles (AgNPs) using aqueous extract of *Dictyopteris woodwardii* (Brown ex Turner) C. Agardh and evaluate antimicrobial & antioxidant potentials. Within 24 hrs. the hue changed from pale yellow to brown-red, indicating the synthesization of Ag-NPs. Characterization of synthesized Ag-NPs was done using X-ray diffractometer (XRD), Ultraviolet-Visible (UV) spectroscopy, High Resolution Scanning Electron Microscopy (HR-SEM), and Fourier Transform Infrared (FTIR) spectroscopy. The existence of an absorption peak at 1.329 at 420 nm using a UV-visible spectrophotometer indicated the presence of Ag-NPs. The HR-SEM scan suggested that most of the particles were spherical, with triangular sizes ranging from 89.32 to 97.72 nm. The nanoparticles were crystalline, as evidenced by the XRD pattern. According to the FTIR data, the reduction performance by phenolic groups presents as diterpenoids in the brown seaweed. Furthermore, the biologically produced Ag-NPs have antibacterial activity against bacterial pathogens such as *Klebsiella pneumoniae* (ATCC 700603), *Pseudomonas aeruginosa* (ATCC 27853), *Staphylococcus aureus* (ATCC 25923), and *Enterococcus faecalis* (ATCC 29212). According to the findings, *Dictyopteris woodwardii* is a prospective

generator of bioactive compounds with high antibacterial potential. It could be utilized as a significant nutraceutical and pharmaceutical product in the future.

**Keywords:** *Dictyopteris woodwardii*, UV-VIS spectrophotometer, HR-SEM, XRD, FTIR, Ag-NPs, Antibacterial.

## ABBREVIATION

UV	Ultraviolet spectroscopy
HRSEM	High Resolution Scanning Electron Microscopy
XRD	X-Ray Diffractometer spectroscopy
FTIR	Fourier Transform Infra-Red spectroscopy
Ag-NPs	Silver Nanoparticles
MHA	Mueller Hinton Agar
ATCC	American Type Culture Collection
SPR	Surface Plasmon Resonance
AgNO <sub>3</sub>	Silver nitrate
Pvt. Ltd.	Private limited
°C	Degree Celsius
mins	Minutes
sec	Second
M	Molar
mg	Milligram
gm	Gram
ml	Milliliter
μl	Microliter
nm	Nanometer
hrs.	Hours
Fig	Figure
cm <sup>-1</sup>	Centimeter <sup>-1</sup>
kV	Kilovolts
mA	milli-Ampere
Cu	Copper
mm	millimeter
PC	Positive Control
K.p	Klebsiella pneumoniae
P.a	Pseudomonas aeruginosa
S.a	Staphylococcus aureus
E.f	Enterococcus faecalis

## 1. INTRODUCTION

Today, nanotechnology is the world's fastest-growing manufacturing sector, with a never-ending hunt for novel nanomaterials and manufacturing methods. Living cells are the most outstanding examples of nanoscale machines capable of performing various activities with outstanding efficiency, ranging from energy production to material extraction<sup>[1]</sup>. Nanomaterials have distinct properties that hinge on their shape, morphology, size and allow them to interact with flora, fauna, and microbes<sup>[2-8]</sup>. Nanoparticles are gaining prominence in the twenty-first century due to their chemical, optical, and mechanical properties<sup>[9]</sup>. Nanoparticles are one of the most sought-after future materials, with applications in a wide range of fields. Nanomedicine, an emerging new topic due to the integration of nanotechnology with medicine, is one of the fields in which nanotechnology finds extensive use. Medicine is no longer only a physician's work; nanoscale materials and devices used for diagnosis, treatment, prevention of diseases and traumatic injury, pain killers, and overall health preservation and improvement<sup>[10]</sup>.

Silver is a glossy, smooth, white transition metal with excellent electrical & thermal conductivity. Before discovering that bacteria are agents of illness, it's been known for longer than recorded human history due to its medicinal and therapeutic benefits. Utilizing various products, including coins, containers, solutions, foils, sutures, and colloids like lotions and ointments. It is the most widely utilized therapeutic agent in treating infectious illnesses and surgical infections. Silver's benefits outweigh its drawbacks.<sup>[11]</sup> There is an urgent

demand for novel and efficient methods of generating nanomaterials. Several physical and chemical approaches have been documented, and several difficulties that restrict the use of nanoparticles in biological applications; these downsides include the usage of toxic solvents, the formation of hazardous by-products, and excessive energy consumption. The search for a strategy to avoid the harmful by-products of present physicochemical procedures led to investigating a biological species capable of generating nanoparticles<sup>[12]</sup>.

Nanoparticles offer far more impressive optical, electrical, magnetic, and catalytic capabilities than bulk materials due to their enormous surface area to volume ratio<sup>[13,14]</sup>. Because of the SPR phenomenon, metal nanoparticles such as silver and gold have distinct colors. The SPR band is visual and infrared due to the surface plasmon of free electrons of nanoparticles in resonance with the frequency of beam of light interactions<sup>[15]</sup>. Ag-NPs have shown promising bactericidal activity against a wide range of diseases<sup>[16-19]</sup>.

They are also utilized in wound dressings as antibacterial drugs<sup>[20-22]</sup>, as topical creams to prevent wound infections<sup>[23]</sup>, and as anticancer agents<sup>[24]</sup>. Production of Ag-NPs nearly 320 tones and usage in Nano medical imaging, bio sensing, and food items each year<sup>[25,26]</sup>. Because of the increased opportunity of Ag-NPs in science; the environment, and technology, there is also a significant demand for a minimal approach for Ag-NPs biogenesis.

The requirement for ecologically friendly synthetic procedures for nanoparticle manufacture drives interest in biological approaches that don't use toxic chemicals as by-products. As a result, "green nanotechnology" is becoming increasingly important. Microorganisms such as bacteria<sup>[27]</sup>, fungi<sup>[28, 29]</sup>, and plants<sup>[30-32]</sup> have been used in several biological approaches for the production of extracellular and intracellular nanoparticles. Seaweed-mediated synthetization of Ag-NPs using *Dictyopteris woodwardii* extract is more favorable than other biological processes such as bacteria and fungus. It avoids the cell culture maintenance procedure and is also better appropriate for the large-scale production of Ag-NPs<sup>[33]</sup>. *Dictyopteris woodwardii*, a marine brown seaweed with several therapeutic characteristics, is a medicinally valuable macro brown seaweed. This kind of brown seaweed came under the order of Dictyotales in the family of Dictyotaceae.

Although various researchers have published papers on the creation and characterization of Ag-NPs, relatively few studies on their green synthesis, biocidal capabilities, and mechanism of action are available. As a result, in this paper, we aimed to provide a detailed description of the biosynthesis of Ag-NPs from the seaweed *Dictyopteris woodwardii*. Different pathogenic microorganisms have explored their potential as antimicrobial agents.

## 2. MATERIALS AND METHODOLOGY

### 2.1 Materials

Hi-media Laboratories Pvt. Ltd. of Mumbai, India, supplied AgNO<sub>3</sub>. Microorganisms from *Staphylococcus aureus* (ATCC-25923), *Enterococcus faecalis* (ATCC-29212), *Klebsiella pneumoniae* (ATCC-700603), and *Pseudomonas aeruginosa* (ATCC-700603) were included in the American Type Culture Collection (ATCC-27853). The seaweed *Dictyopteris woodwardii* was collected at Rameswaram, Tamil Nadu, and India. Seaweeds are upright plants that grow in deeper regions of the littoral zone and are held to the substratum by discoidal holdfasts. They are also non-twisted, cymose, dichotomously to irregular branching, and branches are flattened with a midrib and rounded to a sharp tip.

The following is a categorization of the brown seaweed

Phylum: Phaeophyta

Class: Phaeophyceae

Order: Dictyotales

Family: Dictyotaceae

Genus: Dictyopteris Lamouroux

Species: *Dictyopteris woodwardii* (Brown ex Turner) C. Agardh<sup>[34]</sup>

### 2.2 Collection of Marine Brown Seaweed

Brown seaweed was harvested by hand from the shore of Rameswaram, Tamil Nadu. Clinging to the surface of beach rocks was discovered brown seaweed. The marine seaweed was collected in a synthetic resin bag. A large volume of marine algal samples was surface-sterilized repeatedly with tap water and then with distilled water to remove the unwanted debris<sup>[35, 36]</sup>.



### 2.3 Aqueous Extract of Marine Seaweed Preparation

Intra-cellular extracting technology was used to synthesize the *Dictyopteris woodwardii* aqueous extract, a solvent extraction process previously examined with minor changes. Epiphytes and other algal debris were removed from stored *Dictyopteris woodwardii* samples using distilled water<sup>[37-39]</sup>. The moisture content of the stored *Dictyopteris woodwardii* sample was entirely removed after 15 days of shade drying. The dried seaweed was weighed as dry consistent weight of 380 g using an analytical scale. Dried seaweed was grinded to a fine powder using a grinder. The dried seaweed powder was then collected and kept in a sterile, airtight container weighing 120 g. Following that, an aqueous marine alga extract was made using a 2:8 proportion of pulverized seaweed sample to 90 ml deionized water. The extract was processed for 20 minutes at 60 °C before being screened using a vacuum pump and Whatman no.1 filter paper. The seaweed decoction was then refrigerated to 39.2 degrees Fahrenheit for any further study.

### 2.4 Synthesization of Ag-NPs

In the manufacturing methods of Ag-NPs, a 100 ml conical flask was filled with 20 ml of aqueous extract of crushed seaweed sample (20%) in an 2:8 ratio and 80ml of 0.01 M aqueous AgNO<sub>3</sub> (80%) solution. The amalgamation medium was gradually and indirectly heated above 60°C and agitated for 48 hrs. using a magnetic stirrer<sup>[38, 40]</sup> to accomplish comprehensive metal ion reductions. This step was carried out in dark conditions to prevent photo activation of Ag. A control with no aqueous marine alga extract was also kept for 48 hrs. Before the sample was utilized for additional study, the change in color from light yellow toward a concentrated deep reddish-brown fluid was seen as preliminary confirmation for the creation of Ag-NPs. After 48 hrs. the synthesis medium was centrifuged at about 8000 revolutions per minute for 20 minutes at 30 °C. After centrifugation, the Ag-NPs that gathered at the bottom and formed a pellet, perhaps even the residual, were discarded. The AgNO<sub>3</sub> pellets were subsequently oven-dried for 30 minutes at 50°C to remove the moisture content. A plastic wrap pestle has been used to pulverize the dried Ag-NPs. Approximately 105 mg of Ag-NPs were obtained as the results of the production operation.

### 2.5 Ag-NPs Characterizations

The existence of synthesized Ag-NPs was verified by scanning the reaction mixture for maximum absorbance in Beckman-DU 20 spectrophotometers utilizing Ultraviolet spectra at 300–600 nm. After centrifuging the reaction mixture at 10,000 rpm for 30 mins, the pellet was resuspended in deionized water via a Millipore filter (0.45 m). A piece of this filtrate containing Ag-NPs was analyzed using FTIR, HR-SEM, and XRD. The FT-IR spectra of generated Ag-NPs were investigated in the range of 4,000 cm<sup>-1</sup> to 500 cm<sup>-1</sup> using a Shimadzu, Ir-tracer 100, and the KBr pellet technique to identify the likely molecular compound responsible for AgNO<sub>3</sub> reductions and Ag-NPs stabilization. 15µl of the sample was sputter-coated on a copper stub for electron microscopy, and the pictures of nanoparticles were evaluated using HRSEM.

The morphology of Ag-NPs was also studied. Dried nanoparticles were deposited on an XRD lattice for the XRD investigation. The absorbance was measured using simply a Shimadzu IR-tracer 100 X-ray beam generator set to 40 kV and 30 mA with CuαK<sub>1</sub> radiation<sup>[36]</sup>.

### 2.6 Antibacterial activity of synthesized Ag-NPs

Antibacterial activity of synthesized Ag-NPs of seaweed aqueous extracts was determined using the Agar well diffusion method<sup>[41]</sup> against two gram-positive bacteria, *Staphylococcus aureus* and *Enterococcus faecalis*, and two gram-negative bacteria, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*. The well diffusion method was used to assess antibacterial activity against manufactured Ag-NPs, and comparative tests were conducted with Gentamicin as a positive control and MHA media as a negative control. In wells, 100µl of 1 mg/ml concentration of produced Ag-NPs of seaweed extract (80% concentration) was loaded. Freshly prepared MHA medium was put into sterilized Petri-plates and allowed to solidify for 30 mins. An aliquot number of microbial cultures were added and spread onto the MHA plates. These plates were incubated at 37°C for 24-48 hrs before assessing the inhibitory zone in cm and documented properly.

## 3 RESULT & DISCUSSION

Visual examination validated the biosynthesis of Ag-NPs. The shift in hue is indicative of the production of Ag-NPs. After 48 hours, the reaction mixture became reddish-brown from pale yellow, indicating the synthesis of AgNO<sub>3</sub> (Fig. 1A and B). The reddish-brown hue was caused by the stimulation of SPR, which is common in Ag-NPs. UV-vis spectroscopy is an essential method for investigating the formation of metal nanoparticles. The UV-vis spectra from AgNO<sub>3</sub> and brown seaweed reaction medium were recorded. The UV-vis spectra of the reaction mixture after 30 minutes of reaction are shown in (Fig. 1)<sup>[42]</sup>.

### 3.3 Characterization of Ag-NPs

#### 3.3.1 Analysis of UV-VIS Spectroscopy

The characterization of Ag-NPs based on SPR vibration measured around 420 nm in all three concentrations confirmed the production of Ag-NPs from the seaweed aqueous extract. The nanoparticles generated during the Ag-NPs production technique absorb light at various wavelengths and are triggered by charge density at the UV-Vis spectroscopy interface to develop a distinct peak; this phenomenon is known as SPR. Size of the particles, morphology, aggregation pattern, and the presence of stabilizers in the reaction fluids all influence the wavelength of the peak and the intensity of SPR<sup>[43]</sup>. As illustrated in Fig. 1, the generation of Ag-NPs from aqueous extract of seaweed at a concentration of 20% yielded an optical peak at 420 nm with an absorbance of 1.329. (Fig. 2).

#### 3.3.2 Analysis of FTIR Spectroscopy

FTIR analysis of seaweed produced Ag-NPs in aqueous extracts at 20% concentrations (Fig. 3) displays prominent peaks at 3291.7 cm<sup>-1</sup> for the alcohol's O-H stretching link, 1636 cm<sup>-1</sup> for primary amines' N-H bond, and 1047.9 cm<sup>-1</sup> for the primary alcohols' C-O bond. The FTIR data show that the hydroxyl radicals of phenolic compounds and the amide group of protein in the aqueous extract form a coating on the nanoparticle, acting as a capping agent to prevent aggregation and providing medium stability<sup>[36]</sup>.

#### 3.3.3 Analysis of XRD Spectroscopy

The XRD pattern of the generated Ag-NPs (Fig. 4) revealed nine-strong peaks throughout the whole spectrum of 2θ values ranging from 20° to 70°. The 20 percent concentration of seaweed mediated Ag-NPs showed five peaks at 2 values: 29.941, 44.861, 47.746, 65.315, and 79.216, which corresponded to 133, 224, 115, 444, and 337 planes of silver, respectively. A comparison of the XRD pattern to the standard indicated the formation of silver particles in the XRD study<sup>[36]</sup>.

#### 3.3.4 Analysis of HR-SEM

The HR-SEM was employed to better understand the form and size properties of the generated nanoparticles. The HR-SEM image demonstrated a high density of generated AgNO<sub>3</sub> of seaweed concentrations (20%) that were equally spread on the cell surface. HRSEM micrographs revealed the formation of poly-dispersed nanoparticles with sizes ranging from 80 to 100 nm (Fig. 5) and an average size of 97.72 nm. The interaction of biomolecules between metal atoms (for example, terpenoids, polyphenols, and phenolic chemicals) can be utilized to regulate the size and form of the resultant nanostructures

[44].

### 3.4 Antibacterial Activity by Agar Well Diffusion Assay

Baker et al. (2005)<sup>[45]</sup> found that tiny particles with significantly larger contact surfaces (such as spherical nanomaterials) outperformed big particles against bacteria. Considering the above correlation that Ag-NPs have substantially better antibacterial action, we investigated their impact on bacterial growth.

Antibacterial activity of the synthesized Ag-NPs was investigated using four typical bacterial strains: *Staphylococcus aureus*, *Enterococcus faecalis* (Gram-positive), *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* (Gram-negative). Ag-NPs extracts of seaweed showed antibacterial efficacy against all four harmful strains of bacteria (Table 2 & FIG 6). According to the findings, the antibacterial activities of a 20% concentration of Ag-NPs revealed a greater diameter of inhibition zone in both gram-positive and gram-negative bacteria. The 20 percent concentration of Ag-NPs produced zone results that were just marginally better than common antibiotics (Gentamicin). The differential in cell wall structural properties between Gram-positive and Gram-negative bacteria might explain this observation<sup>[46]</sup>.

## 4 CONCLUSION

Sicknesses caused by contamination were thought to be the most dreadful ill state for early human development, whose occurrence was associated with the usage of meaningful lives. The use of biomolecules to combat the spreading of these illnesses was eagerly anticipated throughout the world. In any case, the widespread use of created synthetic compounds as medicines has altered the pathogenic animals' ability to withstand anti-infective drugs. As a result, the quest for a molecule with diverse chemical diversity was on, and microalgae drew our attention due to their rich bioactive chemicals that may dodge infections. The current research focused on synthesization of Ag-NPs as therapeutic and medicinal benefits of *Dictyopteris woodwardii*. In conclusion, the present findings demonstrated that spectroscopic profiles might be used as a pharmacogenetics marker in the pharmaceutical industry to identify *Dictyopteris woodwardii* out of its adulterants utilizing a reasonably simple, cost-effective spectroscopic profile. *Dictyopteris woodwardii* biological investigation revealed that it has the best antibacterial properties against *Pseudomonas aeruginosa* following *Enterococcus faecalis*, *Staphylococcus*

*aureus* and finally *Klebsiella pneumoniae* that can be utilized in pharmaceutical companies. Consequently, the biological process appears to be a more cost-effective alternative to standard physical or chemical Ag-NPs synthesis methods, and it would be suitable for building a biological mechanism for large-scale manufacture. These AgNO<sub>3</sub> might be used to lower microbial load in wastewater treatment.

#### ACKNOWLEDGEMENT

I would like to acknowledge NRC, SRMIST for the FTIR facility. We would also like to acknowledge SRMIST for High Resolution scanning electron microscope (HR-SEM) facility and XRD facility at SRMIST set up with support from MNRE (Project No. 31-03-2014-15/PVSE-R&D), Government of India.

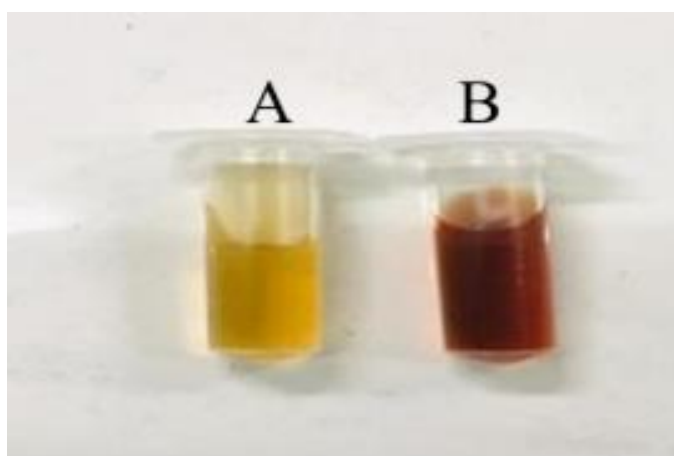
A special and sincere thanks to SRMIST, Kattankulathur for providing facilities to carry out the following research.

#### FUNDING

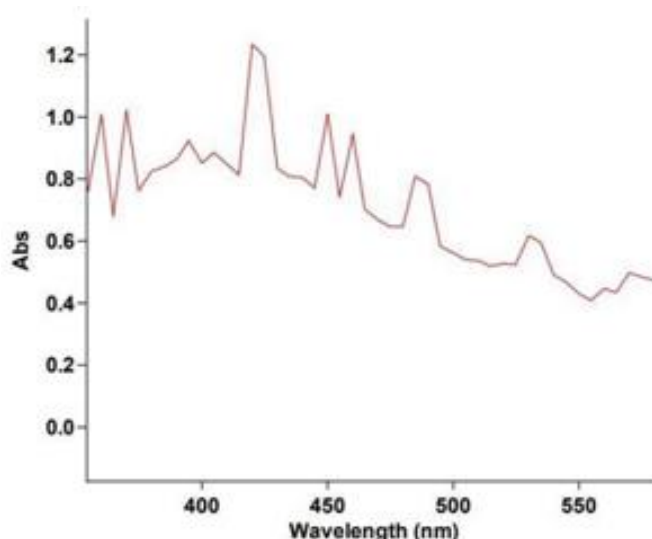
This research did not receive a specific grant from funding agencies.

## 5. APPENDICES

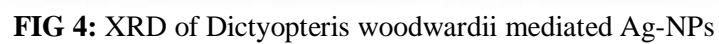
### 5.1 Figures

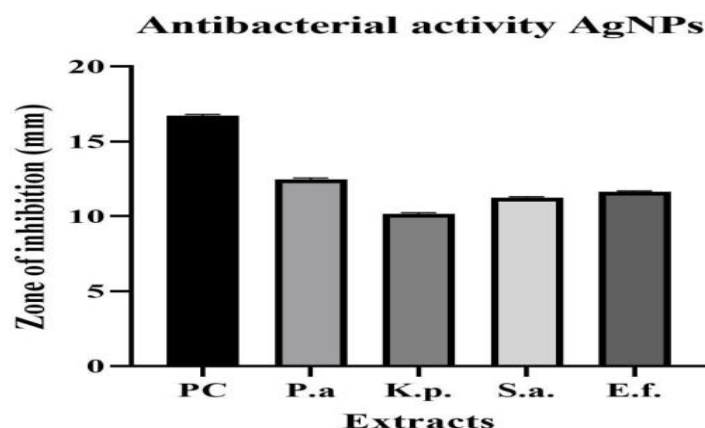


**FIG: 1:** (A). *Dictyopteris woodwardii* aqueous extract without adding AgNO<sub>3</sub> solution, (B). *Dictyopteris woodwardii* aqueous with 0.01M of AgNO<sub>3</sub> (2:8) ratios after 24hrs incubation.



**FIG 2:** UV-Visible spectra of *Dictyopteris woodwardii* mediated Ag-NPs





**FIG 6:** Antibacterial activity of *Dictyopteris woodwardii* synthesized Ag-NPs against different bacterial pathogens

## 5.2 TABLES

**Table 1: Functional groups of the obtained FTIR peaks**

Frequency (cm <sup>-1</sup> )	Bond/stretching	Functional groups
3291.7 cm <sup>-1</sup>	O-H stretching bond	Alcohol
1636 cm <sup>-1</sup>	N-H bond	Primary amide
1047.9 cm <sup>-1</sup>	C-O bond	Primary alcohols

**TABLE 2:** Bactericidal activity of *Dictyopteris woodwardii* synthesized Ag-NPs of aqueous brown seaweed extract against pathogenic bacteria

SAMPLES	<i>Klebsiella pneumoniae</i>	<i>Staphylococcus aureus</i>	<i>Pseudomonas aeruginosa</i>	<i>Enterococcus faecalis</i>
20% concentration of sample	10 mm	11 mm	12 mm	11 mm
+VE control	16 mm	16 mm	16 mm	16 mm
-VE control	-	-	-	-

## REFERENCES

- Goodsell, David S. *Bionanotechnology: lessons from nature*. John Wiley & Sons, 2004.
- Husen A, Siddiqi KS. Phytosynthesis of nanoparticles: concept, controversy and application. *Nanoscale research letters*. 2014 Dec;9(1):1-24. <https://doi.org/10.1186/1556-276X-9-229>.
- Husen A, Siddiqi KS. Plants and microbes assisted selenium nanoparticles: characterization and application. *Journal of nanobiotechnology*. 2014 Dec;12(1):1-0. <https://doi.org/10.1186/s12951-014-0028-6>.
- Siddiqi KS, Husen A. Green synthesis, characterization and uses of palladium/platinum nanoparticles. *Nanoscale research letters*. 2016 Dec;11(1):1-3. <https://doi.org/10.1186/s11671-016-1695-z>.
- Husen A, Siddiqi KS. Carbon and fullerene nanomaterials in plant system. *Journal of nanobiotechnology*. 2014 Dec;12(1):1-0. <https://doi.org/10.1186/1477-3155-12-16>.
- Siddiqi, Khwaja Salahuddin, and Azamal Husen. "Biogenic synthetization of iron/iron oxide nanoparticles and their application." *Nanoscale research letters* 11, no. 1 (2016): 1-13. <https://doi.org/10.1186/s11671-016-1714-0>.
- Siddiqi, Khwaja Salahuddin, and Azamal Husen. "Recent advances in plant-mediated engineered gold nanoparticles and their application in biological system." *Journal of Trace Elements in Medicine and Biology* 40 (2017): 10-23. <https://doi.org/10.1016/j.jtemb.2016.11.012>.
- Daniel MC, Astruc D. Gold nanoparticles: assembly, supramolecular chemistry, quantum-size-related properties, and applications toward biology, catalysis, and nanotechnology. *Chemical reviews*. 2004 Jan 14;104(1):293-346. <https://doi.org/10.1021/cr030698+>.
- Siddiqi KS, Husen A. Engineered gold nanoparticles and plant adaptation potential. *Nanoscale Research Letters*. 2016 Dec;11(1):1-0. <https://doi.org/10.1186/s11671-016-1607-2>.
- Rai M, Yadav A, Gade A. Silver nanoparticles as a new generation of antimicrobials. *Biotechnology advances*. 2009 Jan 1;27(1):76-83. <https://doi.org/10.1016/j.biotechadv.2008.09.002>.

11. Pal, Sukdeb, Yu Kyung Tak, and Joon Myong Song. "Does the antibacterial activity of silver nanoparticles depend on the shape of the nanoparticle? A study of the gram-negative bacterium *Escherichia coli*." *Applied and environmental microbiology* 73, no. 6 (2007): 1712-1720. <https://doi.org/10.1128/AEM.02218-06>.
12. Alexander JW. History of the medical use of silver. *Surgical infections*. 2009 Jun 1;10(3):289-92. <https://doi.org/10.1089/sur.2008.9941>.
13. Nadagouda MN, Varma RS. Green synthesis of silver and palladium nanoparticles at room temperature using coffee and tea extract. *Green Chemistry*. 2008;10(8):859-62. <https://doi.org/10.1039/B804703K>.
14. Poulouse S, Panda T, Nair PP, Théodore T. Biosynthesis of silver nanoparticles. *Journal of nanoscience and nanotechnology*. 2014 Feb 1;14(2):2038-49. <https://doi.org/10.1166/jnn.2014.9019>.
15. Vijayakumar M, Priya K, Nancy FT, Noorlidah A, Ahmed AB. Biosynthesis, characterisation and anti-bacterial effect of plant-mediated silver nanoparticles using *Artemisia nilagirica*. *Industrial Crops and Products*. 2013 Jan 1;41:235-40. <https://doi.org/10.1016/j.indcrop.2012.04.017>.
16. Parsons JG, Peralta-Videa JR, Gardea-Torresdey JL. Use of plants in biotechnology: synthesis of metal nanoparticles by inactivated plant tissues, plant extracts, and living plants. *Developments in environmental science*. 2007 Jan 1;5:463-85. [https://doi.org/10.1016/S1474-8177\(07\)05021-8](https://doi.org/10.1016/S1474-8177(07)05021-8).
17. Wei L, Lu J, Xu H, Patel A, Chen ZS, Chen G. Silver nanoparticles: synthesis, properties, and therapeutic applications. *Drug discovery today*. 2015 May 1;20(5):595-601. <https://doi.org/10.1016/j.drudis.2014.11.014>.
18. Lara HH, Garza-Treviño EN, Ixtapan-Turrent L, Singh DK. Silver nanoparticles are broad-spectrum bactericidal and virucidal compounds. *Journal of nanobiotechnology*. 2011 Dec;9(1):1-8. <https://doi.org/10.1186/1477-3155-9-30>.
19. Siddiqi KS, Husen A. synthetization of metal nanoparticles from fungi and metal salts: scope and application. *Nanoscale research letters*. 2016 Dec;11(1):1-5. <https://doi.org/10.1186/s11671-016-1311-2>.
20. Siddiqi KS, Husen A. synthetization of metal and metal oxide nanoparticles by algae and their toxic effects. *Nanoscale research letters*. 2016 Dec;11(1):1-1. <https://doi.org/10.1186/s11671-016-1580-9>.
21. Singh, Rita, and Durgeshwer Singh. "Chitin membranes containing silver nanoparticles for wound dressing application." *International Wound Journal* 11, no. 3 (2014): 264-268. <https://doi.org/10.1111/j.1742-481X.2012.01084.x>.
22. Habiboallah G, Mahdi Z, Majid Z, Nasroallah S, Taghavi AM, Forouzanfar A, Arjmand N. Enhancement of gingival wound healing by local application of silver nanoparticles periodontal dressing following surgery: a histological assessment in animal model. *Modern Research in Inflammation*. 2014 Jul 24;2014. DOI:10.4236/mri.2014.33016.
23. Nambiar D, Bhatena ZP. Use of silver nanoparticles from *Fusarium oxysporum* in wound dressings. *Journal of Pure and Applied Microbiology*. 2010 Apr 1;4(1):207-14. [https://doi.org/10.1007/978-981-15-9920-0\\_4](https://doi.org/10.1007/978-981-15-9920-0_4).
24. Tian J, Wong KK, Ho CM, Lok CN, Yu WY, Che CM, Chiu JF, Tam PK. Topical delivery of silver nanoparticles promotes wound healing. *ChemMedChem: Chemistry Enabling Drug Discovery*. 2007 Jan 15;2(1):129-36. <https://doi.org/10.1002/cmdc.200600171>.
25. Kaur J, Tikoo K. Evaluating cell specific cytotoxicity of differentially charged silver nanoparticles. *Food and Chemical Toxicology*. 2013 Jan 1;51:1-4. <https://doi.org/10.1016/j.fct.2012.08.044>.
26. Chen X, Schluesener HJ. Nanosilver: a nanoparticle in medical application. *Toxicology letters*. 2008 Jan 4;176(1):1-2. <https://doi.org/10.1016/j.toxlet.2007.10.004>.
27. Nair B, Pradeep T. Coalescence of nanoclusters and formation of submicron crystallites assisted by *Lactobacillus* strains. *Crystal growth & design*. 2002 Jul 3;2(4):293-8. <https://doi.org/10.1021/cg0255164>.
28. Mukherjee P, Ahmad A, Mandal D, Senapati S, Sainkar SR, Khan MI, Parishcha R, Ajaykumar PV, Alam M, Kumar R, Sastry M. Fungus-mediated synthesis of silver nanoparticles and their immobilization in the mycelial matrix: a novel biological approach to nanoparticle synthesis. *Nano letters*. 2001 Oct 10;1(10):515-9. <https://doi.org/10.1021/nl0155274>.

29. Durán N, Marcato PD, Alves OL, De Souza GI, Esposito E. Mechanistic aspects of biosynthesis of silver nanoparticles by several *Fusarium oxysporum* strains. *Journal of nanobiotechnology*. 2005 Jul;3(1):1-7. <https://doi.org/10.1186/1477-3155-3-8>.
30. Chandran SP, Chaudhary M, Pasricha R, Ahmad A, Sastry M. Synthesis of gold nanotriangles and silver nanoparticles using *Aloevera* plant extract. *Biotechnology progress*. 2006;22(2):577-83. <https://doi.org/10.1021/bp0501423>.
31. Li S, Shen Y, Xie A, Yu X, Qiu L, Zhang L, Zhang Q. Green synthesis of silver nanoparticles using *Capsicum annuum* L. extract. *Green Chemistry*. 2007;9(8):852-8. <https://doi.org/10.1039/B615357G>.
32. Huang J, Li Q, Sun D, Lu Y, Su Y, Yang X, Wang H, Wang Y, Shao W, He N, Hong J. Biosynthesis of silver and gold nanoparticles by novel sundried *Cinnamomum camphora* leaf. *Nanotechnology*. 2007 Feb 6;18(10):105104. <https://doi.org/10.1088/0957-4484/18/10/105104>.
33. Singh M, Kalaivani R, Manikandan S, Sangeetha N, Kumaraguru AK. Facile green synthesis of variable metallic gold nanoparticle using *Padina gymnospora*, a brown marine macroalga. *Applied Nanoscience*. 2013 Apr;3(2):145-51. <https://doi.org/10.1007/s13204-012-0115-7>.
34. Kyaw SP, Wai MK, Nyunt T, Soe-Htun U. The Morphology and Distribution of *Dictyopteris woodwardia* (Brown ex Turner) C. Agardh (Dictyotales, Phaeophyta) from Myanmar. *Jour. Myan. Acad. Arts & Sc.* 2009;7(5):2.
35. Bhuyar P, Rahim MH, Sundararaju S, Ramaraj R, Maniam GP, Govindan N. Synthesis of silver nanoparticles using marine macroalgae *Padina* sp. and its antibacterial activity towards pathogenic bacteria. *Beni-Suef University Journal of Basic and Applied Sciences*. 2020 Dec;9(1):1-5. <https://doi.org/10.1186/s43088-019-0031-y>
36. Kumar CM, Yugandhar P, Savithramma N. *Adansonia digitata* leaf extract mediated synthesis of silver nanoparticles; characterization and antimicrobial studies. *Journal of Applied Pharmaceutical Science*. 2015 Aug;5(08):082-9. DOI: 10.7324/JAPS.2015.50813
37. Kannan R, Arumugam R, Ramya D, Manivannan K, Anantharaman P. Green synthesis of silver nanoparticles using marine macroalga *Chaetomorpha linum*. *Applied Nanoscience*. 2013 Jun;3(3):229-33. <https://doi.org/10.1007/s13204-012-0125-5>.
38. Kumar, P., S. Senthamil Selvi, and M. Govindaraju. "Seaweed-mediated biosynthesis of silver nanoparticles using *Gracilaria corticata* for its antifungal activity against *Candida* spp." *Applied Nanoscience* 3, no. 6 (2013): 495-500. <https://doi.org/10.1007/s13204-012-0151-3>.
39. Senthilkumar P, Sudha S. Antioxidant and antibacterial properties of methanolic extract of green seaweed *Chaetomorpha linum* from Gulf of Mannar: Southeast coast of India. 10.5812/jjm.3400
40. Suriya J, Raja SB, Sekar V, Rajasekaran R. Biosynthesis of silver nanoparticles and its antibacterial activity using seaweed *Urospora* sp. *African Journal of Biotechnology*. 2012;11(58):12192-8. DOI: 10.5897/AJB12.452
41. Prasad R, Swamy VS. Antibacterial activity of silver nanoparticles synthesized by bark extract of *Syzygium cumini*. *Journal of Nanoparticles*. 2013;2013. <http://dx.doi.org/10.1155/2013/431218>.
42. Castro L, Blázquez ML, González F, Muñoz JA, Ballester A. Extracellular biosynthesis of gold nanoparticles using sugar beet pulp. *Chemical Engineering Journal*. 2010 Oct 15;164(1):92-7. <https://doi.org/10.1016/j.cej.2010.08.034>.
43. Gao Y, Huang Q, Su Q, Liu R. Green synthesis of silver nanoparticles at room temperature using kiwifruit juice. *Spectroscopy Letters*. 2014 Nov 26; 47 (10):790-5. <https://doi.org/10.1080/00387010.2013.848898>.
44. Shao Y, Jin Y, Dong S. Synthesis of gold nanoplates by aspartate reduction of gold chloride. *Chemical Communications*. 2004(9):1104-5. <https://doi.org/10.1039/B315732F>
45. Baker S, Harini BP, Rakshith D, Satish S. Marine microbes: invisible nanofactories. *Journal of Pharmacy Research*. 2013 Mar 1;6(3):383-8. <https://doi.org/10.1016/j.jopr.2013.03.001>.
46. de Aragao AP, de Oliveira TM, Quelemes PV, Perfeito ML, Araujo MC, Santiago JD, Cardoso VS, Quaresma P, de Almeida JR, da Silva DA. Green synthesis of silver nanoparticles using the seaweed *Gracilaria birdiae* and their antibacterial activity. *Arabian Journal of Chemistry*. 2019 Dec 1;12(8):4182-8. <https://doi.org/10.1016/j.arabjc.2016.04.014>.

## CLOUD LEARNING TECHNOLOGY IN EDUCATION

<sup>1</sup>Sasikala P and <sup>2</sup>Dr. Nachimuthu K

<sup>1</sup>Research Scholar and <sup>2</sup>Professor & Head, Department of Education, Periyar University, Salem- 11

### ABSTRACT

*Education is the key to strengthening a country's economic growth. Classroom teaching is becoming increasingly difficult in today's Pandemic era. Students' education is questionable during this pandemic. Many private schools and colleges are emphasizing cloud education as an alternative to classroom teaching. Cloud computing technology plays a role not only in higher education but also in primary education. Utilizing cloud computing can enhance the quality of education and provide it to students. The cloud helps to make learning and teaching uninterrupted not only for students but also for teachers. This paper talks about the effective teaching process brought about cloud technology. Youngsters of this generation have developed a great interest in cloud technology because the cloud has become a part of their life.*

**Keywords:** cloud learning, Education

Traditional education usually is an outside process of imposing information through teaching and learning. Cloud learning is more of an inside process to facilitate the absorption of information. The cloud learning techniques activate and focus both hemispheres of the brain. The key here is quality, not quantity, learning much more in less time and locking the learning into the long – term memory.

Cloud learning technique help to access ‘success’ patterns in mind, emotions, bodies. Being the best accelerate learning.

### IMPORTANCE OF REVIEW OF RELATED LITERATURE

The review of related literature involves the main role related to the problem. When an investigator is designing a study, published research article provides him with background in the issues that pertain to researcher research question. The review of literature also suggests numerous ideas for further studies.

**Al-Hajri, et.all(2021).** The researcher the objective of the research was to find out the key factors that influence the acceptance and usage of cloud computing systems in the Omani higher education sector, with special emphasis on the COVID-19 outbreak. For this purpose, a quantitative research approach was conducted where 200 students from several Omani higher education institutions were surveyed, and by using Partial Least Square (PLS) to analysis the collected data. The findings revealed that the intention to use cloud computing in this context is significantly dependent on its perceived ease of use, usefulness, perceived reliability and responsiveness. It is noteworthy that this is one of the early studies that address the subject of cloud computing usage during times of crises, and specifically the COVID-19 outbreak. As such, it provides significant contributions in the area of technology adoption.

**Shahzad, Fakhar,et.all,(2020).** Researcher explained the provision of massive open online courses (MOOCs), cloud computing services enable students to synchronize their study materials anywhere, anytime, and using any device, which can improve learning performance and strengthen the teacher-student relationship via knowledge sharing. This study builds on the technological-organizational-environmental (TOE) framework and aims to identify the influencing factors of cloud computing adoption in educational settings for the provision of MOOCs. Another aim is to determine how intrinsic motivation moderates individual intention. Therefore, our study conceptualized a model that is supported by an empirical analysis of 232 respondents and takes into account the technological, organizational, and environmental impacts on individual attitudes toward adopting cloud computing in education. We evaluate the study hypotheses using structural equation modeling. The results demonstrate significant relationships between the technological and organizational constructs and attitudes toward the use of cloud computing. Meanwhile, competitive pressure from the environment has not been identified in any relationship with individual attitudes in government universities. The results provide new directions for policymakers to consider in the implementation of CC systems for the provision of MOOCs in developing countries. We also discuss potential implications, contributions, and suggestions for future research.

### STATEMENT OF THE PROBLEM

Considering the above reviews, research questions and rationale, it is felt by the researcher that cloud computing techniques which has been extensively experimented, systematically studied and rigorously enquired all over the globally need to be studied in India. “Cloud learning technology in education”



---

**CLOUD TECHNOLOGY:**

Developments in technology always create new opportunities for teaching and learning. Changes today are rapid and global. Developments in ICT frequently introduces education changes, which impact on teaching methods and tools and create new learning opportunities. The use of ICT becomes more systematic and impacts in all areas of the everyday school operation.

In an educational context the cloud has the potential to create virtual, pervasive environments, support the development of learning, student portfolios and information repositories, provide supercomputer-like resources and help the convergence of digital devices. At the same time, there are a considerable number of issues that need to be addressed as cloud computing develops. Some of these issues include user safety, security, anonymity and confidentiality of information in the cloud.

**CLOUD LEARNING TECHNOLOGY****Google Classroom**

Google Classroom is a cloud-based learning management system that is a part of Google Apps for Education. Google Classroom enables students to access the platform from computers, tablets, and smartphones.

**Blackboard**

Blackboard provides education, mobile, communication, and commerce software and related services to clients, including education providers, corporations, and government organizations. In January 2014, its software and services are used by approximately 17,000 schools and organizations in 100 countries.

**Knowledge Matters**

Knowledge Matters is a leading cloud-based virtual business online interactive, game-like business simulations teach college and high school students key business lessons.

**Coursera**

The most widely known education platform. On Coursera, you get access to a wide range of disciplines. There is hardly any student in the USA, Canada, Thailand, Russia, and Ukraine who is not aware of an opportunity to get precious knowledge with Coursera.

**Microsoft Education Center**

Microsoft Education Center is created to let students continue obtaining knowledge no matter what. They facilitate online learning and deliver the best education straight to every student.

**Classflow**

Classflow is a cloud-based interactive display lesson delivery software. They provide the users with access to lessons and learning resources 24/7 with no obligatory subscription.

**Cloud Learning Technology in Education**

**Virtual learning communities** - Cloud computing applications make it possible to involve the world outside the classroom. For example, the Internet and video-conferencing allows students access to information and knowledge and opportunities to contact the world outside school and outside of the region where the students live. In the project schools, teachers and students from different countries were paired to explore the opportunities that this provides.

**Challenges and development** - Cloud computing applications can be used in pupil-centred learning approaches that engage and challenge the students. Modern educational theory puts emphasis on approaches to learning where students work on specific project based tasks in order to develop their knowledge and skills. Working in this way the students are asked to experiment and test hypotheses in order to gain knowledge and skills related to different areas of the curriculum. For example, text editing applications, such as Google docs, allow students to work with different text genres.

Access Cloud based applications allow students within schools, and across many different schools, to work collaboratively on the same task. Collaboration involves high level communication skills where students negotiate meaning, ask questions and comment on contributions from others. Students are able to work, not only from school, but from anywhere with Internet access. The Rural School Cloud project made use of, and developed, open source software, so that software costs did not impact on the student's ability to work in school or from home.

---

Cloud computing is widely used in the education sector.

1. Students
2. Teachers
3. Administrators

### **Online Education Courses**

Online Education Courses have been booming during recent years. It's not only about Coursera (that we'll discuss later) but also about education courses not connected to school, college, or university education. With cloud technologies, every one of us has an access to online SMM, SEO, IT (and HTML cheat sheets) courses, Instagram online courses

### **Competitiveness**

Education is not the only sphere that successfully integrates cloud technologies. Businesses are now widely adopting the cloud computing model spending less money, acquiring flexibility, and advanced security. This has given a powerful impulse for cloud computing to develop.

Nowadays, education using cloud technologies can compete with the traditional educational process. We also shouldn't forget that cloud technologies make high-quality self-education possible. Employers are no more suspicious about potential workers who prefer e-learning instead of attending classes and eagerly offer them prestigious job positions.

### **Reduced Time and Costs**

Since the main concept of cloud technologies means connecting to cloud-based applications, neither students nor teachers have a need for specific devices to access the material. Cloud-based programs are perfectly compatible with any device. Even the cheap smartphone allows you to connect to related academic applications.

The SaaS model is considered to be one of the biggest advantages of cloud-based computing. It's common for software applications to be available for students for low-fee or free basis making the education affordable for most students.

### **Expensive Textbooks**

It's a commonly known fact that university-level textbooks are an expensive pleasure. They have outpaced almost any other element of the university involved in university education including tuition fees. This results in more and more students refraining from buying them. Cloud-based textbooks are the only solution to this problem. Digital books are usually less expensive.

### **CONCLUSION**

In the modern age, we cannot walk even a step without the help of computers and the internet. So teachers should be aware of cloud technology could have a significant role to play in educational development. Technology utilization in distance education has demonstrated its significance in the transfer of knowledge for both the instructors and learners. This is also made possible through the use of the internet which helps change the traditional teaching approaches into more modern methods when integrated with pedagogical instruction. The rapid change in the learning environment is the result of speedy developments in cloud computing technologies that have affected all areas of our life. We can make out that cloud computing technology has made many innovations in the field of teaching and also made a drastic change from the old paradigm of teaching and learning. In the new example of learning, the role of the student is more important than teachers. The concept of the paperless and penless classroom is emerging as an alternative to the old teaching-learning method. Nowadays there is the democratization of knowledge and the role of the teacher is changing to that of the Facilitator. We need to have interactive teaching and this changing role of education is inevitable with the introduction of innovative teaching methods.

### **REFERENCE**

- Baharuddin, Ampera et.al (2021). Implementation of Cloud Computing System in Learning System Development in Engineering Education Study Program, International Journal of Education in Mathematics, Science and Technology, 9 (4), 728-740.
- Aydin, Hakan (2021). A Study of Cloud Computing Adoption in Universities as a Guideline to Cloud Migration, SAGE Open, 11(3).

- 
- Al-Hajri et.al (2021). The Cloud Computing Systems' Adoption in the Higher Education Sector in Oman in Light of the COVID-19 Pandemic, *International Journal of Evaluation and Research in Education*, 10(3) 930-937.
  - Shahzad, Fakhar et.al (2020). The Moderating Role of Intrinsic Motivation in Cloud Computing Adoption in Online Education in a Developing Country: A Structural Equation Model, *Asia Pacific Education Review*, 21 (1), 121-141.
  - Almaiah, Mohammed Amin,et.all(2020). Investigating the Main Determinants of Mobile Cloud Computing Adoption in University Campus, *Education and Information Technologies*, 25 (4), 3087-3107.
  - Yadegaridehkordi, Elaheh, et.all(2020). A Behavioral Intention Model for SaaS-Based Collaboration Services in Higher Education, *Education and Information Technologies*, 25(2), 791-816.
  - Asadi, Zoleixa(2020). Cloud Computing Services Adoption among Higher Education Faculties: Development of a Standardized Questionnaire,*Education and Information Technologies*, 25(1), 175-191.
  - Madhan Mohan and Vijaya Kumar (2015).Utilization of e-resources among the faculty members in Engineering Colleges at Karaikal region, Puducherry.*International journal of current research and Development*.Vol 3(1), 77-84.
  - Malarvannan,S.(2015).Utility of e-resources by student teachers, *Journal of Educational Technology and Research*, APH pub, New Delhi. Vol.4(1).
  - Nachimuthu, K. (2014).Utilization of Multimedia awareness among Teacher Educators, *Journal of Education and Emerging Society, An International Journal of Education & Humanities*, APH pub, New Delhi, Vol.01(01).
  - Nachimuthu, K. (2013). Student Teachers attitude towards Social Media, *Education for All, An International Journal of Education & Humanities*, APH pub, New Delhi, Vol. 02(1).
  - Nachimuthu, K. (2012). Impact of LCD Projectors on Teacher Education, *NEST Journal of Teacher Training, A Peer-reviewed National Journal*, Ghaziabad, UP, Vol.4(2).
  - Mahesh, G.; Mittal, Rekha, (2009). Digital content creation and copyright issues": The Electronic Library, Vol. 27( 4).
  - Madhusudhan, M. (2008).Use of UGC-Info net e-journals by research scholars and students of University of Delhi, Delhi: A Study, *Library High Tech*, 26(3).
  - Nachimuhtu, K &Vijayakumari, G (2007). Modern ICT Trends in Teaching Technology, *EDUTRACKS, Journal of Education*, Neel Kamal Publishers, Hydrabad, Vol: 6( 6),.
  - Manimekalai, A. (2006). Internet Use Pattern among the students in Annamalai University, *SRELSJournal of Information Management*, 43(3), 265-270.
  - Margianti,E.S & Mutiara,A.B (2005). Application of cloud computing in education, vol.3(4).

---

**CONSUMER'S RESPONSE AND SATISFACTION TOWARD ONLINE FOOD DELIVERY SERVICES: A CASE OF AHMEDABAD CITY**

---

**Dr. Ankitaben D. Kathiriya**

Assistant Professor, B.K. School of Professional and Management Studies

**ABSTRACT**

*The aim of this research is to know the reasons behinds the using online food delivery services and to understand the factor influence and affect in online food delivery services. This study is carried out in Ahmedabad city of Gujarat state and researcher has used non probability sampling for the research and collected data through structured questionnaire. The result of this research indicates that people are using the online food delivery services to save their time and convenient, no one to cook for them, variety of dishes are available on single platform. Researcher has applied regression to analyse the impact of discount or coupon, price, payment and service quality on customer satisfaction level, result indicates that there is over all 36.6% impact off the independent variable on dependent variable.*

*Keywords: Online food delivery, customer response and satisfaction, discount, price*

**INTRODUCTION**

If we look at the growth rate of any developed country, we can analyse that service sector plays an important role and contribution in GDP from service sector is more. India is developing country and has around 65% contribution from service sector. Previous we had concept of service sector that cannot transport but now a day's service can be transport through internet and technologies and mobile application and software facilities available (Parashar & Ghadiyali, n.d.). Now a day's all world become a village because of speedy communication possible due to internet and telephonic revolution. Everything is available on single click and mostly people are using internet on their smart phone. One of the recent reports indicates growth rate for internet uses among Indians is increases. India is a country where second highest population in the world, has highest young population. Young people are mostly techno savvy so they can handle everything from their smart phone. Now people are switch to online shopping from physical shopping because it saves time and cost for consumer. In India online food industry is 16.2 %every quarter as per the business today report (Businesstoday, 2019). There is improvement in service quality provided by the companies and reduced the average delivery time from 47 minutes to 42 minutes (Peermohamed, 2018). Researcher want to know the reasons for online food delivery application used by them and what are the factors made them satisfied for the online food delivery, so objectives of this study are as under:

- To study the reasons behinds use of online food delivery applications
- To analyse the factors affecting to the customer satisfaction and impact of sales promotion on customer satisfaction in online food delivery services.

**LITERATURE REVIEW****Reason for Online Food Delivery:**

In era of internet all the people want to things on single touch and there are many reasons for using the online shopping among the customers. Now a days people are techno savvy accept new technology and method easily (Ee, 2017; Karthika & Manojanaranjani, 2018) which leads to increase online food delivery usage (Ee, 2017). Many customer thinks it will be convenient to them so they are doing online purchase as one of the research indicates it (Dang, Tran, Nguyen, Le, & Do, 2018; Rathore & Chaudhary, 2018). It also saves the time after doing online order one can do other task and received food on time so it will useful to all to save their time in this fast life. In foreign country more than 70% households are using the online food delivery (Cheow, Yeo, Goh, & Rezaei, 2017). People think about it as time saver and effort saver, many people have money for use but don't have time to buy and visit physically to restaurant and hotels they ordered online for the same (Cheow et al., 2017). Many people believe that easy access of the application is also one of the important factor for the online food delivery (Murat & Hekimoglu, 2012) it is found out one or another way that easy access and delivery leads to increases and prefers the online ordering for food (Cheow et al., 2017; Chorneukar, 2014; Dang et al., 2018; Das, 2018; Ee, 2017; Karthika & Manojanaranjani, 2018; Kedah, Ismail, & Ahmed, 2015; Lumpur, Sethu, & Saini, 2016; Parashar & Ghadiyali, n.d.; Rathore & Chaudhary, 2018). Some people have no option for them as there were no one to cook for them and they want to eat so they prefer to order online for fulfillment of their hunger. Mostly young generation and students are using the online food application because it is possible to compare the prices at single platform and have variety of dishes compare to physical visit.

### Factors Influence Customer Satisfaction in Online Food Services:

As a customer always concern about the price and quality of goods and services apart from this many other factors are also affecting to the customer. Discount and coupon are best strategies to satisfy the customer (Das, 2018), variety of the foods available on single platform also attracts the customer and satisfied the customer. Mostly Customers are not ready to pay the higher charges for delivery they always prefer the free of cost delivery or lower charges for the delivery and they believe in real time tracking system (Montanaro, Ghajargar, Zenezini, & Montanaro, 2016). Payment mode also affect to the customer, as people want hassle free payment some believe in cash on delivery and some believe in online payment through credit or debit card and e-wallet (Rathore & Chaudhary, 2018).

### RESEARCH METHODOLOGY

Researcher has tried to find out the customer response towards the sales and promotional schemes in fast food delivery system in Ahmedabad city. Previous research indicates that mostly generation Z is using more online food delivery applications (Parashar & Ghadiyali, n.d.), so researcher has conducted the focus group discussion among the students regarding online food delivery application used. From the FGD researcher came to know which factors are affecting to them while ordering the foods, and what are the reasons behind the order for online food delivery. Researcher has developed structured questionnaire from the focus group discussion for the study.

Researcher has asked two type of information to the respondent, one is related to the demographic factors like age, sex, occupation and education and second part is related to the online food delivery application uses and reasons for using online food services.

Researcher has collected data from 211 people by using non probability sampling. Researcher has used convenience sampling for data collection for this study as sampling frame is not available. Questionnaire was circulated among respondents through google doc as well as hard copy, it was circulated more than 300 people out of it researcher has received 227 but due to inaccurate and half-filled 16 questionnaire were removed for the analysis. So finally 211 were considered as final respondents for the study.

### DATA ANALYSIS AND RESULT DISCUSSION

#### Demographic Data Discussion:

In respondents 68% are male and 32 % are female, major responses are from students that are 144 than people from private sector than business people, public sector people and finally housewives. In literacy level post graduated are 49%, graduated people are 43% and rests of 8% have SSC and other qualification. In age group classification 1 % are from 13-18 years age group and majority 93% are from 18-30 years old age group as most of the respondents are from student background, 4% respondents are from the 30-50 years old and 2% are from more than 50 years old. In Income Classification Most of the people have an income level up to 250000 that is 70% than comes respondents who has an income between 250000-500000 that is 17% followed by 7% respondents have an income level between 500000-1000000 and 6% of respondents have an income more than 1000000.

#### Reasons for Using Online Food Delivery Services:

Researcher has asked the question on likert scale based question to the respondent, the result indicated most of the variable positively affected to the decision of customer for the online food delivery usages, the summary of the reasons behind the use of the online food services usage are as under.

**Table 1: Reasons for Online Food Services**

Reasons for online food services	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
There is no one to cook	47	73	56	20	16
Ease of delivery	65	107	31	10	4
Time saving	68	80	43	15	6
Variety of Dishes	80	86	31	9	5
Variety of restaurant	87	93	23	5	3
Less costly than physical outlet	44	84	54	20	10
Compare prices	42	73	67	26	5

(Source: Authors calculation from primary research)

**Factors Influence Customer Satisfaction in Online Food Services:**

Researcher has asked questions related to Price, service quality, discount and coupon and payment statement in likert scale basis and take average of similar parameter for measuring the impact of this independent variable on customer satisfaction level of customer. Researcher wants to measures the impact of all these independent variable on dependent variable so researcher has applied the regression analysis for this study.

**Hypothesis Testing:**

$H_0$ = There is no significance impact of coupon, price, discounts, service quality on customer satisfaction.

$H_1$ =There is significance impact of coupon, price, discounts, service quality on customer satisfaction.

**Table: 2** Anova Table for Regression

Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	46.621	4	11.655	31.317
	Residual	76.668	206	.372	
	Total	123.289	210		
a. Dependent Variable: Customer Satisfaction					
b. Predictors: (Constant), Service Quality, Price, Payment, Discount					

(Source: Authors calculation by using SPSS)

The above anova table indicates the independent variables like service quality, price, payment and discounts have significant impact on the dependent variable customer satisfaction.

**Table 3:** Model Summary for Regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.615 <sup>a</sup>	.378	.366	.6101	.378	31.317	4	206	.000	2.093
a. Predictors: (Constant), ServiceQaulity, Price, Payment, Discount										
b. Dependent Variable: CustomerSatisfaction										
(Source: Authors calculation by using SPSS)										

The above test indicates that overall 36.6% independent variables affects to the customer satisfaction. P value is less than 0.05 so it indicates it is significant and has impact on the customer satisfaction.

**Table: 4** Coefficient Table

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.130	.197		-.661	.509
	Discount	.388	.094	.326	4.129	.000
	Price	.026	.080	.024	.327	.744
	Payment	.034	.076	.030	.443	.658
	ServiceQaulity	.599	.103	.372	5.808	.000

(Source: Authors calculation by using SPSS)

Dependent Variable: Customer Satisfaction so here we have taken dependent variables as customer satisfaction and independent variables as prices, discounts, payment, service quality.

Table 4 indicates the coefficient of the dependent and independent variable, It indicates that discount and service quality have significant impact on customer satisfaction but price and payment doesn't affect to their decision and satisfaction level. From the above table researcher can frame the following model for the for customer satisfaction.

$$Y = -0.130 + 0.388X_1 + 0.026X_2 + 0.034X_3 + 0.599X_4$$

Where,

$Y$  = Customer satisfaction ( Dependent variable)

$X_1$  = Discount given on online food delivery services

$X_2$ =Price of online food delivery services

$X_3$ = payment of online food delivery services

$X_4$ = Service quality of online food delivery services

The above model indicates that the customer satisfaction and buying behavior depends on the discount and coupon allowed to customer as well as service quality provided by the online food services to customer more than the price and payment of online food delivery services.

## CONCLUSION

Given the increased use of the online shopping, the study aimed to understand consumer response toward promotional schemes. Specifically, the purpose of this study was to empirically investigate the factors that affect the consumer buying behavior towards ordering food by internet. According to the analysis of the data gathered by questionnaire we found that customer satisfaction is depended on discount coupons and service quality more than price and payment methods. So it can be concluded that promotional schemes directly or indirectly affects to buying decision.

## SCOPE FOR FURTHER RESEARCH

Researcher has analysed data from the Ahmedabad city it can be done for other part of the state and country and researcher can deeply analyse the marketing schemes for the next research. It can be done for stratified sampling as well, so customer preference can be analysed by age, gender and occupation wise in detail.

## MANAGERIAL IMPLICATION

This research can be useful to decision making for the framing of marketing strategies and it will helpful to understand the factors affecting to online food delivery uses as well as impact of the sales and promotion schemes on the customer satisfaction and their decision making for using online food delivery services.

## ACKNOWLEDGEMENT

Researcher wants to acknowledge her students Mr. Vijay Chandapa and Satyen Vora for helping in data collection.

## BIBLIOGRAPHY

- Businesstoday. (2019, March 26). Retrieved June 27, 2019, from [https:// www.businesstoday.in/current/economy-politics/indian-online-food-ordering-market-set-to-grow-at-162-to-touch-1702-billion-by-2023/story/331156.html](https://www.businesstoday.in/current/economy-politics/indian-online-food-ordering-market-set-to-grow-at-162-to-touch-1702-billion-by-2023/story/331156.html).
- Cheow, V., Yeo, S., Goh, S., & Rezaei, S. (2017). Consumer experiences, attitude and behavioral intention toward online food delivery ( OFD ) services. *Journal of Retailing and Consumer Services*, 35(December 2016), 150–162. <https://doi.org/10.1016/j.jretconser.2016.12.013>
- Chorneukar, M. M. J. (2014). To Study the Customer Perceptions of Electronic Food Ordering.
- Dang, A. K., Tran, B. X., Nguyen, C. T., Le, H. T., & Do, H. T. (2018). Consumer Preference and Attitude Regarding Online Food Products in Hanoi , Vietnam, (2). <https://doi.org/10.3390/ijerph15050981>
- Das, J. (2018). Consumer Perception Towards ‘ Online Food Ordering And De Livery Services ’: An Empirical Study, 5(5), 155–163.
- Ee, E. U. N. O. N. G. L. (2017). Factors Influencing The Behavioral Intention To Use Food Delivery Apps, 45(9), 1461–1474.
- Karthika, I., & Manojanaranjani, A. (2018). A Study on the various food ordering apps based on consumer preference, 4(11), 88–89.
- Kedah, Z., Ismail, Y., & Ahmed, S. (2015). Key Success Factors of Online Food Ordering Services : An Empirical Study, (January 2016).
- Lumpur, K., Sethu, H. S., & Saini, B. (2016). Customer Perception and Satisfaction on Ordering Food via Internet , a Case on Foodzoned . Com , in Manipal, (July), 1–13.
- Montanaro, T., Ghajargar, M., Zenezini, G., & Montanaro, T. (n.d.). ScienceDirect Home Home delivery innovations needs Home delivery delivery services : services : innovations and services : innovations. *IFAC-PapersOnLine*, 49(12), 1371–1376. <https://doi.org/10.1016/j.ifacol.2016.07.755>

- 
- Murat, S., & Hekimoglu, H. (2012). A study on tam : analysis of customer attitudes in online food ordering system, 62, 1138–1143. <https://doi.org/10.1016/j.sbspro.2012.09.195>
  - Parashar, N., & Ghadiyali, S. (n.d.). A Study On Customer ' S Attitude And Perception Towards Digital Food App Services.
  - Peermohamed, A. (2018, January 30). Business Standard. Retrieved June 27, 2019, from [https://www.business-standard.com/article/companies/india-s-online-food-ordering-sector-growing-at-15-every-quarter-redseer-118012901417\\_1.html](https://www.business-standard.com/article/companies/india-s-online-food-ordering-sector-growing-at-15-every-quarter-redseer-118012901417_1.html).
  - Rathore, S. S., & Chaudhary, M. (2018). Consumer ' s Perception on Online Food Ordering, 9519, 12–17.



---

**DESIGN & STRENGTH ENHANCEMENT METHOD FOR COMPOSITE GEARS**

---

**Harshal Rajaram Tambave<sup>1\*</sup> and Prof. (Dr.) B. S. Rathod<sup>2</sup>**<sup>1</sup>Department of Mechanical Engineering (Design), Vishwakarma Institute of Information Technology**ABSTRACT**

*Power transmission is the major requirement in any of the mechanical machine without transmission, there will be no relative motion or power within the system. Usually gears are the simplest and most widely used in the transmission of power. Several different types of gears are available in the market for various machine to their receptiveness. In some cases or most of the time gears required in any of the machine varies to its application from shredding machine to prototype models of electronic in the development. So, at all the time one can just not select the same materials for all of the use, sometimes it becomes necessary to take care of weight as well as cost. So our project helps in the determination of gears using composite and studying the failure criteria & solution to enhance its strength by comparing the gears design according to the material selection criteria for Designing & solving the FEM solution using ANSYS workbench. Because composite usually provides improved strength mechanical properties. Our work is mostly concerned with the investigation of differences for metal and composite gears failure and enhancement of strength for the required boundary condition.*

*Keywords: Gears, Weight & Cost, Design, FEM solution, Ansys workbench, Strength enhancement.*

**1. PROBLEM STATEMENT**

Usually spur gears have their teeth that are projected outwards to its cylindrical surface; different varied or same gear ratios are used to transmit the power between relatively parallel shafts. When each gears meshes with each other than certain stress is induced in the gear because of rotational movement and meshing of gear teeth's with each other, & is the simplest and most widely used in the transmission of power. Several different types of gears are available in the market for various machines to their receptiveness. In some cases or most of the time gears required in any of the machine varies to its application from shredding machine to prototype models of electronic in the development. So, at all the time one can just not select the same materials for all of the use, sometimes it becomes necessary to take care of weight as well as cost. If the gears fails to sustain a certain external force generated by meshing teeth on gears than disaster may take place, which than creates major problems failure of machine, surrounding losses, cost orientation & even may create delay in processing of the product. So in order to use certain composite gear it must need to be tested before getting manufactured.

**2. OBJECTIVE**

1. To improvise the design and material terminology in the reduction of cost as well as weight.
2. To make a comparison of the spur gears terminology by using ANSYS workbench for a specific boundary condition by changing its material form for various composite.
3. To investigate the strength between metallic & composite gears at its maximum loading condition.
4. To perform the dynamic structural analysis of spur gear and study the various factors like deformation, stress & strain with its fatigue factors.
5. To make a survey on the material criteria on high strength composites for manufacturing of gears.
6. To prepare an analytical calculation for designing a spur gear.
7. To develop a 3D model of gears using CATIA v5 design tool.
8. To perform a simulation based dynamic structural analysis of spur gear using FEM solution ANSYS workbench.
9. To compare among the other composite materials to the various factors this results in the failure.

**3. SCOPE**

This project helps in predicting the failure ratio of gears between metal and various composite materials which may be used in future for making of gears, at particular boundary conditions like angular velocity and by changing gear terminology.

**4. METHODOLOGY**

Step 1: - We started the work of this project with literature survey. We gathered many research papers which are relevant to this topic. After going through these papers, we learnt about topology optimization, structural analysis & model analysis of the alternator project of our aim.

Step2: - After the study, material selection criteria is surveyed in market according to availability and cost of materials.

Step 3: - After deciding the materials, the 3 D Model and drafting will be done with the help of CATIA software.

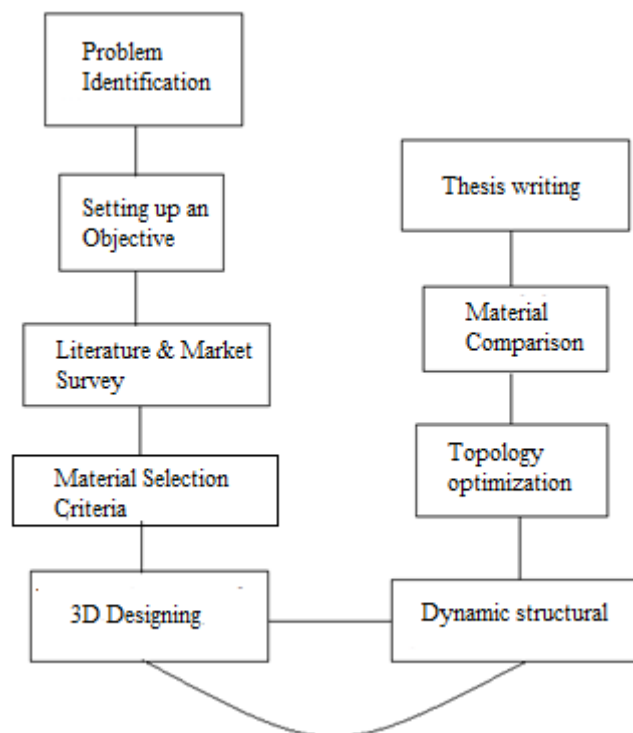
Step 4: - FEM solution will be evaluated 1st using Dynamic structural analysis.

Step 5: - Model An

Step 6: - Topology Optimization.

Step 7: - Material comparison.

Step 8: - Thesis writing.



**Fig 1: Methodology**

## 5. INTRODUCTION

Spur gears are the most simple, common and widely used gears in power transmission. It has cylindrical or disk outer surface on which gear teeth are projected radially. Though the teeth are not exact straight sided (maybe involute or cycloidal) but, the edge of teeth is straight and parallel to each other and axis of rotation. Gears are used to transmit the power from one part to another, some of the gears are used even to convert the direction of rotation to its perpendicularity like worm, bevel differential in transmission etc. Gears have helped in the construction of several machines as well as equipment from time when they were implemented. Now a day you may look at any machine or element it has gears, all of our surrounding is covered with technology which needs gears from transportation, lifting equipments, machines & even a branded analog watch you are just wearing now. When rotational velocity is given to the gear they get meshed with each other and stress factors are induced in it, because of the force we are using for it to handle. Most of the gears are used to manage the angular speed by varying its gear ratio.

### 5.1 TYPES OF GEARS

1. Spur gear
2. Helical gear
3. Double helical gear
4. Bevel gear
5. Spiral bevel gear
6. Hypoid gear: - these are operated when the shaft transmission is required at an angle of 90 degree.

7. Crown gear: - Crown gears are form of bevel gear only but its teeth postioning is projected at right angle to the plane of the wheel.
8. Worm gear: - these are used when the rotating sufaces are inlined or perpendicular angular directon is require (or 90 degree power transmission) etc.

### 1. Internal gear

An external gear also has their teeth formed outside the cylindrical surface or cone. Conversional internals gear is a one which has teeth's on its inners surface of a gear cylindrical or cone surface. A bevel gear with pitch angle exceeding 90 degree is an internal gear, these type of gears do not cause output shaft direction reversal.



**Fig:** Internal Gear

### 2. Spur gear

Spur gears are the most simple, common and wieldy used gears in power transmission. It has cylindrical or disk outer surface on which gear teeth's are projected radially. Though may the teeth are not exact straight sided (maybe involute or cycloidial) but, the edge of teeth is straight and parallel to each other and axis of rotation. These gears get meshed together correctly only if both the gears are fitted to parallel shafts. No axial thrust is created by the tooth loads. These gears are excellent but tend to create noise while rotating at higher rpms.

### 3. Helical

Top: parallel configuration Bottom: crossed configuration

Basically helical gears are the modification to the spur gear,. They teeth leading edges are not parallel in this case to its axis of rotation, by the teeth's are set at an required angle. Since the gear looks curved, these angled teeth make the gear to look like a shape segment helix. These gets meshed each other when their orientation is in parallel or crossed.



**Fig:** Spur & Helical Gear

### 6. Matrieals

Glass fiber a composite consiting of various extermly fine fibers of glass. but mass manufacture of glass fiber was only made possible with the invention of finer machine tooling.

Glass fiber		A-Glass	E-Glass
Tensile strength (MPa)		3310	3445
Tensile modulus (GPa)		68.9	72.3
Density	=	2660 g/cm <sup>3</sup>	
Youngs moduls	=	30000 Mpa	
Poissions ratio	=	0.21	

<b>Epoxy resin</b>			
Youngs modulus	=	3.3 Gpa	
Shear modulus	=	1.2 Gpa	
Poissions ratio	=	0.37	
Density	=	1.2 g/cc	
<b>Silicon carbide</b>			
Density	=	3.2 g/cm	
Tensile strength (MPa)	=	240 Mpa	
Compressive strength	=	1395 Mpa	
Poissions ratio	=	0.25	

Youngs modulus = 454 Gpa

## 7. ADVANTAGES

1. optimized low weight
2. equivalent strength
3. Less cost etc.

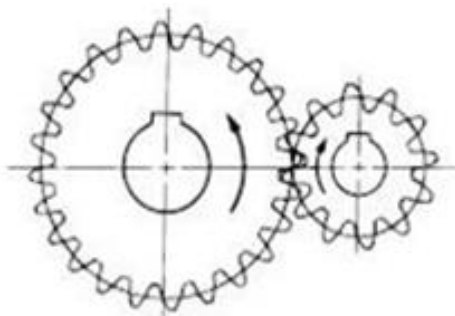
## FACILITIES REQUIRED

- CATIA v5 design tool
  - Surface designing or wireframe design – To create the 3D model of composite spur gear..
- ANSYS 2020 R1workbench
  - structural analysis
  - Topology optimization system.
  - Free body model analysis (vibrational analysis).
- Material comparison

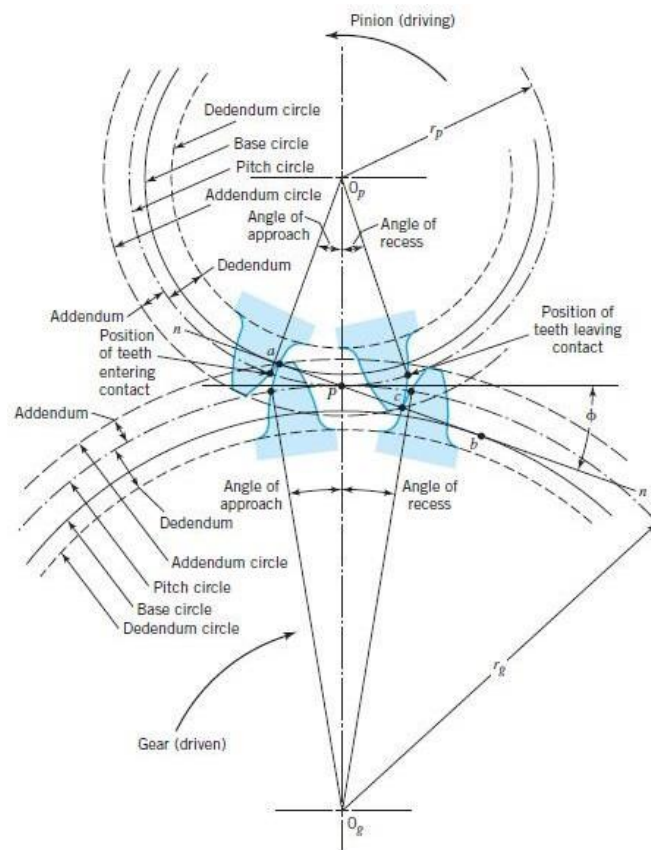
## 8. ANALYSIS

1. Pre-Processing
2. Geometry Modeling
3. Meshing
4. Material and Contact Definition
5. Loading and boundary condition
6. Solution & Post-Processing
7. Deformation
8. Stresses
9. Strain
10. Fatigue analysis factors

## 9. SPUR GEAR TERMINOLOGY



The below diagram shows the various terminologies used in spur gear.



$$i = N_1 N_2 = Z_2 Z_1$$

$N_1 = Z_1$  = speed or number of teeth on driver gear  $N_2 = Z_2$  = speed or number of teeth on driven gear

$$M_t = M_t \cdot k \cdot d$$

$$M_t = 60P / 2\pi N$$

Initially assume  $k \cdot d = 1.3$  symmetric scheme Pitch line velocity  $v = \pi d N / 60$

Further design details will be provided in next review paper.

## 10. CONCLUSION

This paper gives a review idea of my project, Design & strength enhancement method for composite gears. In this review I have stated the material on which I'm going to work for FEM simulation for spur gear for different composite materials. Finally I'm gone compare the composites and metal gears, result factor after evaluating among the others, if the composite gear for required application fails to achieve the required strength than topology optimization will be conducted by varying the gear terminology with the help of ANSYS and CATIA tool.

## REFERENCES

- [1]. V. Siva Prasad, Syed Altaf Hussain, V. Pandurangadu, K. Palani Kumar, — Modeling and Analysis of Spur Gear for Sugarcane Juice Machine under Static Load Condition by Using FEA, International Journal of Modern Engineering Research (IJMER), Vol.2, Issue.4, July-Aug 2012 pp-2862-2866, ISSN:22496645
- [2]. K. Mao, —A new approach for polymer composite gear design, Mechanical Engineering, School of Engineering and Design, Brunel University, Uxbridge, Middlesex UB8 3PH, UK, accepted 14 June 2006
- [3]. K. Mao, —A numerical method for polymer composite gear flash temperature prediction, Mechanical Engineering, School of Engineering and Design Brunel University, Uxbridge, Middlesex UB8 3PH, UK, accepted 8 January 2007
- [4]. S. Kirupasankar, C. Gurunathan, R. Gnanamoorthy, —Transmission efficiency of polyamide nanocomposite spur gears, Indian Institute of Information Technology, Design and Manufacturing

---

(IITD&M) Kancheepuram, Melakottaiyur, Chennai 600 048, India, Materials and Design 39 (2012) 338-343

- [5]. N.A. Wright<sup>1</sup>, S.N. Kukureka, —Wear testing and measurement techniques for polymer composite gears<sup>1</sup>, School of Metallurgy and Materials, The University of Birmingham, Edgbaston, Birmingham B15 2TT, UK, Wear 251 (2001) 1567–1578.
- [6]. Jesper Brauer, Sören Andersson, —Simulation of wear in gears with flank interference—a mixed FE and analytical approach<sup>1</sup>, Department of Machine Design, KTH, Brinellvagen 83, 100 44 Stockholm, Sweden, Wear 254 (2003) 1216–1232.

**NOTE:**

This article has been truncated and was only created to show various elements.

Reference styles should be consistent with other chapters in the book. Use either the American Chemical Association style used above.

OR use the Chicago style (from the *Chicago Manual of Style*) or the APA style (from the American Psychological Association). These will have in-text citations as such: (Kelly, 2004).

## EFFECT OF MILK MIXTURES ON MILK COAGULATION PROPERTIES FROM DIFFERENT SPECIES GROWN ON ALBANIA REGIONS

Migena Hoxha, Suada Muca and Vlash Mara

Faculty of Biotechnology and Food, Agricultural University of Tirana, STS. "Paisi Vodica", 1025 Tirana, Albania

### ABSTRACT

*Our previous studies shown that some sheep breeds milk coagulate very quickly and the milk of goat breeds in a good part of the analyzed samples does not coagulate or show poor coagulation properties (ie do not reach a suitable cutting strength). Our study aims to evaluate improving possibility of coagulation properties by mixing milks from those breeds which shown coagulation abnormalities. For this purpose, sheep milk from Merino-Cigane and Lakon breeds were combined with goat milk (Red Alpina) and cow milk (Jersey). Raw milk from morning milking were collected from two different areas of Albania ( Devoll and Fushe Kruje). Samples of individual milks were analysed for physical-chemical indicators titrable acidity ( $^{\circ}\text{T}$ ), casein content (according to Sorensen), solid non-fat, crude protein, fat, lactose content with ultrasonic milk analyzer. Coagulation properties coagulation time R (min), curd firming after 20 and 30 minutes of R, A20 and A30 (volt) and the rate of curd firming K20 (min) were performed by Optigraph, AMS, France. The results of our study showed that mixing milk from different species improves the coagulation properties of milk. Regardless of the combined breeds, climatic conditions or feeding conditions of individuals, the most suitable combinations for sheep/cow milk are the ratios 3:1(v/v) and 3:2(v/v) and for sheep/goat milk, 2:3(v/v). Further studies needs to evaluate physical-chemical and biochemical changes on curd and cheese produced from milk mixtures of those breeds.*

### INTRODUCTION

Cheesemaking properties of milk are of importance not only for cheese quality and yield but also for the process control at the dairy. Many factors influence the suitability of milk for further use in rennet, plant extracts or chymosin-induced coagulation process. This includes the quality and composition of the raw milk, as well as conditions relating to the further handling and processing of the milk. Regarding the raw milk quality, it has been well documented that unprocessed milk from individual cows represents a wide range of qualities for chymosin-induced coagulation properties [1,2,3]. Many studies had reported coagulation abnormalities and that the majority of samples present not only good coagulation properties but also poor coagulating and even non-coagulating properties [4,5,6,7,8]. As it known many factors influence the milk coagulation properties, including lactation stage, somatic cell count, breed, and parity, these factors influence the properties by manifestation of changes in the milk composition and milk coagulation variabilities [3,4,9]. Numerous studies show that the phenomenon of rapid coagulation of milk, would have two negative effects in technology: 1) the appearance of a rapid syneresis process, which is associated with large losses in the yield of curd formed and 2) a rapid syneresis on the surface of the curd, which is accompanied by the formation of a layer, blockage of capillaries and reduction of permeability, thus hindering the normal process of syneresis. Inhibition of the syneresis process is associated with an increase of the moisture content of the curd formed, adversely affecting a number of maturation processes [10,11]. Commonly identified factors for poor coagulating and non-coagulating milk include low casein (CN) content, especially low  $\kappa$ -CN content,  $\kappa$ -CN genetic polymorphism, larger CN micelles, and lower Ca content [3,12,13,14,15], but the underlying reasons are still not completely elucidated. Many studies have tried to identify the influence of milk mixtures from different species on the biochemical and physicochemical properties of cheese. Sant'Ana et al. [16] highlighted that mixing goat milk and cow milk in equal proportion (1CM:1GM, v/v) did not affect the cheese's protein, moisture, fat, lactose, and ash contents. Many different studies reporting that GM is similar to CM in basic composition [17]. However, other investigations have highlighted contradictory variations in fat content [18,19,20,21]. Some studies have also observed a decrease in protein content [19,20,21], moisture, and salt [20], while others [18] have reported an increase in moisture and fat-in-dry matter (FDM) contents and no significant effects on protein, moisture-in-non-fat-substance (MNFS) and salt. According to Ramírez-López and Vélez-Ruiz [19], no differences were observed for lactose and non-fat solids. The results of the studies mentioned above highlighted that both (i) milk composition (i.e., species origin) and (ii) cheese process manufacturing have an effect on the final cheese composition [22].

The understanding of the impact of the association of milk from different species on molecular structure, location and interactions of components (e.g., fat, proteins) even on coagulation properties during manufacture is essential for predicting the quality attributes of dairy products, particularly cheese.

## MATERIALS AND METHODS

### Sampling

Milk was sampled from morning milking on volume 500 mL per sample. There were selected 5 samples of each cow (Jersey), goat (Red Alpina) and sheep (cross breed Merino-Cigane and Lakon sheep) breeds raised on different regions of Albania (Devoll, Fushe Kruje).

Milk's samples were treated with 1 ml solution of 1% sodium azide (w/v) and were refrigerated at 2-4°C, after that samples were sent to laboratory [23].

### Physical-Chemical Analysis and Coagulation Properties of Raw Milk

Physical and chemical properties, acidity (in Turner degrees), content of casein (according to Sorensen), content of non-fat solids, content of crude protein, content of fat, content of lactose and content of added water are measured with ultrasonic milk analyzer Lactoscan.

Coagulation properties of milk (coagulation time R in minutes, curd firming after 20 and 30 minutes A20 and A30 in volt and rate of curd firming K20 in minutes) were performed by Optigraph, AMS, France for raw milk and different combination portions from different species [24,25,26,27,28,29].

## RESULTS AND DISCUSSION

### Physical-Chemical and Coagulation Indicators of Milk Combinations of Sheep, Cow and Goat.

#### a) Evaluation of coagulation properties for the mixtures of Merino-Cigane (M-C) sheep milk with Jersey cow and Alpina red goat milk, grown in domestic conditions on Devoll area

Since the whole milk of some sheep breeds show rapid coagulation and the milk of goat breeds in a good part of the analyzed samples does not coagulate or show poor coagulation properties (ie do not reach a suitable cutting strength). Due to this, a study was conducted on the evaluation of coagulation parameters in milk mixtures of different species. For this purpose sheep milk was combined with goat milk and cow milk.

Table 1 provides data on physico-chemical and coagulation indicators for whole sheep, cow and goat milk which are combined. The data shown that M-C sheep milks coagulate immediately and go beyond the detection limit, a phenomenon which in technology would have two negative impacts: 1) the appearance of a rapid syneresis process, which is associated with large losses in the yield of curd formed and 2) a rapid syneresis on the surface of the curd, which is accompanied by the formation of a layer, blockage of capillaries and reduction of permeability, thus hindering the normal process of syneresis. Inhibition of the syneresis process is associated with an increase in the moisture content of the curd formed, adversely affecting a number of maturation processes [10,11].

Jersey cow milk exhibits poor coagulation properties, recording long coagulation time (R, 14:15 minutes), very low consistency (A20 2.83 V and A30 6.3 V) and very low coagulation speed (high value of K20(min)). Red alpine goat milk shows good coagulation properties, short coagulation time (R, 8:29 minutes), relatively good consistency (A20 9.9V and A30 11.5V) and high coagulation speed (low K20 value) ).

**Table 1:** Physico-chemical and coagulation indicators for sheep, cow and goat milk, taken to study the difference of coagulation parameters in the combinations between them.

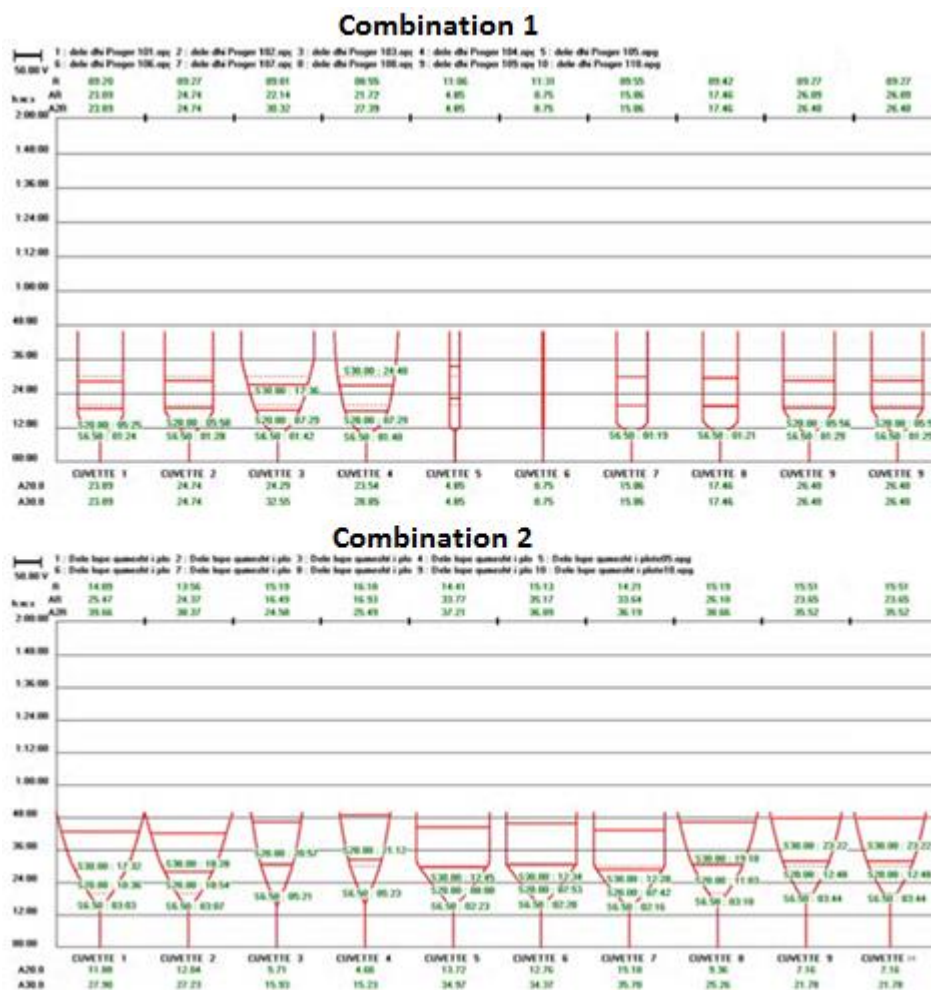
Specie/breed	Coagulation indicators				Physical-chemical indicators						
	R (min)	A20 (volt)	A30 (volt)	K20 (min)	D (kg/m <sup>3</sup> )	Ac (°T)	P (%)	K (%)	Y (%)	SNF (%)	L (%)
Sheep (M-C)	9:15	> 50	>50	NA	1.035	27	6.33	5	9.62	11.31	3.9
Cow (Jersey)	14:15	2.83	6.3	16:30	1.033	14	3.46	2.06	1.94	9.02	4.84
Goat (Red Alpina)	8:29	9.9	11.5	4:33	1.029	17	3.31	1.9	4.2	8.46	4.46
M-C- Crossbreed Merino-Cigane											

Table 2 provides the data of coagulation parameters for the combinations of Merino-Cigane sheep milk with Jersey cow milk (combination no. 1) and Merino-Cigane sheep milk with Red Alpina goat milk (combination no. 2), in the ratios shown in the table. The data show that the best coagulation parameters in the case of sheep / cow milk combination are achieved in the ratios 3: 1 and 3: 2, while in the case of sheep milk / goat milk combination are achieved in the ratio of 1: 3 and 2: 3.



**Table 2:** M-C sheep milk combinations with Jersey cows and red alpine goats milk.

	Ratio (v/v)	R (min)	A20 (volt)	A30 (volt)	K20 (min)
<b>Combination 1</b>					
M-C -Jersej	1:1	14:02	11.90	27.9	3:05
M-C -Jersej	1:3	15:25	5.3	15.5	5:22
M-C -Jersej	3:1	14:57	13.2	34.6	2:22
M-C -Jersej	3:2	14:50	12.4	30.5	2:33
M-C -Jersej	2:3	16:02	7.35	21.5	3:44
<b>Combination 2</b>					
M-C-Red Alpina	1:1	9:24	23.8	23.8	1:26
M-C-Red Alpina	1:3	8:58	23.9	30.3	1:41
M-C-Red Alpina	3:1	11:15	>50	>50	NA
M-C-Red Alpina	3:2	9:48	16.65	16.65	1:20
M-C-Red Alpina	2:3	9:20	26.2	26.2	1:28



**Figure 1:** Graphic representation of coagulation parabolas for milk combinations 1 and 2

### b) Evaluation of coagulation properties for the mixtures of Lakon sheep milk with Jersej cow and Alpina red goat milk raised on the farm (Fushëkrujë area)

Table 3 provides data on the physico-chemical indicators and coagulation properties of Lakon sheep, Jersey cow and red Alpine goat milk. Unlike cow, sheep and goat milk, mentioned above, where milk samples were taken from individuals raised at domestic condition, in this case, samples were taken from individuals raised on the same farm in Fushëkrujë, which means that have the same feeding regime. Lakon sheep milk, unlike those of the M-C breed mentioned above, exhibit very good coagulation properties, but not in terms of a rapid coagulation. Jersey cows' milk again records longer clotting times, as in the first case of the combinations, but even better consistency than that of goat's milk in both cases. This fact can be explained by the climatic changes

between the two areas where the samples were taken, as well as the feeding regimes, without leaving aside the internal genetic features of each individual.

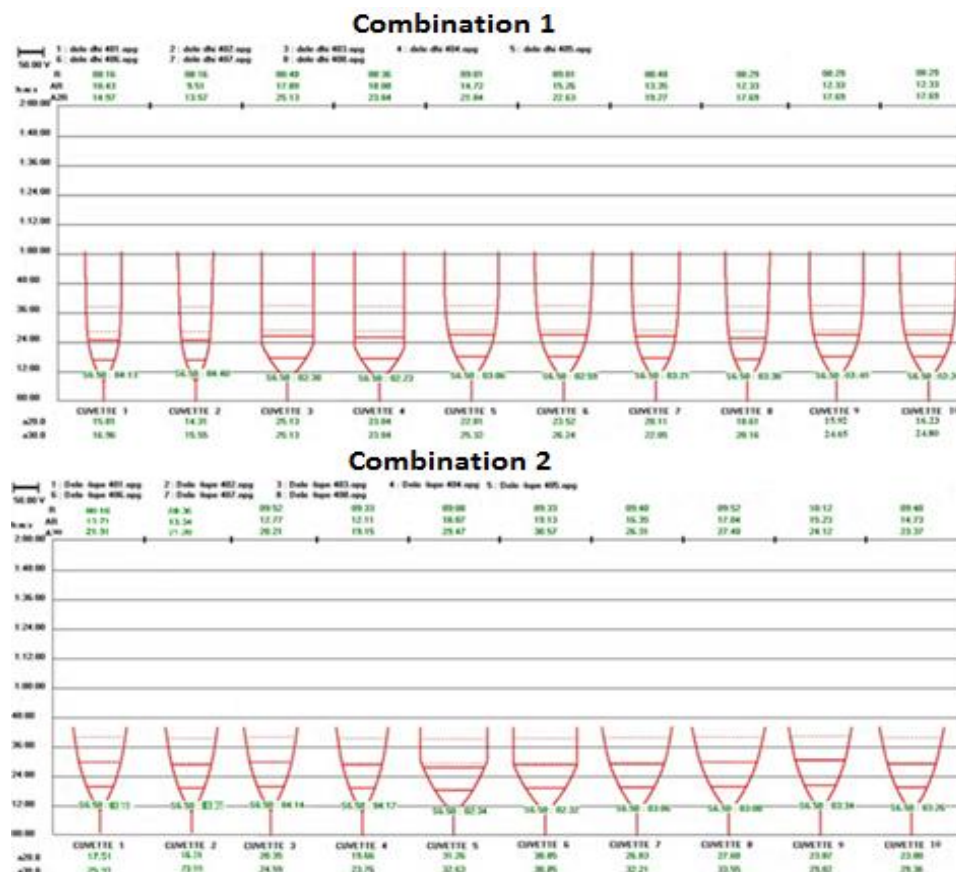
**Table 3:** Physico-chemical and coagulation indicators for sheep, cow and goat milk, taken to study the difference of coagulation parameters in the combinations between them.

Specie/breed	Coagulation indicators				Physical-chemical indicators						
	R (min)	A20 (volt)	A30 (volt)	K20 (min)	D (kg/m <sup>3</sup> )	Ac (°T)	P (%)	K (%)	Y (%)	SNF (%)	L (%)
Sheep (Lakon)	9:27	26.7	33.25	3.12	1.033	19	5.63	3.82	6.72	10.32	3.71
Cow (Jersej)	14:00	11.5	14.44	8:45	1.03	15	3.39	1.62	4.47	8.65	4.56
Goat (Red Alpina)	10:25	10.2	11.05	7:40	1.029	13	3.13	1.62	2.82	8.12	4.31

Regardless of what was said above, the combinations of milk samples in the study recorded the best consistency values in the same ratios, for the sheep-cow milk combination in the 3: 1 and 3: 2 ratios. Also, for the combination: sheep milk-goat milk, the ratio, which has recorded the best consistency parameters, results 2: 3.

**Table 4:** Lakon sheep milk combinations with Jersey cows and red alpine goats milk

	Ratio (v/v)	R (min)	A20 (volt)	A30 (volt)	K20 (min)
<b>Combination 1</b>					
Lakon -Jersej	1:1	8:25	16.9	24.9	3:25
Lakon -Jersej	1:3	9:40	20	26	4:15
Lakon -Jersej	3:1	9:20	31	31.5	2:33
Lakon -Jersej	3:2	9:46	27.1	32	3:03
Lakon -Jersej	2:3	9:56	23.8	29.2	3:30
<b>Combination 2</b>					
Lakon-Red Alpina	1:1	9:01	15.1	21.8	3:33
Lakon-Red Alpina	1:3	9:18	12.25	19.3	4:40
Lakon-Red Alpina	3:1	8:46	14	21.4	4:13
Lakon-Red Alpina	3:2	8:39	14.3	21.4	4:05
Lakon-Red Alpina	2:3	8:29	15.5	24.5	3:40



**Figure 2** Graphical representation of coagulation parabolas for combination 1 and 2

## CONCLUSION

The results of our study showed that mixing milk from different species improves the coagulation properties of milk. Regardless of the combined breeds, climatic conditions or feeding conditions of individuals, the best combination ratios for sheep/cow milk are 3Sh:1C(v/v) and 3SH:2C(v/v) and for sheep/goat milk, 2Sh:3G(v/v). Further studies need to evaluate physical-chemical and biochemical changes on curd and cheese produced from milk mixtures of those breeds.

## REFERENCE

- [1] Jõudu I, Henno M, Kaart T, Püssa T, Kärt O (2008) The effect of milk protein contents on the rennet coagulation properties of milk from individual dairy cows. *Int Dairy J* 18:964–967
- [2] Hallén E, Lundén A, Tyrisevä A-M, Westerlind M, Andrén A (2010) Composition of poorly and noncoagulating bovine milk and effect of calcium addition. *J Dairy Res* 77:398–403
- [3] Frederiksen PD, Hammershøj M, Bakman M, Andersen PN, Andersen JB, Qvist KB, Larsen LB (2011b) Variations in coagulation properties of cheese milk from three Danish dairy breeds as determined by a new free oscillation rheometry-based method. *Dairy Sci Technol* 91:309–321
- [4] Ikonen T, Morri S, Tyrisevä A-M, Ruottinen O, Ojala M (2004) Genetic and phenotypic correlations between milk coagulation properties, milk production traits, somatic cell count, casein content, and pH of milk. *J Dairy Sci* 87:458–467
- [5] Frederiksen PD, Andersen KK, Hammershøj M, Poulsen HD, Sørensen J, Bakman M, Qvist KB, Larsen LB (2011a) Composition and effect of blending of noncoagulating, poorly coagulating, and well-coagulating bovine milk from individual Danish Holstein cows. *J Dairy Sci* 94:4787–4799
- [6] Poulsen NA, Bertelsen HP, Jensen HB, Gustavsson F, Glantz M, Månsson HL, Andrén A, Paulsson M, Bendixen C, Buitenhuis AJ, Larsen LB (2013) The occurrence of noncoagulating milk and the association of bovine milk coagulation properties with genetic variants of the caseins in 3 Scandinavian dairy breeds. *J Dairy Sci* 96:4830–4842
- [7] Hoxha M, Mara V, 2021, Evaluation of coagulation properties and coagulation abnormalities of some breeds of cows, sheep and goats raised in the area of Tirana, Devoll and Korca, International Conference on Agriculture and Life Science ICOALS III- Proceedings book p. 575-577
- [8] Hoxha M, Mara K, Mara V, Shumka S. (2022). Milk clotting properties of liqenasi goat, milk syneresis kinetics and recovery of protein and casein on curd. *Journal of Hygienic Engineering and Design*, Vol. 38, pp. 204-212.
- [9] Devold TG, Brovold MJ, Langsrud T, Vegarud GE (2000) Size of native and heated casein micelles, content of protein and minerals in milk from Norwegian Red Cattle—effect of milk protein polymorphism and different feeding regimes. *Int Dairy J* 10:313–323
- [10] Walstra, P. (1993). Principles of emulsion formation. *Chemical Engineering Science*, 48, 333-349.
- [11] P. DEJMEK, 1987, Dynamic Rheology of Rennet Curd, *J Dairy Sci* 70:1325-1330
- [12] Gustavsson F, Glantz M, Buitenhuis AJ, Lindmark-Månsson H, Stålhammar H, Andrén A, Paulsson M (2014) Factors influencing chymosin-induced gelation of milk from individual dairy cows: major effects of casein micelle size and calcium. *Int Dairy J* 39:201–208
- [13] Jensen HB, Poulsen NA, Andersen KK, Hammershøj M, Poulsen HD, Larsen LB (2012) Distinct composition of bovine milk from jersey and holstein-friesian cows with good, poor, or noncoagulation properties as reflected in protein genetic variants and isoforms. *J Dairy Sci* 95:6905–6917
- [14] Malacarne M, Franceschi P, Formaggioni P, Sandri S, Mariani P, Summer A (2014) Influence of micellar calcium and phosphorus on rennet coagulation properties of cows milk. *J Dairy Res* 81:129–136
- [15] Tsioulpas A, Lewis MJ, Grandison AS (2007) Effect of minerals on casein micelle stability of cows' milk. *J Dairy Res* 74:167–173
- [16] Sant'Ana, A.M.S.; Bezerril, F.F.; Madruga, M.S.; Batista, A.S.M.; Magnani, M.; Souza, E.L.; Queiroga, R.C.R.E. Nutritional and sensory characteristics of Minas fresh cheese made with goat milk, cow milk, or a mixture of both. *J. Dairy Sci.* 2013, 96, 7442–7453.

- [17] Park, Y.W. Goat milk—Chemistry and nutrition. In Handbook of Milk of Non-Bovine Mammals, 2nd ed.; Park, Y.W., Min, D., Haenlein, G.F.W., Eds.; Blackwell Publishing: Oxford, UK, 2006; pp. 34–58.
- [18] Sheehan, J.J.; Patel, A.D.; Drake, M.A.; McSweeney, P.L.H. Effect of partial or total substitution of bovine for caprine milk on the compositional, volatile, non-volatile and sensory characteristics of semi-hard cheeses. *Int. Dairy J.* 2009, 19, 498–509.
- [19] Ramírez-López, C.; Vélez-Ruiz, J.F. Effect of Goat and Cow Milk Ratios on the Physicochemical, Rheological, and Sensory Properties of a Fresh Panela Cheese. *J. Food Sci.* 2018, 83, 1862–1870.
- [20] DoEgypso, R.D.C.R.; Santos, B.M.; Gomes, A.M.P.; Monteiro, M.J.; Teixeira, S.M.; DeSouza, E.L.; Pereira, C.J.D.; Pintado, M.M.E. Nutritional, textural and sensory properties of Coalho cheese made of goats', cows' milk and their mixture. *LWT Food Sci. Technol.* 2013, 50, 538–544.
- [21] Niro, S.; Succi, M.; Tremonte, P.; Sorrentino, E.; Coppola, R.; Panfili, G.; Fratianni, A. Evolution of free amino acids during ripening of Caciocavallo cheeses made with different milks. *J. Dairy Sci.* 2017, 100, 9521–9531.
- [22] Vyhmeister, S.; Geldsetzer-Mendoza, C.; Medel-Marabolí, M.; Fellenberg, A.; Vargas-Bello-Pérez, E.; Ibáñez, R.A. Influence of using different proportions of cow and goat milk on the chemical, textural and sensory properties of Chanco-style cheese with equal composition. *Food Sci. Technol.* 2019, 112, 1–8.
- [23] Martins A.P., Belo A.T., Vasconcelos M.M., Fontes A.L., Pereira E.A., Belo C.C. (2009). Characterization of production system of Niza cheese (PDO): Effect of sheep breed on milk composition and coagulation properties. *Options Méditerranéennes, A.*, 91, pp. 221-225.
- [24] De Marchi M., Dal Zotto R., Cassandro M., and Bittante G. (2007). Milk coagulation ability of five dairy cattle breeds. *American dairy Science Association*, 15, pp. 3986-3992.
- [25] McMahon D.J., Brown R.J., Richardson G.H and Ernstrom C.A: Effects of calcium, phosphate and bulk culture media on milk coagulation properties. *J. Dairy Sci* 1984, 67: 930–938.
- [26] McMahon D.J., Brown R.J. (1982). Evaluation of Formagraph for comparing rennet solutions. *J. Dairy Sci.*, 65, pp. 1639-1642.
- [27] Pellegrini O., Remeuf F., Rivemale M. (1994). Evolution of the physicochemical characteristics and coagulation parameters of sheep's milk collected in the Roquefort region (in French). *Lait*, 74, pp. 425-442.
- [28] Delacroix-Buchet A., Barillet F., Lagrifoul G. (1994). Characterization of the cheese aptitude of Lacaune sheep's milk using a Formagraph (in French). *Lait*, 74, (3), pp. 173-186.
- [29] Toffanin V., De Marchi M., Penasa M., Pretto M., Cassandro M. (2012). Characterization of milk coagulation ability in bulk milk samples. 20th Int. Symp. "Animal Science Days" Proceedings, Kranjska Gora, Slovenia. <URL: <http://aas.bf.uni-lj.si/zootehnika/supl/3-2012/PDF/3-2012-93-98.pdf>. Accessed 15 May 2021.

## EXAMINATION OF PHYSIOLOGICAL PROFILES OF JUDO AND WRESTLING PLAYERS

<sup>1</sup>Sanjeevkumar K. S and <sup>2</sup>Ravindra Gouda S. M<sup>1</sup>Research Scholar and <sup>2</sup>Assistant Director, Department of Physical Education, Kuvempu University, Karnataka, India**ABSTRACT**

*Physiology has a profound and hard association with the focus of reductive science. It is partly because the function, in particular the interesting or unexpected function, derives from the relationships between various complex systems. Therefore, it is unlikely that physiologists will find that molecular structures in isolation provide a detailed view of the hindrances that occurred.*

*The Kodokan Judo of Today is based on the traditional Jujitsu of Old Japan. The techniques of the game are "examined, refined, systematized, and welded to an ideal, became those of the former. Thus it may be said that the Kodokan Judo has elevated Jutsu, "art" or "practiced" to do, "way" or "Principle". Wrestling is one of the oldest forms of sport and combat dating back to 300 B.C. According to American Dictionary, wrestling is a sport in which two competitors attempt to throw or immobilize each other by grappling.*

*The main purpose of the study was to recognize the physiological variables of judo and wrestling players. To achieve the purpose of the study, a total of a hundred (N=100) senior male judo and wrestling players of Karnataka state were randomly selected as a subject. The physiological variables such as Lean body mass, Forced vital capacity, and Cardiorespiratory endurance was selected as variables for the study. The age of the subjects is 18-25 years. For achieving the purpose of the study, paired sample 't-test statistical technique was applied at a 0.05 level of significance. The result of the study showed that there was a significant difference between physiological variables of judo and wrestling players.*

*Keywords: lean body Mass, forced Vital capacity, and cardiovascular endurance.*

**INTRODUCTION**

Sports have become very competitive in recent days. The margin of victory in competitive sports is usually a few centimeters or a fraction of a second. There are many factors, which influence the performance of a sportsman. An athlete devotes as much time as possible to training to maximize their performance. It is well known that the quality and quantity of training bearing on better performance. As all the athletes are given quality training, various subtle factors, which may have the Slightest influence, must be given due importance. Those times of the day may play an important role.

Physiology has a profound and hard association with the focus of reductive science. It is partly because the function, in particular the interesting or unexpected function, derives from the relationships between various complex systems. Therefore, it is unlikely that physiologists will find that molecular structures in isolation provide a detailed view of the hindrances that occurred.

**Judo**

The Kodokan Judo of Today is based on the traditional Jujitsu of Old Japan. The techniques of the game are "examined, refined, systematized, and welded to an ideal, became those of the former. Thus it may be said that the Kodokan Judo has elevated Jutsu, "art" or "practiced" to do, "way" or "Principle".

Judo is the troops of all nations are still trained in the ancient skill of unarmed combat. Towards the latter part of the nineteenth century there were many different schools of Ju-Jutsu being taught throughout Japan and one student of this martial art form or discipline, was a young man by the name of Jigoro kano. Judo is a derivative of jujitsu and is the correct term used to refer to that art in today's language.

The word judo specifically explains the true meaning of the art as it is practiced today. The part of the word means "gentleness" or "giving way" and implies flexibility of techniques. Judo is a tremendous and dynamic combat sport that demands both physical process and physiological discipline. Judo simply involves two individuals who by gripping the judo uniform or judogi, use the forces of balance, power, and movement to attempt to subdue each other. Thus, it is simple and basic. In its simplicity, however, lies its complexity and mastery of even the most basic of judo techniques that often take considerable time.

**Wrestling**

Wrestling is one of the oldest sports in India. Wrestling or also called 'Dangal' is mentioned in the Mahabharata an epic that traces its origin to 4000 BC. The sport almost died away but was revived in the 19th and 20th centuries by the patronage of the Maharajas and royalty in India.

Traditional Indian wrestling isn't just a sport - it's an ancient subculture where wrestlers live and train together and follow strict rules on everything from what they can eat to what they can do in their spare time. Drinking, smoking, and even sex are off" limits. The focus is on living a pure life, building strength, and honing their wrestling skills.

Most countries have a traditional style of wrestling. In India wrestling takes place in a clay dirt pit. The soil is mixed with ghee and other things and is tended to before each practice.

### Statement of the Problem:

The purpose of the study is to examine the Physiological variables of judo and wrestling players

### MATERIALS AND METHODS

To achieve the purpose of the study, a total of a hundred (N=100) senior male judo and wrestling players of Karnataka state were randomly selected as subjects. The age of the subjects ranged from 18 to 25 years. The Physiological variables of the study are lean body mass, Forced vital capacity, and Cardiovascular endurance these are assessed with the help of the 't-test.

### STATISTICAL ANALYSIS

To study the physiological variables of judo and wrestling players, Paired sample 't-test statistical technique was applied. The level of significance was set at 0.05 level. The statistical software SPSS 23<sup>rd</sup> version was used.

**RESULTS:** The data collected was treated with the 't-test and the results are presented in the following tables.

**Table1.** Shows Mean, standard deviation, and value of lean body mass between judo and wrestling players

Sl. No.	Players	Sample Size	Mean value	Standard deviation	't' value
1.	Judo	50	3.43	0.50	3.09
2.	Wrestling	50	3.57	0.46	

\* Significance at 0.05 level.

The above results obtained from the table reveal that there was a significant difference in judo and wrestling players' lean body mass. Here the Wrestling players are having good lean body mass than judo players.

**Table2.** Shows Mean, standard deviation, and 't' value of Forced vital capacity between judo and wrestling players

Sl. No.	Players	Sample Size	Mean value	Standard deviation	't' value
1.1	Judo	50	3.13	0.55	2.67
2.	wrestling	50	2.84	0.48	

\* Significance at 0.05 level.

The results obtained from the table state that there was a significant difference in judo and wrestling players' forced vital capacity. Here the Judo players are having Greater forced vital capacity than wrestling players.

**Table 3.** Shows Mean, standard deviation, and 't' value of cardiovascular endurance between judo and wrestling players

Sl. No.	Players	Sample Size	Mean value	Standard deviation	't' value
1.	Judo	50	71.21	1.74	3.01
2.	wrestling	50	77.10	0.95	

\* Significance at 0.05 level.

Table 3 shows the mean value, standard deviation, and 't' value of the cardiovascular endurance test. The data obtained from the table explains that there was a significant difference in cardiovascular endurance Capacity. Here Wrestling players are having more cardiovascular endurance than judo players.

### CONCLUSION

In table 1, Wrestling players are having good lean body mass than judo players because now the rules are mandated for hydration assessment, body composition assessment, and the rate at which a wrestler may lose weight. The primary purpose of these rules is to provide a safe wrestling environment for all wrestlers. Bodyweight can influence an athlete's speed, endurance, and power, whereas body composition can affect an athlete's strength, agility, and appearance. A lean body, i.e., one with a greater muscle/fat ratio, is often advantageous in sports.

In table 2, Judo players are having greater forced vital capacity than wrestling players. because they require more energy, i.e., more oxygen through respiration. In a judo game, the playing time is four minutes match continuously without resting time. So, it might be the reason to enhance the vital capacity.

In table 3, Wrestlers use their body weight and when combined with the resistance bands they build the muscle endurance to be explosive for their entire match. It will enable the body to receive more oxygen and a higher volume of blood with every pump of the heart. It will also allow the wrestler to sustain a high level of exertion for a long time.

#### **REFERENCE**

1. Ferreira Marinho B, Vidal Andreato L, Follmer B, and Franchini E. Comparison of body composition and physical fitness in elite and non-elite Brazilian jiu-jitsu athletes. *Science & Sports* 31: 129-134, 2016.
2. Mammon koru Lamb. A comparative study of Selected Physical components and Physiological Parameters of offensive and Defensive Hockey Players of College level". (Unpublished thesis Jiwaji University), 1980.
3. Lee SH, Kim MK, Rhee EJ. *Endocrinol Metab (Seoul)*. 2020 Jun;35(2):217-226. DOI: 10.3803/EnM.2020.35.2.217. Epub 2020 Jun 24. PMID: 32615706 Free PMC article. Review
4. Sabatine MS, Giugliano RP, Keech AC, Honarpour N, Wiviott SD, Murphy SA, et al. Evolocumab and clinical outcomes in patients with cardiovascular disease. *N Engl J Med*. 2017;376:1713–22.
5. Wasserman, K, Gitt, A., Weyde, I. and Eckel, H.E. 1995. Lung function changes and exercise-induced ventilatory responses to external restive loads in normal subjects. *Respiration*, 62 (4), 177-84.
6. Horswill CA. Applied physiology of amateur wrestling. *Sports Med*. 1992 Aug;14(2):114-43
7. Yoon J. Physiological profiles of elite senior wrestlers. *Sports Med*. 2002;32(4):225-33.
8. Balady JG, Berra AK, Golding AL, Gordon FN, Mahler AD, Myers NJ, et al. *ACSM'S Guidelines for Exercise Testing and Prescription*. 7th Ed. Philadelphia: Lippincott Williams and Wilkins; 2006.

**FACTORS INCLUDING LOAN REPAYMENT CAPACITY OF FARMERS AFFECTING ON MONSOON PADDY PRODUCTION IN MYANMAR****Nilar Aung<sup>1</sup>, Theingi Myint<sup>2</sup>, Yu Yu Tun<sup>3</sup> and Nyein Nyein Htwe<sup>4</sup>**<sup>1</sup>Research Based PhD Candidate, <sup>2</sup>Professor and Head and <sup>3,4</sup>Professor, Department of Agricultural Economics, Yezin Agricultural University, Naypyitaw, Myanmar, 15013**ABSTRACT**

*Paddy is grown as a main crop and most of the farmers usually grow in monsoon and summer season in Myanmar. About 70% of the rural population engages in paddy farming for their livelihoods. Agricultural loan is the key element for improvement in agricultural production and marketing in many developing countries and also for the modernization of agriculture. Loan is critically important and necessary for small scale farmers in Myanmar and one of the major government microfinance institutions is Myanmar Agricultural Development Bank (MADB) which is providing mainly seasonal crop loans. Objective of the study is to assess the key factors including loan repayment capacity influencing on monsoon paddy production of selected farmers in the study areas. Study areas were selected as the highest indebted ten townships in the specific regions. Purposive sampling and simple random sampling techniques were used in selecting respondents. Descriptive analysis and multiple regression analysis were used to determine the objective of the study. The result showed that MADB seasonal loan of monsoon paddy, paddy grown area, total household income, loan repayment, total variable cost were the significant factors that influenced the total monsoon paddy production of the farmers in Myanmar. The study identified that MADB seasonal loan of monsoon paddy and loan repayment capacity were important factors for farmers to increase paddy production, therefore; these were the critical factors for the total monsoon paddy production in Myanmar. The MADB seasonal loan program should be expended for Myanmar farmer as its important factors affecting for the paddy production meanwhile farmers should effort crop diversification to get sustainable crop income with the support of extension service, irrigation facilities and stable market for the paddy production in Myanmar.*

*Keywords: Farmers, Loan repayment capacity, MADB seasonal loan, Myanmar, Monsoon paddy production,*

**INTRODUCTION**

Paddy is grown as a main crop and most of the farmers usually grow in monsoon and summer season in Myanmar. About 70% of the rural population engages in paddy farming for their livelihoods. Total paddy area was about 7 million hectares, monsoon paddy area was about 6.06 million hectares and summer paddy area was about 0.94 million hectares, total production of paddy was 26.69 million metric tons having average yield of 3.86 MT/ha in 2019-2020 (MOALI, 2021). Most of the farmers grow paddy once at least in a year, and then other crops such as; pulses, oilseed crops, fruits and vegetable, culinary crops were grown after paddy growing season depending on availability of water and soil condition.

Agricultural loan is the key element for improvement in agricultural production and marketing in many developing countries and also for the modernization of agriculture. Rural population, especially farmers rely on the credit or loan for not only crop production but also food, education, clothes, health care and so on. Loan is critically important and necessary for small scale farmers in Myanmar. One of the major government microfinance institutions is Myanmar Agricultural Development Bank (MADB) which is providing mainly seasonal crop loans, term loans, JICA two step loan, MEB two step loans and Covid19 special loan. MADB is only main source of loan for small scale farmers because of low interest when compare the other Micro Finance Institutions. We assume that the seasonal loan program of MADB is related to paddy production of the farmers. Therefore, we attempt to analyze how much influence repayment capacity on monsoon paddy production of farmers.

**OBJECTIVES OF THE STUDY**

Objective of the study is to assess the key factors including repayment capacity influencing on monsoon paddy production of selected farmers in the study areas. To determine socioeconomic condition of selected farm households of the study areas and to study land ownership and receiving seasonal loan based on the crops.

**METHODOLOGY****a) Study Area**

Study areas were selected based on the highest indebted townships in the specific regions. The study was carried out in the ten townships which are Lewe township and Tatfone township in Naypyitaw territory, Yamethin township and Pyawbwe township in Mandalay Region, Yedashe township and Thanatpin township in Bago



Region, Hlegue and kyunkyankone township in Yangon Region, Mawlamyinegyunn and Labutta township in Ayeyarwady Region. Farmers in each township were selected randomly based on the situation of the MADB loan indebt of the farmers in particular. Numbers of selected farmers in the specific study areas are shown in Table 1.

**Table 1:** Numbers of Selected Farmers in the Specific Study Areas

No.	Township	No. of respondent	No.	Township	No. of respondent
1	Lewe	61	6	Thanapin	69
2	Tatkon	61	7	Hlegu	73
3	Yamethin	64	8	Kungyangon	69
4	Pyawbwe	66	9	Mawlamyinegyunn	61
5	Yedashe	64	10	Lubutta	61
<b>Total</b>					649

*Source:* Field Survey, 2022

#### b) Data Collection

Both primary and secondary sources of data were used in the study. For the primary data collection, pre-tested questionnaires, direct observation and personal interview were used to collect the required data and information during January to February 2022. And then, selected enumerators in study areas were trained via Zoom and conduct personal interview in each study township. Purposive sampling and simple random sampling techniques were used in selecting respondents. Collected data was sent by Viber application, e-mail and hard copies of questionnaire. Data consistency checking together with enumerators and data analysis by SPSS was done.

Secondary data collection was done from the literature sources from Myanma Agriculture Development Bank (MADB), Department of Agriculture (DOA), Department of Agricultural Land Management and Statistics (DALMS) under Ministry of Agriculture, Livestock and Irrigation (MOALI), Central Statistical Organization (CSO) and various government organizations.

#### c) Data Analysis

Descriptive analysis and multiple regression analysis were used to determine the objective of the study. The multiple regression model was specified as;

$$Y = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_5 X_5 + \alpha_6 X_6 + \alpha_7 X_7 + \alpha_8 X_8 + \epsilon_i$$

Y= total monsoon paddy production (tons)

$\alpha_0$ = constant term

$\alpha_i$ = parameters to be estimated,  $X_i$  = vector of explanatory variables,

$\epsilon_i$ = error term

$X_1$ = Household size of selected farmers

$X_2$ = Household head's age of the selected farmers

$X_3$ = Household head's education

$X_4$ = MADB seasonal loan for monsoon paddy

$X_5$ = Paddy grown area

$X_6$ = Household annual income

$X_7$ = Loan repayment

$X_8$ = Total variable cost

## RESULTS AND DISCUSSION

### Socioeconomic Condition of Selected Households in the Study Areas

#### Household Size of the Respondents

Table 2 presents the descriptive statistics of household size of the sample household in this study. The average size of the household was 5 persons, maximum is 12 persons and minimum is only 1 person. This indicates that most households have enough family labor to assist with farming operations and off-farm income activities.

**Table 2:** Household size of the respondents in the study areas (N= 649)

No	Townships	Regions	Average	Maximum	Minimum	SD
1.	Lewe	Naypyitaw	5	9	2	2
2.	Tatkon		5	8	1	2
3.	Yamethin	Mandalay	5	10	2	2
4.	Pyawbwe		6	12	2	2
5.	Yedashe	Bago	4	8	2	1
6.	Thanapin		5	12	2	2
7.	Hlegu	Yangon	5	10	2	2
8.	Kungyangon		4	9	1	2
9.	Mawlamyinegyunn	Ayeyarwady	5	9	1	2
10.	Lubutta		4	9	1	1
	Total		5	12	1	2

*Source:* Field Survey, 2022**Household Head's Age**

Table 3 presents the descriptive statistics of age of households' head of selected households in this study. The average age of the household head was 54 years, maximum age was 78 years and minimum was 22 years. This suggests that paddy farming in the study area has attracted not only old but also young generations.

**Table 3:** Age of households' head of selected households in the study areas (N= 649)

No	Townships	Regions	Average	Maximum	Minimum	SD
1.	Lewe	Naypyitaw	52	75	27	12.6
2.	Tatkon		50	71	27	11.2
3.	Yamethin	Mandalay	55	72	30	11.3
4.	Pyawbwe		58	72	32	12.9
5.	Yedashe	Bago	52	76	22	12.0
6.	Thanapin		55	70	22	13.2
7.	Hlegu	Yangon	52	78	28	11.3
8.	Kungyangon		53	76	29	11.1
9.	Mawlamyinegyunn	Ayeyarwady	55	74	33	11.0
10.	Lubutta		55	75	27	11.9
	Total		54	78	22	11.3

*Source:* Field Survey, 2022**Household Head's Education**

Table 4 was also revealed the frequency distribution of the education level of household head's. It showed that 29% of the household head had primary education, 37% had middle education, 16% had high education, and only 4% was graduated. And then, 14% of them had no formal education means that the old generation studied at monastery. 80% of the household heads' education are under high school level. This indicates that most household heads in the study have low level of education and that may affect their capability of learning advanced technology of paddy production.

**Table 4:** Education level of household heads in the study areas (N= 649)

No	Townships	Regions	Percentage				
			Monastery	Primary	Middle	High	Bachelor
1.	Lewe	Naypyitaw	8	16	52	16	7
2.	Tatkon		11	16	26	31	15
3.	Yamethin	Mandalay	8	30	49	11	2
4.	Pyawbwe		8	28	42	20	2
5.	Yedashe	Bago	5	24	45	20	6
6.	Thanapin		28	28	33	9	2
7.	Hlegu	Yangon	4	39	32	19	6
8.	Kungyangon		11	56	23	5	4
9.	Mawlamyinegyunn	Ayeyawwaddy	32	26	29	12	1
10.	Lubutta		28	18	39	13	2
	Total		14	29	37	16	4

*Source:* Field Survey, 2022

**Monsoon Paddy Production Areas and MADB Seasonal Loan for Monsoon Paddy**

Monsoon paddy production areas and seasonal loan received by farmers were shown in Table 5. Average monsoon paddy growing area in the study area was 4.46 ha, maximum area was 85.02 ha and minimum area was 0.04 ha. Myanmar Agricultural Development Bank disburses the seasonal loan to the monsoon paddy farmers. Loan payment rate is 370,500 MMK /ha or 150,000 MMK/ac and maximum acre is 10 acres. Therefore, whoever owned more than 10 acre receives not more than 1.5 million. In the study area, average loan amount of the farmers was about 1 million, maximum loan amount was 1.5 million and minimum loan amount was about 0.15 million.

**Table 5:** Monsoon paddy production areas and seasonal loan received in 2019-2020 (N= 649)

No.	Townships	Monsoon paddy grown area (ha)			Amount of seasonal loan received (000'MMK)		
		Avg.	Max.	Min.	Avg.	Max.	Min.
1.	Lewe	2.03	8.10	0.40	890	1,500	150
2.	Tatkon	3.73	20.24	0.81	1,089	1,500	300
3.	Yamethin	2.09	8.10	0.40	835	1,500	150
4.	Pyawbwe	2.21	8.10	0.40	610	1,500	150
5.	Yedashe	3.71	14.17	0.61	1,130	1,500	300
6.	Thanapin	2.89	12.15	0.81	980	1,500	300
7.	Hlegu	4.37	32.39	0.40	1,172	1,500	150
8.	Kungyangon	6.93	56.68	0.40	1,222	1,500	150
9.	Mawlamyineg yunn	2.63	7.29	0.40	931	1,500	150
10.	Lubutta	14.00	85.02	0.81	1,407	1,500	300
	Total	4.46	85.02	0.40	1,026	1,500	150

Source: Field Survey, 2022

Note: Loan payment rate= 370,500 MMK /ha (150,000 MMK/ac)

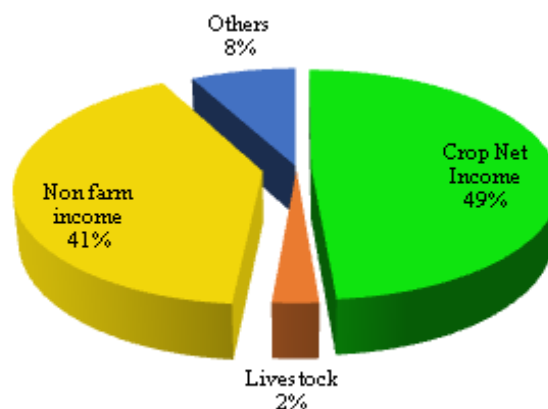
**Household Annual Income****Figure 1:** Household annual income composition of selected farmers

Figure 1 shows the household annual income composition. In the figure, total crop net income shared about 49% to household annual income, and then 41% was non farm income of the household members who were working in the other sectors. In addition, 2% was composed by livestock earning and 8% was from other income sources. It means that most of the selected farmers mainly relied on the agricultural income and off farm income that were more or less similar ration for their livelihood in the study areas.

**Table 6:** Crops grown year-round by farmers in the study area in 2019-2020 (N= 649)

No	Township	Percentage				
		MP-SP	MP-SP- others	MP-Legumes/ others	MP & horticulture crops	MP only

1	Lewei	10	10	52	15	13
2	Tatkon	15	3	43	11	28
3	Yemethin	7	16	61	6	10
4	Pyawbwe	0	0	100	0	0
5	Yedashe	77	12	2	0	9
6	Thatnatpin	0	0	92	0	8
7	Hlegu	32	32	29	1	6
8	Kungyangon	47	3	0	8	42
9	Mawlamyinegun	64	24	12	0	0
10	Laputta	0	0	0	0	100
Total		25	10	39	4	22

Source: Field Survey, 2022

Note: MP=Monsoon Paddy, SP=Summer Paddy, others=sesame, sunflower, groundnut, cotton, sugarcane, betel leaf, corn, etc.

They grew different crops in their farm year-round. Crops grown by selected farmers in their farm year-round are shown in the table 6. Generally, 22% of farmers grew only monsoon paddy in a year and other 88% of them grew crop diversification such as 25% of them grew monsoon paddy and summer paddy, 10% of them grew monsoon paddy, summer paddy and other crop for instant horticulture crop and sesame, groundnut, sunflower, etc., 39 % of them grew monsoon paddy and legumes or other crop for example sesame, sunflower, cotton and sugarcane and 4 % of them grew monsoon paddy and horticulture crop for instant chili, onion, grape, tomato. Respondent farmers in Laputta Township grew only monsoon paddy because they had only rain fed farm land and no more irrigated area in the township. Furthermore, respondent farmers in Pyawbwe Township grew monsoon paddy and legumes or sesame, groundnut, sunflower, corn, cotton, etc. Crop diversification is a strategic way of risk management for climate change and one of the factors of farm income stability and also household income.

#### Factors affecting on the total monsoon paddy production of selected farmers

Descriptive statistic of variables used in estimating the multiple regression function of factors affecting on the total monsoon paddy production of selected farmers is shown in table 7. The table includes; total monsoon paddy production, household size, household head's age, household head's education (%), MADB seasonal loan of monsoon paddy of selected farmer, paddy grown area, household annual income, loan repayment, total variable cost of all crops grown in the year. The average, maximum, minimum and standard deviation of each variable is shown in the table.

**Table 7:** Descriptive analysis of variables for multiple regression analysis of factors affecting on the total monsoon paddy production of selected farmers

N =649

Variable	Unit	Average	Max.	Min.	SD
Total monsoon paddy production	Tons	10.60	125.00	0.02	13.28
Household size	ha	5	12	1	2
Household head's age	Years	54	78	22	11.3
Household head's education (%)	Monastery (14%)	Primary (29%)	Middle (37%)	High (16%)	Bachelor (4%)
MADB seasonal loan of monsoon paddy of selected farmer	MMK	1,026,000	1,500,000	150,000	511,476
Paddy grown area	ha	4.46	85.02	0.40	6.55
Household annual income	MMK	4,213,153	63,932,500	-5652500	5888062
Loan repayment (Dummy in percent)	Fully Repaid (84%)		Default (16%)		
Total variable cost of all crops grown in the year	MMK	2,673,793	21,580,000	78,000	2558408

**Table 8:** Multiple regression analysis of factors affecting on the monsoon paddy production of selected farmers  
N=581

Independent variable	Un-standardized coefficient (B)	Standardized coefficient ( $\beta$ )	t-value	Sig.
Constant	47.227		.749	.454
Household size	-14.549	-.042 <sup>***</sup>	-2.758	.006
Household head's age	-1.253	-.024 <sup>ns</sup>	-1.441	.150
Household head's education	.942	.002 <sup>ns</sup>	.095	.924
MADB seasonal loan of monsoon paddy	4.999	.056 <sup>***</sup>	2.795	.005
Paddy grown area	24.970	.641 <sup>***</sup>	25.776	.000
Household annual income	1.940	.183 <sup>***</sup>	10.506	.000
Loan repayment	45.842	.027 <sup>*</sup>	1.733	.084
Total variable cost	4.832	.199 <sup>***</sup>	8.500	.000

Note: Adjusted  $R^2 = 0.870$ ,  $R^2 = (0.871)$ ,  $F = (484.634)$ ,  $\text{Sig} = 0.000$ ,

Durbin-Watson = 1.729, <sup>\*\*\*</sup>  $p < 0.01$ , <sup>\*\*</sup>  $p < 0.05$ , <sup>\*</sup>  $p < 0.01$

<sup>\*\*\*</sup>, <sup>\*\*</sup> and <sup>\*</sup> are significant at 1%, 5 % and 10% level respectively and <sup>ns</sup> = not significant.

Loan repayment – Yes= 1, No=0

According to the function of factors affecting the paddy production, the coefficient of household size (.042) was negatively signed and highly significant at 1% level of probability. The family members working in the paddy production seem to be the affecting factor of the paddy production. Most of the working age family labors were not much working in the paddy production; therefore, it seems hired labor intensive paddy production in the selected households.

Education of paddy farmers in Eastern Cambodia was not significantly affected to the paddy production (SarSary et al. 2020) as similar as in this study that pointed our education level is not influencing factor of the paddy production in Myanmar. However, household size was positively affected in Cambodian paddy production (SarSary et al. 2020) and Nigerian paddy production (Cordelia and Edwin, 2020) but Myanmar monsoon paddy was negatively affected by the household size.

Paddy production was not influencing by the age of farmers in Nigeria (Adewuyi Adekunle Kolawole, et.al, 2020), it was the same findings of this study in Myanmar paddy production. Therefore, paddy production was operating regardless of the farmer's age level in both countries.

The coefficient of paddy grown area (.641) was positively and highly significant at 1% level of probability. Total paddy production depends on the total paddy grown area naturally therefore it is highly and positively significant. The finding of Myanmar paddy production function was the same as Nigeria paddy production that was positively and highly influenced by the farm size (Cordelia and Edwin, 2020). The coefficient of household annual income (.183) was found positively signed and highly significant at 1% level of probability. Therefore, household annual income also positively influence to the paddy production as selected farmers grew cash crops in the other seasons. If farmers grow not only paddy, but also other crops in other seasons, it will be effectively impact on the paddy production because paddy is the main crop as their priority. Moreover, households can earn from other sources as the non farm income, it will be contribute to the cost of paddy production, and then it can be increasing output level of the paddy of their farm.

MADB seasonal loan for monsoon paddy was also highly significant factor of paddy production. The coefficient of MADB seasonal loan for monsoon paddy (.056) was positively signed and highly significant at 1% level of probability. Adewuyi Adekunle Kolawole, et.al (2020) found that paddy production was not influenced by the credit facility in Nigeria but it was significantly affected in Myanmar paddy production.

Total MADB seasonal loan received by selected farmers were varied by their paddy grown area and limitation of the loan payment. Therefore, seasonal loan receiving rate were different and allocation to the paddy production also were dissimilar among the selected farmers. Nevertheless, the paddy production was positively affected by the seasonal loan receiving rate that was found in the regression function.

The coefficient of loan repayment (.027) was positively signed and significant at 10% level of probability. Loan repayment capacity is also positively related to total paddy production of the household. Farmers who can pay

back the MADB seasonal loan, they can produce more paddies according to the regression function. Therefore, default farmers will reduce the paddy production as it's significant in 10% level probability.

The coefficient of total variable cost (.199) was positively signed and highly significant at 1% level of probability. If total variable cost is high, total paddy production of the household will be high. It mean total variable cost of crop production will lead to increase the production level as the total variable cost of production is a important factor affecting the paddy production.

### **CONCLUSION AND POLICY IMPLICATION**

This research work which centered on the analysis of the factors influencing total monsoon paddy production of farmers who are MADB clients in Myanmar. The paper establishes that MADB seasonal loan of monsoon paddy, paddy grown acre, total household income, loan repayment, total variable cost were the significant factors that influenced the total paddy production of the farmers in Myanmar. The study identified that MADB seasonal loan of monsoon paddy and repayment capacity are important factors for farmers to increase paddy production. Regarding the high labor migration of rural area in Myanmar, household size was negatively related to total paddy production. It indicated that working age family members probably migrated to other sectors or other regions in the country or neighboring countries.

Income and crop diversification can earn more farmers' income that is positively affected to the paddy production. Therefore, cropping pattern with other crops should be done reasonable way for getting more income for the farmers which will increase paddy production. Moreover, the paddy production is definitely boosted by the seasonal loan program of MADB therefore; it is the critical factor for the total paddy production in Myanmar.

The MADB seasonal loan program should be expend for Myanmar farmer as its important factors affecting for the paddy production meanwhile farmers should effort crop diversification to get sustainable crop income with the support of extension service, irrigation facilities and stable market for the paddy production in Myanmar.

### **REFERENCE:**

- Agriculture in Brief, 2021, MOALI
- Adewuyi Adekunle Kolawole et.al, 2020, Economic analysis of paddy production by small-holder women farmers in Adamawa State, Nigeria.
- Cordelia and Edwin, 2020, Analysis of the factors influencing productivity of paddy farms Ebonyi State, Nigeria.
- SarSary, et.al, 2020, Factors Influencing the Paddy Production of Farmers in Rural South-Eastern Cambodia.

---

**MAGNETIC NANOPARTICLE BASED APPROACHES IN CANCER THERAPY – A CRITICAL REVIEW**

---

**Dr. R. Karthikeyan<sup>1\*</sup>, V. Velmurugan<sup>2</sup>, V. Abishek<sup>3</sup> and K. Lakshmi<sup>4</sup>**<sup>1,3,4</sup>Chettinad School of Pharmaceutical Sciences, Chettinad Academy of Research and Education, Kelambakkam 603103, Tamil Nadu, India<sup>2</sup>SRM College of Pharmacy, SRM Institute of Science and Technology, Kattankulathur 603203, Tamil Nadu, India**ABSTRACT**

*Cancer is definitely one of the leading causes of mortality worldwide. Failure in efficacy of the standard treatments (chemo-, radiotherapy and surgery), and the severe side effects, resistance of tumor cells to chemotherapeutics has necessitated alternative therapeutic strategies. Magnetic nanoparticles (MNPs) have been evaluated as promising materials for cancer treatment. Their intrinsic magnetic properties provide a multimodal theranostics platform for cancer diagnosis, monitoring, and therapy. MNPs can be functionalized by binding them to a wide variety of substances, including chemotherapeutic drugs, radionuclides, nucleic acids, and antibodies. They can be used for drug delivery, magnetic or photothermal induced local hyperthermia and photodynamic therapy aimed at killing cancer cells at the tumor site. MNPs may also be useful to challenge drug resistance. The combination of different options of these treatment modalities offers a synergistic effect and significantly reduces the side effects. The functionalized MNPs may be used to remove the unwanted cells from blood, including leukemia cells and circulating tumor cells that key factors in the metastatic process. Despite numerous successful studies, there are still some unpredictable obstacles relevant to the use of MNPs in cancer therapy. This review mainly focuses on application of MNPs in cancer treatment, covering future perspectives and challenges aspects.*

*Keywords: Cancer therapy; Magnetic nanoparticles (MNPs); Functionalization; Drug delivery; Hyperthermia; Combination therapy.*

**INTRODUCTION**

Cancer is one of the the leading causes of death globally and an important barrier to increasing life expectancy of man. It is estimated that 19.3 million new cases and 10.0 million cancer-related deaths worldwide occurred in 2020 (Sung et al., 2021). Successive mutations that may occur in the oncogenes, tumor suppressor genes and DNA repair genes due to various reasons trigger the development of the cancer cell. There is also an important struggle between the body immune system and cancer development. This struggle consists of a three-stage process called "cancer immunoediting", and can be specified with 3E, including elimination (initial response of immune system to the tumor), equilibrium (immune-mediated tumor dormancy) and escape (tumor evasion of immune response) phases (Owen et al., 2013).

In addition to the failure in the standard treatments (chemo-, radiotherapy and surgery), their effectiveness remains limited because of resistance of tumor cells to chemotherapeutics, the suppression of the immune system, dose-related toxicities, and other major side effects. This has led to an urgent need to design and develop alternative therapeutic strategies (Mukherjee et al., 2020). As one of the alternatives, nanotechnology presents a new frontier in cancer treatment. The use of nanoparticle (NP) carriers as effective drug delivery systems encourages studying therapeutic researches for cancers (Awasthi et al., 2018). Functionalized and targeted NPs could benefit from differentially receptors expressed by tumor cells and contribute effective and sustained release of anticancer bio-actives. NPs can be directed into the diseased parts; consequently, they both improve the efficacies of therapeutics and reduce systemic toxicity (Naeem et al., 2020).

An alternate and relatively new cancer treatment methods involve magnetic drug targeting, where magnetic nanoparticles (MNPs) take part in. MNPs are nanomaterials typically range from 1–100 nm in diameter and can be directed to malignant tissues applying an external magnetic field (EMF) (Iqbal et al., 2017). Owing to their very own intrinsic magnetic features and multifunctional design, this type of nanoparticles offers great potentials in many applications, like a multimodal theranostics platform for cancer detection, monitoring, and therapy (Furlani 2010). In addition to their directly anti-cancer properties, MNPs may be gained biocompatible characters by coating and imparted highly-functionalizable by loading some molecules such as drugs, radioactive agents, genes, targeting ligands/antibodies and imaging objects (Figure 2) (Sharma et al., 2017). According to the usage aim, the loading may be alone or in combination forms consisting of two or more choices (Belyanina et al., 2017).

This review aims to focus on usage of the MNPs in cancer treatment. A more detailed overview has been provided about the properties of MNPs, their functionalization, and therapeutic applications including drug delivery, magnetic hyperthermia, and photodynamic therapy. In addition to it, the toxicity, pharmacokinetics, and bio-distribution of MNPs and future perspectives and challenges in regarding to the therapeutic applications have been briefly highlighted.

### **Synthesis and Characterization of MNPS in Cancer Therapy**

MNPs are generally composed of magnetic elements and their chemical compounds such as iron, nickel, and cobalt. Depending on their chemical composition, MNPs can be classified simply as iron oxides (ferrites) and metals containing only metallic core and their coated forms.

The method of synthesis and chemical structure of MNPs affect their physical properties. Magnetic iron oxide (usually maghemite  $\gamma\text{-Fe}_2\text{O}_3$  or magnetite  $\text{Fe}_3\text{O}_4$ ) are the most extensively researched MNP since iron is believed to be more biocompatible. This kind of the MNPs used in biomedical applications mostly consist of one or more magnetite or maghemite cores and with biocompatible shell functionalized with various modifiers. They are called as superparamagnetic iron oxide nanoparticles (SPIONs) (Hosu et al., 2019).

Size, shape, and surface charge of the MNPs affect their effectiveness. Wang et al. used rod-shaped magnetic mesoporous silica-based nanoparticles (MSNs) in suicide gene therapy for hepatocellular cancer. Compared with sphere-like MSNs, they demonstrated that rod-like MSNs, exhibited higher loading capacity, faster prodrug release rate, stronger magnetically enhanced and effective gene delivery and better magnetic hyperthermia properties (Wanga et al., 2018)

These nanomaterials can be synthesized by organic based (e.g., polymeric nanoparticles, magnetoliposomes, micelles or ferrogels) and inorganic based (e.g., gold or mesoporous silica) materials (Prince et al., 2018). MNPs can be tuned for multiple cancer therapy applications. Their surface coatings and their functionality increase colloidal stability, improve biocompatibility, facilitate transport to target tissues/cells, and allow covalent or electrostatic attachment of therapeutic and targeting fragments to the cargos, and also reduce side effects such as internal toxicity and immunogenicity (Tiwari et al., 2012). Polyglycerol (PG) coating, which is a biocompatible polymer and has a chain structure similar to that of polyethylene glycol (PEG), ensures an optimal hydrophilicity, stability, and that resistance to non-specific adsorption of various proteins in vivo milieu (Gosecki et al., 2016).

There are many situations in which drug release particles targeting cancer have to be overcome. To overcome these problems, MNPs can also be designed to control drug release by a variety of stimuli, including pH-, magnetic field, and internal stimuli such as hypoxia-sensitive administration (Durr et al., 2013). To capture the therapeutic drug particles and their releasing in a controlled manner can be ensured by using temperature-, hypoxia- or pH-sensitive materials for their synthesis and applying an EMF (Doswald et al., 2019)

### **Administration, Pharmacokinetics, Biodistribution, Toxicity of MNPs**

The mode of administration, toxicity, pharmacokinetics and biodistribution properties of MNPs are very crucial for successful application in cancer therapy. Depending on the purpose and the target structure, there are several routes of MNPs administration such as parenteral, directly intra-tumoral, oral or nasal. Depending on the administration route, clearance of the MNPs from the bloodstream by metabolism and excretion might be a problem (Navya et al., 2019). The size also has a noteworthy role for pharmacokinetics and biodistribution of MNPs inside body. The smaller particles less than 10 nm are in shorter time filtered out by renal clearance while the larger ones than 200 nm are excreted through the hepatobiliary route following sequestration in the spleen and liver (Gurunathan et al., 2018). Another factor significantly affects the biodistribution and biocompatibility of MNPs is the surface coating of MNPs. These are considered as important aspects in the in vivo applications of the MNPs (Wu et al., 2017).

Drug access into the targeted area can be through passive or active ways. In the passive way, the disrupted vascular barrier at tumor sites allows NPs to accumulate in the tumor tissue. Moreover, the NPs are not rapidly cleared due to poor lymphatic function and they accumulate in the tumor interstitium. This called as enhanced permeability and retention (EPR) effect (Klein et al., 2018).

The active targeting involves affinity-based recognition, retention and facilitated uptake by the targeted cells. This is also known as the ligand-mediated targeted approach. These NPs are internalized by the cells through endocytosis or phagocytosis. Target substrates can be based on receptors that are over- or exclusively expressed by tumor cells, or other over-expressed species such as low molecular weight ligands (folic acid, thiamine, sugars), proteins (transferrin, antibodies, lectins), peptides, polysaccharides and DNA etc. Otherwise antibodies,



lectins, proteins, hormones, charged molecules and low molecular weight ligands (eg folate) are the biomolecules most commonly used as ligands (Li et al., 2012).

In the active targeting, MNP can be guided by means of a magnetic field. Furthermore, binding of one ligand molecule generally facilitates binding of other molecules conjugated the NP to their specific targets, which result in considerably increased cumulative effects (Qi et al., 2012).

MNPs can lead to toxicity by various mechanisms, mainly production of reactive oxygen species (ROS). MNP surfaces can be modified to facilitate passive or active accumulation of the therapeutic molecules at target sites with minimal systemic toxicity. The combined therapies both reduce the toxicity and increase the synergistic effects (Evans et al., 2018).

In order to achieve the best results, there are still many important factors to overcome such as optimizing the density of ligands to be conjugated to MNPs and evaluating the toxicity (Buabaid et al., 2020).

### **Magnetic Nanoparticles in Cancer Therapy**

MNPs have recently contributed to important development in the field of oncology. In addition to direct utilization of MNPs on the basis of killing cancer cells, there are various therapy approaches utilizing nanoparticles such as photothermal therapy (PTT), photodynamic therapy (PDT), magnetic hyperthermia therapy (MHT), delivery of chemo-, radio- and immunotherapeutic molecules, combination of bi-/three modal or other therapy strategies due to their intrinsic properties. These therapy approaches, particularly multimodal therapy consisting of simultaneous hyperthermia and chemotherapy (CT), can increase the effectiveness of the treatment while reducing undesired side effects (Guatierrez et al., 2012)

### **MNPs as Cargo Delivery Vehicle**

#### **Drug Delivery**

MNPs can be loaded with high amount active substances thanks to their large surface/volume ratio. They are considered ideal candidates for controlled and sustained delivery of drugs to the targeted sites owing to their unique magnetic properties, such as size, distribution and surface modification (Zhang et al., 2018). The MNP-attached molecules can be either encapsulated into a magnetic nanosphere or conjugated on its surface and they are administered systemically or locally. They are concentrated in the tumor site by applying an external magnetic field (EMF) (Wu et al., 2017, Huang and Hainfeld 2013)

Using an EMF could be problematic in the case of delivery to some organs, for ex. bone. In these cases, magnetic implants seem to be a viable alternative, wherein the drugs are attached to MNPs in order to create a driving force for delivery them (Kang et al., 2020). By coating or conjugating various biologically active therapeutics or small molecule drugs, these parameters can be designed/alterd to impart therapeutic functionality thorough increasing their systemic circulation and biocompatibility, as well as employing passive and active targeting mechanisms to the tumor site (Eskiizmir et al., 2017).

#### **Chemotherapeutics**

Classically, therapy with chemotherapeutic drugs present limited or no targeting capacity towards specific cancer cells, which lead to many unwanted and sometimes severe side effects. The targeting-based approaches are good strategies to increase the treatment efficiency and to reduce the dose and toxicity of drugs used in the treatment of cancer. (Chen et al., 2015). A subcategory for drug delivery is the group of chemotherapeutics attached to MNPs, including small molecule drugs such including paclitaxel, 5-fluorouracil, temozolomide (TMZ), and doxorubicin (Kang et al., 2017).

Here, MNPs are internalized through endocytosis. Furthermore, the internalize process can be facilitated via specific receptors. Once in the cytoplasm of the target cells, the drug is released and then MNPs are frequently biodegraded.

Additionally, MNPs are often functionalized with the help of antibodies to improve the ability of MNPs to reach to the targeted tumor cells. The antibody-conjugated MNPs may not only be used for the targeting, but may also be used for aiming to treat, early diagnosis and prevention of recurrence of cancers (Gurunathan et al., 2018).

#### **Radiotherapeutics**

Half-life times of the radioactive isotopes to be used for therapy have to be suitable for efficient tumor cell killing and should not harm to surrounding healthy tissue. As in chemotherapeutic-loaded MNPs, MNPs can be equipped with various radioactive isotopes or radionuclides. The radionuclide-loaded MNPs are guided to the tumor cells and, upon internalization, kill then cancer cells through continuous irradiation (Durr et al., 2013)

The radionuclide-loaded MNPs have peculiar advantages over current radiotherapy (RT) techniques by reducing off-target tissue damage. Moreover, ROS caused by radiotherapeutics not only increase the tumor killing, but also enhance response to the irradiation (Klein et al., 2018).

### **Gene therapy**

Gene therapy holds a great promise in the treatment of cancer. Classically, patients with a genetic disease are treated with an exogenous DNA to correct mutations which are responsible for the particular disease. This procedure needs to be improved efficiency of introduction of the nucleic acids into the target cells. Furthermore, the life time of the DNA is very limited since it degrades faster in our body. Therefore, MNPs may pose a significant role in augmentation of the gene transport to the specific target tissues (Li et al., 2012).

Conjugation of the viruses/plasmids carrying nucleic acids to MNPs protects the viruses/plasmids from inactivation by the immune system and allows them to be transported to specific sites. This process is called magnetic transfection or magnetofection gene therapy.

Plank et al. injected plasmid DNA encoding a cytokine, associated with magnetic nanoparticles, directly into the tumor and fixed it there by means of a magnet. Thereby, it reduced the probability of recurrence after surgery due to the activated immune system against the tumor (Qi et al., 2012). But it is too early for the utilization in clinical therapy and adaptation to non-viral transfection of biomolecules (e.g., DNA, siRNA) due to few unsolved issues (Durr et al., 2013).

### **Immunotherapeutics**

Cancer immunotherapy is the utilization of the body's own immune system to attack cancer cells. It involves several approaches using immune checkpoint inhibitors, monoclonal antibodies, and adoptive cell therapies, and non-specific cancer immunotherapeutics, immunomodulators of tumor microenvironment (Evans et al., 2018).

Usually, the currently available anticancer immunotherapeutic agents are systemically administered, which leads to low efficacy and high toxicity. Thus, local administration of NP-loaded immunotherapeutic against cancer have gained promising importance (Buabeid et al., 2020). MNPs loaded with cancer immunotherapeutic agents such as cancer antigens, cytokines, and adoptive cell therapeutic moieties could be targeted to the tumor site by application of an EMF (Gutierrez et al., 2012). Localizing immunotherapy improve both the systemic anticancer immunity and reduce negative effects such as nonspecific immune response, side effects, and inflammatory processes (Buabeid et al., 2020).

### **MNPs as Intrinsic Anticancer Agents:**

#### **MNPs as Anti-Cancer Agent**

The underlying mechanism of the intrinsic effect of the inorganic nanoparticles themselves on diseases is still unclear. Recently, it was demonstrated that FDA-approved an iron oxide NP formulation (ferumoxytol) can kill cancer cells through a ROS-dependent mechanism. In addition, it was proven that it induced a phenotypic shift of macrophages from an anti-inflammatory M2 phenotype to a pro-inflammatory M1 phenotype, resulting in the production of ROS which may induce the cancer cell apoptosis (Zhang et al., 2018).

#### **MNPs as a Catalyst for Tumor Ablation Therapies**

Tumor ablation therapies using MNPs in tumor therapy have become a significant interest field. We can divide this kind of therapy to 3 major categories: 1) magnetic hyperthermia (MHT) (necrotic tumor destruction by the heat generated from MNPs upon applying alternating external magnetic field); 2) photothermal therapy (PTT) (cancer cell death by the heat generated from MNPs by emitting light) and 3) photodynamic therapy (PDT) (cancer cell death using cytotoxic singlet oxygen species generated from MNPs conjugated with photosensitizing agent) (Figure 3) (Mukherjee et al., 2020).

All these strategies can individually be used. Even so, the best therapeutic effect is generally assured by combination of them since their modular design enables MNPs to perform multiple functions simultaneously (Hosu et al., 2019).

#### **Magnetic Hyperthermia (MHT)**

Cancer treatment using magnetic hyperthermia (MHT) is one of the most effective therapeutic methods. The local temperature is increased to a value between 42°C and 47°C for at least 30 minutes in this application<sup>10</sup>. The strength and frequency of the magnetic field, size and concentration of MNPs, and solution viscosity are important parameters in the efficiency of heat generation. Using a heat-labile coating, MHT can also serve for controlled release of cytotoxic agents in the cancer sites (Wu et al., 2017).

The intra-tumoral and intravenous administration of the MNPs are the most popular ones among several applications routes in this method. In the intra-tumoral route, MNPs are firstly injected directly into the tumor, followed by the application of a high-frequency alternating magnetic field (AMF). MNPs generate significant local heat by spinning back and forth and cause destruction of the tumor. The local temperature increase in the tumor site also makes also cancer cells more susceptible to chemo- or radiotherapeutics. In this way, it allows combination therapy and greatly reduces the negative side effects of chemotherapy or radiation (Doswald et al., 2019).

Since the MNPs can deliver themselves anywhere in the body via the intravenous applications, this would be an attractive method for treatment of deep tissue seated tumors. In addition, a simple injection into the bloodstream would let MNPs find their own way into cancerous tissue, wherever it is found in the body. Even metastasized cancer would become a target if they sized their particle correctly (Huang and Hainfeld 2013).

#### **Photodynamic Therapy (PDT)**

PDT is a treatment approaching that uses a drug activated by the excitation of an external light source to kill cancer cells. To enhance the effect, these drugs may be conjugated to MNPs. PDT combines a two-stage which consist of a drug (photosensitizer or photosensitizing agent) to damage cells and a particular light to activate the drug. The photosensitizer is either applied via intravenous or locally basing on the body part. The drug is absorbed by the cancer cells and after a certain amount of time the light is applied to the area to be treated (Mukherjee et al., 2020). PDT has an antitumor activity relying on the generation of ROS; hence, presence of oxygen is essential (Kang et al., 2020).

#### **Photothermal Therapy (PTT)**

PTT is a local treatment modality used to induce cancer cell death with the heat generated in the tumor tissue after exposure to near infrared (NIR) light. The method is minimally invasive and has minimal toxicity. Incorporating a MNP delivery system, such as gold or carbon coated-MNPs, results in improvement in the efficiency of heat production in tumor tissue, with excellent safety. This kind of the application may lead to a marked increase in NIR absorption compared with magnetic  $\text{Fe}_3\text{O}_4$  NPs. PTT, unlike PDT, does not require oxygen in order to generate its cytotoxic effect on cancerous cells. (Eskiizmer et al., 2017).

#### **Combination therapy**

MNPs are used in several different individual ways for cancer therapy. On the other hand, combination therapy is frequently used in order to achieve an enhanced therapeutic effect by synergism. Using EMF enhance magnetically direction of MNPs-loaded therapeutics (e.g., suicide gene, chemotherapeutics) to the tumor site and AMF causes local hyperthermia in the tumor site. The combination of treatments also results in more reduction in tumor sizes and decreases toxicity. (Chen et al., 2015, Kang et al., 2017).

To reach a synergistic therapeutic effect result, trimodal PDT/PTT/CT may be the best combination of regimens with regard to multifunctional NPs compared among several choices. In PDT, the reactions between a photosensitizer and oxygen existing in tissue generate ROS which kill cancer cells. In PTT, photo-absorbing materials generate heat which kills cancer cells. As a result, the cellular uptake of magnetic nanomaterials is synergistically enhanced, and are triggered the release of chemotherapeutic drugs into the cancer tissues (Figure 4) (Klein et al., 2018).

Combined therapy of magnetic hyperthermia with ionizing radiation or chemotherapy has determined a synergistic effect on a number of tumors, which resulting in excellent tumor regression. For example, RT combined with MHT generated good results on patients suffering with glioblastoma and was approved for clinical trials years ago. Like this, CT was combined with hyperthermia, which was a very effective treatment of advanced pelvic cancers (Wu et al., 2017).

Many combination options are possible to achieve a synergistic effect. For example, the radionuclide-loaded MNPs can be combined with the others, such as chemotherapy or gene therapy. Like this, a combination of MNPs-loaded with antibodies and chemotherapeutic drugs is another option. The studies have demonstrated that the combinations have great promising potentials.

Aires et al successfully applied a multi-functionalized iron oxide MNP with anti-CD44 antibody and gemcitabine derivatives for the selective treatment of CD44-positive cancer cells. In addition, Huang et al have achieved very good results with a dual-targeting therapy involving magnetic  $\text{Fe}_3\text{O}_4$  NPs grafted with a single-chain antibody and docetaxel loaded  $\beta$ -cyclodextrin in an ovarian cancer. (Aires et al., 2016, Huang and Hainfeld 2013).

**The Role of MNPs on Cancer Drug Resistance and Metastasis and their Role on Cancer Drug Resistance**

Surgery is still the gold standard for the treatment of most solid tumors. Although they have limitations, radiotherapy and chemotherapy are other options. Because the tumors are mostly located in hard-to-reach areas for surgical operation and have metastasized. Some types of cancer also have drug and radiation resistance that is pre-existing or developed in the course of treatment. This is frequently the cause of recurrence after CT or RT. The resistance may be against a single drug or the simultaneous to several different chemotherapeutic agents (multidrug resistance) thorough various mechanisms (Durr et al., 2013).

MNPs allow for combinations of substances with a wide variety of mechanisms of action and functionalization with one or more different active substances. Consequently, they have potential to use different therapeutic mechanisms concomitantly simultaneously, which significantly reduces the probability of resistance. For example, a triple effect can be achieved with a combination of hyperthermia, CT and RT using MNPs with a magnetic core (such as zinc, iron oxide), chemotherapeutic agent (such as folic acid, cisplatin) and the radioactive material (like <sup>188</sup>rhenium) (Gobbo et al., 2015).

Ideally, the functionalized and biocompatible coated MNPs should have components to meet different tasks, including antitumor effects, overcoming cancer drug resistance, diagnostic/ imaging investigations and enhancement at the target site (Durr et al., 2013).

**Metastasized cancer –limitations and possibilities**

Approximately 50% of tumors have already spread at the time of diagnosis. Therefore, most of these patients can only be offered palliative care. However, there are approaches with therapeutic purposes targeting metastatic cancer. For example, the magnetic hyperthermia transduced by superparamagnetic iron oxide nanoparticles (SPION) in the alternating current magnetic field may be used to reduce or eliminate cancer stem cells (CSC) population. Because CSCs not only can play a major role in cancer initiation, progression and drug resistance, but also these cells survive and migrate to distant sites. The combination therapy monoclonal antibody/chemotherapeutic or radioactive substance loaded SPION will led to significant reduction of tumor growth (Gobbo et al., 2015).

**Removal of Circulating Cancer Cells**

Stem cell transplantation (SCT) is a procedure to restore healthy bone marrow in patients with leukemia. Before SCT, the patient receives high doses of chemo-, and sometimes radiotherapy which kill not only neoplastic cells but also healthy cells. In addition, multidrug-resistant mechanisms to conventional chemotherapeutics ensure dormant cells, considered as cancer stem cells, cause recurrence of the disease (Liu et al., 2015).

Functionalized MNPs has become an area of interest that can provide extracorporeal removal of unwanted cellular entities from the blood. However, there are several challenges for the functionalization of MNPs with a suitable targeting agent such as a peptide or an antibody to bind the specific target (Herrmann et al., 2010).

In our opinion, an alternative approach is to support the recirculation of healthy cells of the patients after separation of cancerous cells targeted by MNPs-loaded with specific molecules (Figure 5). In this application, it is needed a suitable extracorporeal device system, which allows for efficient injection, mixing and elimination of the MNPs to separate the targeted cancerous cells.

CTCs are the key factors in the metastatic process and for the poor outcome of cancers. Hence another alternative could be the removal of the CTCs from blood circulation using functionalized MNPs.

**CONCLUSION**

Considerable advances have been made in the use of MNPs for efficient therapies of cancer. MNPs allow a wide variety of substances (chemotherapeutics, radionuclides, antibodies, immunomodulators, viral vectors carrying gene, etc.) to be transported and delivery to the target site, where they are intended to act. They can also be used to enable local hyperthermia in the targeted site. Besides, it is possible to achieve synergistic effects in order to improve the desired anticancer effects by combining two or more of them. The combination to aim diagnostic and therapeutic (Theranostics) goals in the cancer treatment is certainly another important aspect in the use of MNPs.

Many successful studies have been employed to improve their blood circulation and to reduce the time required in their reaching to the target tissues using various techniques to increase the effectiveness of MNPs, including reduced size and biocompatible shells of polymers or metals.

Other side, there is much more things to be discovered relevant to the use of MNPs for cancer therapy. Despite the successful studies, their clinical applications seem remote to be used in a complete safety due to some unpredictable barriers such as excretion and long-term toxicity.

The researches about the use of MNPs for drug targeted delivery, their synthesis of high-performance, and integration of multifunctional ligands are still in continuous development. The studies are ongoing for simultaneously reducing the dosage as well as minimizing side-effects associated with non-specific uptake of cytotoxic drugs by healthy cells.

MNPs are excellent candidates with a wide range of biomedical applications for diagnosis, therapy and monitoring of severe diseases including cancers.

#### **ACKNOWLEDGEMENT**

The authors are thankful for the management of Chettinad School of pharmaceutical sciences for encouraging and unremitting support to do such activities.

#### **AUTHOR CONTRIBUTIONS**

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the international committee of medical journal editors (ICMJE) requirements/guidelines.

#### **CONFLICT OF INTEREST**

All authors declare that there is no conflict of interest.

#### **SOURCE OF FUNDING**

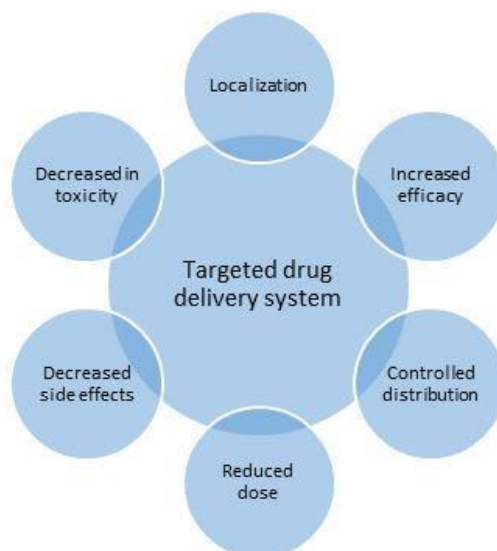
None

#### **REFERENCES**

1. Aires A, Ocampo SM, Simões BM, et al. Multifunctionalized iron oxide nanoparticles for selective drug delivery to CD44-positive cancer cells. *Nanotechnology* 12: 27:065103, 2016.
2. Awasthi R, Roseblade A, Hansbro PM, et al. Nanoparticles in Cancer Treatment: Opportunities and Obstacles. *Curr Drug Targets* 19:1696-1709, 2018.
3. Belyanina I, Kolovskaya O, Zamay S, et al. Targeted Magnetic Nanotheranostics of Cancer. *Molecules* 22: 975, 2017.
4. Buabeid MA, Arafa SA, Murtaza G. Emerging Prospects for Nanoparticle-Enabled Cancer Immunotherapy. *J Immunol Res* 2020: 9624532, 2020.
5. Chen Y, Ai K, Liu J, et al. Multifunctional envelope-type mesoporous silica nanoparticles for pH-responsive drug delivery and magnetic resonance imaging. *Biomaterials* 60: 111–120, 2015.
6. Doswald S, Stark WJ, Schimmer BB. Biochemical functionality of magnetic particles as nanosensors: how far away are we to implement them into clinical practice? *J Nanobiotechnol* 17:73, 2019.
7. Dürr S, Janko C, Lyrer S, et al. Magnetic nanoparticles for cancer therapy. *Nanotechnol Rev* 2: 395–409, 2013.
8. Eskiizmir G, Ermertcan AT, Yapici K. Nanomaterials: promising structures for the management of oral cancer. In: *Nanostructures for Oral Medicine*. Andronescu E, Grumezescu AM (Eds.). Elsevier, Bucharest, 2017: 511-544.
9. Evans ER, Bugga P, Asthana V, et al. Metallic nanoparticles for cancer immunotherapy. *Materials* 21: 673-685, 2018.
10. Furlani EP. Magnetic Biotransport: Analysis and Applications. *Materials* 3: 2412-2446, 2010.
11. Gobbo OL, Sjaastad K, Radomski MW, et al. Magnetic Nanoparticles in Cancer Theranostics. *Theranostics* 5: 1249–1263, 2015.
12. Gosecki M, Gadzinowski M, Gosecka M, et al. Polyglycidol, Its Derivatives, and Polyglycidol-Containing Copolymers—Synthesis and Medical Applications. *Polymers* 8: 227, 2016.
13. Gurunathan S, Kang MH, Qasim M, et al. Nanoparticle-Mediated Combination Therapy: Two-in-One Approach for Cancer. *Int J Mol Sci* 19: 3264, 2018.

14. Gutiérrez L, Mejías R, Barber DF, et al. Morales, "Fighting cancer with magnetic nanoparticles and immunotherapy. In: Colloidal Nanocrystals for Biomedical Applications VII. Wolfgang JP, Kenji YMD, Marek O (Eds.). SPIE BIOS, San Francisco 2012: 82320X.
15. Herrmann IK, Urner M, Koehler FM, et al. Blood purification using functionalized core/shell nanomagnets. *Small* 6:1388–92, 2010.
16. Hervaultab H, Thanh NT. Magnetic nanoparticle-based therapeutic agents for thermo-chemotherapy treatment of cancer. *Nanoscale* 6: 11553–11573, 2014.
17. Hosu O, Tertis M, Cristea C. Implication of Magnetic Nanoparticles in Cancer Detection, Screening and Treatment *Magnetochemistry* 5: 55, 2019.
18. Huang HS, Hainfeld JF. Intravenous magnetic nanoparticle cancer hyperthermia. *International Journal of Nanomedicine* 8: 2521- 2532, 2013.
19. Huang X, Yi C, Fan Y, et al. Magnetic Fe<sub>3</sub> O<sub>4</sub> nanoparticles grafted with single-chain antibody (scFv) and docetaxel loaded beta-cyclodextrin potential for ovarian cancer dual-targeting therapy. *Mater Sci Eng C Mater Biol Appl* 42:325-32, 2014.
20. Iqbal MT, Halasz K, Bhatia D. Metallic Nanoparticles for Targeted Drug Delivery. *NMCT* 1:3-5, 2017.
21. Kang S, Baskaran R, Ozlu B, et al. T1-Positive Mn<sup>2+</sup>-Doped Multi-Stimuli Responsive poly(L-DOPA) Nanoparticles for Photothermal and Photodynamic Combination Cancer Therapy. *Biomedicines* 8: 417, 2020.
22. Kang T, Li F, Baik S, et al. Surface design of magnetic nanoparticles for stimuli-responsive cancer imaging and therapy. *Biomaterials* 136: 98–114, 2017.
23. Klein S, Sommer A, Distel LV, Neuhuber W, Krysch C. Superparamagnetic iron oxide nanoparticles as radiosensitizer via enhanced reactive oxygen species formation. *Biochem Biophys Res Commun* 425: 393 – 397, 2012.
24. Li C, Li L, Keates AC. Targeting cancer gene therapy with magnetic nanoparticles. *Oncotarget* 3: 365 – 370, 2012.
25. Liu H, Lin Lv L, Yang K. Chemotherapy targeting cancer stem cells. *Am J Cancer Res* 5: 880–893, 2015.
26. Mukherjee S, Liang, Veisheh O. Recent Advancements of Magnetic Nanomaterials in Cancer Therapy. *Pharmaceutics* 12: 147, 2020.
27. Naeem M, Awan UA, et al. Advances in colon-targeted nano-drug delivery systems: challenges and solutions. *Arch Pharm Res* 43:153-169, 2020.
28. Navya PN, Kaphle A, Srinivas SP, et al. Current trends and challenges in cancer management and therapy using designer nanomaterials. *Nano Convergence* 6: 23, 2019.
29. Owen JA, Punt JS, Sharon A, Jones PP. Kuby immunology. 7th edition. New York: W.H. Freeman Company. 2013. 627-651.
30. Price PM, Mahmoud WE, Al-Ghamdi AA et al. Magnetic Drug Delivery: Where the Field Is Going Front *Chem* 6:619, 2018.
31. Qi L, Wu L, Zheng S, Wang Y, Fu H, Cui D. Cell-penetrating magnetic nanoparticles for highly efficient delivery and intracellular imaging of siRNA. *Biomacromolecules* 13: 2723 – 2730, 2012.
32. Sharma R, Mody N, Agrawal U, et al. Theranostic Nanomedicine; A Next Generation Platform for Cancer Diagnosis and Therapy. *Mini Rev Med Chem* 17:1746-1757, 2017.
33. Sung H, Ferlay J, Rebecca L, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA Cancer J Clin* 0:1–41, 2021.
34. Tiwari G, Tiwari R, Sriwastawa B et al. Drug delivery systems: An updated review. *Int J Pharm Investig* 2: 2–11, 2012.
35. Wanga Z, Changa Z, Lu M, et al. Shape-controlled magnetic mesoporous silica nanoparticles for magnetically-mediated suicide gene therapy of hepatocellular carcinoma. *Biomaterials* 154: 147-157, 2018.

37. Wu M, Huang S. Magnetic nanoparticles in cancer diagnosis, drug delivery and treatment. *Molecular And Clinical Oncology* 7: 738-746, 2017.
38. Wu M, Huang S. Magnetic nanoparticles in cancer diagnosis, drug delivery and treatment. *Molec Clin Oncol* 7: 738-746, 2017.
39. Zhang H, Liu XL, Zhang YF, et al. Magnetic nanoparticles-based cancer therapy: current status and applications. *Science China Life Sciences* 61: 400, 2018.



**Figure 1.** Ideal characteristics of a nano-based targeted drug delivery system

---

**PC BASED POWER GRID CONTROL USING WIRELESS COMMUNICATION**

---

**Mr. C. Ganesh, P. Nagaveni, A. Hari Priya, P. Manikanteswar Reddy and A. Arun Kumar**

Electrical and Electronics Engineering, Annamacharya Institute of Technology and Sciences, Rajampeta

**ABSTRACT**

*An effective improved intelligent Smart DC Micro Grid for electrical power measurement control and monitor operations to detect the fault in transmission lines. Present power system is undergoing various issues. Because of these issues, there is a loss in power transmission. The present grid system is inefficient to handle these discrepancies. To overcome these discrepancies and other typical snags in power system, there is a requirement for smart and intelligent system. The main goal of the proposed research work to describe the role of advanced sensing systems in the electric grid of the future, a Smart DC Grid technology is to be introduce/embedded in power system. Smart DC Grid is the solution of most of the problems in the power system. Wireless Sensor Network (WSN) based technology Smart DC Grid incorporates effective solutions for multiple problems faced by electricity, it provide a reliable monitoring and fault detection system. Appropriate designed specific sensors were used to monitor the changes in transmission parameters such as voltage, current and power. Whenever fault occurred the data acquired were transmitted to the main hub via Zig-Bee module. With this system, power transmission fault can be detected in real time.*

*Keywords: Smart DC Micro Grid, Wireless Sensor Network, monitoring, Sensors, Zigbee.*

**I. INTRODUCTION**

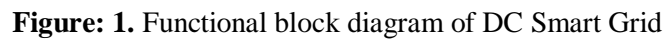
Now a days Energy plays a crucial role in present life. Optimum use of energy must be carried to preserve for future. In terms of energy supply the electrical grid system helps in supplying the demand for energy. As the days goes on by adopting various technologies energy is getting exhausted. Due to several problems the generated power is not used in optimistic way. The present electrical grid is not suitable to handle the present day problems such as monitoring, power theft and load consumption. To overcome these issues in the present grid, the smart grid comes into picture. Smart Grid is an electrical network that uses intelligent and automated components for bidirectional communication. Since most of the energy resources like coal, petroleum are getting exhausted, the renewable energy resources Like solar, wind is promoted. By using this renewable resource a smart DC grid is implemented. Solar energy is the highest source of renewable energy. Solar technology comprises of long term benefits and minimal cost. Solar energy acts as an independent source and is eco-friendly. This energy generates pure DC which is used in the Smart DC grid. But in some hilly regions where solar energy is insufficient, hybrid energy like wind energy is used as an alternative for energy supply.

**II. WIRELESS SENSOR NETWORK BASED DC SMART GRID:**

Power is generated from non-conventional sources of energy like solar energy, Wind energy and hydroelectric etc. design a DC smart grid, solar energy is the main source. The power generated from the solar panel is connected to the battery via the charge controller. Charge controller avoids the reverse flow of current from battery and it prevents the solar cells of the panel, helps in maintaining the battery voltage high and it also boost the voltage when less voltage is generated from the panel.

When sufficient voltage is not generated to charge the battery an alternate energy source like wind energy can be used. Since the power generated from the Hybrid Energy source is AC, the output is step down to a lesser voltage and further converted to DC using a rectifier circuit and is given to the charge controller as shown in the figure 1. Sufficient voltage to charge the battery is given from the charge controller. The battery gets charged to its maximum value and is supplied to the loads. Smart meters are connected to each load, where power consumed is continuously monitored and information is transmitted to the main hub using the Zig-Bee module. For efficient and less consumption of power, the loads are fixed with desired value. When the power consumption exceeds the desired value the power is cut-off shown in figure 2.





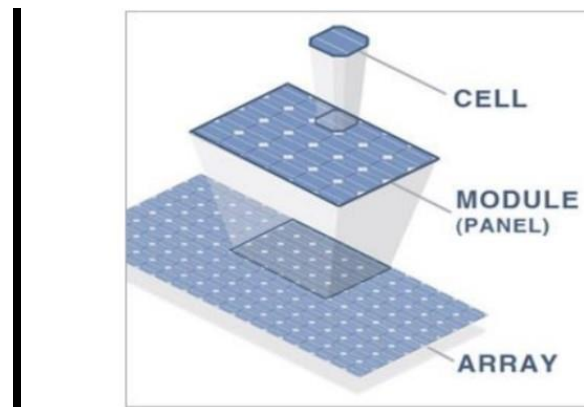
```

graph TD
    Start([START]) --> Solar[Supply from solar panel]
    Solar --> Decision1{If Supply < 12v}
    Decision1 -- Yes --> Hybrid[Hybrid supply]
    Decision1 -- No --> Battery[Battery]
    Hybrid --> Battery
    Battery --> Load[Turn ON load]
    Load --> Decision2{If disturbance occurred}
    Decision2 -- Yes --> Theft[Theft]
    Decision2 -- No --> CheckPower[Check power consumption in load]
    CheckPower --> Decision3{If power consumption < 2W}
    Decision3 -- Yes --> CheckPower
    Decision3 -- No --> TurnOff[Turn OFF through relay]
  
```

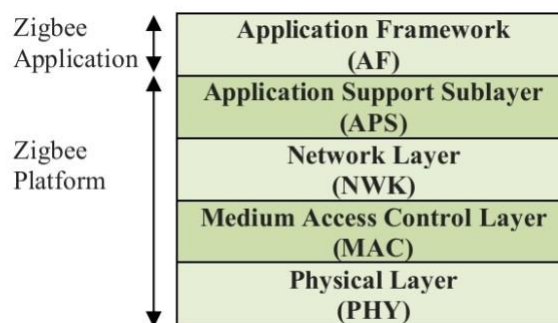
97

### III. HARDWARE SPECIFICATIONS

**Solar Panel:** Used to Generate DC Power which is used for DC Grid and no conversion of AC to DC is required which reduces the conversion losses. A solar panel is an array of solar cells connected in series shown in figure 3.



**Zigbee Model:** F



Zigbee is a used wireless sensor network communication and which operates with a range of 10 to 100mts and it works on one of the high level communication protocol like Universal Asynchronous Receiver Transmitter (UART) where serial data is communicated between transmitter and receiver like ways which is used to transmit and receive the data from main hub to local home networks represented in figure [4]. The Arduino UNO AT mega 328 is preferred compared to the other microcontrollers or microprocessors. The Arduino is used for interface that is we have made a smart meter for reading and monitoring the values in the transmission lines and in the household appliances, these smart meters are made by interfacing Arduino with different sensors like voltage and current sensors, LCD for reading the values and other communication devices for Wireless Sensor Network Communication. Arduino is compatible in this manner by setting the minimum usage of power.

### IV: EXPERIMENTAL RESULTS

Power is generated from non-conventional sources of Energy like solar energy and hybrid energy. The hybrid power is converted into DC and is connected to charge controller for constant voltage. When there is no sufficient power supply from solar energy the controller shifts the supply to hybrid energy.

When voltage generated in solar panel is greater than 12V Hybrid energy is off shown in figure 4. When voltage generated in solar panel is less than 12V Hybrid energy is turned on as shown in figure

**Figure 4:** Power from solar Panel is ON and main supply is OFF:

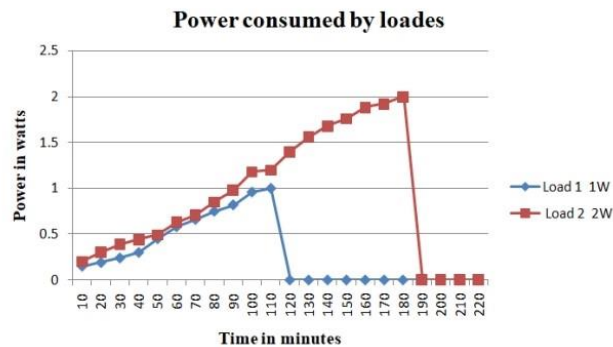


The power consumption of the load is monitored continuously as shown in figure 5 . The power consumption reaches the desired value i.e. 2W, power supply is automatically turned off shown figure.

**Figure 5:** Power consumption of load is monitored:



The power consumed by each loads is minimized to a desired value and then cut off as shown in the figure 6.



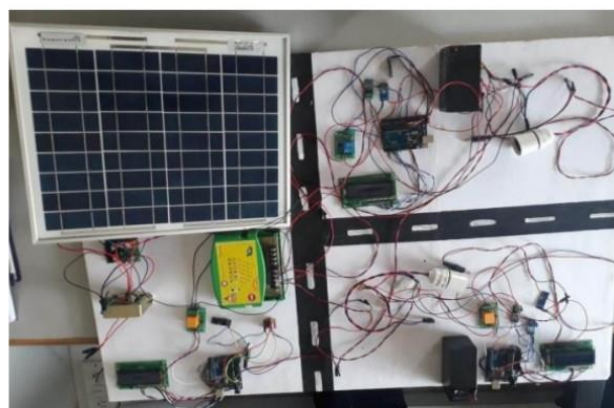
**Figure 6:** Power consumption by the loads

For different applications the loads are varied with different power ratings .Depending on the power generated, sufficient power is supplied to the loads. Figure 9 shows the power consumed by each load. Different loads are fixed with different power consumption values. The maximum power consumption of load 1 =1 Watt and load 2 =2 Watts. When power consumption reaches maximum value the power supply is automatically cut off shown in figure 7



**Figure 7:** Theft Monitoring system

When any disturbance is detected theft has been occurred. Such as like power drawn from the transmission lines and other fault conditions. The complete prototype model as shown in figure 8.



**Figure 8:** Prototype model

## V: CONCLUSION

Wireless Sensor Network (WSN) used for monitoring transmission continuously. WSN used for measuring variations in load parameters like voltage, current and power. Each load is equipped with individual smart meters. The power consumption value of each load is transmitted to the main hub through Zig-Bee. By improving the power reliability and quality, enhancing the efficiency of the existing power grid is increased. Many disturbances in the transmission lines like power theft are avoided using this smart DC micro-grid. Even power consumed through each transmission line is recorded through smart meters. When the load consumes more power than the desired value the power supply is cut-off.

---

**REFERENCES**

- [1] Muhammad Abrar, "Real Time Smart Grid Load Management By integrated and secured communication". International Conference on Innovative Trends in Computer Engineering (ITCE), 2018.
- [2] Minh-Triet Nguyen, "practical implementation of wireless network based smart home system for smart grid integration". International Conference on Advanced Technologies for Communications (ATC), 2015.
- [3] Aryadevi Remanidevidas, "WSN monitoring and Optimizing Electrical". Fourth International Conference on Sensor Technologies and Applications, 2016
- [4] Munhaw Kam, "WSN Based Utility System for Effective Monitoring and Control of Household Power Consumption" 978-1-4673-6386 IEEE, 2014.
- [5] J. Wang, L. Y. Kang and B. G. Cao, "Study of energy complementary control of distributed power generation system based on renewable energy. journal of system simulation", vol. 17, no. 6, pp-1438-1440, 2005.
- [6] J. Wang, L. Y. Kang and B. G. Cao, "Study of energy complementary control of distributed power generation system based on renewable energy. journal of system simulation", vol. 17, no. 6, pp-1438-1440, 2005.
- [7] F. L. Gao and J. D. Cai, "Analysis for distributed generation impacts on current protection in distribution networks", Journal of Electric Power Science and Technology, vol. 23, no. 3, pp94-96, 2008.

---

**ROBOTIC PROCESS AUTOMATION: LITERATURE REVIEW, CHALLENGES AND OPPORTUNITIES**

---

**Neelam Yadav<sup>1</sup> and Dr. Supriya P. Panda<sup>2</sup>**<sup>1</sup>ABES Engineering College, Ghaziabad, UP, India<sup>1,2</sup>Computer Science and Engineering, FET, Manav Rachna International Institute of Research and Studies, Sector-43, Aravalli Hills, Faridabad, Haryana**ABSTRACT**

*Digitization and Automation is a buzzing word in Business Organizations. Organizations are in a rush to automate its business processes so as to increase the Productivity and ROI (return on investments) there by reducing the costs. Robotic Process Automation is a solution to substitute the human task force with automated software robots. RPA robots mimics' human actions and it sits on top of the underlying information system. RPA scripts are executed to do mundane and repetitive tasks more efficiently there by enabling human task force to do focus on strategic and decision making tasks. As RPA being a recent topic; its literature lacks a harmonization of RPA main topics. Hence this research aims to help the academic community to understand RPA in terms of research opportunities, challenges and future trends. This literature review is based on the articles and research papers retrieved from the libraries of Scopus, IEEE, ACM, Science Direct and Google scholar.*

*Keywords: RPA, Robotic Process automation, Intelligent Automation, Process Mining, Candidate Processes, Process Discovery, Business Process Management, UI logs*

**1. INTRODUCTION**

Automation is the exploitation of technology to emulate the tasks or activities to accomplish a common goal of a business process with minimum or no human intervention. Supply of software robotic systems in job automation has soared in recent years. Business Organizations are in extreme pressure to adopt the dawn of new technologies like Artificial Intelligence, Robotic Process Automation, Machine Learning and IOT to improve their Business Processes and cut the costs [1].

RPA is most eminent solution for such digital transformation of Business processes in terms of automation. Van der Aalst et al. define RPA as an Umbrella [2] that stands on top of an organization's information system and mimics human behavior to complete tasks. AI (Artificial Intelligence) and RPA provides a solution that "what is to be done by humans and what a machine can do"[3]. So AI provides ability to a machine to "think and decide" and RPA provides the ability to a machine to "implement"[4].

**2. FUNDAMENTAL CONCEPTS**

**Business Process:** Business Process is a systemic sequence of activities or events that are performed in a chronological order for a business to work and realize the goals of the organization [5][6]. These processes are generally matured and standardized and have specific goals to accomplish. Some common business processes are claims processing, registration, auditing, customer services management, Purchase to Pay, order management, supply chain, banking, taking appointments, inventor management etc. Activities conducted during a process are generally stored in digital event logs [8].

**Business Process Management:** Business processes have changed now days to accommodate the new challenges with the increase of technology and innovation. Business Process Management is a systematic practice used to control, align, capture, design, execute, document, measure and coordinate the business processes to achieve organizations goal [8]. It helps in implementing process improvement practices like automation, digitization, optimization and reducing the bottle necks. Through BPM, processes can be aligned with organizational business strategies.

**Business Process Modeling Notation:** BPMS is a graphical notation to depict the activities in a business process. It coordinates the sequences of process and depicts the flaws of business process [9]

**Process Mining:** Process Mining is like an x-ray of your processes [7]. It provides the insights of a process to discover, scrutinize, correct and monitor the processes. Process Mining is typically done by event logs [10]. The event logs trap all the events conducted by a user while executing the process. It includes, caseId, timestamp, coordinates of the clicks etc. Process Mining helps in automated process discovery[7]. Process mining unveils optimizing opportunities using automation.

### 3. ROBOTIC PROCESS AUTOMATION

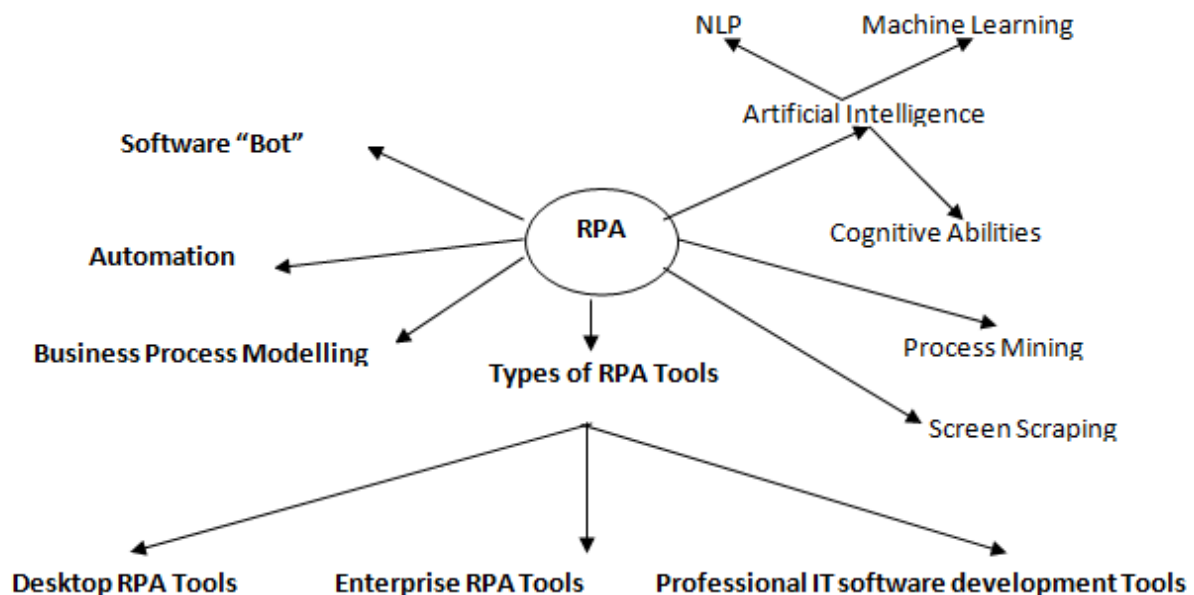
Robotic Process Automation is a “software ROBOT” that is programmed and deployed in business organizations to do the repetitive and mundane tasks that were typically done by humans. The term “Robots” are often connotes with electromechanical or hydraulic machines [11]. Rather RPA is a software solution that automates the repetitive and routine, so that humans can focus on the cognitive part of the processes. Repetitive tasks that collate, copy, search, sending emails, access multiple systems or screens and taking simple decisions are the prime targets for RPA implementation [12].

The RPA bots perform the rule based, deterministic, well structured and repetitive tasks in a process by executing the scripts which includes the recording of interactions of human with User Interface (screen) of the Information System. RPA uses the Graphical User Interface Adapters (GUI) instead of using Application Programming Interfaces (API's).

According to Willcocks [13], there are three types of RPA software products Figure 1 (i)Desktop RPA Tools , (ii)Enterprise RPA Tools and (iii) Professional IT software development Tools . The desktop RPA tools are simple and it works like a screen recorder. Enterprise tools are generally configures on organizations servers and perform the tasks from the component libraries. Professional IT Software development tools consist of Business process Modeling tools and software development kit. These tools are used by IT experts along with business analysts.

Several RPA Vendors i.e Automation Anywhere, Blue Prism, UiPath, WorkFusion, Pegasystems, NICE, Kryon, EdgeVerve, Redwood, Kofax, Contextor, and Softomotive provides out of the box solution for RPA Lifecycle [12][14]. UI path has emerged as the marked leader with the highest ranking among other RPA providers. As it offers innovative RPA solutions, making it fit for large and global enterprises [15]. The search was performed to get the articles, research papers, white papers from 2021 onwards. We get around 70 articles. After reviewing the content 56 articles were extracted for this study.

In 2020, the world's foremost research and advisory group, Gartner, anticipates that RPA market will grow exponentially by 2024, and that 90% of large will adopt [16]. A survey conducted by Deloitte illustrated that payback period for RPA is usually less than 12 months [17].



**Figure 1:** RPA and its Tools.

### 4. RPA BENEFITS

RPA implemented Software “bots” can work tirelessly 24/7, thereby replacing the work of human [18]. Numerous case studies have shown that implementation of RPA Robots lead to cost reductions [19] and improved efficiencies [20][21]. RPA technology incises the cost of an off-shore FTE (full-time equivalent) in half. According to a report by McKinsey and Company estimates that around 110 to 140 million FTE's will be substituted by automation tools by 2025[21].

As RPA “bots” sits on the top of the underlying Information System. The current applications do not interfere with the bots as the bots interact with the User Interface. It takes less time (two to four weeks) to integrate with systems and develop new functionalities [22] as it does not require high level programming skills [20] [21] [23].

A number of case studies as depicted in Table 1 replicate how RPA technology has augmented the capability and meticulousness of the business process involving the human workers. O2 and Vodafone have greatly enhanced their business processes in terms of cost benefits and FTE's as a result of RPA adoption [11]. Xchanging [11], a London-based business process and technology service provider, automated its 14 core processes and configured 27 robots to handle 120,000 monthly transactions. Global Telecommunication Giant Vodafone utilized the payback of RPA and Process mining to attain an order rate of 92% and trims down its purchasing costs. University Hospital Birmingham (UHB) [24] National Health Service Foundation Trust used the RPA technology to trim down the time it took to register patients. The patient administration system is automated thereby reducing the overhead of staff by registering 50 % more patients to register. 25 to 40 percent digital labor costs are reduced by implementing RPA.

Fields	Authors	Benefits	Objectives
Manufacturing	Abraham et al. 2021 [25]	Utilizing robotic process automation technologies for streamlining the additive manufacturing design workflow	Presented an approach for automating a part of the AM-based Product Development Workflow.
Auditing	F.Huang et al. 2019 [26]	Applying robotic process automation (RPA) in auditing: A framework	Implementation of RPA reduced the costs in Auditing procedures.
Health Care	University Hospitals Birmingham by Blue Prism 2015 [24]	6 core processes were automated.	Implemented RPA in Patient Administration System (PAS)
	Liu et al. Green Field Hospital in Singapore, 2020 [27]	Integrated hospital logistics and operation with RPA.	The transportation system in the hospital, transmitting rule of the lifts and robots, are optimized through extensive simulation using RPA.
	Ratia et al. 2018 [28]	Improved function-oriented value analytics to spot the prospective for automation in the private healthcare industry.	Value establishment through knowledge work digitalization in private healthcare in Finland.
	Bhatnagar et al. 2019 [29]	New drug discovery, improve drug formulation process and drug delivery mechanisms.	RPA and data science tools were used to handle Medical Big Data
Financial	Asatiani et al. 2016 [22]	OpusCapita	To build in-house capacity to implement RPA projects.
	Kokina et al. 2019 [30]	cost savings, Lower Error rates, better report quality and more accurate measurements of process improvement	RPA based Task-Technology Fit (TTF) and Technology-To-Performance Chain (TPC) is used for Tasks Automation.
Supply Chain	Hartley et al. 2019 [31]	Several companies comprise of Packaging, CPG1 and Equipment1 are in process to automate their order-to-cash, procure to pay and logistics processes by using RPA.	After implementing software robots, employees can do better strategic tasks and can manage exceptions
	Rhouati et al. 2020 [32]	Task selection issue for	Use of Automation in all



		Supply chain is resolved.	Supply Chain processes.
Accounting	Kokina et al. 2019 [30]	Task analysis done for order-to-cash, record to report and procure to play processes in supply chain.	Six themes(motivation to implement RPA, initial RPA implementation, challenges, risk and control environment, organizational governance structure, and bot onboarding) for tasks analysis in accounting
Insurance	Lacity et al. [13]	14 Core Processes were automated,30% cost savings	Building in-house RPA capability, scalability, Higher Accuracy

**Table 1:** Key RPA implementation in different domains

## 5. RPA DISADVANTAGE

Literature shows certain disadvantage of RPA not only the benefits. Several vendors acknowledge the problems with RPA implementation. Some of the disadvantages are listed in Table 2. One of the main disadvantages is to find suitable process among different business processes in organizations. As applying RPA to an inefficient process will not give the advantages and good ROI (return on investment).

Disadvantages	Explanation	References
Lack of Clarity in “What to Automate”	Operational Team is not skilled in identifying the right use cases or tasks to automate.	Accenture 2019 [33] Fung et al. 2014 [34] Hallikainen et al. 2018 [35] Leshob et al. 2018 [36] Lamberton et al. 2017 [37]
Handling unstructured Data	RPA “bots” does not learn from experience and hence is not able to handle unstructured data.	Burges et al. 2018 [38] Suri et al. 2017 [39] Vishnu et al. 2017 [40]
Monitor bots for deviations and exceptions.	Human intervention is required to monitor the bots for failures and exceptional conditions.	Hodge et al. 2017 [41] Burges et al. 2018 [38]
Challenge to use RPA in Legacy Systems	RPA implementation in Legacy System is a temporary solution as the “bots” will not scale in longer run.	Asatiani et al. 2016 [22] Hallikainen et al. 2018 [35]
Does not guarantee cost reductions.	Automating a process does not always guarantee cost reductions.	Hallikainen et al. 2018 [35] Suri et al. 2017 [39]
Maintenance	Lots of efforts involved in maintain the ROBOTS.	Stople et al. 2017 [42]

**Table 2:** Disadvantages of RPA

## 6. RESEARCH METHODOLOGY FOR LITERATURE REVIEW

The aim of this research to delineate and merge the speckled knowledge of the RPA in the literature systematically. This study will provide a broad analysis on the challenge and opportunities RPA in real-world applications. This research is based on the literature search from electronic library databases, like Emerald Insight, IEEE Xplore Digital Library, ScienceDirect, Springer Online Journal Collection and Google Scholar. The search strings uses keywords like “robotic process automation”, “Process Mining using RPA”, “Candidate process selection in RPA projects” and “intelligent automation”.

## 7. LITERATURE REVIEW

RPA Technology has its initial emergence in 2000’s [43]. The history of RPA is difficult to understand as organizations are exploiting automation since decades. In 2012, Phil Fersht, founder of HfS (Horses for Sources) bring into play the term ROBOTIC AUTOMATION. Afterwards Patrick Geary, the chief marketing officer at Blue Prism named its products as ROBOTIC PROCESS AUTOMATION. After that the other vendors started renaming their products as RPA Tools[24].



RPA offerings are very valuable and great, but it has challenges too.

RQ-1 The foremost challenge is to find a suitable business process that can utilize the aid of RPA.

RQ-2 The second challenge is to increase the cognitive abilities of RPA implemented Business Processes using AI-enabled technologies.

RQ-3 Testing the “bots” to identify the disruption of software “bots”

## 8. RQ1. SUITABLE BUSINESS PROCESS SELECTION CRITERIA FOR RPA

RPA literature showed that selecting a suitable process/Task for RPA implementation is important. To realize the benefits of RPA, identifying the suitable processes for automation is the need of the hour [15] [45] [46]. But the question always lies how we should assess that which process is suitable. In Literature three techniques are discussed.

- (i) Process Quality Characteristics
- (ii) Process Mining Technique.
- (iii) Interviews, surveys & discussion- based Methods

### 8.1 Process Quality Characteristics Approach:

The current approach to identify suitable process in an organization for automation is through process quality characteristics, Interview, walkthrough and after having interaction with the users of the process. According to Ernst & Young. In 2017 characteristics of candidate Processes for RPA are (i) the actions in a process should be consistent; the tasks must be performed repetitively. (ii) The steps in a process should be template driven; with data being entered into specific fields in a repetitive manner. (iii) It should be deterministic and must be rules-based. After deep analysis and research we find the following Table 3. characteristics of RPA suitable process from these papers. Table 4. Shows the key example from literature contributing for Process Quality Characteristics for RPA

Process Quality Characteristics	Researcher Name	
Standardization	Somayya et al. 2019 [48] Fung et al., 2014 [33] Asatiani et al., 2016 [22] Moffitt et al., 2018 [49]	Lacity & Willcocks, 2016 [20] Aguirre et al., 2017 [21] Geyer et al. 2018 [47] Somayya et al. 2019 [48]
Maturity	Moffitt et al., 2018 [49] Somayya et al. 2019 [48] Fung et al., 2014 [33]	Lacity & Willcocks, 2016 [20] Geyer et al. 2018 [47] Aguirre et al., 2017 [21]
High Volume	Rhouati et al., 2021 [32] Aguirre et al., 2017 [21]	Somayya et al. 2019 [48] Syed et al. 2020 [45] Andre et al., 2021 [50]
Less Exceptions	Rhouati et al., 2021 [32] Somayya et al. 2019 [48]	Lacity & Willcocks, 2016 [20] Fung et al., 2014 [33]
Low cognitive Requirements	Aguirre et al., 2017 [21] Somayya et al. 2019 [48]	Asatiani et al., 2016 [22] Khramov 2018 [51]
Repetitive execution	Rhouati et al., 2021 [32] Somayya et al. 2019 [48] Syed et al. 2020 [45]	Geyer et al. 2018 [47] Andre et al., 2021 [50]
Highly deterministic	Rhouati et al., 2021 [32] Aguirre et al., 2017 [21] Asatiani et al., 2016 [22]	Somayya et al. 2019 [48] Fung et al., 2014 [33] Lacity & Willcocks, 2016 [20] Moffitt et al., 2018 [49]
Structured data input	Rhouati et al., 2021 [32] Aguirre et al., 2017 [21] Asatiani et al., 2016 [22]	Fung et al., 2014 [33] Lacity & Willcocks, 2016 [20] Moffitt et al., 2018 [49]
Manual execution	Rhouati et al., 2021 [32] Aguirre et al., 2017 [21] Asatiani et al., 2016 [22]	Fung et al., 2014 [33] Lacity & Willcocks, 2016; [20] Moffitt et al., 2018 [49] Geyer et al. 2018 [47]

Accessibility to multiple systems	Andre et al., 2021 [50] Aguirre et al., 2017 [21] Asatiani et al., 2016 [22]	Fung et al., 2014 [33] Lacity & Willcocks, 2016 [20] Moffitt et al., 2018 [49]
-----------------------------------	--	--

**Table 3.** Listing of Process Quality Characteristics.

Paper	Research Objective	Research Method	Main Findings/Conclusions	Future Scope/Research Challenge/Limitation
Audrey et al.	Proposed a four step approach to guide the organizations to analyze their business process to identify the most suitable process for RPA.	Four approaches are used to find suitable RPA processes. 1.) Validate the process eligibility (Maturity and standardization), 2.) Evaluating the RPA potential of a business 3.) Evaluate RPA Relevance (high volume and low complexity) 4.) RPA classification for business process.	The designed method helps organizations to effectively use RPA.	<ul style="list-style-type: none"> <li>- intricate a set of metrics for process analysis</li> <li>- design and execute a tool that supports the method,</li> <li>- weigh up the method with a bigger experimental data</li> <li>- use Process Mining techniques to improve the RPA</li> </ul>
Jonas Wanner et. al 2019	An automatable indicator system is developed to help companies to identify prioritize the RPA activities and to reduce costs.	Four measures for evaluating the automation potential of business processes. a.) execution frequency b.) degree of stability c.) degree of rule-based procedure d) Degree of standardization.	This research provides indicators for process selection in RPA.	<ul style="list-style-type: none"> <li>- Some measures to be identified to measure the parts of the process for RPA automation.</li> <li>- To improve the decision making abilities of Robots.</li> </ul>
Geyer Klienberget al. 2018	Process Mining is used to visualize the processes and to identify the suitable process for automation.	Event log is extracted from the SAP database tables. In SAP, manual users are tracked as dialog users, robots are marked as system users. For each activity stored in the event log, the automation rate is calculated as ratio of cases where an activity was executed by a system user divided by the total number of instances of this activity.	Automation rate of the two processes are calculated with deviations to find a mature and standardized process.	<ul style="list-style-type: none"> <li>- To use this automation rate to compare different processes of organizations.</li> </ul>

**Table 4.** Key example from literature contributing for Process Quality Characteristics for RPA

## 8.2 Robotic Process Mining Technique:

Mining the process to identify the bottle necks and exceptions of processes is a critical step in Business Process Management. To identify which process to automate; Process Mining is the way forward [47]. Process Mining Technique gives the insights of a process by using the event Logs [10] [63]. An event log records the traces of the activities. It stores the information about the activity, a time stamp and a unique case ID. These event logs are analyzed to find the repetitiveness and User Interaction of a process. The activities in a process can be visually detected using various process modeling tools like BPMN, Petri net etc. Table 5. refers the research literature where process mining is used to find the potential of processes for Robotic Process Automation.

Paper	Research Objective	Research Method	Main Findings/Conclusions	Future Scope/Research Challenge/Limitation
V. Leno et al. (2020)	Introduces RPM (Robotic Process Mining) tool to discover repetitive routine processes from the logs of interaction (UI) between user, web and desktop applications.	RPA executable scripts were generated by preprocessing the UI logs. The UI logs were segmented to trace the event logs. The process was prioritizing as per their repetitiveness.	Discovering automatable routines for RPA implementation	<ul style="list-style-type: none"> <li>- To measure the defect rate of a software bot.</li> <li>- To identify the factors for bot failures.</li> <li>- To identify the exception conditions where a bot behave abnormally.</li> </ul>
Leopold et al. (2018)	Identifying suitable Candidate Process for automation in Textual Process Descriptions.	A supervised ML algorithm SVM is used to classify the process as an automated, manual or a human interaction. 47 textual descriptions were used as a dataset.	F1-Measure is 81%. 324 tasks are implemented correctly out of 424 activities from 47 textual descriptions.	<ul style="list-style-type: none"> <li>- To add more features and test other classifiers.</li> <li>- Textual documentation should be complete and suitable to implement this research.</li> </ul>
Augusto et al. (2020)	Provide a methodical review and comparative analyses between Automated Process Discovery methods	Twelve proprietary real-life event logs, and nine quality metrics were used to discovery automatable Processes.	A systematic literature review for automated process discovery methods.	<ul style="list-style-type: none"> <li>- To adapt a filtering approach to deal with complex event logs.</li> <li>- To develop universal measures of fitness and precision for data modeling models that would not only work with petrinets.</li> </ul>
Ghalia et al.(2019)	To reduce the gap between process event logs and process model activities.	Many ML classification Techniques were explored counting SVM, ANN and Random Forest. The dataset consists of event logs from a SAP company.	Random forest algorithm fits best among SVM, ANN with an accuracy of 96.4%	<ul style="list-style-type: none"> <li>- To improve the accuracy</li> </ul>
Jimenez-Ramirez et al. (2019)	A Method to Improve the Early Stages of the Robotic Process Automation Lifecycle.	UI Logs, AutoIt scripting Lanugage, Java, Spring, Rest API, ProM plugin, mysql, XES using Python	58% and 38% new paths are discovered in process models in two BPO companies	<p>To add Experts opinion to discover process models.</p> <p>To use other process discovery algorithm to make a final model. To remove the noise in the UI logs using screen-scraping tools.</p>

Bosco et al. (2019)	Discovering Automatable Routines From User Interaction Logs	Colored Petri nets	To discover automatable routines from User Interaction logs with reduced execution times.	Noise filtering techniques to be used.
Agostinelli et al(2020)	proposed a cross-platform tool named 'SmartRPA'	Action Logger, Log Processing Tool, Event Abstraction Component, Process Discovery, python executable script are used.	This tool exploits the UI logs and it generates the executable RPA scripts for Software Robots. SmartRPA records the event that happened during the UI interaction and then converts it into automatable scripts.	SmartRPA tool develops the script based on the most frequent routines; a better approach would be to derive the software robots behavior by interpreting different routines executions in stored logs. Secondly the tool should be improved so that it will not only automate the tasks for fixed pre-defined fields rather it should work dynamically.

**Table 5.** Key example of literature where Process Mining Technique is used for RPA Implementation

### 8.3 Interviews, Surveys & Discussion- Based Methods:

These methods utilize the domain expert's knowledge like the developers, existing RPA experts, and Domain workers by interviewing them. To conclude which process to automate, survey techniques are also used. Wellman et al proposed a framework to identify candidate processes by using five different process quality perspectives. The selection of candidate processes for deploying software robots was based on 13 different criteria's which were grouped in 5 different perspectives (Task, Time, Data, System and Human). Limitations of this work focused on (i) More measures needs to identify to make this a generalized framework. (ii) Conducting expert interviews can enhance this framework.

## 9. RQ-2 ASSOCIATION OF AI AND RPA TO IMPROVE THE COGNITIVE ABILITIES OF RPA IMPLEMENTED BUSINESS PROCESSES TO ACHIEVE INTELLIGENT AUTOMATION

Though RPA is a powerful technology, but its relevance are only restricted to highly rule-based, mature, structured, standardized, well documented and recurring logic for easy tasks/processes with structured data input. Organizations now days are seeking for more intelligent and innovative solutions [57] which can work with structured as well as unstructured data. To increase the cognitive and decision making skills of robots, the classic RPA are integrated with Intelligent Automation to harness the cognitive capability of Machine Learning and AI in terms of Natural Language Processing, speech recognition to automate high order tasks [35]. Ketkar et. al put forward a method to collect and process structured and unstructured data. The researchers suggested using AI with RPA to for more efficient workflow.

RPA showed significant improvements in turnaround times and cost reduction, however developing IPA would involve high cost. As IPA needs data preprocessing and feature selection techniques, before building the AI enabled RPA software bots [6]. High costing and maintenance leads to low adaption leads of IPA. Table 6. shows the key example from literature for Intelligent Automation to implement cognitive capabilities.

RPA with IA	Techniques used	Authors	Result	Future Scope	Dataset
Using machine learning for cognitive Robotic Process Automation (RPA)	Deep Learning, CNN, RPA, Eclipse IDE, Tensor Flow, YOLO V3 algorithm	Pedro Martins, Filipe Sá, Francisco Morgado, Carlos Cunha (2020)	The detection rate (mAP) was 95.6% in this case. The second test set was focusing on different colors, components on screen. The average precision was in	Future work consist of creating more larger dataset, usage or RPA with more advanced AI skills like the software robots	The dataset consists of 10.000 snapshots of different application software interfaces, tools, configuration

			between 73% to 93.32%.	should automatically install and configure applications and actuation.	panels, and web pages.
Association of RPA with AI. Possible behavioral failures in power meters.	Multiple Linear Regression, Random Forest Random Forest	Pedretti et al. (2021)	AI is capable of providing recommendations, diagnoses, warnings, actions, and judgments to help cognitive analysis using RPA..	Integration of Python modules in to RPA.	1.4 million power meter data
Role of Robotic Process Automation in Pharmaceutical Industries	Regression Analysis ,Naive Bayes Clustering Algorithms Decision Trees ,Ensemble Learning, Classification	Bhatnagar et al. (2019)	Standardized the complex process of making an Ayurvedic Medicine - Bhasma	To improve the learning capabilities of RPA systems with Machine Learning.	Dataset from Ayurvedic texts, Ayurvedic Pharma Companies and Ayurvedic Practitioners
Predicting process behaviour using deep learning	Deep Learning, LSTM, RNN	Evermann et al. (2017)	80% Validation Precision	To predict the next event in a business process.	Real dataset from a loan application process in a Dutch financial institute with 13,087 traces.

**Table 6.** Key example from literature of Intelligent Automation**10. RQ-3 TESTING THE VIRTUAL AGENTS"BOOTS" TO IDENTIFY THE DISRUPTION**

Testing the software bots is one of the key success factors in successful implementation of RPA projects. Software bots needs to be tested for scalability and reliability. Testing provides an assurance that the bots will not disturbed the underlying Information system and hence is secure and ready to be implemented. Table 7. shows the key examples from literature for automation testing of ROBOTS.

Author Name	Objective	method	Finding/Result	Future Scope
Cewe et al. (2017)	Integration of TDD(Test Driven development) with RPA	The activities performed by a user in complete a process was recorded in a video using a screen recorder. RPA developers create a test case by picking items from the video backlog	Improvement in Requirements Engineering and Process Definition.	Limitations to this approach are that this methodology is currently in its initial phase. It needs to be tested on an actual environment.
Enr'iquez et al. (2019)	Proposed a method of automating testing of software robots. As to test the software bots on the real production environment can be	Firstly the activities that were earlier done by human workers were monitored and UI logs were generated. Then a test environment was created which shows the	Prototype development and promising results were obtained from this research.	Use of ML to focus on the result of the UI interaction not on the behavior of the interactions. UI logs can be

	very risky. So to mitigate the risks a synthetic test environment was created to test the robots.	image and confirms whether the robots are actually mimicking the process or not.		preprocessed by using Process Mining to separate single long test cases.
Egger et al. (2020)	Process logs and software bots logs were merged to discover the deviations and exceptions of Software bots.	The bot log parser was used to fetch bot logs of the three foremost RPA vendors software into the XES format. XES parsed bot logs were merged with the process logs using Java. DFvM (a visual miner) is an open source ProM framework to visualize the merge process.	Two measures ETI (Exception Time Impact) and Relative Fails were used to analyze the failures and average time to failure for bots.	Event correlation approach needs to be developed to connect attributes of both bot logs and process logs. ML(machine learning) can be applied to predict the bot behavior after analyzing bot failure patterns.

**Table 7.** Listing of Automation Testing of software “bots”**11. RPA FUTURE OPPORTUNITIES AND RESEARCH CHALLENGES:**

RPA provides automation opportunities to mundane tasks done by the humans there by replacing them with software “bots”. To leverage these opportunities, it is always interesting to explore the benefits and challenge to use RPA. Future Research Agenda are described here:

1. Techniques To clean (noise reduction) and enhance the UI Logs for Automated Process Discovery.
2. To assess implementation challenges of RPA in different domains.
3. Build a consistent Framework to identify suitable process for RPA implementation.
4. Build measures or metrics to identify bots behavior for deviations and exceptions.
5. To trap Software bot’s UI logs to create test cases to identify bot’s behavior.
6. Governance Framework to be developed for bot implementation.
7. Develop Quantitative and Qualitative Performance measurement of bots.
8. To develop strategies to monitor and control the software “bots”.
9. To explore Cognitive RPA and AI capabilities to handle unstructured data for end to end process automation.
10. Establish uniform practices for standardization of RPA across all the domains.

**12. CONCLUSION**

RPA is a “software Robot” and it is equivalent to one software license. RPA is the future of all the business organization in terms of Automation. RPA “virtual Agents” ensembles with Artificial Intelligence supply cognitive capabilities to all domains of businesses. This type of automation is gradually being adopted by organizations but as it spreads, some challenge will also occur.

This research study explored the main topics of RPA such as what is RPA, its benefits, disadvantages, domains of RPA implementation, suitable process selection strategies, Intelligent Automation and its future challenges and opportunities. One of the most prominent challenges is to identify the potential of processes to be automated. Other challenges include that currently RPA not able to cope up with unstructured, exceptional and deviated data. This study provides the Future of RPA with AI/ML will uncover many possibilities across all the domains. As it becomes wide spread there would be challenges to monitor, test and control these RPA implemented “bots” for deviations and exceptions.

Though RPA has several benefits but this study founds certain future challenges to implement RPA successfully. Overcome these challenges will surely increase the productivity and efficiency of the Business processes in organizations.

**REFERENCES**

- [1] Vedder, R., & Guynes, C. S. (2016). The challenge of botsourcing. *Review of Business Information Systems (RBIS)*, 20(1), 1-4.
- [2] Van der Aalst, W. M., Bichler, M., & Heinzl, A. (2018). Robotic process automation. *Business & Information Systems Engineering*, 60(4), 269-272.
- [3] Pedretti, A., Santini, M., Scolimoski, J., Queiroz, M. H. B. D., Toshioka, F., Rocha, E. D. P., ... & Ramos, M. P. (2021). Robotic Process Automation Extended with Artificial Intelligence Techniques in Power Distribution Utilities. *Brazilian Archives of Biology and Technology*, 64.
- [4] Ansari, W. A., Diya, P., Patil, S., & Patil, S. (2019, April). A review on robotic process automation-the future of business organizations. In *2nd International Conference on Advances in Science & Technology (ICAST)*.
- [5] Mangu, S. (2020). ROBOTIC PROCESS AUTOMATION APPROACH. *Technology*, 11(11), 831-840.
- [6] Chakraborti, T., Isahagian, V., Khalaf, R., Khazaeni, Y., Muthusamy, V., Rizk, Y., & Unuvar, M. (2020, September). From robotic process automation to intelligent process automation. In *International Conference on Business Process Management* (pp. 215-228). Springer, Cham.
- [7] <https://www.uipath.com/rpa/what-is-process-mining>
- [8] Flechsig, C., Lohmer, J., & Lasch, R. (2019). Realizing the full potential of robotic process automation through a combination with BPM. In *Logistics Management* (pp. 104-119). Springer, Cham.
- [9] <https://www.bpmn.org/>.
- [10] Augusto, A., Conforti, R., Dumas, M., La Rosa, M., Maggi, F. M., Marrella, A., ... & Soo, A. (2018). Automated discovery of process models from event logs: review and benchmark. *IEEE transactions on knowledge and data engineering*, 31(4), 686-705.
- [11] Willcocks, L. P., Lacity, M., & Craig, A. (2015). Robotic process automation at Xchanging.
- [12] Le Clair, C., Cullen, A., & King, M. (2017). The Forrester Wave™: Robotic Process Automation, Q1 2017. Forrester Research.
- [13] Willcocks, L., Lacity, M., & Craig, A. (2017). Robotic process automation: strategic transformation lever for global business services?. *Journal of Information Technology Teaching Cases*, 7(1), 17-28.
- [14] Anagnoste, S. (2018). Robotic Automation Process–The operating system for the digital enterprise. In *Proceedings of the International Conference on Business Excellence* (Vol. 12, No. 1, pp. 54-69).
- [15] <https://www.uipath.com/resources/automation-analyst-reports/forrester-wave-rpa>
- [16] <https://www.gartner.com/reviews/market/robotic-process-automation-software>
- [17] Wright, D., Witherick, D., & Gordeeva, M. (2017). The robots are ready. Are you? Untapped advantage in your digital workforce.
- [18] Fersht, P., & Slaby, J. (2019). Robotic automation emerges as a threat to traditional lowcost outsourcing (HfS Research). Retrieved on, 22.
- [19] Anagnoste, S. (2017, July). Robotic Automation Process-The next major revolution in terms of back office operations improvement. In *Proceedings of the International Conference on Business Excellence* (Vol. 11, No. 1, pp. 676-686).
- [20] Willcocks, L., Lacity, M., & Craig, A. (2016). Robotic process automation at telefónica O2. *MIS Q Exec*, 15(1), 21-35.
- [21] Aguirre, S., & Rodriguez, A. (2017, September). Automation of a business process using robotic process automation (RPA): A case study. In *Workshop on engineering applications* (pp. 65-71). Springer, Cham.
- [21] Manyika, J., Chui, M., Bughin, J., Dobbs, R., Bisson, P., & Marrs, A. (2013). *Disruptive technologies: Advances that will transform life, business, and the global economy* (Vol. 180, pp. 17-21). San Francisco, CA: McKinsey Global Institute.
- [22] Asatiani, A., & Penttinen, E. (2016). Turning robotic process automation into commercial success–Case OpusCapita. *Journal of Information Technology Teaching Cases*, 6(2), 67-74.

- 
- [23] Khramov, D. (2018). Robotic and machine learning: how to help support to process customer tickets more effectively.
- [24] Primer, A. (2015). Introduction To Robotic Process Automation. Institute for Robotic Process Automation.
- [25] George, A., Ali, M., & Papakostas, N. (2021). Utilising robotic process automation technologies for streamlining the additive manufacturing design workflow. *CIRP Annals*, 70(1), 119-122.
- [26] Huang, F., & Vasarhelyi, M. A. (2019). Applying robotic process automation (RPA) in auditing: A framework. *International Journal of Accounting Information Systems*, 35, 100433.
- [27] Liu, W., Zhang, W., Dutta, B., Wu, Z., & Goh, M. (2020). Digital twinning for productivity improvement opportunities with robotic process automation: Case of greenfield hospital. *Int. J. Mech. Eng. Robot. Res.*, 9(2), 258-263.
- [28] Ratia, M., Myllärniemi, J., & Helander, N. (2018). The new era of business intelligence: Big Data potential in the private health care value creation. *Meditari Accountancy Research*.
- [29] Bhatnagar, N. (2019, March). Role of robotic process automation in pharmaceutical industries. In *International Conference on Advanced Machine Learning Technologies and Applications* (pp. 497-504). Springer, Cham.
- [30] Kokina, J., & Blanchette, S. (2019). Early evidence of digital labor in accounting: Innovation with Robotic Process Automation. *International Journal of Accounting Information Systems*, 35, 100431.
- [31] Hartley, J. L., & Sawaya, W. J. (2019). Tortoise, not the hare: Digital transformation of supply chain business processes. *Business Horizons*, 62(6), 707-715.
- [32] Rhouati, A., Ettifouri, E. H., Dahhane, W., & Abou Haidar, G. (2021, May). Impact of robotic process automation in supply chain: A model for task selection. In *2021 the 3rd International Conference on Robotics Systems and Automation Engineering (RSAE)* (pp. 17-20).
- [33] Fung, H. P. (2014). Criteria, use cases and effects of information technology process automation (ITPA). *Advances in Robotics & Automation*, 3.
- [34] <https://www.accenture.com/au-en/insight-robotic-process-automation-scaling-up>
- [35] Hallikainen, P., Bekkhus, R., & Pan, S. L. (2018). How OpusCapita Used Internal RPA Capabilities to Offer Services to Clients. *MIS Quarterly Executive*, 17(1).
- [36] Leshob, A., Bourgouin, A., & Renard, L. (2018, October). Towards a process analysis approach to adopt robotic process automation. In *2018 IEEE 15th International Conference on e-Business Engineering (ICEBE)* (pp. 46-53). IEEE.
- [37] Lamberton, C., Brigo, D., & Hoy, D. (2017). Impact of Robotics, RPA and AI on the insurance industry: challenges and opportunities. *Journal of Financial Perspectives*, 4(1).
- [38] Burgess, A. (2018). Starting an AI journey. *The Executive Guide to Artificial Intelligence*.
- [39] Suri, V. K., Elia, M., & Hillegersberg, J. V. (2017, February). Software bots-the next frontier for shared services and functional excellence. In *International Workshop on Global Sourcing of Information Technology and Business Processes* (pp. 81-94). Springer, Cham.
- [40] Vishnu, S., Agochiya, V., & Palkar, R. (2017). Data-centered dependencies and opportunities for robotics process automation in banking. *Journal of Financial Transformation*, 45(1), 68-76.
- [41] Hodge, B. (2017). How to manage risk and ensure control-what to look out for in robotic process implementation. Tech. rep.
- [42] Stople, A., Steinsund, H., Iden, J., & Bygstad, B. (2017). Lightweight IT and the IT function: experiences from robotic process automation in a Norwegian bank. *Bibsys Open Journal Systems*, 25(1), 1-11.
- [43] <https://www.uipath.com/blog/rpa/the-evolution-of-rpa-past-present-and-future>
- [44] Lacity, M., & Willcocks, L. (2021). Becoming Strategic with Intelligent Automation. *MIS Quarterly Executive*, 20(2), 1-14.
- [45] Syed, R., Suriadi, S., Adams, M., Bandara, W., Leemans, S. J., Ouyang, C., ... & Reijers, H. A. (2020). Robotic process automation: contemporary themes and challenges. *Computers in Industry*, 115, 103162.
-



- 
- [46] Pramod, D. (2021). Robotic process automation for industry: adoption status, benefits, challenges and research agenda. *Benchmarking: An International Journal*.
- [47] Geyer-Klingenberg, J., Nakladal, J., Baldauf, F., & Veit, F. (2018, July). Process Mining and Robotic Process Automation: A Perfect Match. In *BPM (Dissertation/Demos/Industry)* (pp. 124-131).
- [48] Madakam, S., Holmukhe, R. M., & Jaiswal, D. K. (2019). The future digital work force: robotic process automation (RPA). *JISTEM-Journal of Information Systems and Technology Management*, 16.
- [49] Moffitt, K. C., Rozario, A. M., & Vasarhelyi, M. A. (2018). Robotic process automation for auditing. *Journal of emerging technologies in accounting*, 15(1), 1-10.
- [50] Pedretti, A., Santini, M., Scolimoski, J., Queiroz, M. H. B. D., Toshioka, F., Rocha, E. D. P., ... & Ramos, M. P. (2021). Robotic Process Automation Extended with Artificial Intelligence Techniques in Power Distribution Utilities. *Brazilian Archives of Biology and Technology*, 64.
- [51] Khramov, D. (2018). Robotic and machine learning: how to help support to process customer tickets more effectively.
- [52] Wanner, J., Hofmann, A., Fischer, M., Imgrund, F., Janiesch, C., & Geyer-Klingenberg, J. (2019). Process selection in RPA projects—towards a quantifiable method of decision making.
- [53] Leno, V., Augusto, A., Dumas, M., La Rosa, M., Maggi, F. M., & Polyvyanyy, A. (2020, October). Identifying candidate routines for robotic process automation from unsegmented UI logs. In *2020 2nd International Conference on Process Mining (ICPM)* (pp. 153-160). IEEE.
- [53] Leopold, H., Aa, H. V. D., & Reijers, H. A. (2018). Identifying candidate tasks for robotic process automation in textual process descriptions. In *Enterprise, Business-Process and Information Systems Modeling* (pp. 67-81). Springer, Cham.
- [54] Augusto, A., Conforti, R., Dumas, M., La Rosa, M., Maggi, F. M., Marrella, A., ... & Soo, A. (2018). Automated discovery of process models from event logs: review and benchmark. *IEEE transactions on knowledge and data engineering*, 31(4), 686-705.
- [55] Tello, G., Gianini, G., Mizouni, R., & Damiani, E. (2019, September). Machine learning-based framework for log-lifting in business process mining applications. In *International Conference on Business Process Management* (pp. 232-249). Springer, Cham.
- [56] Jimenez-Ramirez, A., Reijers, H. A., Barba, I., & Valle, C. D. (2019, June). A method to improve the early stages of the robotic process automation lifecycle. In *International Conference on Advanced Information Systems Engineering* (pp. 446-461). Springer, Cham.
- [57] Bosco, A., Augusto, A., Dumas, M., Rosa, M. L., & Fortino, G. (2019, September). Discovering automatable routines from user interaction logs. In *International Conference on Business Process Management* (pp. 144-162). Springer, Cham.
- [57] Agostinelli, S., Lupia, M., Marrella, A., & Mecella, M. (2020, September). Automated generation of executable RPA scripts from user interface logs. In *International Conference on Business Process Management* (pp. 116-131). Springer, Cham.
- [58] Martins, P., Sá, F., Morgado, F., & Cunha, C. (2020, June). Using machine learning for cognitive Robotic Process Automation (RPA). In *2020 15th Iberian Conference on Information Systems and Technologies (CISTI)* (pp. 1-6). IEEE.
- [59] Evermann, J., Rehse, J. R., & Fettke, P. (2017). Predicting process behaviour using deep learning. *Decision Support Systems*, 100, 129-140.
- [60] Cewe, C., Koch, D., & Mertens, R. (2017, September). Minimal effort requirements engineering for robotic process automation with test driven development and screen recording. In *International Conference on Business Process Management* (pp. 642-648). Springer, Cham.
- [61] Montero, J. C., Ramirez, A. J., & Enríquez, J. G. (2019, May). Towards a method for automated testing in robotic process automation projects. In *2019 IEEE/ACM 14th International Workshop on Automation of Software Test (AST)* (pp. 42-47). IEEE.
- [62] Egger, A., ter Hofstede, A. H., Kratsch, W., Leemans, S. J., Röglinger, M., & Wynn, M. T. (2020, November). Bot log mining: Using logs from robotic process automation for process mining. In *International Conference on Conceptual Modeling* (pp. 51-61). Springer, Cham.
-

## SMART HOME ENERGY MANAGEMENT USING MATLAB

**Dr. J. Vijaya Kumar<sup>1</sup>, K. Saiharini<sup>2</sup>, B. Usharani<sup>3</sup>, J. Jayateja<sup>4</sup> and P. Priyanka Reddy<sup>5</sup>**<sup>1</sup>Professor and <sup>2,3,4,5</sup>Students (B.Tech), Department of EEE, Anil Neerukonda Institute of Technology and Sciences (Autonomous), Visakhapatnam**ABSTRACT**

*Although many steps are being taken to improve energy use in houses, current energy audit tools, and the energy audit process itself for large buildings still do not address continuous improvement over time. Despite many tools have already been developed to help energy auditors, and the energy audit process itself is well defined by now, no tool leverage the possibility of reusing measures from both Energy Conservation and Operation and Maintenance data from the audit report to identify appealing opportunities if the prices of the materials involved drop. In this paper energy auditing is analysed for home using MATLAB and suggested energy conservation measures for Homes and Buildings that will save the energy to a little higher extent by using Energy Efficient Devices. The result is compared by with and without energy conservation devices and it shows a great saving of units as well as money for the smart home.*

*Keywords: Energy Conservation, Energy Auditing, ECM's, Smart home, MATLAB.*

**1. INTRODUCTION**

Energy Auditing (EA) aims at inspecting and analyzing the energy flow of a building or system through a database in order to reduce the amount of energy spent. EA became a very important field during recent years, since it can be used to implement energy efficiency measures and achieve energy conservation, mainly in the industry sector that was responsible for 43% of the final energy used worldwide in 2011. Since most energy sources are finite, their cost will keep rising and therefore energy usage has to be traced and understood to be better managed. Therefore, there is a need for Energy Auditing. Since EA requires gathering, analyzing and evaluating all the relevant information of a facility, an Energy Auditor is needed. This information is saved for later analysis in order to suggest possible improvements that will result in energy efficiency measures. Although this may look simple and straight forward, it is not. And if a tool would be able to easily create and save scenarios over the current conditions, allow the continuous update of data without needing to redo all calculations, or to alert the energy audit or to changes in the building, this tool would vastly increase the ease of EA. EA gathers data regarding the building envelope, and power consumption sources, schedules or periods, weather factors and energy prices into data bases that end up containing a lot of information, which is very hard to explore manually[1].

EA should be done taking into account a vast variety of information about the building (e.g. walls, ceilings, floors, doors, windows), the energy appliances (e.g. heating, ventilation, air conditioning equipment, lights), environmental aspects (e.g. weather, solar orientation), and the energy bills of the previous years as well as data regarding the time at which the building is operating, and at what capacity.

This is done in order to identify if the rear areas in which the costs raised more than expected, and also, to detect appliances that although didn't suffer from increase of use cost, have become outdated and can be replaced for newer, more efficient technologies, that have proved to be more efficient. An energy audit is a technique for identifying energy losses, quantifying them, estimating conservation potential and evolving technological options for conservation and techno economics for the measures suggested. Its primary objective is to determine ways to reduce energy consumption per unit of product output or to lower operating cost [2].

In this paper energy auditing is analysed using MATLAB and suggested energy conservation measures for Homes and Buildings that will save the energy to a little higher extent by using Energy Efficient Devices.

**2. ENERGY AUDIT**

An energy audit is an inspection, survey and analysis of energy flows for energy conservation in a building, Process or system to reduce the amount of energy input into the system without negatively affecting the output. It shows where the power consumption is more in the given system. It can also be called as controlling of the power to avoid losses for maximize efficiency [3].

Energy savings of the order of 5 to 20% are possible by optimizing use of Energy with better housekeeping, low cost retrofitting measures and use of Energy efficient equipment at the time of replacement, renovation or up gradation. Indian industry consumes much more energy per unit production as compared to its counterparts in the developed countries. Energy Audit will help to understand more about the ways energy and fuel are used in

any industry, and help in identifying the areas where waste can occur and where scope for improvement exists. The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programs which are vital for production and utility activities. Such an audit programme will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc. In general, Energy Audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame. The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. Energy Audit provides a “bench- mark” (Reference point) for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization [4].

## 2.1 TYPES OF ENERGY AUDITS

Energy Audit is a schematic approach for decision making in the area of energy management. It is defined as the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving Energy Efficient with cost benefit analysis and an action plan to reduce energy consumption. There are two types of Audits [5]:

### A) PRELIMINARY AUDIT

The preliminary audit alternatively called a simple audit, screening audit or walk-through audit, is the simplest and quickest type of audit. It involves minimal interviews with site operating personnel, a brief review of facility utility bills and other operating data, and a walk-through of the facility to become familiar with the building operation and identify glaring areas of energy waste or inefficiency. Typically, only major problem areas will be uncovered during this type of audit. Corrective measures are briefly described, and quick estimates of implementation cost, potential operating cost savings, and simple payback periods are provided. This level of detail, while not sufficient for reaching a final decision on implementing proposed measures, is adequate to prioritize energy efficiency projects and determine the need for a more detailed audit.

### B) DETAILED ENERGY AUDIT

It is a comprehensive Audit provides a detailed energy project implementation since it evaluates all major energy using systems. It is an accurate method for Energy saving and Audit. In this audit mainly two phases are involved

Phase-I: Pre Audit Phase.

Phase-II: Audit Phase.

Phase-III: Post Audit Phase.

## 2.2 STEPS INVOLVED IN ENRGY AUDIT

- 1) **Interview with key facility person:** In this, Meeting is scheduled with auditor and all key auditing personals the meeting is focussed on Audit objectives, scope of work, facility rules and regulations, Roles and Responsibilities of members. In addition to these administrative issues, the discussion during this meeting seeks to establish: operating characteristics of the facility, energy system specifications, operating and maintenance procedures, preliminary areas of investigation, unusual operating constraints, anticipated future plant expansions or changes in product mix, and other concerns related to facility operations.
- 2) **Facility Tour:** After the initial meeting, a tour of the facility is arranged to observe the various operations first hand, focusing on the major energy consuming systems identified during the interview, including the architectural, lighting and power, mechanical, and process energy systems.
- 3) **Document Review:** During the initial visit and subsequent kick-off meeting, available facility documentation are reviewed with facility representatives. This documentation should include all available architectural and engineering plans, facility operation and maintenance procedures and logs, and utility bills for the previous three years. It should be noted that the available plans should represent "as-built" rather than "design" conditions. Otherwise, there may be some minor discrepancies between the systems evaluated as part of the audit and those actually installed at the facility.
- 4) **Facility Inspection:** After a thorough review of the construction and operating documentation, the major energy consuming Processes in the facility are further investigated. Where appropriate, field measurements are collected to substantiate operating parameters.

- 5) **Staff Interviews:** Subsequent to the facility inspection, the audit team meets again with the facility staff to review preliminary findings and the recommendations being considered. Given that the objective of the audit is to identify projects that have high value to the customer, management input at this junction helps establish the priorities that form the foundation of the energy audit. In addition, interviews were scheduled with key representatives designated by the facility as having information relevant to the energy audit. These representatives may include major energy consuming system service and maintenance contractors and utility representatives.
- 6) **Utility Analysis:** The utility analysis is a detailed review of energy bills from the previous 12 to 36 months. This should include all purchased energy, including electricity, natural gas, and fuel oil, liquefied petroleum gas (LPG) and purchased steam, as well as any energy generated on site.
- 7) **Identify/Evaluate Feasible ECMs:** Typically, an energy audit will uncover both major facility modifications requiring detailed economic analysis and minor operation modifications offering simple and/or quick paybacks. A list of major ECMs is developed for each of the major energy consuming systems (i.e., envelope, HVAC, lighting, power, and process). Based upon a final review of all information and data gathered about the facility, and based on the reactions obtained from the facility personnel at the conclusion of the field survey review, a finalized list of ECMs (energy conservation measures) is developed and reviewed with the facility manager.
- 8) **Economic Analysis:** Data collected during the audit is processed and analysed back in our offices. We build models and simulations with software to reproduce our field observations and develop a baseline against which to measure the energy savings potential of ECMs identified. We then calculate the implementation cost, energy savings and simple payback for each of the ECMs being investigated.
- 9) **Prepare a Report Summarizing Audit Findings:** The results of our findings and recommendations are summarized in a final report. The report includes a description of the facilities and their operation, a discussion of all major energy consuming systems, a description of all recommended ECMs with their specific energy impact, implementation costs, benefits and Payback. The report incorporates a summary of all the activities and effort performed throughout the project with specific conclusions and recommendations.
- 10) **Review Recommendations with Facility Management:** A formal presentation of the final recommendations is presented to facility management to supply them with sufficient data on benefits and costs to make a decision on which ECMs to be implemented [6].

### 3. RECOMMENDATIONS FOR LOW POWER CONSUMPTION IN HOMES AND BUILDINGS

A) **LIGHTING:** Take advantage of sunlight and leave lights off during the day. Use compact fluorescent light bulbs in place of conventional incandescent light bulbs. CFL uses approximately one-fourth the wattage of an incandescent bulb producing a similar level of illumination, and they last 8,000 to 10,000 hours. Install motion-detection switches or timers for outdoor lighting rather than leaving lights on all night. Replace incandescent night lights with LED or electro luminescent lights. Change conventional ballast with electronic ballast. Many automatic devices can help in saving energy used in lighting. Consider employing infrared sensors, motion sensors, automatic timers, dimmers and solar cells wherever applicable, to switch On/off lighting circuits.

B) **FANS:** As in case of lights, switch off the fans when not in use. If you are buying a new fan, buy energy efficient fans. Wherever your fan usage is more than 12 hours, replace them by energy efficient fans, you will get your money back in 2 years and after that it will be all bonuses for you.

C) **TV:** Most of the time, we keep the TV and associated electronic items (Set-up box, Speakers, etc.) on even when not in use. You may think that this does not consume a lot of electricity, but it does. Make it a habit to switch off the TV when you are not watching it.

D) **REFRIGERATORS:** Keep the refrigerator away from the wall by about half feet. Refrigerators throw out heat and this heat needs to escape. If we do not let the heat go away, its efficiency reduces. Also, do not keep your fridge stuffed with lot of food items. In winters, you can keep the fridge in min cool mode. If some container has very less food, try to finish it, as the fridge will waste more energy in keeping the container itself cool.

E) **AC's:** If you have one or more ACs at home, this is the item you should focus on the most to save electricity. Ensure that your doors and windows are properly closed when you use the ACs. Replace the old Air

Conditioner with Energy Efficient Equipment .Switching on the fan while using the ACs helps you in keeping the AC at a higher temperature old ACs use lot of electricity so better to replace it with new equipment.

#### **F) REDUCE ELECTRICITY USAGE:**

1. Turn off all electric appliances (lights, computers, televisions) when they are not in use. Computer printers and photocopiers are typically.
2. Watch TV with the light off
3. Change out a CRT TV with an LCD model of equivalent size.
4. Reduce miscellaneous electric use from power adapters and electronics in standby mode by plugging them into a power strip that can be switched off.
6. Set your computer to automatically shut off the monitor and switch to standby mode (if available) after a certain number of minutes of disuse. Choose a flat panel display instead of a conventional CRT. Adjust your display's brightness to the surrounding light conditions (less brightness is needed in dark rooms).
7. Purchase a laptop and use it as a replacement for your desktop computer. Most laptops are optimized for energy efficiency and don't need an uninterruptible power supply, since the battery can be used during thunderstorms.
8. Use products with the Energy Star logo (or similar). In particular, recycling and replacing old refrigerators with an Energy Star-approved one can save a few hundred kilowatt-hours a year. Replacing old refrigeration and air conditioning units (even if they are still functional) with more efficient ones is often an economically and ecologically sound decision.
9. Consider installing and using a clothes line for drying clothes. Each load not dried in an electric dryer saves 3 to 5 kilowatt hours.
10. Unplug appliances that will not be used for an extended period of time; many devices, especially consumer electronics, use a small amount of electricity even when they are switched off, due to indicator lights or listening for remote-control signals. Direct current converters, which are typically used to connect small consumer electronics devices to household power, lose a significant amount of energy as heat, even when the device is not plugged into the converter.
11. Refrigerator is probably among the biggest energy users in the home. Take special care to operate it efficiently:
12. Clean the condenser coils on your refrigerator to keep them operating efficiently.
13. Reduce the number of trips you make to the refrigerator/freezer and do not leave the door open unnecessarily.
14. Small refrigerators are often less efficient than larger models because they usually have less insulation or a less efficient compressor [7] [8].

#### **4. RESULTS AND DISCUSSIONS**

##### **Case Study:**

Calculation for total wattage consumption for existing devices:

1Unit =1 kWh=1000 W-h

1) Total number of T12Tube lights with 55w is:  $4 \text{ no} \times 55 \text{ w} \times 4 \text{ hours}$  daily consumption=512watts per day=0.512kWh.

2) Total number of Ceiling fans with 80w rating is 4 with 12 hours daily usage is  $=80 \text{ w} \times 4 \text{ no} \times 12 \text{ hrs}$  usage=3840 watts per

Day =3.84kWh daily Consumption.

3) Refrigerator (Single door) with 230 litres capacity= $800 \text{ w} \times 24 \text{ hours}$ =19200 watts per day=19.2 kWh per day.

4) Air conditioner 1.5 Ton= $2400 \text{ watt} \times 5 \text{ hrs}$ =12000 watts per day=12 kWh per day.

5) Heating: Electric Iron= $1100 \text{ watts} \times 1 \text{ hrs}$  daily=1100 watts per day=1.1 kWh per day.

6) Entertainment: Television= $188 \text{ w} \times 14 \text{ hours}$  daily=2632 watts=2.632 kWh per day.

7) Desktop computer=250w\*5hours=1250watts per day=1.25 kWh per day.

8) Other Appliances: Mixer =200\*2hrs=400 watts=0.4 kWh per day.

9) Washing Machine=1500w\*2hrs=3000watts =3.0 kWh per day.

10) Water Pump 1 HP=750\*1hrs=750watts=0.75 kWh per day.

Total power consumed by these regular Appliances is=44684 watts =44.684 kWh per day.

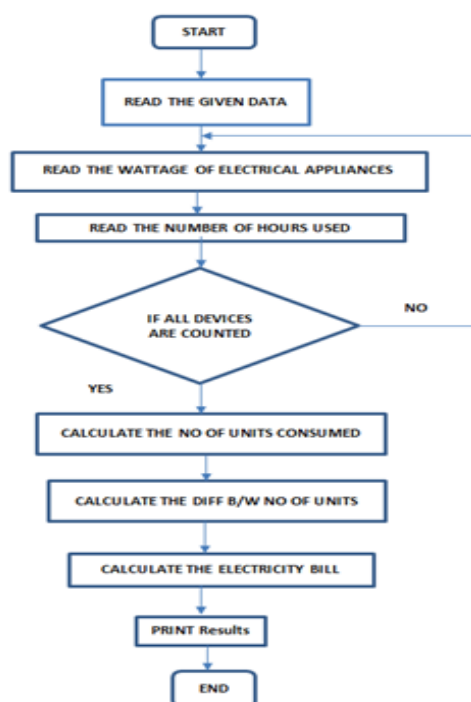
The above conservation options are considered and as a Case Study, these are applicable to the building unit (HOUSE). A program was written in the MATLAB and results were verified. The results showed that with these conservation options, there was a possibility of saving a power was possible. Electricity bill before Energy Conservation Options is calculated and compared with Electricity Bill after Conservation Options are implemented. This comparison shows that the number of units saved is 4800 and total savings per annum is Rs. 41, 383. These results were shown in the following Tables.

**Table1:** Appliances without conservation practice per annum

Appliance	Ratings in (watts)		Hours per day		No. of Items
Filament bulbs	60		3		2
Tube lights	40	50	6	3	2
Ceiling fans	80	75	10	5	1
Table fans	50		3		2
Mixers	750		0.08		1
Grinders	1500		0.3		1
Iron boxes	1000		0.5		1
Heaters	1500		0.5		1
Geysers	2000		0.16		1
Refrigerators	500		24		1
Television's	250		10		1
Washing m/c	2500		1		1

**Table2:** Appliances with conservation practice per annum

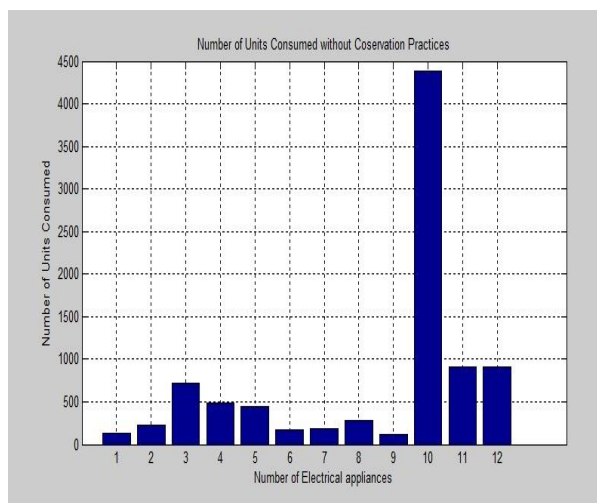
Appliance	Ratings in (watts)		Hours per day		No. of Items
CFL bulbs	20		3		3
Tube lights	20	20	6	3	2
Ceiling fans	50	50	10	5	1
Table fans	30		3		2
Mixers	500		0.08		1
Grinders	500		0.3		1
Iron boxes	500		0.3		1
Heaters	500		0.5		1
Geysers	1500		0.16		1
Refrigerators	250		24		1
Television's	150		10		1
Washing m/c	1500		1		1



**Fig.1**Flowchart for the MATLAB Program

**Table 3:** Comparison between with and without conservation practices per annum

Appliances	No. of units consumed per annum	Appliances	No. of units consumed per annum
Filament bulbs	131.400	Fluorescent bulb	65.700
Tube lights	229.950	Tube lights	109.500
Ceiling fans	720.875	Ceiling fans	456.250
Table fans	483.625	Table fans	306.600
Mixers	450.775	Mixers	288.350
Grinders	164.250	Grinders	54.750
Iron boxes	182.500	Iron boxes	54.750
Heaters	273.750	Heaters	91.250
Geysers	116.800	Geysers	87.600
Refrigerators	4380.000	Refrigerators	2190.000
Television's	912.500	Television's	547.500
Washing machine	912.500	Washing machine	547.500
<b>Total Units</b>	<b>8958.25</b>		<b>4158.5</b>
<b>Total Cost (Rs.)</b>	<b>87,361/-</b>		<b>45,978/-</b>



**Fig. 2** No. of Units Consumed without conservation practice

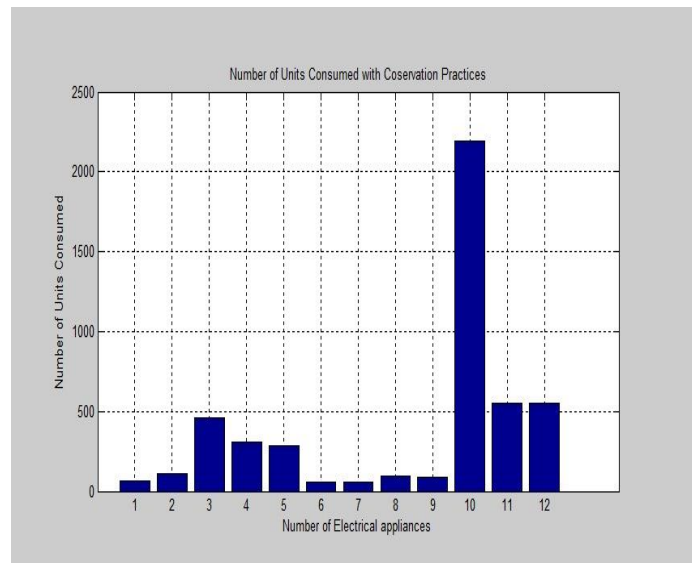
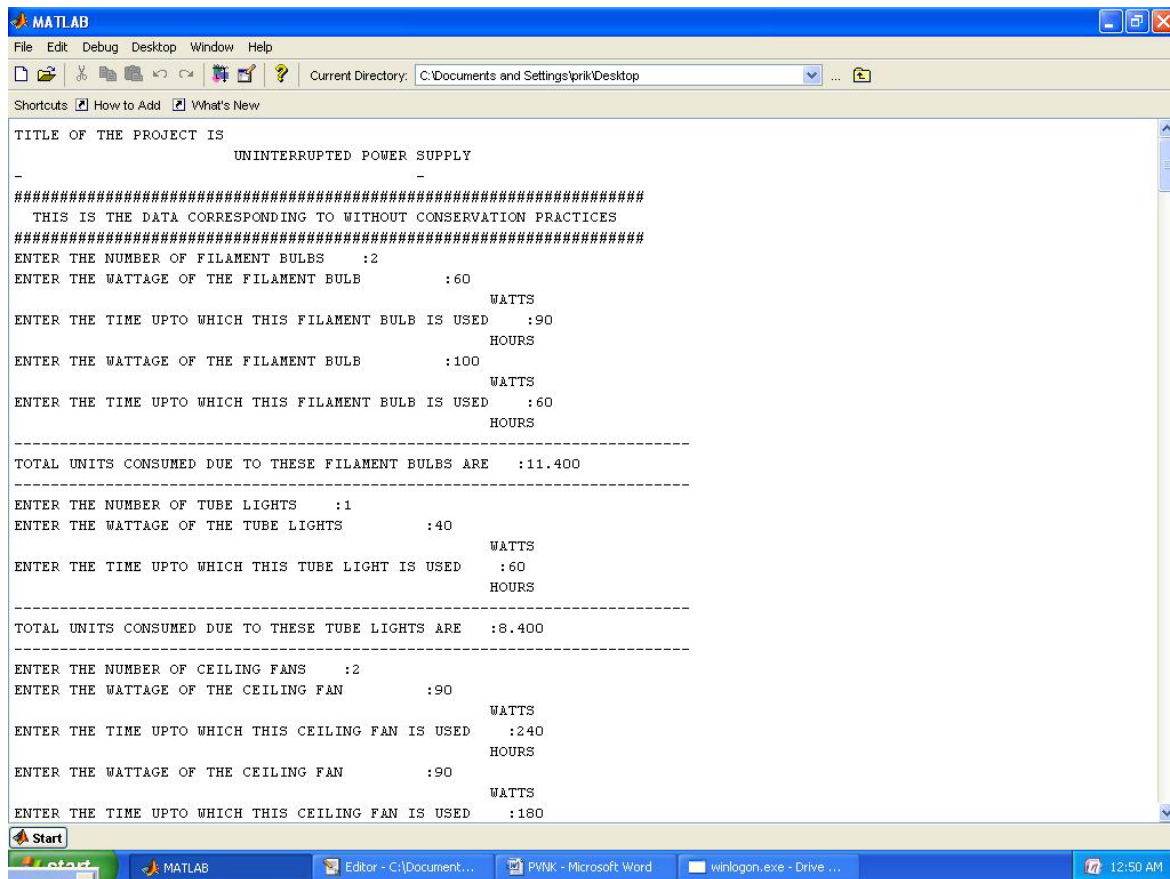


Fig. 3 No. of Units Consumed with conservation practice

```
Editor - C:\Documents and Settings\priki\Desktop\Fullprogram.m*
File Edit Text Cell Tools Debug Desktop Window Help
[Icons] Stack: Base
1 - clc
2 - clear
3 - disp('TITLE OF THE PROJECT IS ')
4 - disp('UNINTERRUPTED POWER SUPPLY')
5 - disp('-----')
6 - disp('#####')
7 - disp('THIS IS THE DATA CORRESPONDING TO WITHOUT CONSERVATION PRACTICES')
8 - disp('#####')
9 - b=0;
10 - d=0;
11 - g=0;
12 - j=0;
13 - i=0;
14 - FB=input('ENTER THE NUMBER OF FILAMENT BULBS :');
15 - if FB<=0
16 -     TOTAL1=0;
17 - end
18 - for i=1:FB
19 -     W(i)=input('ENTER THE WATTAGE OF THE FILAMENT BULB :');
20 -     disp('WATTS')
21 -     T(i)=input('ENTER THE TIME UPTO WHICH THIS FILAMENT BULB IS USED :');
22 -     disp('HOURS')
23 -     G(i)=W(i)*T(i);
24 -     total1=sum(G);
25 -     TOTAL1=(total1/1000);
26 - end
27 - disp('-----')
28 - fprintf('TOTAL UNITS CONSUMED DUE TO THESE FILAMENT BULBS ARE :%4.3f\n',TOTAL1)
29 - disp('-----')
30
31
32 - TL=input('ENTER THE NUMBER OF TUBE LIGHTS :');
33 - if TL<=0
34 -     TOTAL2=0;
35 - end
[Icons] script Ln 4 Col 57 OVR
MATLAB Editor - C:\Document... PWNK - Microsoft Word winlogon.exe - Drive ... 12:11 AM
```



A screenshot of the MATLAB software interface. The title bar says 'MATLAB'. The menu bar includes 'File', 'Edit', 'Debug', 'Desktop', 'Window', and 'Help'. The 'Current Directory' is 'C:\Documents and Settings\pri\k\Desktop'. The main workspace shows a script with the following text:

```
TITLE OF THE PROJECT IS
UNINTERRUPTED POWER SUPPLY
-
#####
THIS IS THE DATA CORRESPONDING TO WITHOUT CONSERVATION PRACTICES
#####
ENTER THE NUMBER OF FILAMENT BULBS      :2
ENTER THE WATTAGE OF THE FILAMENT BULB    :60
                                           WATTS
ENTER THE TIME UPTO WHICH THIS FILAMENT BULB IS USED :90
                                           HOURS
ENTER THE WATTAGE OF THE FILAMENT BULB    :100
                                           WATTS
ENTER THE TIME UPTO WHICH THIS FILAMENT BULB IS USED :60
                                           HOURS
-----
TOTAL UNITS CONSUMED DUE TO THESE FILAMENT BULBS ARE :11.400
-----
ENTER THE NUMBER OF TUBE LIGHTS          :1
ENTER THE WATTAGE OF THE TUBE LIGHTS      :40
                                           WATTS
ENTER THE TIME UPTO WHICH THIS TUBE LIGHT IS USED :60
                                           HOURS
-----
TOTAL UNITS CONSUMED DUE TO THESE TUBE LIGHTS ARE :8.400
-----
ENTER THE NUMBER OF CEILING FANS         :2
ENTER THE WATTAGE OF THE CEILING FAN      :90
                                           WATTS
ENTER THE TIME UPTO WHICH THIS CEILING FAN IS USED :240
                                           HOURS
ENTER THE WATTAGE OF THE CEILING FAN      :90
                                           WATTS
ENTER THE TIME UPTO WHICH THIS CEILING FAN IS USED :180
```

The taskbar at the bottom shows the 'Start' button, 'MATLAB' icon, 'Editor - C:\Document...', 'PVNK - Microsoft Word', 'winlogon.exe - Drive ...', and the system clock '12:50 AM'.

Fig.4 MATLAB code for energy management for a house

## CONCLUSION

By carrying out energy management, energy savings worth equivalent to 52.6% of the total bill identified. The total saving obtained by using energy conservative practices are Rs. 41,383/-per annum. Energy saving was possible and at the same time money also saved. Though this energy management pertains to building unit (HOUSE), almost all the suggestions are applicable to other houses, agricultural motors and industries. The results showed that there was a possibility of energy saving. Only one Conservation Technique was considered and the results were verified by writing a program in MATLAB.

## REFERENCES

- [1] IEMA Journal Perspective upon renewable energy, Vol 3, 2019.
- [2] K. Maharjan, Demand Side Management: Load Management, Energy Audit, Reliability, Urban, Semi-Urban and Rural Setting. Saar-brcken, Germany: LAP (LambertAcad. Publ.), 2010.
- [3] A.Alessandro, P.deGianluca, D.Paolo, V.Antonio, "Load Sceduling for House hold Energy Consumption", pp.64-23, vol.4, no.4, 2013.
- [4] A.Guillemmin and N.Morel, "Aninnovative lighting controller integrated in a self-adaptive building control system", Energy and Buildings, Vol.3, no.5, pp.477-87, 2001.
- [5] DHW Li and JC Lam, "Measurements of solar radiation and luminance on vertical surfaces and day lighting implications", Renewable Energy, vol.20, pp.389-404, 2000.
- [6] Guide to Electric Load Management by Anthony J.Pansini, Kenneth D.Smalling, Pernwell publications (1988).
- [7] Energy Management handbook by Tumer, Wayne C, Lilbum, The Fairmont press (2001).
- [8] Handbook of Energy Audits by Albert Thumann, Fairmount Press, 5<sup>th</sup> edition, 1998.

## POTENTIOMETRIC SENSOR FOR MEASURING AMMONIA AND AMMONIUM IONS IN LIQUID AND GASEOUS MEDIA

Sergey D. Aronbaev<sup>1</sup>, Charos A. Raimkulova<sup>2</sup>, Dmitry M. Aronbaev<sup>3</sup> and Kodirbek M. Narbaev<sup>4</sup>

<sup>1</sup>Professor, Department of Inorganic Chemistry and Materials Science, Academician of the Russian Academy of Natural Sciences

<sup>2</sup>PhD Student, Department of Inorganic Chemistry and Materials Science

<sup>3</sup>Associate Professor, Department of Inorganic Chemistry and Materials Science,

<sup>4</sup>Master Student, Department of Inorganic Chemistry and Materials Science, Samarkand State University, Uzbekistan, 140104 Samarkand, University Boulevard, 15

### ABSTRACT

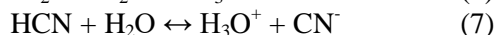
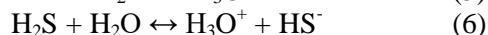
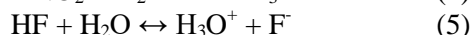
*The design of a potentiometric sensor for the determination of ammonia and ammonium ions in liquid and gaseous media using a pH sensitive electrode made of a graphite thin-walled tube impregnated with a saturated solution of quinhydrone is described. The results of testing the sensor are presented on examples of the determination of ammonia in model solutions and real objects, including drinking and waste water and air exhaled by a person. Shown is the Nernst dependence of the analytical signal on the concentration of ammonium ions with a slope of  $-53.2 \pm 1.5 \text{ mV} / \text{pNH}_4^+$  in the range of its concentrations from 0.017 to 170 mg / L ( $10^{-6}$  -  $10^{-2} \text{ M}$ ). High selectivity and reproducibility of the analytical signal were found.*

**Keywords:** gas gap electrode; graphite electrode; quinhydrone; pH measurement; ammonia

### INTRODUCTION

Ammonia is included in the list of toxic compounds in water and gas environments. Ammonia exists in water in two forms ( $\text{NH}_4^+$  - ammonium ion and  $\text{NH}_3$  - combined ammonia), which together make up total ammonia nitrogen. The ratio of these components depends on pH, temperature and the presence of high salt concentrations. In natural water, the total concentration of ammonia already at a concentration of  $0.25 \text{ mg L}^{-1}$  can be dangerous for fish and other aquatic animals. High concentrations of ammonia in drinking water and other water resources can lead to adverse effects on humans and the environment [1,2]. For this reason, ammonia is one of the substances that must be controlled in accordance with environmental standards. Acceptable levels of ammonia in fresh and drinking water range from  $0.5 \text{ mg L}^{-1}$  to  $3.0 \text{ mg L}^{-1}$ , subject to regulatory and regional specificities.

There are various methods for determining and assessing ammonia pollution in water and air. This list includes a wide variety and modification of spectrophotometric, potentiometric, ionometric, ion chromatographic and other methods. Each of these methods can be appreciated at their merits, but they also have a number of disadvantages, including either low sensitivity and reproducibility of measurements, or expensive equipment and the need to use scarce materials. Against this background, potentiometric methods for the determination of ammonia in aqueous and air environments can to a greater extent meet the requirements of analysis by the criterion "price-quality". This primarily concerns the use of ion-selective electrodes with the  $\text{pNH}_4^+$  function [3]. Difficult to overcome disadvantages of such sensors include low sensitivity and insufficient selectivity to ammonium ions in the presence of potassium, sodium, etc. ions. However, these disadvantages can be overcome by using the so-called "gas gap" electrodes. The literature describes the reactions [4] of the interaction of a number of gases with aqueous solutions of electrolytes, leading to a change in the pH of the solution:



In accordance with reactions (1) - (7), the corresponding ion-selective electrode can be used to determine each of these gases [5], and since all these reactions lead to the appearance of products that change the pH of the medium, then to determine these gases one can use glass pH electrode [6]. Thus, the EMF of a cell consisting of a pH electrode and a silver chloride reference electrode is related to the concentration of the analyzed gas (for example,  $\text{NH}_3$ ) in the analyzed solution in accordance with the Nairnst equation:

$$E = E^0 - S \lg C \text{ NH}_3,$$

where  $S$  is the slope of the electrode function.

The purpose of the work is to create a fundamentally new design of an electrode with a gas gap, sensitive to ammonia and ammonium ions.

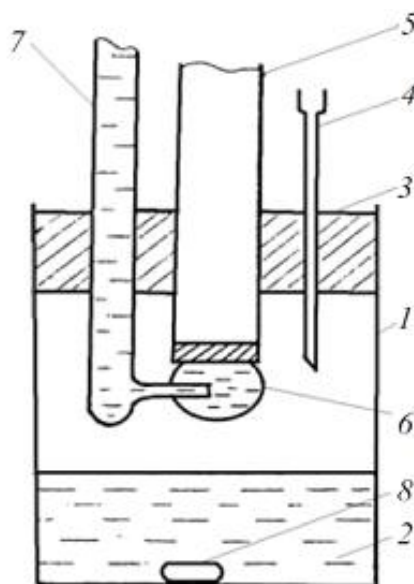
### EXPERIMENTAL

Thin-walled tubes made of graphite electrodes for emission analysis with dimensions of  $50 \times 6$  mm were used as a working pH-sensitive electrode. The wall thickness of the tube was 0.5-1.0 mm. The resulting workpiece was saturated with a quinhydrone solution under vacuum. The process was continued until the evolution of air bubbles ceased. The reference electrode was a silver chloride electrode. The sensor was assembled by fixing the graphite tube in the container of the sensor body intended for this with the help of rubber plugs. The vessel was filled with a saturated solution of quinhydrone.

A vessel filled with crystalline alkali, which was connected to the inlet end of a tubular electrode, served as a gas converter. Mass transfer of ammonia was carried out by a purified air flow supplied by a microcompressor. The sensor was connected to an automatic potentiometer. The sensor was calibrated using solutions of ammonium chloride with a known concentration, which were introduced into the gas-converter using a medical syringe or pipette micro-dispenser.

### RESULTS AND DISCUSSION

Figure 1 shows a schematic diagram of an electrochemical cell for the determination of ammonia using a gas gap electrode.



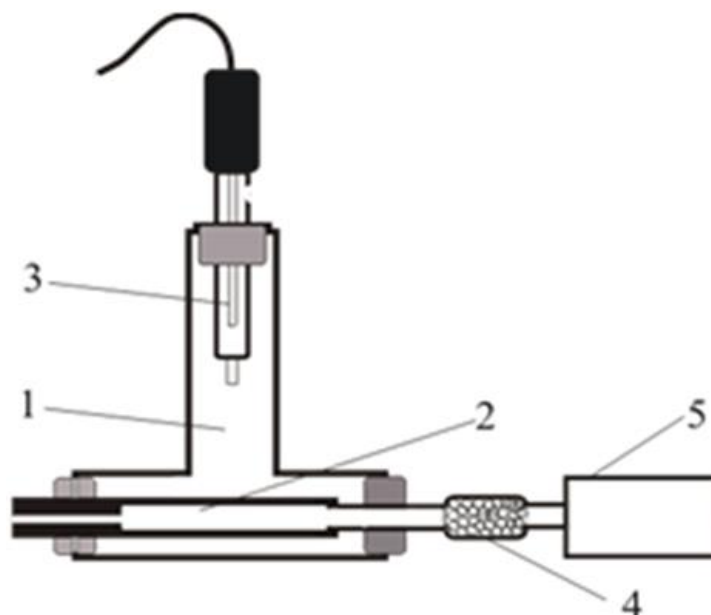
**Fig1.** Scheme of a gas-sensitive cell with a pH electrode:

- 1- Glass vessel;
- 2 - The analyzed solution;
- 3 - Rubber stopper;
- 4 -medical needle;
- 5 - PH sensitive electrode;
- 6 - Drop of electrolyte;
- 7 - Electrolytic bridge reference electrode;
- 8 - magnetic stirrer.

Such a gas-sensitive cell for the determination of ammonium ion [7] includes a vessel closed with an electrode system of an integrated (combined) electrode and a salt bridge. The integrated electrode is a structurally combined indicator glass electrode and a silver chloride reference electrode. The near-electrode electrolyte layer is held on the surface of the integrated electrode from below by means of an annular ring made of hydrophilic

material. When alkali is added to the analyzed solution stirred with a magnetic stirrer, part of the gaseous ammonia diffuses through the air gap into the near-electrode layer of the electrolyte, in which the change in pH is recorded. The main disadvantages of such a sensor are: the complexity of the design, insufficient reproducibility of the analytical signal, the difficulty of reproducing the hanging of the near-electrode electrolyte drop on the indicator electrode, the inertia associated with the mass transfer of gaseous ammonia, as well as non-selectivity in the presence of volatile organic substances (alcohols, aldehydes, amines). Replacing a sensitive glass electrode in a pH sensor with an ammonium selective electrode based on nonactin, as described in [8], does not simplify the design of the cell. In this case, the main disadvantages of the described sensor remain: the complexity of the design, relatively large dimensions, insufficient reproducibility of renewal of the near-electrode electrolyte layer, inertia associated with a number of diffusion restrictions, the need to introduce alkali into the analyzed solution to shift the equilibrium between ammonium ions and ammonia towards the formation of gaseous ammonia.

We propose a fundamentally new design of an electrochemical cell for the potentiometric determination of ammonia in water and air. (Fig 2) [9].



**Fig 2.** Sensor circuit for the determination of ammonia (ammonium ions):

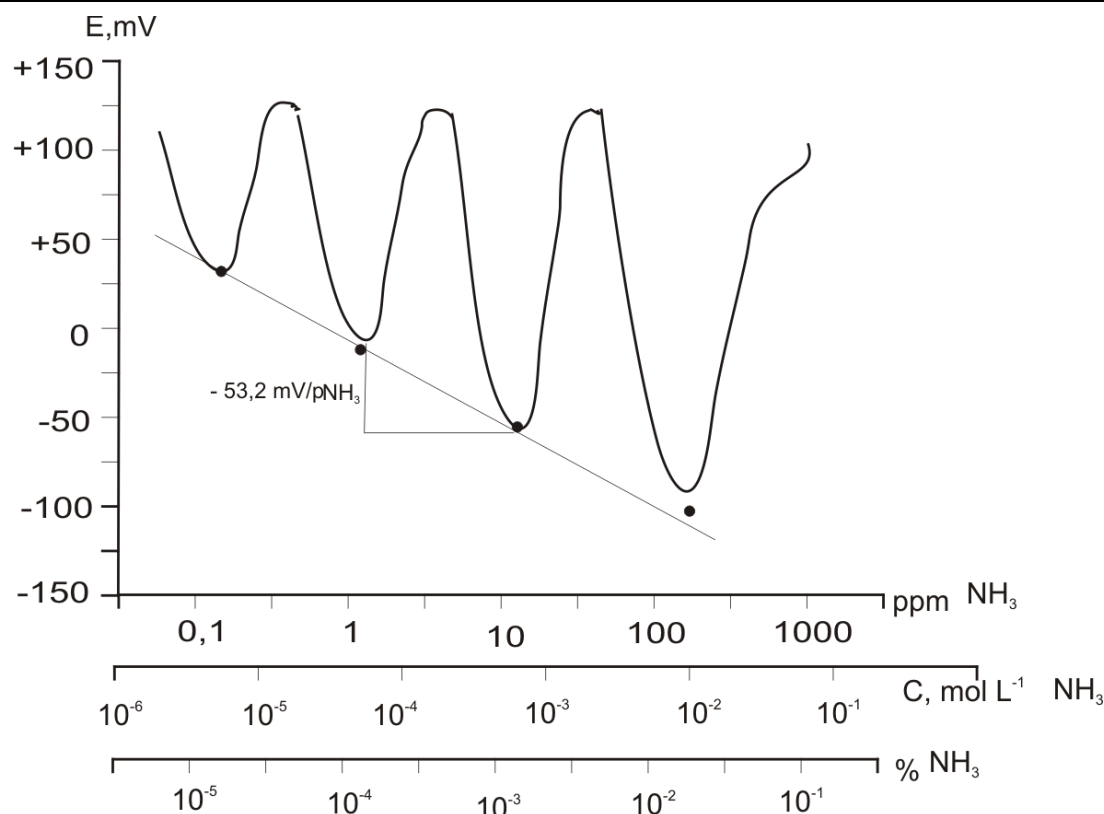
1. - vessel-body filled saturated solution of quinhydrone;
2. - Indicator electrode in the form thin - walled porous tube graphite material;
3. - silver chloride reference electrode.
4. Gas conversion capacity, with crystalline alkali or calcium oxide;
5. micro-compressor.

The design feature is the use as a pH-sensitive element - a thin-walled tubular graphite electrode, impregnated with a saturated solution of quinhydrone [10].

In this case, the quinhydrone itself, located in the pores of the electrode, performs the function of a near-electrode electrolyte and its volume is incomparably small, in relation to a drop suspended on the surface of a glass pH electrode, as described in known sensors with an electrode with a gas gap. As a result, the sensitivity and reproducibility of the system increases, and its inertia decreases. Gas transformation of ammonium ions from solution into gaseous ammonia occurs in a gas-converting vessel filled with crystalline NaOH or calcium oxide, into which the analyzed sample enters, entrained by a stream of air created by a microcompressor.

With all this, the problem of simplifying the design of the sensor is solved, since the introduction of alkali into the solution is not required, the mixing of the analyzed solution is excluded, the problem of hanging an electrolyte drop on the indicator electrode is solved. The sample to be analyzed is injected using a syringe or pipette micro-dispenser into a gas-converting container. The cell is calibrated against standard solutions of ammonium chloride in the range of  $10^{-6}$  -  $10^{-2}$  M. (which may correspond to 0.017 - 170 ppm) [11].

The calibration dependence  $E = fC_{\text{NH}_3}$  is shown in Figure 3.



**Fig 3.** Calibration dependence  $E = fC_{\text{NH}_3}$

It was found that the slope of the electrode function of the gas-sensitive cell has a value close to sub-Nerst, and is  $53.2 \pm 1.5 \text{ mV} / \text{pNH}_4^+$  at  $25^\circ\text{C}$ . The performance of the sensor was tested using model solutions and samples of natural and waste waters. For this, a 0.2 - 0.5 ml sample to be analyzed was injected through a valve into a gas-converting vessel with crystalline NaOH. The air flow supplied by the micro-compressor was 120 ml / min.

Table 1 shows the results of assessing the reproducibility and accuracy of the determination of ammonium ions.

**Table I.** Evaluation of the reproducibility of the dermination of ammonium ions in waters (in terms of ammonia)

Content range, $\text{mg L}^{-1}$ (as $\text{NH}_3$ )	Additive amount		Number tests, n	$S_r$
	entered	found		
0.017 – 0.17	0.034	0.030	8	0.122
0.17 – 1.70	0.85	0.90	10	0.078
1.7 – 17	4.25	4.20	10	0.055
17 – 170	42.5	39.8	8	0.082

From table 1 it follows that in the range of  $\text{NH}_4^+$  -ions contents from 0.017 to 170  $\text{mg L}^{-1}$ , which corresponds to  $10^{-6} - 10^{-2} \text{ M}$ , the relative standard deviation does not exceed 0.122 (12.2%).

The assessment of the correctness of the determination by the Student's criterion showed that the systematic error is insignificant. Moreover, in the range of 0.17 - 17  $\text{mg L}^{-1}$  ( $10^{-5} - 10^{-3} \text{ M}$ ), which corresponds to 0.17 - 17 ppm - the relative standard deviation is the smallest, and does not exceed 8%.

The high sensitivity of the sensor and the accuracy of measuring ammonia allows the sensor to be used to determine ammonia in the air exhaled by a person for the purpose of non-invasive diagnosis of bacterial infection with *Helicobacter pillory* using the urease test.

For this, a urease test was performed in a group of 15 patients. The measurements were carried out twice: before and after taking 100 ml of a 1% urea solution by the subjects. Considering the large scatter of the results obtained for healthy individuals (reference zone), a clear excess of the obtained values compared to the initial values was taken as a reliable determination of the presence of *Helicobacter pillory* [12-15].

The exhaled air was taken into elastic containers with a volume of up to two liters. Re-measurement after the patient took the urea solution was carried out after 20 minutes. A qualitative assessment of the presence of *Helicobacter pillory* was carried out.

In most of the subjects, the initial ammonia content in the exhaled air was in the range of 0.2-1.2 ppm.

After the "urease" test, an increase in the ammonia content to 1.7-2.0 ppm was observed, and only two had this indicator of 15-28 ppm, which clearly indicated infection. Thus, the proposed sensor can be used for biomedical research for the purpose of non-invasive screening of *Helicobacter pylori* infection.

## CONCLUSION

For the determination of ammonia / or ammonium, a fundamentally new design of a pH-sensitive electrode with a gas gap has been proposed. A feature of such a measuring electrode is the manufacture of a thin-walled tube made of graphite of spectral purity, the pores of which are impregnated with quinhydrone. The sensor in the concentration range of ammonia / ammonium  $10^{-6}$  -  $10^{-2}$  M shows the Nernst dependence with a slope of  $-53.2 \pm 1.5$  mV /  $\text{pNH}_4^+$  at 25 °C. The ammonia sensor has been tested in water and human respiration to detect *Helicobacter pylori* infection.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest whatsoever.

## REFERENCES

1. L. J. Dobler, J. M. Gibbons, V. Yu. Evtodienko, US Patent No 7033839, Issued April 25th (2006).
2. Dong Kim Loan, Tran Hong Con, Tran Thi Hong and Luong Thi Mai Ly, Environmental Sciences, 2(1) (2013), 83 (<http://dx.doi.org/10.12988/es.2013.31010>.)
3. D. Midgley, K. Torrance, Potentiometric analysis of water, Mir, Moscow, 1980, 519 p. <https://www.twirpx.com/file/455489/>.
4. G. I. Bebesko, E. M. Nesterina, Industrial laboratory. Diagnostics of materials. 82(5) (2016) 9 ([https://www.zldm.ru/jour/article/view/245?locale=en\\_US](https://www.zldm.ru/jour/article/view/245?locale=en_US)). .
5. K. Kamman, Working with ion-selective electrodes, Mir, Moscow, 1980, 285 p.
6. P. Bates, Determination of pH, theory and practice, Chemistry, Leningrad, 1972. <https://www.twirpx.com/file/2333054/>.
7. Ye. B. Nikolskaya, Academician B. P. Nikolsky, A life, Proceedings, School: Collection / Ed. A. A. Belyustin, F. A. Belinskaya, Publishing house of S.-Pb. University, 2000, p. 251 - 266. [http://elib.biblioatom.ru/text/akademik-nikolskiy\\_2000/go,0/](http://elib.biblioatom.ru/text/akademik-nikolskiy_2000/go,0/).
8. G. I. Bebesko, E. M. Nesterina, Patent RU2168720 C1, Issued (10 June (2001)). <https://patent.ru/patent/RU2168720C1>.
9. D. M. Aronbaev, S. D. Aronbaev, Ch. A. Raimkulova, Application for a patent of RUz No. IAP 20210436, 30 August 2021.
10. S. D. Aronbaev, D. M. Aronbaev, Kh. N. Kholmiraeva, D. T. Isakova, G. N. Narmaeva, Universum: chemistry and biology, 68 (2020), 21. URL: <https://7universum.com/ru/nature/archive/item/8650>.
11. Converter of gas concentration units / <https://www.gazoanalizators.ru/converter.html>. (14 October 2021).
12. Ch. A. Raimkulova, S. D. Aronbaev, D. M. Aronbaev, Universum: chemistry and biology: electron. scientific. zhurn. 79, (2021). URL: <https://7universum.com/ru/nature/archive/item/11153>.
13. S. L. Lukash, Computers and systems, 9, (2010), 62 <http://dspace.nbuv.gov.ua/bitstream/handle/123456789/46391/07-Lukash.pdf>.
14. F. Yu. Kopylov, et. all., Clinical Medicine, 10 (2013), pp. 16-21. <https://cyberleninka.ru/article/n/perspektivy-diagnostiki-razlichnyh-zabolevaniy-po-sostavu-vydyhaemogo-vozduha/pdf>.
15. Ch. Raimkulova, S. D. Aronbaev, S. M. Vasina, D. M. Aronbaev, Austrian Journal of Technical and Natural Sciences, 1-2 (2020), 47. <https://doi.org/10.29013/AJT-20-1.2-47-5>.

## A SURVEY ON MARKET STATUS OF KNEE SLEEVE

Shivangi Agarwal<sup>1</sup>, Dr. Shalini Juneja<sup>2</sup> and Dr. Sumit Nathani<sup>3</sup><sup>1</sup>Research Scholar and <sup>2</sup>Associate Professor, Department of Home Science, Banasthali Vidyapith, Rajasthan<sup>3</sup>Associate Professor, Department of Dravyaguna, National Institute of Ayurveda, Jaipur, Rajasthan

## ABSTRACT

Pain is an unpleasant sensory or emotional experience associated with actual or potential tissue damage. Knee pain is prevalent among all age groups at present. The purpose of the present study was to explore the market status of available knee sleeves. The survey was divided into nine categories viz. sleeves type, available sleeves, fibers present in knee sleeves, thickness of knee sleeves, consumer's age, purpose of knee sleeves, cost of knee sleeves and any complaints for knee sleeves. The self-structured questionnaire was developed as a tool for the study. The 50 medical store owners were surveyed to gather information. Findings indicated that majority of the store owners had simple type of knee sleeve. Majority of the stores had Tynor and Profix brands knee sleeve. Nylon fiber was majorly used as the raw material for knee sleeve. The results showed that thickness of majority of the knee sleeves vary from 1-2 mm. It was also seen that majority of the consumers for both using and purchasing the knee sleeves belong to the age group of 40-50 years. All the medical stores had knee sleeves ranging from 100-300 rupees and 75 per cent medical stores had knee sleeves ranging above 300 rupees. None of the medical store had received any complain from consumers regarding knee sleeves. Hence, it can be concluded that majority of the consumers use knee sleeve as a remedy for relieving pain.

Keywords: knee sleeve, compression garment, knee pain, chronic venous disease.

## INTRODUCTION

According to World Health Organization (2010), pain has been defined as “an unpleasant sensory or emotional experience associate with actual or potential tissue damage, or described in terms of such damage” (Beautily *et al.*, 2020).

Knee pain is a common musculoskeletal symptom among working age people. The prevalence of knee pain varies from 10 to 60 % depending on occupation, age and the definition of knee pain.

Knee pain may occur because of other reasons that osteoarthritis and the risk factors may also differ than osteoarthritis (Miranda *et al.*, 2002). An injury, such as torn cartilage or ruptured ligament may result in knee pain. Medical conditions like gout, arthritis and infection also can cause knee pain. It is a recognized medical problem resulting in further non-communicable diseases which are widely increasing throughout the world. It is affecting 15% to 40% of the people over 40 years of age globally.

Knee pain treatment options are alienated into three categories: surgery, rehabilitation and drug therapy. Surgery includes joint replacement and gel injections. Medicines are taken by patients in drug therapy. Rehabilitation includes clinical practice (therapy) and kinesio taping (KT). KT tapes are of two types: elastic and non-elastic (Abolhasani *et al.*, 2019). Compression therapy is the only method to cure venous leg ulcers, as there is no surgery or medication to cure it. Compression therapy primarily enhances the blood flow back to the heart, reduce oedema, improves the functioning of calf muscle pumps and valves and also prevents the veins swelling. It should also be noted that compression therapy may be harmful if not applied properly, as they provide high pressure as well as high tension (Rajendran and Anand, 2014). Compression garments are the leading edge proposal for the management of venous diseases and to avoid their re-occurrence through compression treatment (Kumar *et al.*, 2014).

The principle of compression garment is established on the principle of Laplace. When a constant tension is applied by a compression garment on a limb of increasing circumference, it gives sub-bandage pressure incline with bandage tension (directly proportional) but limb circumference is inversely proportional. The fabric structure, yarns elastomeric property as well as applied finish to the fabric determines the sub-bandage pressure ability of a compressor garment (Rajendran and Anand, 2014).

Compression garments are adapted in the area of chronic venous disease (CVD), orthopaedic support, sportswear, scare treatment and body shaping. Compression wears are extraordinary clothes that contain elastomeric yarns or fibers that are responsible for applying significant mechanical pressure on the required body surface for compressing, stabilizing and supporting underlying tissues. Compression garments are fabricated for a specific body region and in the form of gloves, bandages, face masks, stockings, sleeves and bodysuits (Xiong and Tao, 2018).

Knee sleeves are mostly elastic compression garment and used to relieve pain and to improve function and quality of life (Schween *et al.*, 2015).

The research work had been carried out with objective to explore market status of available knee sleeves.

### MATERIAL AND METHODS

Market status of knee sleeves was studied through survey method. The self-structured questionnaire was developed as a tool for the market survey.

**Construction of Questionnaire:** A self-structured questionnaire was developed consisting of close-ended and open-ended questions. The information about types of available knee sleeves in market, brands, fiber composition and price range, need of knee sleeves and other related aspects was collected through questionnaire which helped in extracting the meaningful results.

**Data Collection:** The data was collected from 50 medical store owners or retailers in Uttarakhand through developed questionnaire. Medical store owners or retailers were selected through convenience sampling method.

**Data Analysis:** Data was gathered and analyzed on the basis of the responses given by the respondents. Frequency and percentage of responses was calculated.

### RESULTS AND DISCUSSION

The present study was done to understand knee sleeves status and availability in the market. The survey was carried out in Uttarakhand. The survey was divided into nine categories *viz.* sleeves type, available sleeves, fibers present in knee sleeves, thickness of knee sleeves, consumer's age, purpose of knee sleeves, cost of knee sleeves and any complaints for knee sleeves. The 50 medical store owners were surveyed to gather information and the findings of survey are presented below.

#### Sleeves Type

Simple knee sleeve	100
Padded knee sleeve	0

Gel knee sleeve	20
Adjustable knee sleeve	20
Other	0

It was seen that all the stores had simple knee sleeves available for the sale, which was followed by only 20 per cent stores had gel knee sleeve and adjustable knee sleeve and none of the store had padded knee sleeve.

#### Available Sleeve Brand

Tynor	30
Vector	65
Profix	35
Dr.ortho	65
Other	5

When surveyed for different brands of knee sleeves available in the shops it was found that Tynor and Profix brand knee sleeves was available in only 30 and 35 per cent stores respectively. Whereas, Vector and Dr. Ortho brand knee sleeves were available in 65 per cent shops and about 5 per cent shops had other brands knee sleeves.

#### Fibers Present in Knee Sleeves

Cotton	35
Wool	30
Nylon	100
Polyamide	0
Other	0

During the study it was found that nylon knee sleeves were available in 100 per cent stores. Whereas, wool and cotton knee sleeves were present in only 30 and 35 per cent stores respectively. Also it was found that polyamide and other fabric knee sleeves were not available in any shops.



**Thickness of Knee Sleeves**

Below 1 mm	0
1-2 mm	100

2-3 mm	0
Above 3 mm	0

The thickness of knee sleeves was found to be 1-2 mm in 100 per cent shops.

**Consumer's Age Distribution**

Below 30 years	40
30-40 years	65
40-50 years	75
Above 50 years	50

The result shows that the maximum knee sleeve users/consumer belong to the age group of 40-50 years viz. 75 per cent. Followed by the 65 per cent of consumers that belong to 30-40 years of age group, then which was followed by 50 per cent consumers who belongs to the age group of above 50 years and least usage of knee sleeve was seen in 30-40 years of age group i.e. 40 per cent.

**Purpose of Knee Sleeves**

Relieving pain	94
Supporting ligament	20
Sports or gym	50
Dance	0

During study it was found that 94 per cent consumers purchase knee sleeves for pain relief, 50 per cent consumers purchase it for the purpose of sports and gym and 20 per cent consumers for the usage as supporting ligament. None purchased for the purpose of dance at stores.

**Cost of Knee Sleeves**

Below 100 rupees	8
100-200 rupees	100
200-300 rupees	100
Above 300 rupees	75

It was observed that all stores had knee sleeves ranging from rupees 100 to 300, 75 per cent stores had knee sleeves ranging above 300 and only 8 per cent stores had knee sleeves below 100 rupees.

**Complaints for Knee Sleeves**

None of the medical store had received any complain from consumers regarding knee sleeves.

**CONCLUSION**

Studies indicate that compression therapy may help in inflammation, reduce muscular structural damage and pain management, as it compress the underlying veins and tissues and create pressure to increase the blood flow speed by applying mild pressure to that specific muscle group. The present study showed that simple knee sleeve was available in majority of the medical stores and Tynor and Profix is the most preferred brand by the medical store owners for knee sleeves. Nylon fiber was present in majority of the knee sleeves as raw material for its construction. Majority of the knee sleeve consumers belong to 40-50 years of age group and purchase it for pain relief.

**REFERENCES**

- Abolhasani, M., Halabchi, F., Afsharania, E., Moradi, V., Ingle, L., Shariat, A. and Hakakzadeh, A. (2019). Effects of kinesiotaping on knee osteoarthritis: A literature review. *Journal of Exercise Rehabilitation*, 15(4), 498-503. DOI: <http://doi.org/10.12965/jer.1938364.182>.
- Beautily, V., Bhuvaneswaran, D., Esaivani, V.D. and Sherin, P.L. (2020). Effectiveness of camphor oil application on arthritis among geriatrics at Kondancheri rural area. *International Journal of Applied Research*, 6(11), 74-76. Retrieved from: <https://www.allresearchjournal.com/archives/2020/vol6issue11/>

---

PartB/6-10-539-289.pdf.

- Kumar, B., Das, A. and Alagirusamy, R. (2014). Science of compression bandage. New Delhi: Woodhead Publication India Pvt. Ltd., 90, 103.
- Miranda, H, Juntura, E.V., Martikainen, R. and Riihimaki, H. (2002). A prospective study on knee pain and its risk factors. Osteoarthritis and Cartilage, 10, 623-630. DOI: 10.1053/joca. 2002.0796.
- Rajendran, S. and Anand, S.C. (2014). High-performance textiles for wound care. In Lawrence, C.A. (Ed.), High-performance Textiles and Their Applications, woodhead publishing, U.K.190-222. DOI: 10.1533/9780857099075.190.
- Schween, R., Gehring, D. and Gollhofer, A. (2015). Immediate effects of an elastic kneesleeve on frontal plane gait biomechanics in knee osteoarthritis. Plos One, 10(1), 1-11. DOI: 10.1371/ journal. Pone. 0115782.
- Xiong, Y. and Tao, X. (2018). Compression garments for medical therapy and sports. Polymers, 10(663), 1-19. DOI: 10.3390/polym10060663.

---

**A STUDY ON IMPACT OF BEHAVIOURAL FINANCE ON INVESTMENT DECISION OF  
INDIVIDUAL INVESTORS IN HIMACHAL PRADESH**

**Sunil Kumar**

Research Scholar, HPKV BS, School of Commerce and Management Studies, Central University of Himachal Pradesh

**ABSTRACT**

*The goal of this research is to determine the potential influence of behavioural finance on the investing decisions of Himachal Pradesh's individual investors. As Himachal Pradesh is a Himalayan state and there are very limited options available to Individual Investors in Himachal Pradesh to invest their savings. The most popular investment avenue in Himachal are Savings A/C, FD, Gold, Post office Savings Accounts and Public Provident Fund. Most individuals in Himachal Pradesh are salaried employees, thus the decisions they make must be solid, since they cannot afford a second chance. This study is also part of an initiative to investigate the influence of behavioural biases on individual investors' investment decisions in Himachal Pradesh. A questionnaire is created, and responses are gathered from 203 respondents who prefer to invest in areas with little or moderate risk, and are more concerned about losses in their investments than big gains. Furthermore, the majority of respondents were saving for a specific goal, such as their retirement plan or to educate their children. This study finds that an investor's risk-taking ability is determined by their degree of income and the sources of their income. Although everyone has biases, individuals tend to think more rationally than ordinary investors in many aspects since they are aware of their needs and the investments they make.*

*Keywords: Investment Behaviour, Himachal Pradesh, Individual Investors.*

---

CLINICAL STUDY ON THE EFFECT OF SIRAVYADHANA ALONG WITH TRISHOTHADI  
LEPAM ON VENOUS FOOT ULCERS

---

**Dr. Devyani Dasar (Jaiswal)**

Associate Professor, Department of Shalya-Tantra, Mahatma Gandhi Ayurved College, Hospital & Research Centre, Datta Meghe Institute of Medical Sciences (DU), Wardha, Maharashtra, India

**ABSTRACT**

**Background:** An ulcer is a break in the continuity of the covering epithelium, either skin or mucous membrane due to molecular death. Usually progressive infection, non-debridement and continuous anti-gravitational stasis does have bad impact in the management of foot ulcers.

**Aim:** A long term multidisciplinary care and integration of traditional new wound healing technologies are required for healthy healing.

**Materials and Methods:** Siravyadhana (venepuncture) parasurgical procedure with Trishothadi Lepam was used in the present study.

**Results:** Siravyadhana has shown better results in wound healing process than having cumulative 71.60% respectively.

**Conclusion:** The process of Siravyadhana was effective for relieving vascular stasis, reducing venous congestion and beginning of revascularization and other wound healing process than Siravyadhana throughout the study.

**Keywords:** Siravyadhana, Trishothadi Lepam, Venous Foot ulcers, Parasurgical Procedure.

---

**EVALUATION OF EFFECTIVENESS OF MICROLEARNING METHOD AMONG  
UNDERGRADUATE STUDENTS- A WAY OF MINDFUL EDUCATION STYLE IN STRESS  
MANAGEMENT**

---

**Dr. Reena Jaiswal**

Associate Professor, Department of Shalya –Tantra (Surgery), Mahatma Gandhi Ayurved College, Hospital & Research Centre, Salod (H), Wardha, Maharashtra, India

**ABSTRACT**

**Background:** Stress affects everyone from time to time and not all stress is harmful. However, high levels of stress over time can negatively affect your mental and physical health and may be a risk factor for depression or anxiety. They typically include behaviours that improve physical health, nutrition and exercise, but also incorporate strategies that improve cognitive and emotional functioning. The stress-reduction approach based on mindfulness practices has recently enjoyed an explosion of interest from a variety of healthcare and epidemiological researchers. E-Learning is training, learning, or education delivered online through a computer or any other digital device. It also can be termed as a community enabled switch of competencies and knowledge. Microlearning is a form of continuous training and learning in which complex chunks of information are broken down into simplified sections that are taught over a period employing the benefits of repetition. Aim: The aim of this study is to evaluate the effectiveness of Microlearning method among undergraduate students

**Objectives:** To introduce Microlearning method among undergraduate students

**Methodology:** The undergraduate Final year BAMS students of MGAC.H & RC will be selected for the study and equally divided in two equal groups i.e A and B. 'Inguinal Hernia' will be taken as study topic. In Group A, topic will be taught by CBME method while in Group B it will be taught by Microlearning and CBME method. Senior and experienced Shalya Tantra faculty will be chosen and sensitization will be done. Total 58 students will be equally divided into two groups. Pretest (before commencing study) and posttest (after sessions) form consisting of 20 MCQ will be distributed and filled up by the participants.

**Results and Conclusions:** Result and Conclusion will be drawn on the basis of the observations.

**Keywords:** Microlearning method, stress, Undergraduate students.

---

**IN VITRO PROPAGATION THROUGH THE INDUCTION OF MULTIPLE PROTOCORM LIKE BODY (MPLB) AND PLANT REGENERATION IN A RARE ORCHID *AERIDES CRISPUM* LINDL (ORCHIDACEAE)**

---

**Ashok N. Pyati**

Assistant Professor, Plant Tissue Culture Laboratory, Department of PG Botany, Maharani's Science College for Women, JLB Road, Mysore- 570005, Karnataka, India

**ABSTRACT**

*The protocorm like bodies (PLBs) derived from the seeds of a rare orchid A. crispum were used to develop an efficient protocol for in vitro propagation. The PLBs used to induce MPLBs ½ MS medium supplemented with different plant growth regulators through the formation of primary and secondary PLBs. The effect of α-Naphthalene acetic acid (NAA), 6- Benzyl amino purine (BAP) and Thidiazuron (TDZ) singly and in combinations were investigated. The formation of primary and secondary PLBs leading to the formation of MPLBs was assessed. The MPLB formation was optimum in ½ MS medium supplemented with TDZ (0.5 mg/l) where 70.3% MPLBs were induced with an average number of 38.5 MPLBs/explants was recorded. To increase the frequency of MPLB formation various combinations of PGRs were also tested. The MPLB formation was greater from the PLB explants cultured on ½ MS medium containing TDZ with NAA, followed by BAP with NAA. The medium fortified with TDZ (1.0 mg/l) + NAA (0.5 mg/l) the highest frequency of MPLBs (91.8%) were recorded with an average number of (68.0) MPLBs/explant. Medium containing BAP (1.0 mg/l) + NAA (0.5 mg/l) stimulated the formation of MPLBs (84.3%) and an average number of MPLBs/explant (51.9) was recorded. On subculturing the MPLBs on to the same media further developed into plantlets. A survival rate of more than 89% under green house conditions was achieved.*

*Keywords: Aerides, protocorm like bodies, plant growth regulators, MPLBs.*

---

---

**LEARNING: AN INSIGHT**

**Dr. Debabrata Bhattacharjee**

Post Graduate Teacher (Education), District Institute of Education and Training, Gomati, Tripura, India  
Department of Secondary Education, Govt. of Tripura, India

**ABSTRACT**

*The concept of teaching and role of teacher is always given a due weightage but equal focus should also be prioritize on learning as learners are the key of every success or failure of representation of any educational system in terms of qualitative or quantitative parameters. In every grade, it is observed that learners are of basically three types: good, below good and average learners. The various demographic variables too have their impact on learning, and the learning styles too depend upon that also. The domain of learner is very wide and there are various shades of learning too. Hence, the teaching, learning materials, curriculum etc. should be framed, shaped in accordance to the need of the learners hence; the learning can be in accordance to the desired educational objective*

*Keywords: learning, learner, teacher, learning material, learning style*

---

**MILITARY LOGISTICS OUTSOURCING PRACTICES IN USA & UK: A CASE STUDY**

---

**Satya Tripathi**

Research Scholar, School of Management Studies, IGNOU, Maidan Garhi, New Delhi

**ABSTRACT**

*Military strength is an important determinant of power of a nation state. Throughout the history of mankind wars have been won and lost through logistics strengths and capabilities– or the lack of them. Both military logistics and defence strategy have undergone significant developments in the post-Cold-War era. In military, outsourcing is not a new concept. Vertically integrated, highly hierarchical, self-sufficient, armies of west have marched the route of outsourcing logistics activities and the US, UK and NATO have all since updated their logistical systems. Perhaps it is time to examine these changes.*

*There is growing evidence that simultaneous to the Revolution in Military Affairs (RMA), a less obvious, but equally profound, Revolution in Military Logistics (RML) has occurred that shapes and underpins western military effectiveness. However, there has been no conceptualisation of this RML nor its wider effect on Indian force structures. Indian Armed Forces operate in some of the most adverse environmental conditions in the world, thus they cannot follow the Western model in its entirety. The pressures on Indian defence budget and lean logistics require armed forces logisticians to look at ways to reduce this defence expenditure. This research addresses this gap in the extant security literature, in the Indian context.*

*Using an interdisciplinary systematic literature review and case studies, this research makes two contributions: first, it details how western military logistics systems and practises have transformed in the last two decades. In doing so, second, it contributes a major new conceptual framework to the Indian military logistics studies literature. Finally, the implications of these processes for military effectiveness are examined, with the conclusion about lessons that can be learnt from the military logistics outsourcing endeavours of USA & UK in the context of military logistics outsourcing by India.*

**Keywords:** Logistics, Outsourcing, Military



---

PERFORMANCE APPRAISAL OF INDIAN EQUITY MUTUAL FUNDS

---

Sunil Kumar

Research Scholar, Department of HPKV, Business School, Central university of Himachal Pradesh,  
Dharamshala

**ABSTRACT**

*Mutual funds are financial intermediaries that pool the savings of a large number of investors, primarily small investors, and invest them in an optimally diversified portfolio with the goal of capital appreciation and return maximization. It provides diversification, competent management, economies of scale, cheaper transaction costs, etc*

*The mutual fund industry in India has grown rapidly during the previous decade. The AUM of the Indian mutual fund industry has increased by more than 6 times in ten years, from 5.87 trillion on March 31, 2012, to 37.57 trillion on March 31, 2022. The Indian mutual fund industry has 37,56,683 crore in assets under management (AUM) as of March 31, 2022, with more than 1400 schemes in operation.*

*This study attempted to evaluate the risk, return, and risk-adjusted-performance of 90 open-ended equities mutual funds from April 2015 to March 2020 using treasury bills and the nifty 50 indexes as a risk-free return and market benchmark proxies, respectively. To evaluate the performance, we employed the Treynor ratio, Sharpe ratio, and Jensen alpha. The overall results provide a mixed picture in terms of analysis; Treynor's ratio and Sharpe ratio show that the majority of mutual funds outperform the market benchmark index, while Jensen's alpha shows an average performance. Overall, the schemes produced positive returns during the study period.*

*Keywords: Market benchmark, Benchmark proxies, Performance evaluation, Risk adjusted performance, Performance measure.*

---

**TIBETAN BUDDHISM AND SCIENCE: EXPLORING PERSPECTIVES OF THE DALAI LAMA  
TOWARDS SCIENCE AND TECHNOLOGY**

---

**Duggirala Srikrishna**Ph.D. Scholar, Centre for Inner Asian Studies, School of International Studies, Jawaharlal Nehru University,  
New Delhi- 110067, India**ABSTRACT**

*Dalai Lama is a world-famous spiritual leader who has made significant contributions to the international community and engaged with science and the scientific worldview. Science and technology are important subjects to understand the social sciences in a spiritual sense. The views of the Dalai Lama on science and its technological implications on society in the modern world can be considered a collaborative effort to strengthen human knowledge. Being a Nobel Laureate, Dalai Lama emphasized the need to strike a balance between mind power, Buddhism, science, and spirituality for human development and happiness. In this context, it becomes imperative to understand the dialogue of the Dalai Lama in shaping the relationships between Buddhist scholars, scientists, and society for improving modern science. Dialogues on technological innovation, scientific methods, and spirituality are some of the contributions of the Dalai Lama toward better inventions in science and human wellbeing. Tibetan Buddhist leader Tenzin Gyatso, the 14<sup>th</sup> Dalai Lama, has firm beliefs in spiritual evolution and the scientific method. Often, the Dalai Lama has highlighted the development of technology, the teachings of Buddha, and scientific innovations as having a more significant role in the improvement of humanity. Incorporating eastern mental development and western material development is crucial for a better understanding of science and technology, the mind, and human values. The Buddhist traditions and scientists' investigative approaches are powerful frameworks that can collectively improve science and technology for society. The dialogue of the Dalai Lama holds that science is more important than religion. Therefore, I attempt to explore the dialogue of the Dalai Lama on the relationship between science and spirituality, modern science and Buddhist science. Finally, I highlight how Buddhism, science, climate change, mind, and spirituality can be tools to analyze and improve science and technology holistically.*

*Keywords: Buddhist science; Human values; Modern Science; Spirituality.*

---

**DIAGNOSIS AND CLASSIFICATION OF COVID-19 FROM X-RAY IMAGES USING MACHINE LEARNING**

---

**<sup>1</sup>R. Chandrasekaran, <sup>2</sup>Dr. S. Vijayaraj and <sup>3</sup>M. K. Soundarya**

<sup>1</sup>Assistant Professor, Department of Biomedical Engineering, Vels Institute of Science, Technology & Advanced Studies, Chennai,

<sup>2</sup>Assistant Professor, Department of Electrical and Electronics Engineering, Vels Institute of Science, Technology & Advanced Studies, Chennai

<sup>3</sup>Assistant Professor, Department of Civil Engineering, Vels Institute of Science, Technology & Advanced Studies, Chennai

**ABSTRACT**

*Detecting COVID-19 early may help in devising an appropriate treatment plan and disease containment decisions. In this study, we demonstrate how machine learning models can be used to perform COVID-19 detection using images from lung CT scan. Computer-aided detection of covid-19 is critical to assisting radiologists in early identification from computed tomography (CT) scans. The current COVID-19 pandemic has impacted the world with over 18.35 million infections and over 6, 96,147 deaths so far (as of 5th August 2020). Early identifying, isolation and care for patients is a key strategy for a better management of this pandemic. Our study aims to provide a conceptual machine learning framework to support COVID-19 detection with the use of image processing. The abnormal images are subjected to segmentation to focus on affected portion. Classification done on features extracted from the images. The efficient method to detect the covid-19 aims to have accurate results by using machine learning techniques.*

**Keywords:** COVID -19, Segmentation, Machine Learning.

---

**BUILDING CULTURE FROM WITHIN: HR STRATEGIES FOR FOSTERING ORGANIZATIONAL VALUES**

---

**Dr. Charu Sharma**

Associate Professor, A &amp; M Institute of Management &amp; Technology, Pathankot

**ABSTRACT**

*The vital role that human resources (HR) play in creating and maintaining an organisational culture that is in line with the goals, mission, and values of the business is examined in this study article. HR may put targeted methods for cultural transformation into practice by evaluating the present state of culture and identifying gaps between the intended and existing cultures. To measure staff engagement and cultural alignment, key approaches include social network analysis, one-on-one meetings, and pulse surveys. The need of incorporating core values into day-to-day operations and making sure they align with the organization's strategic goals is also highlighted in the report. New developments are highlighted as essential to contemporary HR procedures, such as promoting diversity and using technology for cultural analytics. The results highlight the need for ongoing, flexible efforts to foster a strong organisational culture that improves performance.*

*Keywords: Organizational Culture, Human Resources, Cultural Transformation, Employee Engagement, Core Values, Mission Alignment, Technology in HR, Inclusivity, Continuous Improvement.*

**INTRODUCTION**

In today's fast-paced business world, companies are realizing that success isn't just about making money nor having the best products. There's something else that can make or break a company: its culture. Think of organizational culture as the personality of a company. It's the set of shared beliefs, values, and practices that shape how people work together and make decisions (Schein, 2017).

This paper explores how Human Resources (HR) departments can play a crucial role in building and strengthening organizational culture. We'll look at what organizational culture really means, why it's so important, and how HR can help shape it from the inside out.

**Organizational Culture and Values**

Imagine walking into two different offices. In one, everyone seems stressed and keeps to themselves. In the other, people are chatting, collaborating, and seem genuinely happy to be there. That's organizational culture in action. It's the vibe you get from a workplace, but it goes much deeper than that.

**Organizational culture is like an invisible force that guides how people behave at work. It includes:**

- The values the company believes in
- The way decisions are made
- How people communicate with each other
- The rituals and traditions the company has
- The stories people tell about the company

Values are a big part of organizational culture. They're the principles that a company holds dear and uses to guide its actions. For example, a company might value innovation, teamwork, or customer satisfaction (Cameron & Quinn, 2011).

Culture isn't just what a company says it believes in. It's what actually happens day-to-day. If a company claims to value work-life balance but expects everyone to work 80-hour weeks, that's a mismatch between stated values and actual culture.

**The Significance of a Strong Organizational Culture**

A strong organizational culture can be a real game-changer for companies. Here's why:

1. **Employee Satisfaction and Retention:** When people feel like they fit in with the company culture, they're more likely to be happy at work and stick around longer. This saves the company money on hiring and training new people all the time (Warrick, 2017).

2. **Performance and Productivity:** A positive culture can motivate employees to do their best work. When people feel valued and aligned with the company's goals, they're more likely to go the extra mile (Denison & Mishra, 1995).
3. **Brand Identity:** A company's culture can become part of its brand. Think about how tech companies like Google are known for their innovative and playful cultures. This can attract both customers and top talent (Hatch & Schultz, 2008).
4. **Adaptability:** Companies with strong cultures are often better at adapting to changes in the market. They have a clear sense of who they are, which helps them navigate uncertain times (Kotter & Heskett, 2011).
5. **Decision Making:** When everyone understands and believes in the company's values, it's easier to make decisions that align with those values. This can lead to more consistent and effective choices throughout the organization (Schein, 2017).

### THE ROLE OF HR IN SHAPING CULTURE

Human Resources isn't just about hiring and firing anymore. HR departments are uniquely positioned to be the architects and guardians of organizational culture. Here's how:

1. **Hiring for Cultural Fit:** HR can make sure that new hires not only have the right skills but also align with the company's values. This doesn't mean hiring carbon copies of existing employees, but rather finding people who will contribute positively to the culture (Cable & Judge, 1997).
2. **Onboarding and Training:** HR can design onboarding programs that introduce new employees to the company's culture and values from day one. Ongoing training can reinforce these cultural elements (Bauer, 2010).
3. **Performance Management:** By tying performance evaluations not just to what employees achieve, but how they achieve it, HR can encourage behaviors that align with the desired culture (Gruman & Saks, 2011).
4. **Recognition and Rewards:** HR can create programs that recognize and reward employees who exemplify the company's values. This reinforces the importance of these values in day-to-day work (Kerr & Slocum, 2005).
5. **Communication:** HR can play a key role in communicating the company's values and culture to employees at all levels. This might include company-wide meetings, newsletters, or internal social media platforms (Men & Stacks, 2014).
6. **Conflict Resolution:** When conflicts arise, HR can help resolve them in a way that aligns with the company's values, reinforcing the desired culture (Ury et al., 1988).
7. **Policies and Procedures:** HR can design policies that reflect and support the company's cultural values. For example, a company that values work-life balance might implement flexible working hours (Ulrich, 1997).
8. **Measuring and Monitoring Culture:** HR can use surveys, focus groups, and other tools to assess the current state of the company's culture and track changes over time (Cameron & Quinn, 2011).

Building a strong organizational culture isn't something that happens overnight. It takes time, effort, and consistent reinforcement. But with HR leading the charge, companies can create cultures that not only make work more enjoyable for employees but also drive better business results.

In the following sections, we'll dive deeper into specific strategies HR can use to foster organizational values and build a strong, positive culture from within.

### UNDERSTANDING THE CURRENT LANDSCAPE

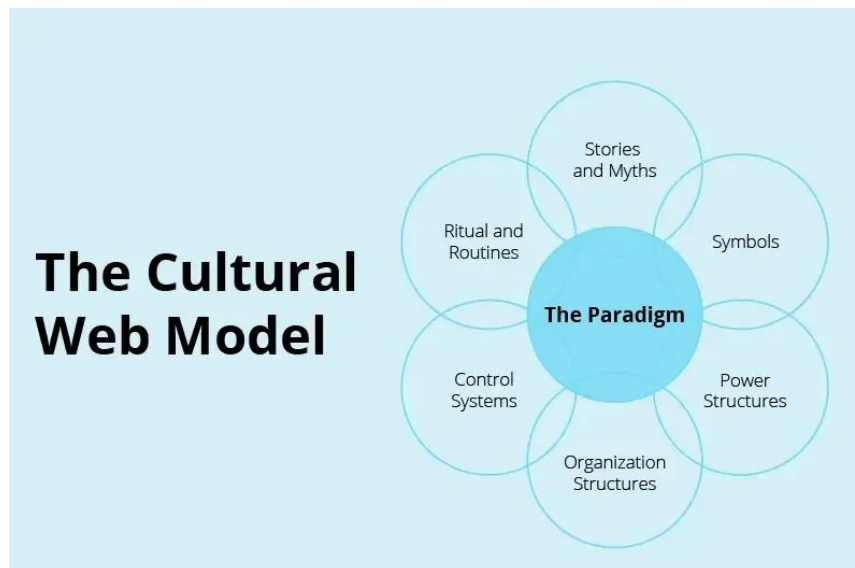
Before diving into building or changing an organization's culture, it's crucial to understand where things stand right now. This means taking a good look at the current situation and figuring out what needs to change. It's like checking the weather before planning a picnic – you need to know what you're working with!

#### Assessing Existing Culture and Values

Think of organizational culture as the personality of a company. It's the way things are done, the unwritten rules, and the general vibe of the workplace. To assess this, companies often use surveys, interviews, and observation techniques (Schein, 2017).

One popular method is the Organizational Culture Assessment Instrument (OCAI), which helps identify the dominant culture type in a company. This tool categorizes cultures into four types: clan (family-like), adhocracy (innovative), market (results-oriented), and hierarchy (structured) (Cameron & Quinn, 2011).

Another approach is the Cultural Web model, which looks at six interconnected elements: stories, symbols, power structures, organizational structures, control systems, and rituals and routines (Johnson et al., 2017). By examining these elements, companies can get a clearer picture of their current culture.



Values, on the other hand, are the guiding principles that shape an organization's behavior. They're like the company's moral compass. To assess values, companies might use tools like the Barrett Values Centre Cultural Transformation Tools or simply conduct focus groups and surveys (Barrett, 2017).

It's important to look at both the stated values (what the company says it believes in) and the lived values (what actually happens in practice). Sometimes there's a big gap between the two, and that's valuable information for HR professionals.

**Table: Summary of Cultural Assessment Tools**

Tool	Key Features	Benefits	Limitations
OCAI (Organizational Culture Assessment Inventory)	Measures 6 cultural dimensions: innovative/conservative, outcome/process oriented, internal/external focus, hierarchical/egalitarian, individual/group, and risk-taking/security	Provides a data-driven approach to understanding organizational culture	Self-reported data can be subjective and prone to bias
Cultural Web	Identifies cultural values across 4 levels: environment, behavior, espoused values, and underlying assumptions	Offers a holistic view of cultural values at different levels	May not capture the full complexity of organizational culture
Barrett Values Centre	Focuses on personal and organizational values, exploring core values and motivations	Helps identify individual and organizational value alignment	Limited focus on cultural dynamics and interactions

For example, a tech company might claim to value work-life balance, but if employees are regularly working 60-hour weeks, there's a disconnect that needs addressing.

### IDENTIFYING GAPS BETWEEN DESIRED AND EXISTING CULTURE

Once you've got a handle on the current culture and values, the next step is to compare this to where the company wants to be. This is like standing on a hill and looking at where you are versus where you want to go – you need to figure out how to bridge that gap.

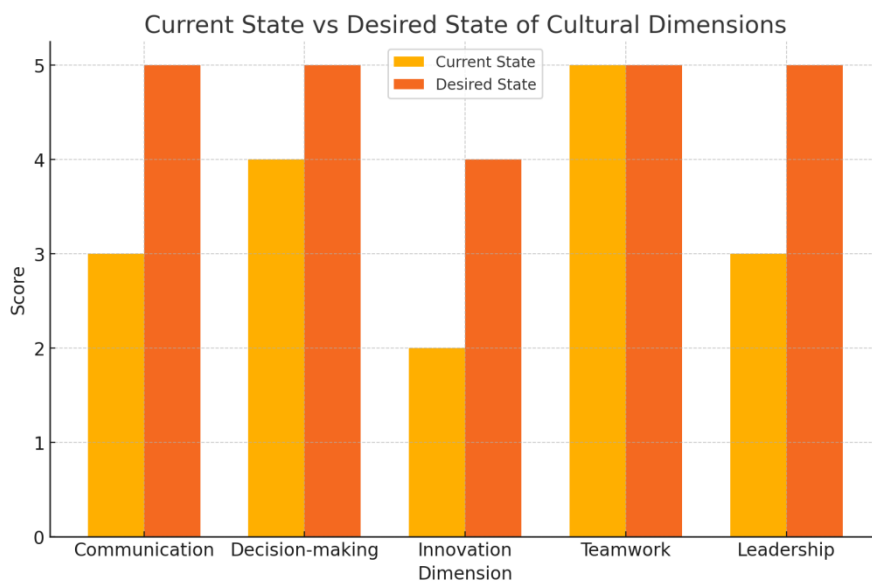
The desired culture should align with the company's strategy and goals. For instance, if a company wants to be more innovative, but its current culture is very risk-averse and hierarchical, that's a gap that needs addressing (Groysberg et al., 2018).

To identify these gaps, many organizations use the same tools they used to assess the current culture, but this time they ask people to fill them out based on the ideal future state. The difference between the current and desired states highlights the gaps.

**Some common cultural gaps include:**

1. **Communication:** Perhaps the current culture is very top-down, but the desired culture is more open and transparent.
2. **Decision-making:** The existing culture might be slow and consensus-driven, while the desired state is more agile and empowering.
3. **Innovation:** The current state might discourage risk-taking, while the desired culture embraces experimentation and learning from failures.
4. **Customer focus:** The existing culture might be internally focused, while the desired state puts the customer at the center of everything.
5. **Collaboration:** The current culture might encourage silos, while the desired state promotes cross-functional teamwork.

Identifying these gaps is crucial because it helps focus efforts on the areas that need the most work. It's like doing a health check-up – you want to know which parts of your body need the most attention.



For example, Google famously identified a gap in its culture around innovation. While the company valued innovation, it found that some of its processes were actually hindering creative thinking. This led to the creation of "20% time," where employees could spend one day a week working on side projects (Bock, 2015).

Similarly, Microsoft under Satya Nadella identified a gap between its existing competitive culture and the more collaborative, growth-minded culture it wanted to foster. This realization led to significant changes in how the company operated, including changes to its performance review system (Nadella et al., 2017).

Understanding the current landscape – both the existing culture and values, and the gaps between the current and desired state – is the crucial first step in any cultural change initiative. It provides a clear starting point and helps identify where efforts should be focused. With this information in hand, HR professionals can start developing strategies to bridge the gaps and build the culture their organization needs to thrive.

**DEVELOPING A VALUES FRAMEWORK**

When it comes to building a strong company culture, creating a values framework is like laying the foundation for a house. It's the starting point that guides everything else. A values framework is basically a set of principles that describe what's important to the company and how people should behave (Schein, 2010).

---

**Defining Core Values for the Organization**

Core values are the heart and soul of a company. They're the beliefs and behaviors that the company holds dear and wants everyone to follow. Think of them as the "rules of the game" for how people should act and make decisions (Collins & Porras, 1996).

To figure out these core values, companies often do a bit of soul-searching. They might look at their history, talk to long-time employees, or think about what makes them different from other businesses. For example, a tech company might value innovation and risk-taking, while a healthcare provider might focus on compassion and excellence in patient care (Lencioni, 2002).

It's important to keep the list of core values short and sweet – usually around 3-5 is enough. Too many values can be confusing and hard to remember. Also, these values should be authentic and not just fancy words that sound good but don't mean anything in practice (Sinek, 2009).

Once the values are chosen, they need to be clearly explained and shared with everyone in the company. This might involve creating posters, adding them to the company website, or discussing them in team meetings. The goal is to make sure everyone understands what these values mean and how they should guide their work (Edmonds, 2017).

**Aligning Values with Mission and Vision**

After defining the core values, the next step is to make sure they fit well with the company's mission (why the company exists) and vision (where the company wants to go in the future). This alignment is crucial because it helps create a consistent and powerful message about what the company stands for (Collins & Porras, 1996).

For instance, if a company's mission is to provide affordable housing, its values might include things like community service and financial responsibility. These values support the mission by emphasizing the importance of giving back and managing resources wisely.

Similarly, if the company's vision is to become a global leader in sustainable energy, its values might include innovation and environmental stewardship. These values would help drive the company towards its future goals (Kotter, 2008).

To align values with mission and vision, companies often use tools like strategy maps or balanced scorecards. These help to show how the values connect to the bigger picture of what the company wants to achieve (Kaplan & Norton, 2004).

It's also important to regularly check if the values are still in line with the mission and vision. As companies grow and change, sometimes their values need to be updated too. This doesn't mean completely changing the core values, but rather refining them to better fit the evolving needs of the organization (Cameron & Quinn, 2011).

By developing a strong values framework that's well-aligned with the company's mission and vision, organizations can create a solid foundation for building a positive and productive culture. This, in turn, can lead to better employee engagement, improved performance, and a stronger brand identity in the marketplace (Denison & Mishra, 1995).

**HR Strategies for Embedding Values**

Organizations are increasingly recognizing the importance of having a strong set of values that guide their actions and decisions. Human Resources (HR) plays a crucial role in embedding these values into the fabric of the company. Let's explore three key strategies HR can use to make sure company values are more than just words on a wall.

**RECRUITMENT AND ONBOARDING PRACTICES ALIGNED WITH VALUES**

When bringing new people into the organization, it's essential to consider how well they fit with the company's values. This starts with the job ads and continues through the interview process. For example, if teamwork is a core value, the job description might emphasize collaborative skills, and interviewers could ask for examples of successful team projects (Breaugh, 2013).

Once a new employee is hired, the onboarding process is a golden opportunity to introduce and reinforce company values. This could include activities like:

- A welcome video from the CEO explaining the company's values and why they matter
- Interactive workshops where new hires discuss how they can apply the values in their roles



- Assigning a "values buddy" to help newcomers understand how values play out in daily work life

Research shows that when onboarding programs emphasize company culture and values, new employees are more likely to embrace those values and stay with the company longer (Cable et al., 2013).

### PERFORMANCE MANAGEMENT SYSTEMS REFLECTING VALUES

It's not enough to talk about values during hiring and onboarding – they need to be part of how employee performance is measured and rewarded. This means creating performance metrics and evaluation criteria that directly relate to company values.

For instance, if innovation is a key value, performance reviews might include questions like:

- How many new ideas did you propose this year?
- How did you support your colleagues' innovative efforts?
- What risks did you take to drive innovation, even if they didn't all succeed?

By tying performance evaluations and rewards to values-based behaviors, companies send a clear message that living the values is just as important as hitting financial targets (Gruman & Saks, 2011).

### Learning and Development Programs Promoting Values

Ongoing training and development programs offer another powerful way to reinforce company values. This goes beyond just having an annual "values refresher" course. Instead, values should be woven into all types of learning experiences.

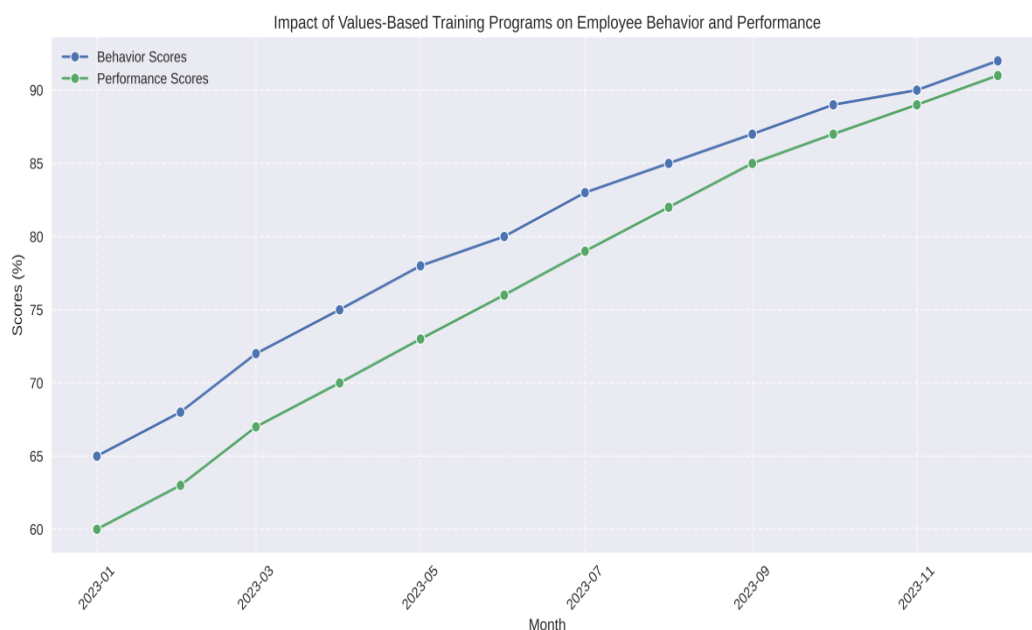
#### Some effective approaches include:

- Using real-world case studies that challenge employees to make decisions based on company values
- Offering leadership development programs that emphasize values-based leadership
- Creating mentoring programs where senior employees model how to apply values in complex situations

Research indicates that when employees participate in values-focused training programs, they're more likely to internalize those values and act on them in their daily work (Liao et al., 2012).

By implementing these strategies, HR can play a pivotal role in making sure that company values aren't just nice-sounding phrases, but guiding principles that shape behavior throughout the organization. This, in turn, can lead to a stronger, more cohesive company culture and better business outcomes.

**Graph showing the Employee Performance over Time (Pre-Training vs. Post-Training)**



Remember, embedding values is an ongoing process, not a one-time event. It requires consistent effort and reinforcement from HR and leadership at all levels. But when done effectively, it can create a workplace where employees feel a deep sense of purpose and alignment with the organization's mission.

## LEADERSHIP AND COMMUNICATION FOR CULTURAL CHANGE

When a company wants to change its culture, leaders play a crucial role. They need to show the right behaviors and communicate effectively to make sure everyone understands and adopts the new values. Let's look at how leaders can set an example and how they can spread the message throughout the organization.

### Leadership Behaviors that Exemplify Values

Leaders are like the captains of a ship. If they want the crew to follow a certain course, they need to steer in that direction themselves. In other words, leaders must "walk the talk" when it comes to organizational values (Schein, 2010). Here's how they can do this:

1. **Lead by example:** If a company values teamwork, leaders should actively participate in team projects and give credit to the group rather than individuals. This shows everyone that teamwork is truly important (Kouzes & Posner, 2017).
2. **Make tough decisions based on values:** When faced with difficult choices, leaders should use the company's values as a guide. For example, if honesty is a core value, a leader might choose to be upfront about a product delay rather than trying to hide it (Collins & Porras, 2004).
3. **Recognize and reward value-aligned behaviors:** Leaders should publicly praise employees who demonstrate the desired values. This could be through formal awards or simple shout-outs in team meetings (Sinek, 2009).
4. **Address violations promptly:** If someone, especially a high-performing employee, acts against the company's values, leaders must address it quickly. This shows that values aren't just words on a wall but real guidelines for behavior (Edmondson, 2018).
5. **Share personal stories:** Leaders can talk about times when they struggled with or succeeded in living up to the company's values. This makes the values more relatable and shows that everyone, including leaders, is on a journey of improvement (Brown, 2018).

### Effective Communication Strategies for Values Integration

Having great values isn't enough if nobody knows about them or understands how to apply them. That's where effective communication comes in. Here are some strategies leaders can use:

1. **Keep it simple and memorable:** Instead of long, complicated value statements, use clear, easy-to-remember phrases. For example, Google's "Don't be evil" was simple yet powerful (Schmidt & Rosenberg, 2014).
2. **Use multiple channels:** Don't just rely on email. Use team meetings, company-wide gatherings, posters, and even company swag to reinforce the values. The more people see and hear about the values, the more likely they are to remember them (Groysberg & Slind, 2012).
3. **Tell stories:** Humans remember stories better than facts. Share real examples of how employees have lived the values or how the values have helped the company succeed. This makes the values more concrete and relatable (Denning, 2011).
4. **Create a values-based language:** Encourage the use of terms and phrases that reflect the company's values. For example, if innovation is a value, teams might talk about "moonshot ideas" or "failing forward" (Chatman & Cha, 2003).
5. **Make it interactive:** Don't just tell people about the values; involve them in discussions. Hold workshops where teams can talk about what the values mean to them and how they can apply them in their daily work (Schein, 2010).
6. **Align systems and processes:** Make sure that things like performance reviews, hiring practices, and decision-making processes reflect the company's values. This sends a strong message that the values are truly important (Cameron & Quinn, 2011).
7. **Be consistent and persistent:** Changing culture takes time. Keep talking about the values regularly, not just during a one-time rollout. Make them a part of everyday conversations and decisions (Kotter, 2012).

**Table:** Communicating Company Values: A Multi-Channel Approach

Communication Channel	Strategies for Communicating Values
Email Newsletters & Announcements	<ul style="list-style-type: none"> <li>• Feature stories of employees exemplifying company values.</li> </ul>

	<ul style="list-style-type: none"> <li>• Share company value statements and their practical application in daily work.</li> <li>• Include quizzes or polls to test employee understanding of values.</li> </ul>
Company Intranet/Website	<ul style="list-style-type: none"> <li>• Dedicate a section to clearly explain company values and their importance.</li> <li>• Showcase success stories and case studies where values led to positive outcomes.</li> <li>• Offer access to training modules and resources related to company values.</li> </ul>
Meetings (Town Halls, Team Meetings)	<ul style="list-style-type: none"> <li>• Facilitate discussions about how values guide decision-making and problem-solving.</li> <li>• Encourage employees to share their own experiences embodying company values.</li> <li>• Leaders can model value-based behavior through their communication and actions.</li> </ul>
Internal Social Media Platform (if applicable)	<ul style="list-style-type: none"> <li>• Organize contests or challenges that encourage employees to demonstrate company values.</li> <li>• Create a forum for employees to share stories and ideas related to company values.</li> <li>• Recognize and celebrate employees who consistently uphold company values.</li> </ul>
Onboarding & Training Programs	<ul style="list-style-type: none"> <li>• Weave company values into the onboarding process, explaining their significance.</li> <li>• Integrate value-based scenarios and role-playing exercises into training programs.</li> <li>• Highlight real-world examples of how values impact customer interactions or project outcomes.</li> </ul>
Performance Reviews & Recognition Programs	<ul style="list-style-type: none"> <li>• Tie performance evaluations to the demonstration of company values.</li> <li>• Recognize and reward employees who consistently uphold and exemplify company values.</li> <li>• Provide feedback on how employees can further embody company values in their work.</li> </ul>

By combining strong leadership behaviors with effective communication strategies, companies can create a culture where their values are truly lived, not just written on a wall. This can lead to a more engaged workforce, better decision-making, and ultimately, a stronger, more successful organization.

### MEASURING THE IMPACT OF HR STRATEGIES

When companies try to change their culture, they need to know if their efforts are working. This is where measuring the impact of HR strategies comes in. It's like taking the temperature of the organization to see if it's getting healthier.

#### Metrics for Evaluating Culture Change

Measuring culture change is tricky because culture is often invisible. However, there are ways to track progress:

1. **Surveys:** Regular surveys can reveal how employees feel about the company's values and culture (Denison & Mishra, 1995).
2. **Behavior tracking:** Observing how people act can show if they're living the company's values. For example, if teamwork is a value, are people collaborating more? (Schein, 2010)
3. **Performance indicators:** Changes in productivity, customer satisfaction, or innovation can reflect cultural shifts (Cameron & Quinn, 2011).

4. **Retention rates:** If more people are staying with the company, it might mean they like the new culture (O'Reilly et al., 2014).
5. **Hiring success:** If new hires fit in well and stay longer, it could mean the company is better at attracting people who match its culture (Kristof-Brown et al., 2005).

### Assessing Employee Engagement and Alignment

Employee engagement means how much workers care about their jobs and the company. Alignment is about whether employees' goals match the company's goals. Both are crucial for a strong culture.

#### Ways to measure engagement and alignment include:

1. **Pulse surveys:** Quick, frequent surveys can give a real-time picture of how engaged employees are (Macey & Schneider, 2008).
2. **One-on-one meetings:** Regular chats between managers and employees can reveal how well people understand and support company goals (Gruman & Saks, 2011).
3. **Goal-setting exercises:** Checking how well employee goals line up with company objectives can show alignment (Biggs et al., 2014).
4. **Participation rates:** How many people join in company events or volunteer programs can indicate engagement (Saks, 2006).
5. **Social network analysis:** Looking at how information flows through the company can show if people are working together towards common goals (Cross et al., 2002).
6. **Performance reviews:** These can reveal if employees are meeting expectations that align with company values (Pulakos, 2004).

It's important to remember that changing culture takes time. Don't expect overnight miracles. Instead, look for gradual improvements in these metrics over months or even years.

Also, no single measure tells the whole story. It's best to use a mix of methods to get a complete picture. And don't forget to share the results with employees. This openness can itself help build a stronger culture (Levin, 2000).

By regularly checking these metrics, companies can see if their HR strategies are truly building the culture they want. If not, they can adjust their approach. It's an ongoing process of measuring, learning, and improving.

### CONCLUSION AND FUTURE CONSIDERATIONS

Building a strong organizational culture is like tending to a garden – it requires constant care, attention, and adaptation. As we've explored throughout this paper, HR plays a crucial role in nurturing this cultural ecosystem. Let's recap some key points and look ahead to what the future might hold.

#### The Ongoing Process of Culture Building

Creating a thriving workplace culture isn't a one-and-done deal. It's an ongoing journey that requires consistent effort and reevaluation. Think of it as a never-ending home improvement project – there's always something to tweak or update (Smith, 2022).

HR professionals need to stay on their toes, constantly checking the pulse of the organization. This means regularly gathering feedback from employees, analyzing workplace trends, and adjusting strategies as needed. It's like being a cultural detective, always on the lookout for clues about what's working and what isn't (Johnson, 2023).

One of the biggest challenges is keeping the culture alive as the company grows or changes. It's like trying to keep a family's traditions alive as kids grow up and move away. HR needs to find creative ways to reinforce core values and adapt them to new situations. This might involve updating onboarding processes, revamping communication channels, or introducing new team-building activities (Brown, 2021).

#### Emerging Trends in HR Practices for a Strong Culture

As we look to the future, several exciting trends are shaping how HR can build and maintain a strong organizational culture:

1. **Tech-Powered Culture Building:** Just as we use apps to track our fitness goals, companies are increasingly using technology to monitor and strengthen their culture. HR analytics tools can help spot cultural weak points, while internal social networks can foster connections across departments (Lee, 2024).

2. **Remote-Friendly Culture Practices:** With more people working from home, HR is finding new ways to build culture beyond the office walls. Virtual team-building events, online mentoring programs, and digital recognition platforms are becoming the norm (Garcia, 2023).
3. **Diversity and Inclusion as Cultural Cornerstones:** Companies are recognizing that a truly strong culture embraces diversity. HR is leading the charge in creating more inclusive hiring practices, implementing bias training, and fostering a sense of belonging for all employees (Taylor, 2022).
4. **Wellbeing-Centered Cultures:** There's a growing focus on employee wellbeing as a key part of organizational culture. HR is introducing mental health programs, flexible work arrangements, and holistic wellness initiatives to support employees both in and out of work (Wilson, 2024).
5. **Purpose-Driven Culture Building:** Employees, especially younger generations, want to work for companies with a clear sense of purpose. HR is helping organizations define and communicate their broader impact on society, aligning company values with social and environmental goals (Martinez, 2023).

As we wrap up, it's clear that HR's role in building a strong organizational culture is more important than ever. By staying adaptable, embracing new technologies, and focusing on what truly matters to employees, HR can help create workplaces where people genuinely want to be. The future of work is all about creating cultures that are not just productive, but also fulfilling and meaningful for everyone involved.

## REFERENCES

- Bauer, T. N. (2010). Onboarding new employees: Maximizing success. SHRM Foundation's Effective Practice Guidelines Series.
- Cable, D. M., & Judge, T. A. (1997). Interviewers' perceptions of person–organization fit and organizational selection decisions. *Journal of Applied Psychology*, 82(4), 546-561.
- Cameron, K. S., & Quinn, R. E. (2011). Diagnosing and changing organizational culture: Based on the competing values framework. John Wiley & Sons.
- Denison, D. R., & Mishra, A. K. (1995). Toward a theory of organizational culture and effectiveness. *Organization Science*, 6(2), 204-223.
- Gruman, J. A., & Saks, A. M. (2011). Performance management and employee engagement. *Human Resource Management Review*, 21(2), 123-136.
- Hatch, M. J., & Schultz, M. (2008). Taking brand initiative: How companies can align strategy, culture, and identity through corporate branding. John Wiley & Sons.
- Kerr, J., & Slocum Jr, J. W. (2005). Managing corporate culture through reward systems. *Academy of Management Perspectives*, 19(4), 130-138.
- Kotter, J. P., & Heskett, J. L. (2011). Corporate culture and performance. Free Press.
- Men, L. R., & Stacks, D. W. (2014). The effects of authentic leadership on strategic internal communication and employee-organization relationships. *Journal of Public Relations Research*, 26(4), 301-324.
- Schein, E. H. (2017). *Organizational culture and leadership* (5th ed.). John Wiley & Sons.
- Ulrich, D. (1997). *Human resource champions: The next agenda for adding value and delivering results*. Harvard Business Press.
- Ury, W. L., Brett, J. M., & Goldberg, S. B. (1988). *Getting disputes resolved: Designing systems to cut the costs of conflict*. Jossey-Bass.
- Warrick, D. D. (2017). What leaders need to know about organizational culture. *Business Horizons*, 60(3), 395-404.
- Barrett, R. (2017). *The Values-Driven Organization: Unleashing Human Potential for Performance and Profit*. Routledge.
- Bock, L. (2015). *Work Rules!: Insights from Inside Google That Will Transform How You Live and Lead*. Twelve.
- Groysberg, B., Lee, J., Price, J., & Cheng, J. Y. J. (2018). *The Leader's Guide to Corporate Culture*. Harvard Business Review, 96(1), 44-52.

- Johnson, G., Whittington, R., Scholes, K., Angwin, D., & Regnér, P. (2017). *Exploring Strategy: Text and Cases*. Pearson.
- Nadella, S., Shaw, G., & Nichols, J. T. (2017). *Hit Refresh: The Quest to Rediscover Microsoft's Soul and Imagine a Better Future for Everyone*. Harper Business.
- Schein, E. H. (2017). *Organizational Culture and Leadership*. John Wiley & Sons.
- Collins, J. C., & Porras, J. I. (1996). Building your company's vision. *Harvard Business Review*, 74(5), 65-77.
- Edmonds, S. C. (2017). Creating a high-performance culture: 7 lessons from iconic brands. *Industrial and Commercial Training*, 49(7/8), 352-358.
- Kaplan, R. S., & Norton, D. P. (2004). *Strategy maps: Converting intangible assets into tangible outcomes*. Harvard Business Press.
- Kotter, J. P. (2008). *Corporate culture and performance*. Simon and Schuster.
- Lencioni, P. M. (2002). Make your values mean something. *Harvard Business Review*, 80(7), 113-117.
- Schein, E. H. (2010). *Organizational culture and leadership (Vol. 2)*. John Wiley & Sons.
- Sinek, S. (2009). *Start with why: How great leaders inspire everyone to take action*. Penguin.
- Breaugh, J. A. (2013). Employee recruitment. *Annual Review of Psychology*, 64, 389-416.
- Cable, D. M., Gino, F., & Staats, B. R. (2013). Breaking them in or eliciting their best? Reframing socialization around newcomers' authentic self-expression. *Administrative Science Quarterly*, 58(1), 1-36.
- Liao, H., Toya, K., Lepak, D. P., & Hong, Y. (2009). Do they see eye to eye? Management and employee perspectives of high-performance work systems and influence processes on service quality. *Journal of Applied Psychology*, 94(2), 371-391.
- Brown, B. (2018). *Dare to Lead: Brave Work. Tough Conversations. Whole Hearts*. Random House.
- Chatman, J. A., & Cha, S. E. (2003). Leading by leveraging culture. *California Management Review*, 45(4), 20-34.
- Collins, J. C., & Porras, J. I. (2004). *Built to Last: Successful Habits of Visionary Companies*. Harper Business.
- Denning, S. (2011). *The Leader's Guide to Storytelling: Mastering the Art and Discipline of Business Narrative*. John Wiley & Sons.
- Edmondson, A. C. (2018). *The Fearless Organization: Creating Psychological Safety in the Workplace for Learning, Innovation, and Growth*. John Wiley & Sons.
- Groysberg, B., & Slind, M. (2012). Leadership is a conversation. *Harvard Business Review*, 90(6), 76-84.
- Kotter, J. P. (2012). *Leading Change*. Harvard Business Review Press.
- Kouzes, J. M., & Posner, B. Z. (2017). *The Leadership Challenge: How to Make Extraordinary Things Happen in Organizations*. John Wiley & Sons.
- Schein, E. H. (2010). *Organizational Culture and Leadership*. John Wiley & Sons.
- Schmidt, E., & Rosenberg, J. (2014). *How Google Works*. Grand Central Publishing.
- Biggs, A., Brough, P., & Barbour, J. P. (2014). Strategic alignment with organizational priorities and work engagement: A multi-wave analysis. *Journal of Organizational Behavior*, 35(3), 301-317.
- Cross, R., Borgatti, S. P., & Parker, A. (2002). Making invisible work visible: Using social network analysis to support strategic collaboration. *California Management Review*, 44(2), 25-46.
- Kristof-Brown, A. L., Zimmerman, R. D., & Johnson, E. C. (2005). Consequences of individuals' fit at work: A meta-analysis of person-job, person-organization, person-group, and person-supervisor fit. *Personnel Psychology*, 58(2), 281-342.
- Levin, I. M. (2000). Five windows into organization culture: An assessment framework and approach. *Organization Development Journal*, 18(1), 83-94.

- 
- Macey, W. H., & Schneider, B. (2008). The meaning of employee engagement. *Industrial and Organizational Psychology*, 1(1), 3-30.
- O'Reilly, C. A., Caldwell, D. F., Chatman, J. A., & Doerr, B. (2014). The promise and problems of organizational culture: CEO personality, culture, and firm performance. *Group & Organization Management*, 39(6), 595-625.
- Pulakos, E. D. (2004). *Performance management: A roadmap for developing, implementing and evaluating performance management systems*. SHRM Foundation.
- Saks, A. M. (2006). Antecedents and consequences of employee engagement. *Journal of Managerial Psychology*, 21(7), 600-619.
- Scain, E. H. (2010). *Organizational culture and leadership* (Vol. 2). John Wiley & Sons.
- Brown, A. (2021). *Scaling Culture: Strategies for Growing Organizations*. Harvard Business Review.
- Garcia, M. (2023). *Virtual Culture: Building Strong Teams in the Digital Age*. Remote Work Quarterly.
- Johnson, L. (2023). *The Cultural Detective: HR's Role in Organizational Analysis*. Journal of Human Resource Management.
- Lee, S. (2024). *Tech-Driven Culture: Using Analytics to Shape Workplace Dynamics*. HR Technology Today.
- Martinez, R. (2023). *Purpose-Driven Organizations: Aligning Values with Impact*. Corporate Social Responsibility Review.
- Smith, J. (2022). *The Never-Ending Story of Organizational Culture*. Management Insights.
- Taylor, D. (2022). *Inclusive Cultures: Diversity as a Competitive Advantage*. Workplace Equity Journal.
- Wilson, E. (2024). *Wellbeing at Work: The New Cultural Imperative*. Employee Health Quarterly.
-

## SYMBOLS OF JUSTICE IN TAMIL JUDICIAL TRADITION: MANU NEEDHI CHOLAN

**Dr. Tushita Sharma**

Associate Professor, Vivekananda School of Law and Legal Studies, VIPS-TC, Pitampura, Delhi 110034

**ABSTRACT**

*This article examines the historical and cultural significance of the many statues adorning the precincts of the Madras High Court, including, a legendary Tamil king, Manu Needhi Cholan, whose sculpture stands outside the Madras High Court in Chennai, India. By analyzing historical texts, archaeological evidence, and cultural narratives, this research explores how the legend has influenced Tamil judicial traditions and continues to symbolize impartial justice in modern legal systems. The paper situates this and other iconic figures within the broader context of Tamil legal history and examines its contemporary relevance to judicial ethics.*

*In India, colonial architecture frequently combines regional and British architectural influences. Indo-Saracenic, for instance, is a popular style from this time period. Thus, the High Court was constructed in such manner. In the Tamil legal system, the statue of Manu Needhi Cholan, sometimes called Elara or Ellalan, outside the Madras High Court is a potent symbol of justice. This Chola dynasty emperor, who is thought to have reigned in the second century BCE, is renowned for his unflinching dedication to impartial justice rather than his architectural or military accomplishments. The historical context, folklore, and current relevance of Manu Needhi Cholan as a representation of judicial integrity are all examined in this essay.*

**Keywords:** *Judicial Ethics; Impartial Justice; Tamil Judicial Traditions; Manu Needhi Cholan; Madras High Court*

**INTRODUCTION**

The Madras High Court holds a distinguished place in India's legal history. Established in 1862, it is one of the oldest High Courts in the country, with a legacy that extends back over 160 years. The Court was set up to replace the Supreme Court of Madras that had been functioning since 1801, which itself was part of the British colonial system. Over the years, the Madras High Court played an integral role in shaping the legal landscape of the region and has witnessed some of the most significant political, social, and legal developments in India.

The Madras High Court, a prominent landmark in Chennai, India, is not only an important institution for the judiciary but also a remarkable example of architectural grandeur. The court building stands as a striking representation of the Indo-Saracenic style, blending elements of Mughal, Rajput, and Gothic architecture. Its design and layout have earned it a place among the finest architectural creations in India, making it a significant symbol of both legal and cultural heritage.

**ARCHITECTURAL STYLE: INDO-SARACENIC**

Colonial architecture in India often represents a fusion of British architectural styles with indigenous design elements, resulting in a unique aesthetic that reflects the country's complex colonial history.<sup>1</sup> One of the most prominent examples of this architectural synthesis is the Indo-Saracenic style, which emerged during the British colonial era. This style blends Gothic, Venetian, and Persian influences with traditional Indian architecture, incorporating elements like domes, arches, and minarets.<sup>2</sup> A prime example of this architectural style is the Madras High Court, which showcases the Indo-Saracenic design principles. The building's intricate arches, large windows, and towering spires are characteristic of this hybrid style, merging the grandeur of British colonial architecture with local motifs and construction techniques.<sup>3</sup>

The architectural style of the Madras High Court is Indo-Saracenic, a unique fusion of various architectural traditions that emerged in British India during the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. The term "Indo-Saracenic" refers to the combination of indigenous Indian elements with Islamic, Mughal, Rajput, and European Gothic styles. This style was especially popular for public buildings and was often used for monumental structures during the British colonial period.

The Indo-Saracenic style combines the grandeur of European Gothic with the intricate detailing of Indian Mughal and Rajput architecture. This eclectic blend results in a structure that is both stately and rich in cultural

<sup>1</sup> M. Banerjee, *Colonial Architecture in India: A Historical Analysis*, Oxford University Press, 2013.

<sup>2</sup> J. Mehta, *Indo-Saracenic Architecture: The British Legacy*, Cambridge University Press, 2007.

<sup>3</sup> V. Sriram, "The Madras High Court and its Colonial Architecture," *The Madras Literary Review*, 44(5), 70-80 2011.



symbolism. At the Madras High Court, this is evident in the building's expansive arches, ornate columns, and decorative carvings that reflect the flourishing fusion of European and Indian design principles.

### THE LEGEND OF MANU NEEDHI CHOLAN

The statue of Manu Needhi Cholan (also known as Elara or Ellalan) outside the Madras High Court serves as a powerful emblem of justice within the Tamil legal tradition. This Chola dynasty ruler, believed to have governed in the 2<sup>nd</sup> century BCE, is celebrated not for military conquests or architectural achievements, but for his unwavering commitment to impartial justice.<sup>1</sup> This article explores the historical background, legendary narratives, and contemporary significance of Manu Needhi Cholan as a symbol of judicial integrity.

Situated outside the Madras High Court (Chennai High Court) depicts Manu Needhi Cholan, also known as Elara Cholan or Ellalan — a legendary Tamil king from the Chola dynasty who ruled around the 2<sup>nd</sup> century BCE. It stands as a symbolic representation of justice within the Tamil legal tradition. Manu Needhi Cholan, a ruler from the Chola dynasty is not celebrated for military conquests or monumental architectural feats but for his deep commitment to justice.<sup>2</sup> The legend of Manu Needhi Cholan is well-known in Tamil culture, wherein it is said that he demonstrated his unwavering dedication to justice by personally overseeing the punishment of his own son, who had killed a calf, despite his familial ties. This legendary story underscores the ruler's impartiality and his belief that justice should transcend personal relationships or status.

The statue outside the Madras High Court serves as a poignant reminder of this ideal, embodying the principles of fairness, integrity, and impartiality that continue to resonate within the legal system.<sup>3</sup> The figure of Manu Needhi Cholan symbolizes the broader values of justice and righteousness, reflecting not only Tamil cultural traditions but also aligning with modern legal ideals of equality before the law. As such, the statue has become a significant emblem of judicial integrity in contemporary India, reminding the public and legal professionals of the importance of impartiality in the administration of justice.



Statue of Ellalan, King of Anuradhapura in the premises of Madras High Court in Chennai

c. 205 – c. 161 BCE

source: <https://thefederal.com/states/south/tamil-nadu/udumalpet-caste-killing-case-disproofs-that-led-to-acquittal-of-prime-accused> (Image 1)

<sup>1</sup> K. A. Nilakanta Sastri, *A History of South India*, Oxford University Press, p. 112-114, 1955.

<sup>2</sup> Supra n. 1.

<sup>3</sup> K. Rajan, "Manu Needhi Cholan: A Legend of Justice in Tamil Tradition," *Journal of Tamil Studies*, 35(2), 15-29, 2016.

This article delves deeper into the historical background of Manu Needhi Cholan, exploring the legendary narratives associated with his reign and the ways in which his image has been embraced as a symbol of judicial integrity. Additionally, it will examine the contemporary relevance of this symbol in the context of India's evolving legal landscape and its importance in the broader discourse on justice and fairness.

### HISTORICAL CONTEXT

The Chola dynasty represents one of South India's longest-ruling dynasties, with a documented history spanning from the 3<sup>rd</sup> century BCE to the 13<sup>th</sup> century CE.<sup>1</sup> Early Chola kings are mentioned in Ashokan edicts and Sangam literature, establishing their historical legitimacy.<sup>2</sup> While precise historical details about Manu Needhi Cholan remain contested among scholars, historical records from Sri Lanka, particularly the Mahavamsa, reference a just Tamil king named Elara who ruled Anuradhapura for 44 years (205-161 BCE).<sup>3</sup>

Archaeological evidence from this period reveals sophisticated administrative and legal systems developing across Tamil kingdoms. Inscriptions from later Chola periods suggest continuation of legal principles attributed to these early rulers.<sup>4</sup> These historical fragments provide context for understanding how Manu Needhi Cholan emerged as a judicial exemplar in Tamil tradition.

### THE LEGEND AND ITS VARIATIONS

The central legend associated with Manu Needhi Cholan involves his unwavering commitment to justice even at personal cost, when it came to his only son and heir apparent. According to the most widely circulated version, the king installed a bell of justice (the "*Araichi Mani*"), placed just outside his palace. Any citizen seeking Justice could ring this bell and the King would personally hear their grievance and provide justice.<sup>5</sup> One day, the king's son, the prince and heir apparent, was driving his chariot through the streets when he accidentally ran over and killed a calf. The mother cow, in her grief, went to the palace and rang the justice bell with her horn. When King Manu Needhi Cholan learned what had happened, he was faced with an impossible choice between his duty as a king and his love as a father. Staying true to his principles of equal justice for all, he ordered that his son be punished in the same manner as the crime. The king sentenced his own son to death by the same means — being run over by a chariot — thus demonstrating that no one, not even royal blood, was above the law.<sup>6</sup>

Regional variations of this legend exist throughout Tamil Nadu. Some versions name the prince *Veedhividangan*, while others emphasize the divine approval of Manu Needhi's decision through miraculous occurrences following the judgment.<sup>7</sup> In certain folklore, the king himself drives the chariot that executes his son, underscoring his personal commitment to justice.

These narratives share common elements with justice legends found in other cultures, including the blinding of Prince Kunala in ancient Indian tradition and Solomon's judgment in Judeo-Christian traditions, suggesting universal themes in judicial folklore.<sup>8</sup>

### SIGNIFICANCE OF THE STATUE

The statue depicts the king seated on his throne with the justice bell in front of him, symbolizing:

1. The principle that no one is above the law.
2. The ideal of impartial justice regardless of status or power.
3. A ruler's duty to uphold dharma (righteousness) and justice even at personal cost.

<sup>1</sup> Y. Subbarayalu, *South India Under the Cholas*, Oxford University Press, p. 23-25, 2012.

<sup>2</sup> R. Champakalakshmi, *Trade, Ideology and Urbanization: South India 300 BC to AD 1300*, Oxford University Press, p. 87, 1996.

<sup>3</sup> Wilhelm Geiger, (Trans.), *Mahavamsa: Great Chronicle of Ceylon, Chapter 21, verses 10-15*, Pali Text Society, 1912.

<sup>4</sup> K. R. Venkataraman, *Administration in the Chola Empire*, Annamalai University Historical Series, p. 156-158, 1985.

<sup>5</sup> K. Sivathamby, *Literary History in Tamil*, Tamil University Press, p. 78-80, 1987.

<sup>6</sup> Zvelebil, Kamil, *The Smile of Murugan: On Tamil Literature of South India*, E.J. Brill, p. 201-203, 1973.

<sup>7</sup> A.K. Ramanujan, *Folktales from India*, Pantheon Books, p. 114-116, 1991.

<sup>8</sup> Wendy Doniger, *The Hindus: An Alternative History*, Oxford University Press, p. 324-326, 2010.

The presence of this statue outside the Madras High Court, symbolizes impartial justice and is a powerful reminder of judicial fairness in the Indian legal system. It serves as a powerful reminder to judges and lawyers of their duty to uphold justice without fear or favour, regardless of who stands before them.

This legendary tale continues to be recounted in Tamil culture as an example of ideal kingship and perfect justice, making Manu Needhi Cholan an enduring symbol of the Tamil judicial tradition that predates modern legal systems.

### SYMBOLIC REPRESENTATION IN ART AND ARCHITECTURE

The iconography of Manu Needhi Cholan typically portrays him seated on a throne with the justice bell prominently displayed. This representation appears not only in the Madras High Court statue, erected during the British colonial period (1862), but also in numerous temple sculptures throughout Tamil Nadu.<sup>1</sup>

The visual language of these representations emphasizes three key elements: the seated king (symbolizing authority), the bell (representing accessibility of justice), and occasionally the cow (signifying protection of the vulnerable). This tripartite symbolism communicates the inseparability of power, accessibility, and protection in Tamil judicial philosophy.<sup>2</sup>

The colonial-era decision to place Manu Needhi Cholan's statue at the Madras High Court represents a fascinating intersection of British imperial administration and Tamil cultural heritage. By incorporating indigenous symbols of justice, colonial authorities attempted to legitimize new legal institutions through connection to established traditions.<sup>3</sup>

### INFLUENCE ON TAMIL JUDICIAL TRADITIONS

The principles attributed to Manu Needhi Cholan have significantly influenced Tamil legal thinking. The concept of "Needhi" (justice) in Tamil tradition encompasses broader principles than modern legal systems, integrating moral, ethical, and cosmic dimensions of righteousness.<sup>4</sup>

#### Key principles derived from the Manu Needhi tradition include:

- Equal justice regardless of social status
- Accessibility of justice to all citizens, including the most vulnerable
- Personal accountability of rulers to uphold justice
- The inseparability of judicial and executive functions in ensuring dharma (righteousness)<sup>5</sup>

These principles found expression in later Chola legal systems, which developed sophisticated judicial procedures including village assemblies (*sabhas*), royal courts, and specialized tribunals. Inscriptional evidence suggests that these institutions—maintained ideals of accessibility and impartiality attributed to Manu Needhi Cholan.<sup>6</sup>

### CONTEMPORARY RELEVANCE

In contemporary legal discourse, Manu Needhi Cholan continues to serve as a reference point for judicial ethics. The Tamil Nadu judicial academy includes his story in training materials for new judges, emphasizing the tradition of judicial independence that predates modern legal formulations.<sup>7</sup>

<sup>1</sup> Jennifer Howes, "Colonial Courts and Legal Iconography in British India," *Journal of Colonial Studies*, 45(2), p. 112-118, 2007.

<sup>2</sup> Vidya Dehejia, "The Sensuous and the Sacred: Chola Bronzes from South India," *American Federation of Arts*, p. 87-89, 2002.

<sup>3</sup> Lauren Benton, *Law and Colonial Cultures: Legal Regimes in World History: 1400-1900*, Cambridge University Press, p. 156-158, 2002.

<sup>4</sup> Daniel E. Valentine, *Fluid Signs: Being a Person the Tamil Way*, University of California Press, p. 62-65, 1984.

<sup>5</sup> K. S. Nagarajan, *Elements of Ancient Indian Law: Theory and Practice*, University of Madras Press, p. 123-125, 2008.

<sup>6</sup> Noboru Karashima, *A Concise History of South India: Issues and Interpretations*, Oxford University Press, p. 76-78, 2014.

<sup>7</sup> Tamil Nadu State Judicial Academy, Training Manual for Subordinate Judges, Government of Tamil Nadu, p. 12-14, 2018.

Legal scholars have drawn parallels between the principles represented by Manu Needhi Cholan and contemporary legal concepts such as equality before the law, judicial independence, and the rule of law.<sup>1</sup> These connections demonstrate how traditional narratives can provide cultural foundations for modern legal principles.

The statue at the Madras High Court continues to function as a powerful visual reminder of judicial responsibility. Judges and lawyers frequently reference the Manu Needhi legend in contemporary legal arguments and judicial opinions, demonstrating its ongoing relevance to legal practice.<sup>2</sup>

### **Thomas Munro's Sculpture and its Significance**

The Madras High Court itself was established in 1862 and is one of the oldest high courts in India, with the current building being completed in 1892, featuring distinctive Indo-Saracenic architecture.

Apart from the statue outside the Madras High Court, as discussed above, the statue of "Lady Justice" (also known as Justitia), is a common feature at many courthouses around the world,<sup>3</sup> there is another specific historical statue with an interesting story outside the Madras High Court: the statue of Thomas Munro.

The statue of Thomas Munro, located outside the Madras High Court in Chennai, is one of the most prominent public sculptures in the area. As with many such statues erected during the British colonial period, it serves, both as a commemoration of an individual and a symbol of the colonial legacy in India. Thomas Munro, a significant British colonial administrator in India, played a critical role in shaping the revenue and administrative systems of the Madras Presidency in the early 19<sup>th</sup> century. The statue stands not only as a tribute to his personal achievements but also as a reflection of the complex history of British rule in India.

### **The Statue of Thomas Munro Outside the Madras High Court: A Reflection of British Colonial Legacy**

Thomas Munro (1761–1827) was a British soldier and colonial administrator who served as the Governor of Madras from 1820 until his death in 1827. Munro is best remembered for his administrative reforms, particularly his contributions to the agrarian and revenue systems in the Madras Presidency. His tenure as the Collector of the North Arcot district and later as the Governor is marked by his efforts to streamline land revenue collection and reduce corruption, which had plagued the system under earlier British officials.<sup>4</sup>

Munro's most notable contribution was the introduction of the *ryotwari system*, which replaced the earlier *zamindari system* that had been used in many parts of India. Under the *ryotwari system*, individual farmers (or *ryots*) were made directly responsible for paying taxes to the British government, bypassing the zamindars (landowners) and aiming to reduce intermediary exploitation. While the system was designed to ensure more direct control over revenue collection, it also brought with it its own challenges, including a heavy tax burden on farmers.<sup>5</sup> Nonetheless, Munro's reforms were considered vital for the administration of the Madras region during British rule.<sup>6</sup>

### **Munro's Statue and its Symbolism**

The statue of Thomas Munro outside the Madras High Court was erected in the 19<sup>th</sup> century to honour his significant contributions to the British administration. The sculpture was commissioned after his death, in recognition of his role in establishing the foundations of modern governance in the region. The statue depicts Munro in military uniform, reflecting his dual role as both a soldier and an administrator. His posture is dignified, standing with a commanding presence, symbolizing his authority and the influence he wielded during his time in India.

<sup>1</sup> N.R. Madhava Menon, "Indigenous Legal Traditions and Modern Jurisprudence," *Indian Journal of Legal Studies*, 24(3), p. 45-52, 2012.

<sup>2</sup> Narendra Subramanian, *Ethnicity and Populist Mobilization: Political Parties, Citizens and Democracy in South India*, Oxford University Press, p. 178-180, 2010.

<sup>3</sup> P. Sundaram, *The Lady Justice and Her Role in Indian Legal Symbolism*. *International Journal of Law and Society*, 19(3), 28-36, 2014.

<sup>4</sup> J. R. McLane, *Indian Nationalism and the British Empire: The Impact of Colonial Policies on the Indian Economy*. Cambridge University Press 1993.

<sup>5</sup> K. Pannikar, *The History of Indian Taxation and Revenue Systems under British Rule*. Oxford University Press, 2014.

<sup>6</sup> R. Ray, *Colonialism and the Indian Revenue System: The Ryotwari System in Madras*. *South Asian Studies*, 18(3), 63-80, 2001.

While the statue was intended to honour Munro's legacy, its location outside the Madras High Court is particularly significant. The court itself represents the judicial branch of the government, and placing Munro's statue near such a vital institution emphasizes his influence on the legal and administrative systems in the region. His work in revenue administration and legal reform in the Madras Presidency shaped the structure of governance that would later affect the judicial system.

However, it is important to acknowledge that Munro's legacy is not without controversy. As a representative of the British colonial administration, his reforms were part of a broader system that sought to extract resources from the Indian population and maintain British control over the region. For many, the *ryotwari system* and other administrative measures were seen as exploitative, leading to increased hardships for Indian farmers and peasants.<sup>1</sup> Therefore, while the statue serves as a testament to his role in shaping colonial governance, it also stands as a reminder of the complex, often problematic legacy of British colonial rule.

### Controversy and Modern Perspectives around Munro's Equestrian Statue

In contemporary times, the statue of Thomas Munro has become a subject of debate. While it once represented the British colonial establishment, today it is viewed by some as a symbol of colonial oppression. The legacies of colonial figures like Munro are increasingly questioned in post-independence India, where there is a growing movement to reassess the role of such individuals in the country's history.



Source: <https://www.navrangindia.in/2020/04/sir-thomas-munro-equestrian-statue.html> (Image 2)

For example, the *ryotwari system*, while praised for its efficiency and directness by some historians, is also criticized for its negative impact on the Indian peasantry. The heavy taxes imposed on farmers under this system contributed to widespread poverty and famines in many areas, and the lack of intermediary support systems like the zamindari class led to greater exploitation in some cases. Critics argue that Munro's system, although rational from a British imperial perspective, failed to consider the well-being of the Indian population.

Additionally, as India continues to grapple with the legacies of colonialism, the presence of statues honouring British figures like Munro has become increasingly contentious. Statues of colonial figures in public spaces have been removed in various parts of the world, and calls to reconsider their place in Indian cities have grown louder. The debate surrounding the statue of Thomas Munro outside the Madras High Court is part of a larger discourse on how colonial history should be remembered and whether such figures should continue to be honoured in post-colonial societies.

The statue of Munro, located just outside this building, serves as a reminder of the colonial foundations upon which the Indian judicial system was initially built. As one of the key figures in the administration of the Madras Presidency, Munro's presence in statue form symbolizes the nexus between the British colonial state and its legal institutions.

### The Legacy of Thomas Munro and his Statue

This statue, outside the Madras High Court, is a complex and multifaceted symbol. It stands as a tribute to a British administrator who played a pivotal role in shaping the governance and revenue systems in colonial India.

<sup>1</sup> V. Sriram, *The Madras High Court: A Historical and Architectural Overview*, Chennai Heritage Review, 2015.

At the same time, it also embodies the contradictions of colonial rule, highlighting both the contributions and the detrimental effects of British policies on the Indian populace.

While some may view the statue as a reminder of the past, it also presents an opportunity for reflection on India's colonial legacy and the ways in which modern India grapples with its history. The statue of Thomas Munro, much like other colonial-era statues, invites ongoing discussions about the intersection of history, memory, and national identity. As India continues to evolve in its post-colonial journey, the question of how to engage with the legacies of figures like Munro remains an important aspect of the nation's broader cultural and political discourse.

The statue has an amusing legend associated with it that has become part of Chennai's folklore. According to local tradition, if a case is going to be decided in your favour at the High Court, Sir Thomas Munro's horse will raise one of its legs as you pass by. This superstition has led many litigants to observe the statue carefully before their court hearings.

There's also a humorous story that when the statue was first installed, local residents were confused about why a man was depicted sitting on a horse that appeared to be standing on only two legs (as the other two legs are raised in the standard equestrian pose). The story goes that some locals would place stones under the raised hooves of the horse at night, concerned that the horse might fall over without proper support. While this is more urban legend than historical fact, it reflects the cultural impact the statue has had.<sup>1</sup>

The statue has been a landmark in Chennai for over 180 years and has witnessed the transformation of the city from a colonial outpost to a major metropolis. It stands as a reminder of the colonial past of Chennai and the establishment of the British legal system that formed the foundation of India's current judiciary.

### **Conclusion: Architectural and Cultural Context of the Madras High Court**

The Madras High Court stands as a symbol of the legal and administrative systems that the British established in India. Designed by British architect, Henry Irwin, in 1892, it is a fine example of Indo-Saracenic architecture, a style that combines British colonial elements with traditional Indian features. The building itself reflects the grandeur of British colonial power while integrating indigenous elements such as domes and arches. The statue of Thomas Munro, therefore, fits into the architectural and cultural context of the area, which was meant to project British authority and control.

The legend of Manu Needhi Cholan represents more than mere folklore; it embodies fundamental principles of justice that continue to resonate in contemporary legal ethics. As a symbol, Manu Needhi Cholan bridges ancient Tamil judicial traditions and modern legal systems, providing cultural continuity amid institutional transformation.

The enduring power of this symbol lies in its clear articulation of judicial impartiality, even at personal cost—a principle that remains essential to legitimate legal systems across cultural contexts. In an era when judicial independence faces various challenges, the statue outside the Madras High Court serves as a persistent reminder of the ideal that justice must remain accessible to all and apply equally to everyone, regardless of power or position.

The statue of Thomas Munro outside the Madras High Court stands as a testament to his influence on the administrative and legal structures of colonial India. While his reforms, such as the introduction of the *ryotwari system*, were significant in shaping the economy and governance of the Madras Presidency, they also left a legacy that has been critiqued for its exploitation of the Indian peasantry. Today, the statue serves as a reminder of India's colonial past, sparking debates about how such figures should be remembered in modern times. Whether viewed as a symbol of British imperial authority or as a historical artifact to be critiqued, the statue of Thomas Munro continues to be an important landmark in the cultural and political landscape of Chennai.

The statue of Manu Needhi Cholan ties directly into the Tamil identity, drawing on centuries-old traditions and the region's rich history of literature, law, and governance. In similar tradition, the Lady Justice sculpture speaks to the global nature of legal systems and the shared ideals of fairness and justice that transcend national borders. Together, the sculptures form an important part of the architectural and cultural landscape of the Madras High Court, blending the local with the universal.

---

<sup>1</sup> P. Taylor, *Colonial Legacies: The Political Significance of Statues in Post-Colonial India*. Journal of South Asian Studies, 30(2), 125-145, 2018.

---

Beyond their symbolic importance in the legal realm, the statues outside the Madras High Court are an integral part of Chennai's cultural and architectural heritage. The Madras High Court itself is a significant historical landmark, and the sculptures add to its narrative, contributing to the city's broader identity as a hub of legal and intellectual activity in India. The city of Chennai has long been recognized for its cultural and intellectual history, and the sculptures outside the Madras High Court reflect this legacy.

The sculptures outside the Madras High Court — serve as powerful symbols of justice, morality, and impartiality. They connect the ancient Tamil legal tradition with modern judicial ideals, serving as reminders of the enduring importance of fairness and equality within the legal system. These statues do not merely decorate the space; they embody the core values that the Madras High Court and, by extension, the Indian legal system strive to uphold. As such, these sculptures are not only artistic creations but also civic symbols, reinforcing the ongoing quest for justice in an ever-changing society.



# MANUSCRIPT SUBMISSION

## GUIDELINES FOR CONTRIBUTORS

1. Manuscripts should be submitted preferably through email and the research article / paper should preferably not exceed 8 – 10 pages in all.
2. Book review must contain the name of the author and the book reviewed, the place of publication and publisher, date of publication, number of pages and price.
3. Manuscripts should be typed in 12 font-size, Times New Roman, single spaced with 1" margin on a standard A4 size paper. Manuscripts should be organized in the following order: title, name(s) of author(s) and his/her (their) complete affiliation(s) including zip code(s), Abstract (not exceeding 350 words), Introduction, Main body of paper, Conclusion and References.
4. The title of the paper should be in capital letters, bold, size 16" and centered at the top of the first page. The author(s) and affiliations(s) should be centered, bold, size 14" and single-spaced, beginning from the second line below the title.

**First Author Name1, Second Author Name2, Third Author Name3**

1 Author Designation, Department, Organization, City, email id

2 Author Designation, Department, Organization, City, email id

3 Author Designation, Department, Organization, City, email id

5. The abstract should summarize the context, content and conclusions of the paper in less than 350 words in 12 points italic Times New Roman. The abstract should have about five key words in alphabetical order separated by comma of 12 points italic Times New Roman.
6. Figures and tables should be centered, separately numbered, self explained. Please note that table titles must be above the table and sources of data should be mentioned below the table. The authors should ensure that tables and figures are referred to from the main text.

## EXAMPLES OF REFERENCES

All references must be arranged first alphabetically and then it may be further sorted chronologically also.

### • Single author journal article:

Fox, S. (1984). Empowerment as a catalyst for change: an example for the food industry. *Supply Chain Management*, 2(3), 29–33.

Bateson, C. D., (2006), 'Doing Business after the Fall: The Virtue of Moral Hypocrisy', *Journal of Business Ethics*, 66: 321 – 335

### • Multiple author journal article:

Khan, M. R., Islam, A. F. M. M., & Das, D. (1986). A Factor Analytic Study on the Validity of a Union Commitment Scale. *Journal of Applied Psychology*, 12(1), 129-136.

Liu, W.B, Wongcha A, & Peng, K.C. (2012), "Adopting Super-Efficiency And Tobit Model On Analyzing the Efficiency of Teacher's Colleges In Thailand", *International Journal on New Trends In Education and Their Implications*, Vol.3.3, 108 – 114.



- **Text Book:**

Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (2007). *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies* (3rd ed.). New York: McGraw-Hill.

S. Neelamegham," Marketing in India, Cases and Reading, Vikas Publishing House Pvt. Ltd, III Edition, 2000.

- **Edited book having one editor:**

Raine, A. (Ed.). (2006). *Crime and schizophrenia: Causes and cures*. New York: Nova Science.

- **Edited book having more than one editor:**

Greenspan, E. L., & Rosenberg, M. (Eds.). (2009). *Martin's annual criminal code: Student edition 2010*. Aurora, ON: Canada Law Book.

- **Chapter in edited book having one editor:**

Bessley, M., & Wilson, P. (1984). Public policy and small firms in Britain. In Levicki, C. (Ed.), *Small Business Theory and Policy* (pp. 111–126). London: Croom Helm.

- **Chapter in edited book having more than one editor:**

Young, M. E., & Wasserman, E. A. (2005). Theories of learning. In K. Lamberts, & R. L. Goldstone (Eds.), *Handbook of cognition* (pp. 161-182). Thousand Oaks, CA: Sage.

- **Electronic sources should include the URL of the website at which they may be found, as shown:**

Sillick, T. J., & Schutte, N. S. (2006). Emotional intelligence and self-esteem mediate between perceived early parental love and adult happiness. *E-Journal of Applied Psychology*, 2(2), 38-48. Retrieved from <http://ojs.lib.swin.edu.au/index.php/ejap>

- **Unpublished dissertation/ paper:**

Uddin, K. (2000). A Study of Corporate Governance in a Developing Country: A Case of Bangladesh (Unpublished Dissertation). Lingnan University, Hong Kong.

- **Article in newspaper:**

Yunus, M. (2005, March 23). Micro Credit and Poverty Alleviation in Bangladesh. *The Bangladesh Observer*, p. 9.

- **Article in magazine:**

Holloway, M. (2005, August 6). When extinct isn't. *Scientific American*, 293, 22-23.

- **Website of any institution:**

Central Bank of India (2005). *Income Recognition Norms Definition of NPA*. Retrieved August 10, 2005, from <http://www.centralbankofindia.co.in/home/index1.htm>, viewed on

7. The submission implies that the work has not been published earlier elsewhere and is not under consideration to be published anywhere else if selected for publication in the journal of Indian Academicians and Researchers Association.

8. Decision of the Editorial Board regarding selection/rejection of the articles will be final.

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

**Journal**

**Volume 7, Issue 2 (I)**  
April – June 2020

ISSN 2394 - 7780

International Journal of  
**Advance and Innovative Research**

**Indian Academicians and Researchers Association**  
[www.iaraedu.com](http://www.iaraedu.com)

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

**Journal**

ISSN 2394 - 9554

**International Journal of Research in  
Science and Technology**

Volume 6, Issue 2: April - June 2019



**Indian Academicians and Researchers Association**  
[www.iaraedu.com](http://www.iaraedu.com)

**Become a member of IARA to avail  
attractive benefits upto Rs. 30000/-**

<http://iaraedu.com/about-membership.php>



## **INDIAN ACADEMICIANS AND RESEARCHERS ASSOCIATION**

**Membership No: M / M – 1365**

### **Certificate of Membership**

This is to certify that

**XXXXXXXX**

is admitted as a

**Fellow Member**

of

**Indian Academicians and Researchers Association**

in recognition of commitment to Educational Research

and the objectives of the Association



Date: 27.01.2020

*Ramy*  
Director

*Islam*  
President





# INDIAN ACADEMICIANS AND RESEARCHERS ASSOCIATION

Membership No: M / M – 1365

## Certificate of Membership

This is to certify that

**XXXXXXXXXX**

is admitted as a

**Life Member**

of

**Indian Academicians and Researchers Association**

in recognition of commitment to Educational Research  
and the objectives of the Association



Date: 27.01.2020

Director

President



# INDIAN ACADEMICIANS AND RESEARCHERS ASSOCIATION

Membership No: M / M – 1365

## Certificate of Membership

This is to certify that

**XXXXXXXXXX**

is admitted as a

**Member**

of

**Indian Academicians and Researchers Association**

in recognition of commitment to Educational Research

and the objectives of the Association



Date: 27.01.2020

Director

President

# **IARA Organized its 1<sup>st</sup> International Dissertation & Doctoral Thesis Award in September'2019**

## **1<sup>st</sup> International Dissertation & Doctoral Thesis Award (2019)**



Organized By



**Indian Academicians and Researchers Association ( IARA )**

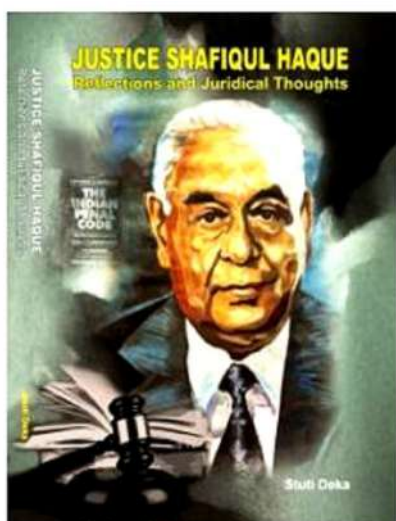


# EMPYREAL PUBLISHING HOUSE

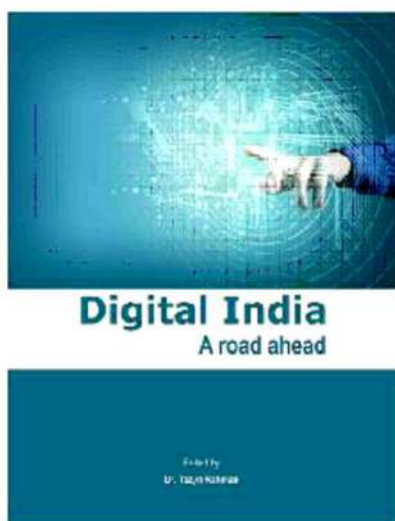
[www.editedbook.in](http://www.editedbook.in)

**Publish Your Book, Your Thesis into Book or  
Become an Editor of an Edited Book with ISBN**

## BOOKS PUBLISHED



Dr. Stuti Deka  
ISBN : 978-81-930928-1-1



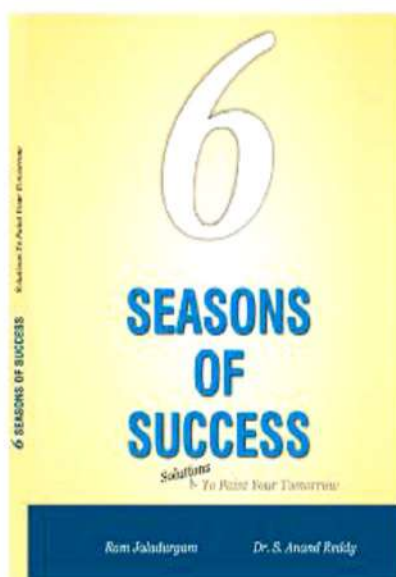
Dr. Tazyn Rahman  
ISBN : 978-81-930928-0-4



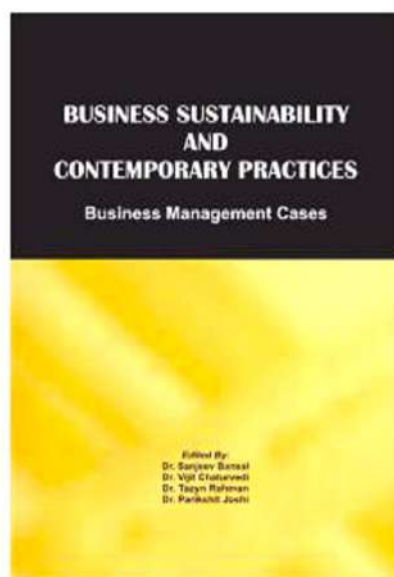
Mr. Dinbandhu Singh  
ISBN : 978-81-930928-3-5



Dr. Ismail Thamarasseri  
ISBN : 978-81-930928-2-8



Ram Jaladurgam  
Dr. S. Anand Reddy  
ISBN : 978-81-930928-5-9

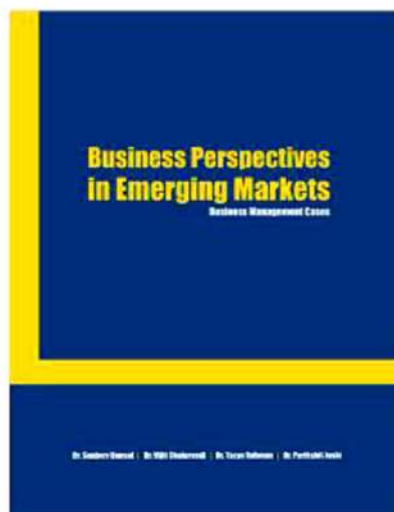


Dr. Sanjeev Bansal, Dr. Vijit Chaturvedi  
Dr. Tazyn Rahman, Dr. Parikshit Joshi  
ISBN : 978-81-930928-6-6





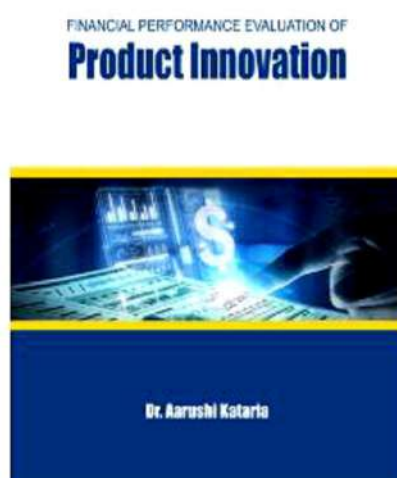
Ashish Kumar Sinha, Dr. Soubhik Chakraborty  
Dr. Amritanjali  
ISBN : 978-81-930928-8-0



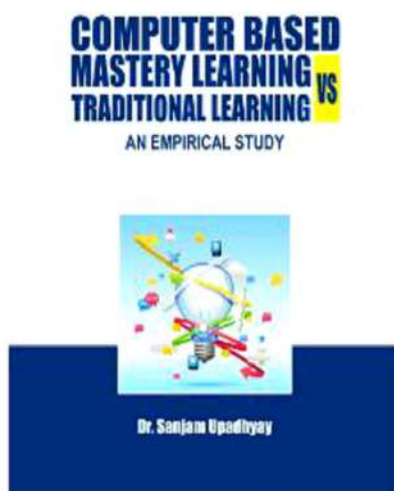
Dr. Sanjeev Bansal, Dr. Vijit Chaturvedi  
Dr. Tazyn Rahman, Dr. Parikshit Joshi  
ISBN : 978-81-936264-0-5



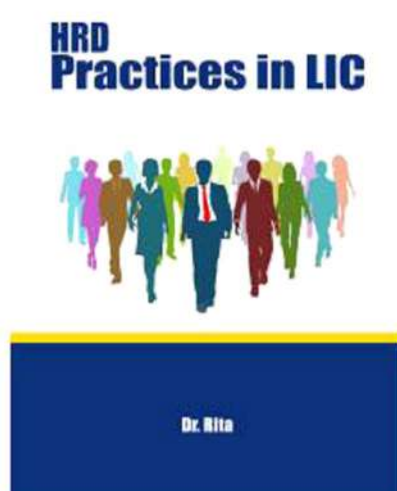
Dr. Jyotsna Golhar  
Dr. Sujit Metre  
ISBN : 978-81-936264-6-7



Dr. Aarushi Kataria  
ISBN : 978-81-936264-3-6



Dr. Sanjam Upadhyay  
ISBN : 978-81-936264-5-0



Dr. Rita  
ISBN : 978-81-930928-7-3



Dr. Manas Ranjan Panda, Dr. Prabodha Kr. Hota  
ISBN : 978-81-930928-4-2



Poomima University  
ISBN : 978-8193-6264-74



Institute of Public Enterprise  
ISBN : 978-8193-6264-4-3

## Vitamin D Supplementation in SGA Babies



Dr. Jyothi Naik  
Prof. Dr. Syed Manazir Ali  
Dr. Uzma Firdaus  
Prof. Dr. Jamal Ahmed

Dr. Jyothi Naik, Prof. Dr. Syed Manazir Ali  
Dr. Uzma Firdaus, Prof. Dr. Jamal Ahmed  
ISBN : 978-81-939070-9-8



## Gold Nanoparticles: Plasmonic Aspects And Applications

Dr. Abhishosh Kedia  
Dr. Pandian Senthil Kumar

Dr. Abhishosh Kedia  
Dr. Pandian Senthil Kumar  
ISBN : 978-81-939070-0-9

## Social Media Marketing and Consumer Behavior



Dr. Vinod S. Chandwani

Dr. Vinod  
S. Chandwani  
ISBN : 978-81-939070-2-3

## Select Research Papers of

Prof. Dr. Dhananjay Awasarwar



Prof. Dr. Dhananjay Awasarwar

Prof. Dr. Dhananjay  
Awasarwar  
ISBN : 978-81-939070-1-6

## Recent ReseaRch Trends in ManageMent



Dr. C. Samudhra Rajakumar  
Dr. M. Ramesh  
Dr. C. Kathiravan  
Dr. Rincy V. Mathew

Dr. C. Samudhra Rajakumar, Dr. M. Ramesh  
Dr. C. Kathiravan, Dr. Rincy V. Mathew  
ISBN : 978-81-939070-4-7

## Recent ReseaRch Trends in Social Science



Dr. C. Samudhra Rajakumar  
Dr. M. Ramesh  
Dr. C. Kathiravan  
Dr. Rincy V. Mathew

Dr. C. Samudhra Rajakumar, Dr. M. Ramesh  
Dr. C. Kathiravan, Dr. Rincy V. Mathew  
ISBN : 978-81-939070-6-1

## Recent Research Trend in Business Administration



Dr. C. Samudhra Rajakumar  
Dr. M. Ramesh  
Dr. C. Kathiravan  
Dr. Rincy V. Mathew

Dr. C. Samudhra Rajakumar, Dr. M. Ramesh  
Dr. C. Kathiravan, Dr. Rincy V. Mathew  
ISBN : 978-81-939070-7-8

## Recent Innovations in Biosustainability and Environmental Research II



Dr. V. I. Paul  
Dr. M. Muthulingam  
Dr. A. Elangovan  
Dr. J. Nelson Samuel Jebastin

Dr. V. I. Paul, Dr. M. Muthulingam  
Dr. A. Elangovan, Dr. J. Nelson Samuel Jebastin  
ISBN : 978-81-939070-9-2

## Teacher Education: Challenges Ahead



Sajid Jamal  
Mohd Shakir

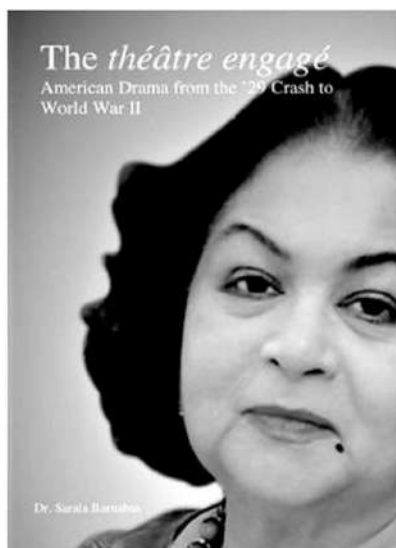
Sajid Jamal  
Mohd Shakir  
ISBN : 978-81-939070-8-5



## Project Management



Dr. R. Emmaniel  
ISBN : 978-81-939070-3-0

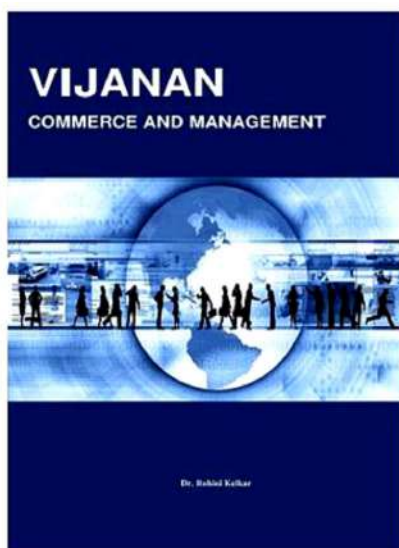


Dr. Sarala Barnabas  
ISBN : 978-81-941253-3-4



AUTHORS  
Dr. M. Banumathi  
Dr. C. Samudhra Rajakumar

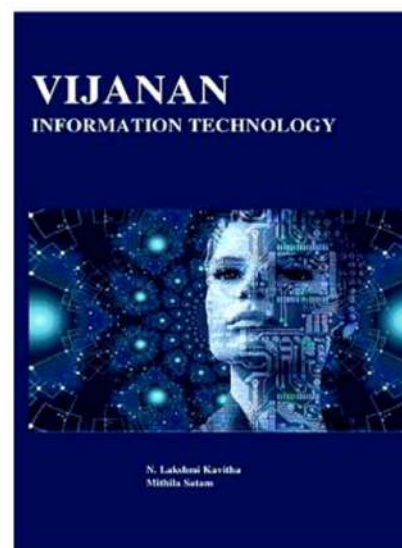
Dr. M. Banumathi  
Dr. C. Samudhra Rajakumar  
ISBN : 978-81-939070-5-4



Dr. (Mrs.) Rohini Kelkar  
ISBN : 978-81-941253-0-3



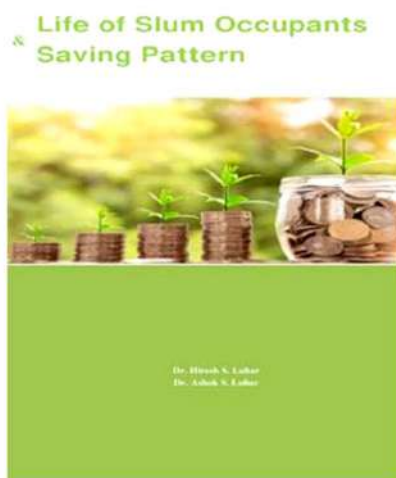
Dr. Tazyn Rahman  
ISBN : 978-81-941253-2-7



Dr. N. Lakshmi Kavitha  
Mithila Satam  
ISBN : 978-81-941253-1-0



Dr. Hiresuh Luhar  
Prof. Arti Sharma  
ISBN : 978-81-941253-4-1



Dr. Hiresuh S. Luhar  
Dr. Ashok S. Luhar  
ISBN : 978-81-941253-5-8



Dr. Babita Kanojia  
Dr. Arvind S. Luhar  
ISBN : 978-81-941253-7-2

## SKILLS FOR SUCCESS



SK Nathan  
SW Rajamonaharane

Dr. Sw Rajamonaharane  
SK Nathan  
ISBN : 978-81-942475-0-0

## Witness Protection Regime An Indian Perspective



Aditi Sharma

Aditi Sharma  
ISBN : 978-81-941253-8-9

## Self-Finance Courses: Popularity & Financial Viability



Dr. Ashok S. Luhar  
Dr. Hires S. Luhar

Dr. Ashok S. Luhar  
Dr. Hires S. Luhar  
ISBN : 978-81-941253-6-5

## SMALL SCALE INDUSTRIES MANAGEMENT Issues, Challenges and Opportunities



Dr. B. Augustine Arockiaraj

Dr. B. Augustine Arockiaraj  
ISBN : 978-81-941253-9-6



## SPOILAGE OF VALUABLE SPICES BY MICROBES

Dr. Kuljinder Kaur

Dr. Kuljinder Kaur  
ISBN : 978-81-942475-4-8

## Financial Capability of Students: An Increasing Challenge in Indian Economy

Dr. Priyanka Malik



Dr. Priyanka Malik  
ISBN : 978-81-942475-1-7

## THE RELATIONSHIP BETWEEN ORGANIZATION CULTURE AND EMPLOYEE PERFORMANCE: HOSPITALITY SECTOR



Dr. Rekha P. Khosla

Dr. Rekha P. Khosla  
ISBN : 978-81-942475-2-4

## A GUIDE TO

TWIN LOBE BLOWER AND ROOT BLOWER TECHNIQUE



Dilip Pandurang Deshmukh

Dilip Pandurang Deshmukh  
ISBN : 978-81-942475-3-1



## SILVER JUBILEE COMMEMORATIVE LECTURE SERIES 2019-SNGC

Dr. D. Kalpana  
Dr. M. Thangavel

Dr. D. Kalpana, Dr. M. Thangavel  
ISBN : 978-81-942475-5-5





## Indian Commodity Futures and Spot Markets

Dr. Aloysius Edward J.

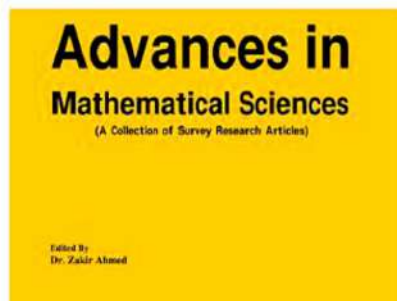
Dr. Aloysius Edward J.  
ISBN : 978-81-942475-7-9



## Correlates of Burnout Syndrome Among Servicemen

Dr. Binomay Ohiagueri Ekechukwu

Dr. R. O. Ekechukwu  
ISBN : 978-81-942475-8-6



## Advances in Mathematical Sciences

(A Collection of Survey Research Articles)

Edited By  
Dr. Zakir Ahmed



Dr. Zakir Ahmed  
ISBN : 978-81-942475-9-3

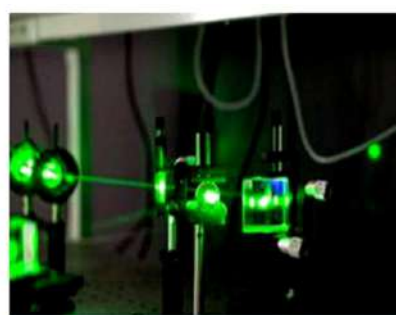


## Fair Value Measurement

Challenges and Perceptions

Dr. (CA) Ajit S. Joshi  
Dr. Arvind S. Luhar

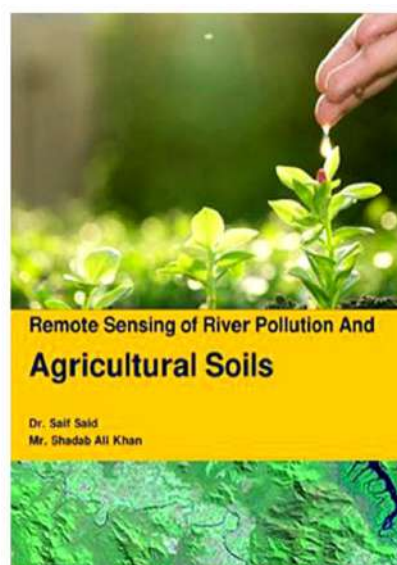
Dr. (CA) Ajit S. Joshi  
Dr. Arvind S. Luhar  
ISBN : 978-81-942475-6-2



## NONLINEAR OPTICAL CRYSTALS FOR LASER Growth and Analysis Techniques

Madhav N Rode  
Dilipkumar V Mehraam

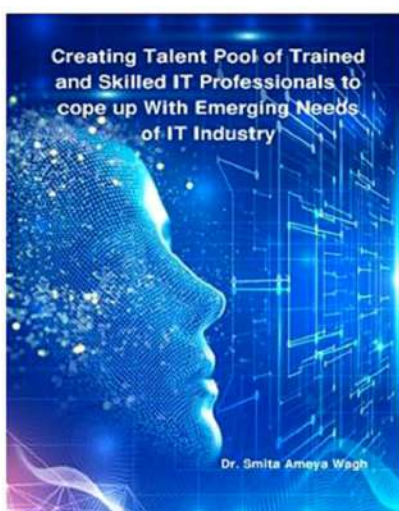
Madhav N Rode  
Dilip Kumar V Mehraam  
ISBN : 978-81-943209-6-8



## Remote Sensing of River Pollution And Agricultural Soils

Dr. Saif Said  
Mr. Shadab Ali Khan

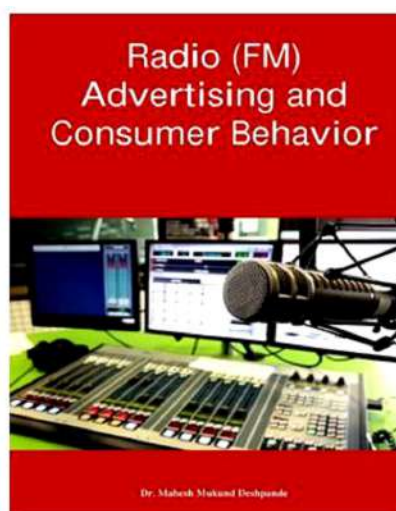
Dr. Saif Said  
Shadab Ali Khan  
ISBN : 978-81-943209-1-3



## Creating Talent Pool of Trained and Skilled IT Professionals to cope up With Emerging Needs of IT Industry

Dr. Smita Ameya Wagh

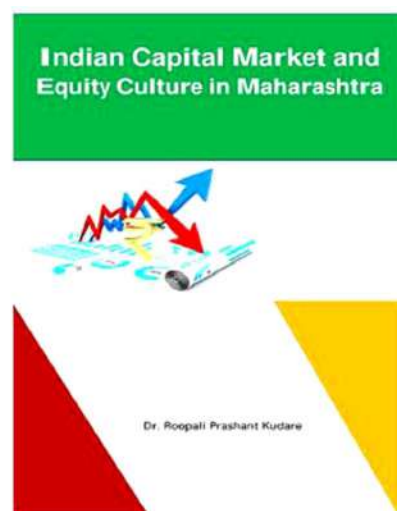
Dr. Smita Ameya Wagh  
ISBN : 978-81-943209-9-9



## Radio (FM) Advertising and Consumer Behavior

Dr. Mahesh Mukund Deshpande

Dr. Mahesh Mukund Deshpande  
ISBN : 978-81-943209-7-5



## Indian Capital Market and Equity Culture in Maharashtra

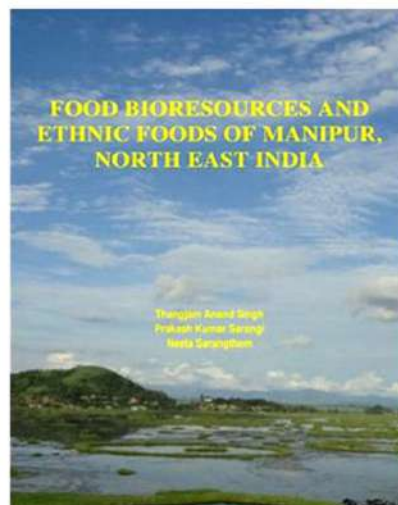
Dr. Roopali Prashant Kudare

Dr. Roopali Prashant Kudare  
ISBN : 978-81-943209-3-7

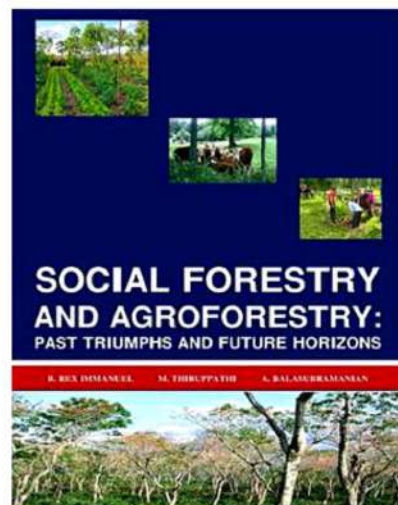




M. Thiruppathi  
R. Rex Immanuel  
K. Arivukkaran  
ISBN : 978-81-930928-9-7



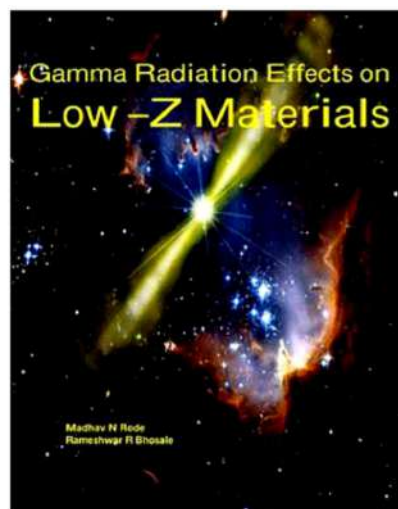
Dr. Th. Anand Singh  
Dr. Prakash K. Sarangi  
Dr. Neeta Sarangthem  
ISBN : 978-81-944069-0-7



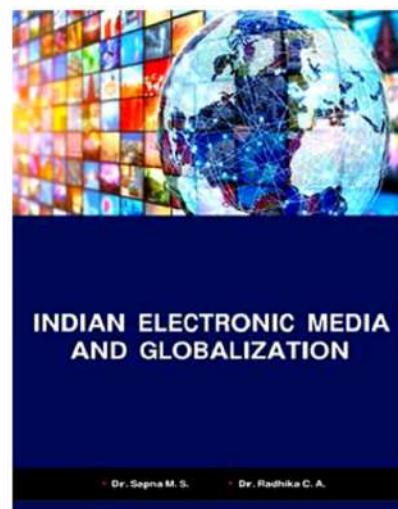
R. Rex Immanuel  
M. Thiruppathi  
A. Balasubramanian  
ISBN : 978-81-943209-4-4



Dr. Omkar V. Gadre  
ISBN : 978-81-943209-8-2



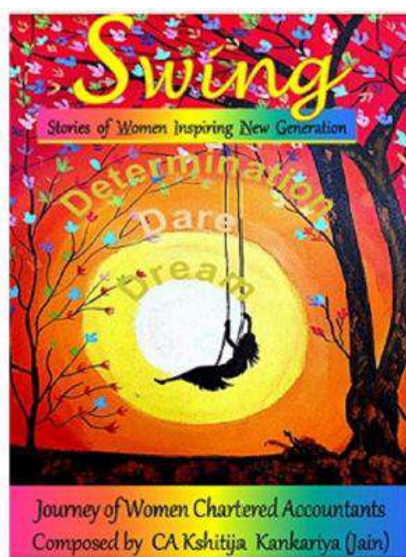
Madhav N Rode  
Rameshwar R. Bhosale  
ISBN : 978-81-943209-5-1



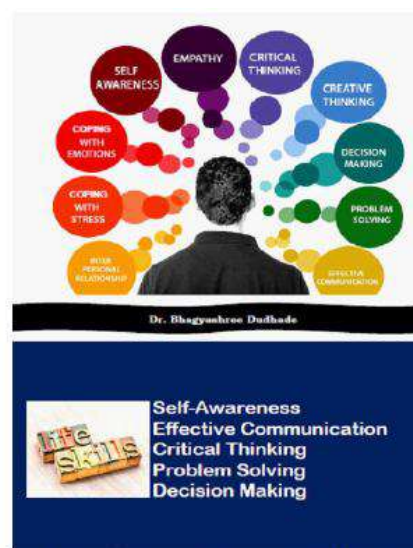
Dr. Sapna M S  
Dr. Radhika C A  
ISBN : 978-81-943209-0-6



Hindusthan College  
ISBN : 978-81-944813-8-6



Swing  
ISSN: 978-81-944813-9-3



Dr. Bhagyashree Dudhade  
ISBN : 978-81-944069-5-2





S. Saad, S. Bushra, A.A. Khan

S. Saad, S. Bushra, A. A. Khan

ISBN: 978-81-944069-9-0



Prashant S. Kore  
Pravina S. Ugile-Pawar  
Madhav N Rode

Prashant S. Kore

Pravina S. Ugile-Pawar

Madhav N Rode

ISSN: 978-81-944069-7-6

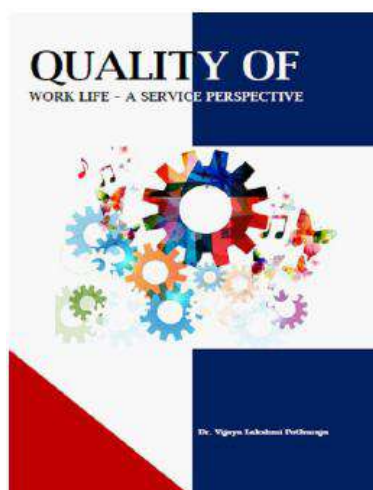


## Mixed Magnetic Oxides

Dilipkumar V Meshram  
Madhav N Rode

Dilipkumar V Meshram and  
Madhav N Rode

ISSN: 978-81-944069-6-9



Dr. Vijaya Lakshmi Pothuraju

Dr. Vijaya Lakshmi Pothuraju

ISBN : 978-81-943209-2-0



## National Level Seminar

on  
'E-Business: A Paradigm Shift in the 21st Century'  
January 30th & 31st 2020

Organized by  
Department of Commerce & Management



Sponsored by

Savitribai Phule Pune University, Pune  
(under Quality Improvement Programme)

Kamala Education Society's  
Pratibha College of Commerce and Computer Studies,  
Accredited by NAAC with "B" Grade (CGPA 2.68)

## PROCEEDINGS

Pratibha College

ISBN : 978-81-944813-2-4



STATE LEVEL SEMINAR

'Emerging Environmental Challenges  
&  
Its Sustainable Approaches'

7th & 8th, February 2020

Sponsored by

Savitribai Phule Pune University, Pune  
(under Quality Improvement Program)

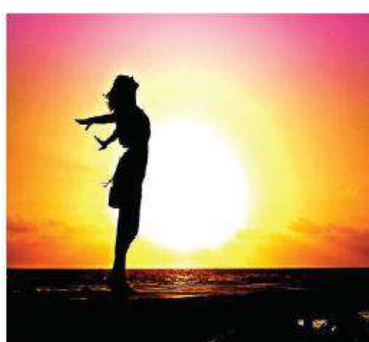
## PROCEEDINGS

Organized by

Department of Environmental Science  
Kamala Education Society's  
Pratibha College of Commerce and Computer Studies,  
(Accredited with NAAC "B" Grade)  
Tel. (Off.) : 8800100942/45, 020-65111411  
www.pccos.org.in

Pratibha College

ISBN : 978-81-944813-3-1

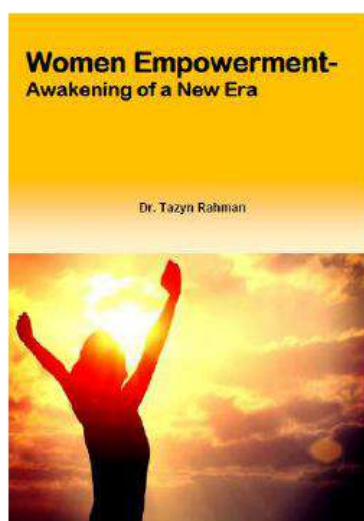


## Women Empowerment

Dr. Tazyn Rahman

Dr. Tazyn Rahman

ISBN : 978-81-936264-1-2

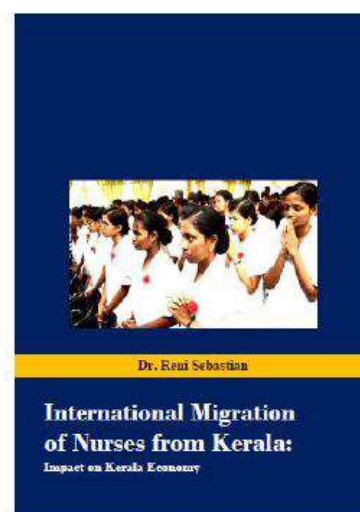


## Women Empowerment- Awakening of a New Era

Dr. Tazyn Rahman

Dr. Tazyn Rahman

ISBN : 978-81-944813-5-5



Dr. Reni Sebastian

## International Migration of Nurses from Kerala: Impact on Kerala Economy

Dr. Reni Sebastian

ISBN : 978-81-944069-2-1



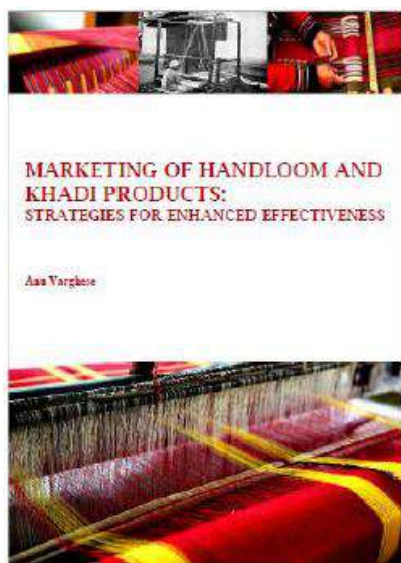
**Dr. Vijay Prakash Gupta**  
ISBN : 978-81-944813-1-7



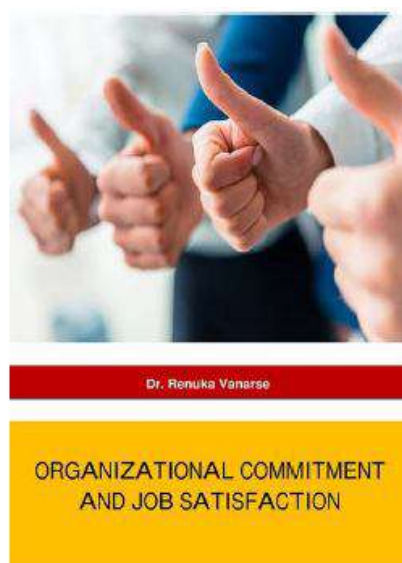
**Dr. Deepa Vijay Abhonkar**  
ISBN : 978-81-944813-6-2



**Arasu Engineering College**  
ISSN: 978-81-944813-4-8



**Dr. Ann Varghese**  
ISBN : 978-81-944069-4-5



**Dr. Renuka Vanarse**  
ISBN : 978-81-944069-1-4





# INDIAN ACADEMICIANS & RESEARCHERS ASSOCIATION

## Major Objectives

- To encourage scholarly work in research
- To provide a forum for discussion of problems related to educational research
- To conduct workshops, seminars, conferences etc. on educational research
- To provide financial assistance to the research scholars
- To encourage Researcher to become involved in systematic research activities
- To foster the exchange of ideas and knowledge across the globe

## Services Offered

- Free Membership with certificate
- Publication of Conference Proceeding
- Organize Joint Conference / FDP
- Outsource Survey for Research Project
- Outsource Journal Publication for Institute
- Information on job vacancies

## Indian Academicians and Researchers Association

Shanti Path ,Opp. Darwin Campus II, Zoo Road Tiniali, Guwahati, Assam

Mobile : +919999817591, email : [info@iaraedu.com](mailto:info@iaraedu.com) [www.iaraedu.com](http://www.iaraedu.com)



# EMPYREAL PUBLISHING HOUSE


- Assistant in Synopsis & Thesis writing
- Assistant in Research paper writing
- Publish Thesis into Book with ISBN
- Publish Edited Book with ISBN
- Outsource Journal Publication with ISSN for Institute and private universities.
- Publish Conference Proceeding with ISBN
- Booking of ISBN
- Outsource Survey for Research Project

**Publish Your Thesis into Book with ISBN “Become An Author”**

## EMPYREAL PUBLISHING HOUSE

Zoo Road Tiniali, Guwahati, Assam

Mobile : +919999817591, email : [info@editedbook.in](mailto:info@editedbook.in), [www.editedbook.in](http://www.editedbook.in)



---

Empyreal Institute of Higher Education  
Guwahati  
[www.empyreal.co.in](http://www.empyreal.co.in)