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(Affiliated to Sant Gadge Baba Amravati University) Maharashtra, India.
Eurasian Institute of Science and Technology, EU.
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Bali, Indonesia

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Dr.Jessica C.

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International Conference on Research and Innovations

Editors: Dr.Chirag M. Patel, Dr.(hc) Rania Lampou, Dr.Jessica C.

(Conference Proceedings Issue / Special Issue)

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Conference, Seminar, Symposium organization in association/collaboration with different Institutions.

Conference, Seminar, Symposium Publication with ISSN Journals and ISBN Books (Print / Online).

About the organizing Institutions:

International Scientific Research Association is a registered and an esteemed research association working on to provide scientific research services, educational studies and activities at international level, also coordinate with other research organizations for the educational research events. Scientific Research Association as honorary partner of the 'Research Culture Society' with MoU – collaboration.

Matoshree Vimalabai Deshmukh Mahavidyalaya, established in 1956 in Amravati, is a premier institution affiliated with Sant Gadge Baba Amravati University and managed by Shri Shivaji Education Society. Originally founded to empower rural youth through education by Dr. Panjabrao Deshmukh, it was renamed in 1999 to honor Matoshree Vimalabai Deshmukh, a pioneer in women's empowerment and education. The college offers a wide range of granted and non-granted courses including Arts, Home Science, Commerce, and Science. Under the visionary leadership of Dr. Smita Deshmukh, the college achieved NAAC A Grade accreditation in 2023 and continues to expand through digital learning tools, MoUs, and research programs. It boasts modern infrastructure, smart classrooms, and excellent sports and wellness facilities. The institution emphasizes holistic development through academics, co-curriculars, NSS, NCC, and leadership training, nurturing socially responsible future leaders.

'Research Culture Society' (RCS) is a Government Registered International Scientific Research organization. Registered with several United or Government bodies. It is also an independent, professional, non-profit international level organization. RCS-ISRO shall also initiate and setting up new educational and research programs with other international organizations. Society has successfully organized 165+ conferences, seminars, symposiums and other educational programmes at national and international level in association with different educational institutions.

Eurasian Institute of Science and Technology (EU) : Institute of Science & Technology is a self financed college, sponsored has been started in the year 2013 with a noble aim of imparting technical education. The institution enables them to be placed as the best professionals in industries and make them enter into high level programs with competence and confidence. Institute trains specialists in Physical Science, Life Science and Computer Science. Eurasian University is an institution of the central region of EU, for qualified personnel training in science, engineering, technology, management, law, education and research specializations.

Supported by :- The International Languages Council is working to promote Languages and Literatures at different national and international levels, and also coordinate with other institutions and organizations for the educational and community development. It also offer to provide literature, ELT, linguistics research services, educational studies and organizing activities.

Venue: Bali Rani Hotel, Kuta, Bali, Indonesia.

About the Conference :

ICRI-2025 is a good platform to bring together accomplished academicians, scientists, researchers, scholars and students to exchange and share their knowledge, experiences and research results on the aspects of advancements in Science, Agriculture, Engineering, Technology, Business Management, Commerce, Social Sciences, Literature, ELT and Education. This forum can & will spell a scholarly platform to network and discuss the practical challenges encountered and the solutions adopted in their respective domains worldwide. The Conference main Aim is to provide an interaction stage for researchers, students and practitioners from academia and industries to deal with state-of-the-art advancement in their respective fields. The outcome based aim is an ambience that will be instrumental in taking our participants and delegates to the next level of their expertise in their profession. Participants also will visit the city and country as it is a famous tourist attraction.

Objective of the International Conference is to bring together innovative academics, researchers and industrial experts in the field of Scientific, Multidisciplinary Innovation Studies in the Research field to a common platform. The main objective of the scientific conference is to exchange of ideas, discuss issues and views towards the advancement of theory and practices and to create space for presentation of current results of research and scientific work in the field of Sciences, Agriculture, Engineering and Technology, Business Management, Trade, Economy, Social Sciences, Literature, ELT and Education. Conferences such as this provide a valuable opportunity for researchers, academicians and students to share experiences.

Tracks :

- **Track 1 – General – Basic Sciences, Applied Science and Allied Science.**
- **Track 2 – Engineering and Technology.**
- **Track 3 – Business Management.**
- **Track 4 – Commerce / Trade – Economy.**
- **Track 5 – Social Sciences, Law, ELT and Literature.**
- **Track 6 – Education and Physical Education – Sports Science.**

About the Special Issue / Conference Book :

Science, Engineering and Technology cross nearly every facet of modern life and, as problem solvers, engineers are perfectly capable of managing technical activities, mastering innovative ways of science and engineering field, when they spend time and efforts understanding and acting in the field. Scientific and technological innovation, as strategic support to improve social productivity and overall national strength, must be placed at the center for development of any country.

The framework includes engineering and technology as they relate to applications of science. Engineering is used to mean engagement in a systematic design practice to achieve solutions to particular human problems. Technology is used to include all types of human-made systems and processes.

The special issue / conference proceedings / edited book is a collection of peer-reviewed scientific papers submitted by active researchers in the International Conference on Science, Engineering & Technological Innovation. This book can be helpful to understand the various concepts of Science and Technological Innovation to the researchers and academia.

Dr.Jessica C.
Founder President, International Scientific Research Association.
Email : scientificresearchassociation@gmail.com

Message

Dear Colleagues !

I am grateful to co-organizing institutions, all the speakers, committee members and presenters of 'International Conference on Research and Innovations' (ICRI-2025) The overwhelming response to the contributors were acknowledged in very positive manner and its shows that new age is very much eager to work with technical literature. The rising researcher and scholar from various institutions and in-house participants motivate us to improve ourselves.

We are currently in the era of science and engineering revolution, spearheaded by recent developments in engineering, technology and sciences, providing sustainable solutions to various issues.

Here I am delighted that the series of conference on contemporary issues in computer technology has successfully completed its three folds and entered into fourth one, it's all due to the valuable efforts of faculty members of computer science and engineering department.

I extend my best wishes for the editorial team of the special issue; at last, I hope this technological literature interaction will be a source of inspiration to upcoming educationists, technocrats and stakeholders.

Jessica

ICRI - 2025 Conference Head
Founder, International Scientific Research Association

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Principal's Message

It gives me an immense pleasure to collaborate for the 'International conference on Research and Innovations' to be held on 5th and 6th May, 2025. Research has become order of the day, to make contribution in the field of Science, Technology, Commerce and Industry. The innovation era has begun with the development of artificial intelligence expanding its domain in both manufacturing as well as service sectors.

I congratulation the Research Culture Society (RCS)and the entire team associated in organizing this conference to promote research and encouraging the innovations in various fields of Commerce, Industry, Business and Technology. 8 faculty members from our college are presenting paper in the conference. Matoshree Vimalabai Deshmukh Mahavidyalaya will have a long lasting relationship with 'Research Culture Society', collaborating for many other events.

Dr Smita Deshmukh

PRINCIPAL
Matoshri Vimalabai Deshmukh Mahavidyalaya Amravati
Affiliated to Sant Gadge Baba Amravati University
Amravati, Maharashtra (India)

Prof. Maria Eropenko
Dean, Eurasian Institute of Science and Technology
Eurasian University
Email : eist@eurasianuniversity.uk

MESSAGE

Dear Colleagues!!!

I am proud to be the part of Organizational Committee of "International Conference on Research and Innovations - 2025", jointly organized by 'Scientific Research Association' and Eurasian Institute of Science and Technology, Eurasian University in collaboration with 'Research Culture Society' (5 – 6 May, 2025).

We have an exciting program at this conference that will allow participants to reflect upon and celebrate their accomplishments, renew friendships and extend networks, and jointly explore current and future research directions. I hope that all participants will have a productive and fun-filled time at this online conference.

I sincerely hope that this conference will deliberate and discuss all the different facets of this exciting topic and come up with recommendations that will lead to a better world.

I wish the conference great success.

Maria Eropenko
Dean, Eurasian Institute of Science and Technology,
Eurasian University

Dr.C. M. Patel

Director, RESEARCH CULTURE SOCIETY

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Email : director@researchculturesociety.org

Message

Dear Professional Colleagues,

It is gratifying to note that 'International Scientific Research Association'; Matoshri Vimalabai Deshmukh Mahavidyalaya Amravati Affiliated to Sant Gadge Baba Amravati University Amravati, Maharashtra (India); Eurasian Institute of Science and Technology (EU) in collaboration with 'Research Culture Society' (Government Registered Scientific Research organization) are organizing - 'International Conference on Research and Innovations' during 5 – 6 May, 2025.

The aim of the conference is to provide an interaction stage to researchers, practitioners from academia and industries. The main objective is to promote scientific and educational activities towards the advancement of common citizen's life by improving the theory and practice of various disciplines of science and engineering. Provide the delegates to share their new research ideas and the application experiences face to face.

I believe, this International Conference will help in redefining the strong connection between students and academicians from different institutions. An additional goal of this international conference is to combine interests and scientific research related to General Science, Physical Science, Applied Sciences, Engineering and Technology Development to interact with members within and outside their own disciplines and to bring people closer for the benefit of the scientific community worldwide.

My best wishes to the committee members, speakers and participants of this scientific conference ICRI-2025.

Dr.C. M. Patel
Director, Research Culture Society.

Conference Committee :

Organizers – Conference Chair Members :

Dr.Maria Eropenko, Dean, Eurasian Institute of Science and Technology, Eurasian University(EU).
Dr. Jessica C., Founder President, Scientific Research Association.
Dr Smita Deshmukh, Principal, Matoshri Vimalabai Deshmukh Mahavidyalaya Amravati Affiliated to Sant Gadge Baba Amravati University, Amravati, Maharashtra (India).
Dr. Chirag Patel, Director – Research Culture Society, Program Head, Eurasian University(EU).

Keynote Speakers :

Dr. Rukminingsih, The Dean of Teacher Training and Education Department, PGRI Jombang University, Indonesia ; & International Languages Council, Member – Indonesia
Dr.(hc).Rania Lampou, STEM instructor and an ICT teacher trainer, at the Greek Ministry of Education, Greece. & Head, STEM Department, Eurasian Institute of Educational Technology, E.U.
Dr. Xihui Haviour Chen, Associate Professor of Accounting and Finance, Keele Business School, Keele University, United Kingdom.

Guest Spekakers:

Prof. Dr. Redzuan Sofian, President and CEO Trichester Consulting, Malaysia.
Dr. Daria Suprun, Professor, Department of Social Work and Rehabilitation, National University of Life Science and Environmental Sciences of Ukraine, Ukraine, Europe.

Coordinator :

Dr. Rupali S. Talegaonkar, Matoshree Vimalabai Deshmukh Mahavidyalaya Amravati, Sant Gadge Baba Amravati University, Amravati, Maharashtra, India.

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Dr.Anna Jasiulewicz, Assistant Professor, Management Institute at Warsaw University of Life Sciences (SGGW), Warszawa, Poland.

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Applications & Plant Growth Regularity Activity Derived From Schiff's Bases & Their Complexes

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Abstract :- *The biological applications of Schiff bases can be extended from antimicrobial, Plant Growth Regulators, Antioxidants, Enzymatic, Anticancer, Antiinflammatory, Anti-malarial, Antiviral, Neuroprotective, Analgesicactivities. In modern agriculture practice various chemicals in solutions or aqueous suspension are sprayed on to the crop plants within the object of accelerating & modifying the plant growth & development. Among several economical important plants Brassica (Mohari) &Trigonella (Methi) are selected as a plant system..*

This revise summarizers the applications of Schiff bases & their complexes & compounds with metals as agrochemicals namely insecticides & plant growth regulators. In the present investigation, effect of ligand, complex & metal ion on percentage seed germination, root length, shoot length has been studied. The work also deals with the study of Chlorophyll, Percentage of Nitrogen & Protein Estimation. Chlorophyll Pigments were found affected in Methi &Mohari plants by the treatments. Percentage of Nitrogen is found to be greater in plant growth of complex solution. The Schiff Base ligands & their complexes of transition metal are tested for their plant growth regulating activity with seeds of Mohari & Methi plants. Plant growth regulatory activity studied on seeds of Mohari & Methi & results have been discussed.

Keywords :- *Schiff Bases, Metal Complexes, Plant Growth Activity, Parameters, Soil, Double Distilled Water, Methi & Mohari Seeds etc.*

1. INTRODUCTION :-

Plants though they appear common in place & passive, proved to be complex & fascinating functions of systems & understanding them is a challenging task, for both the students & scientists. Of course, the task is beyond anyone individual & many scientists have engaged in it. the study has become especially intense in recent years.

The problem of understanding life as a functioning machine has sometimes proved so difficult that philosophers have proposed an alternative, that life functions depend on something beyond the limits of the physics, chemistry, engineering – a spirit of intelechy. this is known as 'Vitalistic Theory', as compared to the concept of mechanism. Mechanism states that life can be understood on the basis of physical & chemical events. Vitalism has been completely unproductive in science while mechanism provides the only approach that allows experimentation & application of the scientific method. Although, future research is bound to bring about some modifications, we might begin to formulate a definition of life. Life is a peculiar series of functions associated with a peculiar series of organized structures in which certain macromolecules, having building blocks, arranged in non repeating but reproducing sequences, have the ability to reproduce, transfer & utilization of information & catalysis of metabolic reactions. All of these being organized to a level allowing the functions of growth, metabolism, irritability & reproduction.

One analysis of plant function & structure makes it possible to define the various fields of biological science & also to see the expanding overlap in some of these traditional fields. Physics isconcerned with various manifestations of matter. There may be only one Science: Physics, concept with the manifestation of matter & Chemistry is concerned with those manifestations involving the exchange or sharing of electrons, that is chemical reaction. This is usually contrasted with Biology, but it should be readily apparent that Biology is in a sense really a branch of physics, a branch concerned with manifestation of matter, known as life.

Plant physiology will probably also assume an increasingly, important role in agricultural research problems. As world population increases, mankind faces enormously complex problems. Their solutions will require input from many sources: social, economical, technological & agricultural. One of the primary tasks of the future will be to increase food, forage, fibre & wood production substantially throughout the world. Future agricultural research programme will continue, as in the present, to have as their major goals the production of new & better varieties & strains of crop plants, the improvement of plant protection against insects, diseases & weeds, the control of soil fertility & an increase in mechanization efficiency. But in addition, there will be a sharp intensification of demand of plant physiologists not only to supply basic information regarding how plants grow & develop but also to undertake research programmes designed specially to increase yields of plant products.

One of the important contributions of the nineteenth century experimental plant physiology to agricultural was the discovery that soil fertility & crop yields could be increased by adding several nutrients to the soil. Prior to the nineteenth century, the common method for increasing crop production was to apply plant & animal (manners, copouts etc.) to so. It was not released that this treatment returned to the soil only a portion of nutrients that had been extracted by plants. Another centuries old agricultural practice was to rotate crops periodically with other crops. This practice resulted in increased growth of crops only in the early 1800's, agricultural scientists realize that crop plants grow in proportion to the amounts of various nutrients present in soils. This principle was adopted by nineteenth century agronomists. Today the application of various salts to soils is a basic feature of agricultural practice. Without the application of these & other fertilizer to soils the large crop yields obtained in developing countries throughout the world during the past 50 years or more could not be possible. In modern agricultural practice, various chemicals in solution or aqueous suspension are sprayed on to the crop plants within the object of accelerating & modifying the plant growth & development.

Powerful support for the connection between chelation & cancer has come out from discovery that some of the coordination compounds of platinum are very effective in inhibiting the growth of tumors.

2. Aim of The Present Work :

The information about the role of metal complexes in biological systems, their concentration & presence in different equilibria is of immense importance. Greshon et al 1,2 reported that the activity of metal chelates is considerably increased as compared to that of the free metal & ligand alone on their complexation. The observation of antifungal & antibacterial activities of complexes show that they are more active as compared to for ligand & metal involved3,4.

The biological activity of metal ion & ligand of Cu (II) complexes towards some fungi & bacteria are evaluated5. Rare earth metal ions, when they replace the metal ion Ca^{2+} in complex, spectral properties of the systems are modified with no change in functionalities of the complex6. Rare earth ions are used as probe in bio-chemistry of calcium. Zielinski et al 7 showed that, Lanthanide ion could substitute the calcium ion to produce active enzyme system. Some bivalent metal ions have been reported to be useful in agriculture as plant growth regulators. Such a vast uses of lanthanide necessitate concentrating on the study of lanthanides & ligands for studying the germination pattern.

The complexes of transition metal with bis-alkyl thiourea are prepared & their herbicidal & plant growth regulating activity are tested with wheat & cucumbers by Darnall et al 8. Complexes of piperidene-2-carboxylic acid with some bivalent metal ions have been reported to be useful in agricuiture as plant growth regulators9. The complexes of rare earth with peptides showed the herbicidal & plant growth regularity activity with wheat & barley plant10.

Since organic drugs have intense biological activity & since no work is prepared on

the biological applications of binary complexes of Pr (III) with 2'- Hydroxy, 3' – bromo, 5' chloro-4-methoxy-N[orthonitrophenyl]Chalcone imine (HBCMNCI) & comparing with pure ligand, metal & control solution doubly distilled water to study the effect of complex, metal, ligand & control solution on germination survival, seedling height etc. on Mohari (Brassica) & Methi (Trigunella) plants in order to make suggestion whether complex, metal & ligands can be used as plant growth regulators.

The following aspects were studied in laboratory

(i) Estimation of chlorophyll contents
(ii) Estimation of percentage of nitrogen & protein

3. Materials & Experimental Method :

Metal Ions : The solutions of metal ions in form of nitrate of the concentration of 0.01 M were prepared using doubly distilled water.

Ligand : 0.01 M solutions of ligands were prepared in distilled water. The applications of complex, metal, ligand solution are studied by dissolving it in proper solvent at desired pH. The biological applications are therefore studied in aqueous medium at 3.60, 7.00 & 10.5 pH & at constant ionic strength of 0.01 M potassium nitrate solution.

Soil : Fertilized soil was collected from Lonar Lake & Satpuda, Chikhaldara. Stone & other material were removed from it. It was then grind & filtered. Two parts of this finely powdered soil was mixed with one part of filtered pink stone sand. This soil was then filled in two wooden trays having four compartments of equal size. The soil in the tray was moistened with water. Sowing of seeds was done in this soil after one hour.

Experiments Performed :

In general practice, various chemicals are used in agricultural as an important ingredient of various pesticides, insecticides, fertilizers etc. to improve the crop yield. Amongst several economical important plants Brassica (Mohari) & Trigonella (Methi) are selected as a plants system. These plants are in ideal systems to study the germination & growth pattern. Further, their economical importance is reflected by its wide use for the vegetable purposes. The important uses of Mohari & Methi in daily life are persuasive to study its response against metal ion, ligand & its complex regarding to physiological processes, particularly germination is a vital process for the growth of plants.

Therefore, these plants are selected as a plant systems.

1] Healthy seeds of Mohari of same germination were taken & thoroughly washed using doubly distilled water. 100 seeds from these healthy seeds of equal size were chosen, immersed in tested solution of pH 3.6, 7.00 & 10.5 for about 6 hours. These seeds soaked were taken out of each solution. The seeds were sowed in the wooden trays in a row. The experiments were carried out during 28th June to 28th Jully 2002, the wooden trays were kept under the atmosphere pressure at room temperature.

2] Using Trigonella (Methi) performed similar experiment.

3] Effect of ligand, metal ion, complex solution on growth of Abelmoschus esculentus plants was studied at different pH (3.6, 7.00 & 10.5) the seeds being immersed in solution at about 4, 6 & 8 hours.

4] Effect of ligand, metal Pr (III), complex on percentage of nitrogen, percentage of proteins & chlorophyll in the leaves of Mohari (Brassica) plants was studied.

5] For the estimation of chlorophyll content, all the vegetables selected for the purpose were green. They contain chlorophyll pigments in the chloroplast. The attempt was made to find out total chlorophyll pigments in 1 gm of fresh leaves. This was determined by spectrophotometry method given by Jahagirdar11.

The total amount of chlorophyll, & chlorophyll 'a' & chlorophyll 'b' reported in Table 8 (a) & 8(b) determined by using –

Total chlorophyll (g/lit.) = 0.202 (O.D.)645 + 0.00802 (O.D.)663.

chlorophyll 'a' (g/lit). = 0.0127 (O.D)663 – 0.00269 (O.D.)645.

chlorophyll ;a; (g/lit.) = 0.0127 (O.D.)663 – 0.00269 (O.D.)645.

chlorophyll 'b' (g/lit.) = 0.0229 (O.D.)645 – 0.00488 (O.D.)480.

The total nitrogen present in the leaves of treated plants has been calculated. The percentage of Protein was calculated by multiplying 6.25 to the, total amount of nitrogen, 6.25 is the

constant known as protein factors in plant material.

Parameters :-

Plants growth is decided on the basis of parameters such as percentage of germination survival, seedling height, shoot length, root length (root length/shoot length) & thickness of young leaf having high values compared to control system. The germination was noted after 1&1/2 days & 10 days for both plants.

After noting the survival of the plants, they were taken out of the soil. The seedling height (root length/shoot length) & thickness (width length) of young leaf of survived plants were measured. The average values of these parameters are presented in Table (1-6).

It is observed from Tables (1- 6) that percentage of survival of seeds is more than that of germination in many cases. This is due to the facts some seeds germinated after recording the germination.

4. Result & Discussion :-

Some attempts have been made by Bera et al12 have observed the effect of raw savage water on mustard. In the present investigation, effect of ligand, complex & metal ion on percentage seed germination, root length, shoot length (root/shoot ratio) has been studied. The work also deals with the study of chlorophyll, percentage of nitrogen & protein estimation.

Percent Germination :-

To understanding seed germination is one of the major goals of plant physiology. Actually, development is an organism goes through in its life cycle. Plant development is a cyclic process. If any cycle can be said to have a beginning in plants, beginning would be would be germination of seed is a convenient place to begin because seeds are quiescent or resting organs that represents a normal hiatus in life cycle. When the conditions are appropriate, the seed will renew its growth & germinates. Such an important phenomenon will be affected by different conditions.

It was cleared from Tables (1-6), the percent germination in all the treatment almost increases than that of control.

Root Length, Shoot Length & Root/ Shoot Ratio :-

Germination starts when the seed shows emergence phase of growth, which begins, with penetration of embryo from the seed coat & end with the development of root & shoot system. The elongation of shoot axis follows emergence of radical.

The rate &extent of elongation is subjected to a variety of controls, including nutrition, harmones & environmental factors. Though the root & shoot development start within a fraction of time but the further developments may vary according to the nutrients required for the development of root & shoot independently. Therefore, root & shoot length differ from each other. Tables 1 to 6 clearly indicate that average root length in HBCMNCI, complex, Pr(III) at all pH increase over control for both the plant systems. In the shoot length, for Mohari plant system (Table 1-6), it is seen that in Pr(III)-complex with HBCMNCI showed decrease in shoot length but increase as compared to control.

The changes in the growth pattern of root & shoot were studied by the proportional growth in both the cases. The root & shoot ratio reflects the same & represents the development in root & shoot simultaneously.

Chlorophyll Content :-

The existence of all forms of life on this planet has been made possible mainly by means of energy conversions. Organism trap energy from environment, which they utilize for their activities & after a series of interconversations, energy is returned to the environment. The phenomenon of energy input from a biological environment to the biological systems is always through the green plants. Green plants thus can be regard as the basic fulcrum on which all forms of life revolve. The unique phenomenon of energy input in form of solar radiation into biological system is known as photosynthesis & has to be medicated only through the green plant.

Photosynthesis is the process in which the light energy will be converted into chemical energy. There are some basic requirements for the process of photosynthesis as CO2, H2O & light energy besides of course, the structural framework of green plant in the form of chloroplast, which is a unique cell having most important role in all the physiological reactions, starting from the absorption of light energy. Basically, among the smallest group of coordinating pigment molecules necessary to effect a photo chemical act, the most important pigments involved in photosynthesis are cholorophyll & carotenoid. Cholorophyll 'a' appears blue green in transmitted light but reddish in reflected light & is the principal pigment involved in trapping the light of wavelength 670nm. Chlorophyll 'b' is yellowish green in transmitted light but reddish in reflected light & traps light of wavelength 645 nm. Table-7 shows the absorption of leaves plants which is higher at 663 nm for all the systems.

Chlorophyll pigments were found affected in Methi & Mohari plants by the treatments. It can be seen from Table-8 that, the order of total chlorophyll is found to be as – Ligand > Complex > Metal > Control for Mohari & Metal > Complex > Control > Ligand for Methi plant system.

The percentage of nitrogen & proteins was determined in leaves of Mohari for control, ligand, complex & metal ion systems as shown in Table – 9. The order of the percentage of nitrogen & protein is as follows.

Percentage of Nitrogen → Complex > Ligand > Control > Metal
Percentage of Protein → Complex > Ligand > Control > Metal

It could be concluded from Table – 9 that, the percentage of nitrogen & protein is found to be greater in the plant growth of complex solution.

Table – 1
Effect of Ligand, Metal Ion & Complexes on Germination, Survival, Seedling Height etc. on Brassica (Mohari) Test System
(Seed soaked in solution for 6 hours)

pH = 3.60 **μ** = 0.1 M

Parameters	Effect of				General Order of Plant Growth Regulators
	Water or Control	Ligand	Complex	Metal	
% Germination after 2 & 1/2 days	45.00	60.00	48.00	46.00	HBCMNCI > Complex > Metal > Water
%Survival after 10 days	60.00	76.00	70.00	68.00	
Seedling Height (cm)	2.20	2.35	2.30	2.29	
Root Length (cm)	3.95	4.02	4.00	3.99	
Shoot Length (cm)	4.20	4.40	4.35	4.30	
Root / Shoot	0.9404	0.9136	0.9195	0.9279	
Width length of young leaf (cm)	0.9562	0.9998	0.9920	0.9855	

Ligand – HBCMNCI **Control –** Distilled Water
Complex – Pr(III) – HBCMNCI **Metal –** Pr(III)

Table – 2
Effect of Ligand, Metal Ion & Complexes on Germination, Survival, Seedling Height etc. on Brassica (Mohari) Test System
(Seed soaked in solution for 6 hours)

pH = 7.00 **μ** = 0.1 M

Parameters	Effect of				General Order of Plant Growth Regulators
	Water or Control	Ligand	Complex	Metal	

% Germination after 2 & 1/2 days	48.00	62.00	52.00	51.00	HBCMNCI > Complex > Metal > Water
% Survival after 10 days	62.00	77.00	73.00	72.00	
Seedling Height (cm)	2.31	2.37	2.33	2.32	
Root Length (cm)	3.97	4.04	4.02	4.01	
Shoot Length (cm)	4.22	4.45	4.40	4.38	
Root / Shoot	0.9875	0.9078	0.9136	0.9155	
Width length of young leaf (cm)	0.9599	1.0050	1.0000	1.0030	

Ligand – HBCMNCI **Control –** Distilled Water
Complex – Pr(III) – HBCMNCI **Metal –** Pr(III)

Table – 3
Effect of Ligand, Metal Ion & Complexes on Germination, Survival, Seedling Height etc. on Brassica (Mohari) Test System
(Seed soaked in solution for 6 hours)

pH = 10.5 **μ** = 0.1 M

Parameters	Effect of				General Order of Plant Growth Regulators
	Water or Control	Ligand	Complex	Metal	
% Germination after 2 & 1/2 days	49.00	65.00	55.00	52.00	HBCMNCI > Complex > Metal > Water
% Survival after 10 days	65.00	79.00	74.00	73.00	
Seedling Height (cm)	2.32	2.39	2.37	2.35	
Root Length (cm)	3.99	4.06	4.03	4.02	
rShoot Length (cm)	4.25	4.50	4.43	4.40	
Root / Shoot	0.9388	0.9022	0.9097	0.9136	
Width length of young leaf (cm)	0.9678	1.0090	1.0080	1.0076	

Ligand – Ligand – HBCMNCI **Control –** Distilled Water
Complex – Pr(III) – HBCMNCI **Metal –** Pr(III)

Table – 4
Effect of Ligand, Metal Ion & Complexes on Germination, Survival, Seedling Height etc. on Trigonella (Methi) Test System
(Seed soaked in solution for 4 hours)

pH = 3.60 **μ** = 0.1 M

Parameters	Effect of				General Order of Plant Growth Regulators
	Water or Control	Ligand	Complex	Metal	
% Germination after 2 & 1/2 days	50.00	70.00	63.33	70.00	Metal > Ligand > Complex > Control
% Survival after 10 days	52.00	76.00	72.00	68.00	
Seedling Height (cm)	1..27	1.32	1.30	1.29	
Root Length (cm)	3.05	3.15	3.10	3.08	
Shoot Length (cm)	4.01	4.23	4.20	4.12	
Root / Shoot	0.7605	0.7446	0.7380	0.7403	
Width length of young leaf (cm)	0.9851	0.9215	0.9200	1.0052	

Ligand – HBCMNCI **Control –** Distilled Water
Complex – Pr(III) – HBCMNCI **Metal –** Pr(III)

Table – 5
Effect of Ligand, Metal Ion & Complexes on Germination, Survival, Seedling Height etc. on Trigonella (Methi) Test System
(Seed soaked in solution for 4 hours) **μ** = 0.1 M

Parameters	Effect of					
	Control or Water			Ligand		
	3.60	**7.00**	**10.5**	**3.60**	**7.00**	**10.5**
% Germination after 2 & 1/2 days	50.20	50.25	50.30	72.00	72.10	72.30
% Survival after 10 days	52.00	76.00	72.00	68.00	68.90	69.00
Seedling Height (cm)	1..28	1.29	1.30	1.30	1.32	1.35
Root Length (cm)	3.08	3.09	3.10	3.18	3.20	3.22
Shoot Length (cm)	4.02	4.03	4.05	4.25	4.27	4.29
Root / Shoot	0.7661	0.7664	0.7654	0.7482	0.7494	0.7505
Width length of young leaf (cm)	0.9880	0.9356	0.9958	0.9855	0.9889	0.9980

Table – 6
Effect of Ligand, Metal Ion & Complexes on Germination, Survival, Seedling Height etc. on Trigonella (Methi) Test System
(Seed soaked in solution for 4 hours)
μ = 0.1 M

Parameters	Effect of					
	Complex			Metal Ion		
	3.60	**7.00**	**10.5**	**3.60**	**7.00**	**10.5**
% Germination after 2 & 1/2 days	63.50	63.58	63.65	71.00	72.06	71.15
% Survival after 10 days	72.50	77.00	73.05	69.00	70.05	71.00
Seedling Height (cm)	1..32	1.34	1.35	1.31	1.33	1.34
Root Length (cm)	3.07	3.18	3.12	3.10	3.12	3.13
Shoot Length (cm)	4.02	4.06	4.07	4.01	4.08	4.10
Root / Shoot	0.7636	0.7832	0.7741	0.7730	0.7647	0.7634
Width length of young leaf (cm)	0.9881	0.9350	0.9952	0.9725	0.9735	0.9982

Table – 7
Measurement of Optical Density For Methi & Mohari Plants System

Sr. No.	Leaves of Plants With Treatment of Following		Optical Density At		
			480 nm	**645 nm**	**663 nm**
1	Water or Control	MR	0.403	0.197	0.439
		MI	0.306	0.142	0.406
2	Ligand	MR	0.504	0.232	0.607
		MI	0.270	0.128	0.391
3	Complex	MR	0.388	0.186	0.495
		MI	0.300	0.144	0.412
4	Metal-Pr (III)	MR	0.296	0.133	0.339
		MI	0.275	0.180	0.471

MR --- Mohari **MI** ---- Methi

Table – 8
Estimation of Chlorophyll For Methi & Mohari Plants System

Sr. No.	Leaves of Plants With Treatment of Following		Total Chlorophyll g / lit.	Total Chlorophyll 'a' g / lit.	Total Chlorophyll 'b' g / lit.
1	Water or Control	MR	6.500 x 10-3	5.045 x 10-3	2.544 x 10-3
		MI	6.124 x 10-3	4.714 x 10-3	1.358 x 10-3
2	Ligand	MR	9.554 x 10-3	7.084 x 10-3	2.853 x 10-3
		MI	5.725 x 10-3	4.821 x 10-3	1.6136 x 10-3
3	Complex	MR	7.727 x 10-3	5.786 x 10-3	2.366 x 10-3
		MI	6.2130 x 10-3	4.8451 x 10-3	1.883 x 10-3
4	Metal-Pr (III)	MR	6.522 x 10-3	3.967 x 10-3	2.555 x 10-3
		MI	7.413 x 10-3	5.497 x 10-3	2.292 x 10-3

MR --- Mohari **MI** ---- Methi

Order of Total Chlorophyll :-
Ligand > Complex > Metal > Control ---------- For MR Plant System
Order of Total Chlorophyll :-
Metal > Complex > Control > Ligand ---------- For MI System

Table – 9
Estimation of Total Nitrogen & Proteins In Leaves Powder of Mohari Plants

Sr. No.	Treatment of Following On Mohari Plant	% Elements			Proteins %
		N	C	H	
1	Control or H2O	7.06	57.23	6.28	44.125
2	Ligand (HBCMNCI)	7.41	59.25	6.56	46.312
3	Complex	7.49	59.41	6.15	46.812
4	Metal	6.69	52.41	5.75	41.812

5. Conclusion :-

It was concluded that, the Percent Germination in all the treatments like Ligand, Metal Ion & Complex almost increases than that of Control in both plants. It clearly conclude that, the Average Root Length in HBCMNCI (Ligand), Complex, Pr (III) at all pH increases over Control for both Methi & Mohari plant systems. It is also conclude that in Pr (III)-Complex with HBCMNCI (Ligand) showed decrease in shoot length but increase as compared to Control. The Root & Shoot ratio reflects the same & represents the development in Root & Shoot simultaneously in both plants. The Chlorophyll is found to be more in Ligand & low in control for Mohari Plant system, while chlorophyll found in Metal ion solution more & low in ligand for Methi Plant system.Again it could be concluded that, the Percentage of Nitrogen & Protein is found to be greater in the Plant Growth of Complex Solution

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REFERENCES :-

1. Gershon, H;Parmegiani, R., and Nicerson, W. J. : Appl. Microbiol;10,556 (1962).
2. Gershon, H;Parmegiani, R : Appl. Microbiol;11,62 (1963).
3. Shel,A.M.;Shariel,E.A.;Gharib,A&Ammar, Y.A. : J.Ind. Chem. Soc.:60,1067 (1968).

4. Shashindharam, P &Ramchandra, L.K.: J.Ind.Chem.Soc.,62, 920 (1985).
5. Sharma, R. C.; Tripathi, S. P. & Sharma, R. S. : Current Science., 52, 410 (1983).
6. Oberoi, M., Chaturvedi, S., Chaturvedi, R. & Chaturvedi G. K. : J. Ind. Chem. Soc., 63, 616 (1986).
7. Zielinski, S; Lomosik, L. & Wojclechowska, A. : mh. Chem., 245, 6484 (19700).
8. Darnall, D. W. & Brinhawn, E. R. : J. Bio. Chem., 245, 6484 (1970).
9. Darnall, D. W. & Brinhawn, E. R. : J. Bio. Chem., 12, 48 (1973).
10. Vesile, V. G., Genchev, M. & Daverski, K. : Dolk Bolg Akad. Nauki 32 (12), 1705 (1979). Chem. Abstr. 92, 13 (1980).
11. Jahagirdar,D.V. : Experiments in Chemistry, 1st Edition Himalaya Publishing House (1994).
12. Bera, A. K. & Bokaria, K. : Envir. Ecol., 17 (4), 958 (1999).
13. Adhikari, S., Mitra, A. & Gupta S. K. : J. Instr. Publ. Hlth. Enhrs,India, 2,5 (1998).

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Exploring Bioactive Compounds Derived from Plant Trichodesma zeylanicum and Their Applications

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Abstract: *Many of the chemical compounds produced by plants, have potent biological activities. Phytochemistry is the study of that chemical compounds. These natural products include alkaloids, flavonoids, terpenoids, phenolics, and glycosides, among others. With increasing interest in plant-based therapies, understanding phytochemistry is pivotal for drug discovery, nutraceutical development, and ethnopharmacology.*

The present investigation was focused on the preliminary phytochemical analysis of extraction in distilled water, ethyl alcohol, petroleum ether, Acetone, ethyl acetate, benzene and chloroform of root sample of Trichodesma zeylanicum Plant ,common name is Blue Bell . The site was selected in Mahendri forest, Tal-Warud, Dist-Amravati of Maharashtra State(Area from the border between Madhya Pradesh and Maharashtra).The results clearly indicates the presence of Alkaloid, carbohydrate, cardiac glycosides, Protein, Saponin, Tanin, Resin, Phenol, Steroids. Thus it will be assurely suggests that, this plant can be utilize as an alternative source of useful drug.

Keywords : *Saponins, alkaloids, flavonoids, carbohydrates, tannin, protein , Trichodesma zeylanicum Phytochemical.*

1. INTRODUCTION

The plant kingdom is a treasure house of potential drugs and in the recent years there has been an increasing awareness about the importance of medicinal plants. Drugs from the plants are easily available, less expensive, safe, and efficient and rarely have side effects. The plants which have been selected for medicinal use over thousands of years constitute the most obvious choice of examining the current search for therapeutically effective new drugs such as anticancer drugs antimicrobial drugs antihepatotoxic compounds. According to World Health Organization (WHO), medicinal plants would be the best source to obtain variety of drugs. About 80% of individuals from developed countries use traditional medicines, which has compounds derived from medicinal plants. However, such plants should be investigated to better understand their properties, safety, and efficiency.[1] Medicinal plants contain some organic compounds which provide definite physiological action on the human body and these bioactive substances include tannins, alkaloids, carbohydrates, terpenoids, steroids and flavonoids. These compounds are synthesized by primary or rather secondary metabolism of living organisms.[2]

Trichodesma R. Br. is a genus of about 45 species known from tropical and subtropical regions of Africa, Asia, and Australia[2-4]. Brown described Trichodesma in 1805 . It belongs to the family Boraginaceae established by Jussieu. The group comprises predominantly perennial herbs, a genus well defined by flowers with a deeply divided and strongly accrescent calyx, the absence of fomices, anthers

usually with fairly long, soft hairs on the back and conspicuous long, linear, often twisted connectives produced above the thecae . The name Trichodesma is derived from the Greek words, thrix or trikhos (hair), and desme (band or bundle) and alludes to the twisted hairs or awns that terminate the anthers. The species name is a reference to the relatively narrow root.[5]The root paste is applied to reduce swellings, particularly of the joints; the extract is given to children suffering from dysentery and fever. The plant is useful in vitiated conditions of Vata and Cough, arthralgia, inflammations, dyspepsia, diarrhoea, dysentery, leprosy and skin diseases [6]

2. OBJECTIVE

The present study aims to identify phytochemical constituents from the leaf by using solvent extraction method, Analysis of proximate constituents like moisture, cold and hot water solubility, acid and alkaline solubility, organic matter and crude fiber. And Characterization by FTIR Spectrophotometer.

3. LITERATURE SURVEY

Study was done by Mensah, J. K., on Hypertension is one of the principal health problems in the society and a leading cause of cardio-vascular deaths in various communities worldwide. Over 33 plants and their products have been reported in Nigeria and other West African countries to offer remedies for the management of hypertension.

Soni, A., & Sosa, S. studied to evaluate the phytochemical constitution and antioxidant activity of methanolic extract of dried root of four medicinally important herbs Ocimum sanctum, Mentha spicata, Trigonella foenum-graecum, Spinacia oleracea utilized in our routine diet along with one medicinal important tree Gmelina arborea. Antioxidant activity was studied through DPPH and reducing power assay.[7]

Phytochemical analyses and mineral elements compositions of Anchomanes difformis, Anisopus mannii, Pavetta crassipes, Stachytarpheta angustifolia and Vernonia blumeoides were carried out with a view to assess the therapeutic values and or safety of the plants in ethnomedicine. The results revealed higher concentrations of bioactive constituents comprising alkaloids. [8]

Numerically constituting a large group of world flora, medicinal plants form the source for large variety of herbal drugs used for medicinal purpose .[9]

Euphorbia hyssop folia is a herbaceous plant found in Nigeria and is used as a purgative both in the eastern and northern parts of the country. Extracts of the root are used in the treatment of constipation or inducement of purging to control weight and/or shape. Despite its toxicity and clinical use, analyses of its proximate and mineral composition, as well as the phytochemical analysis revealed other possible applications of the plant. Proximate analysis showed high moisture content of 83.00%, crude fat 3.20%, ash content 3.80%, crude fibre.[10]

A total of 47 plant extracts representing 132 genera and 172 species of plants distributed over 59 families were collected from various parts of Nigeria. The plant extracts were screened for the presence of alkaloids, saponins, tannins, phlobatannins and anthraquinones. The number of positive tests obtained was 176 (32.18%) for alkaloids, 242 (44.24%) for saponins, and 435 (79.52) for tannins. A few were positive for phlobatannins and anthraquinones .[11]

Phytochemicals are group of compounds derived from plant resource and shown to have many pharmacological activities. Identification and quantification of chemical constituents in complex matrix of plant is a challenging task. LC-MS is the most prominent analytical technique for this purpos.[12]

4. EXPERIMENTAL

Preparation of sample: -

First the site was selected in Mahendri Forest, Tal-Warud, Dist-Amravati of Maharashtra State(Area from the border between Madhya Pradesh and Maharashtra). Before picking the whole plant, the soil was moistened. The sample was washed smoothly by distilled water, and then shed dried out at room temperature. Sample was crushed individually in pestle-mortar to segregate fine powder. This powder was treat as sample powder for various investigate.

Fig- *1. Trichodesma zeylanicum Plant*

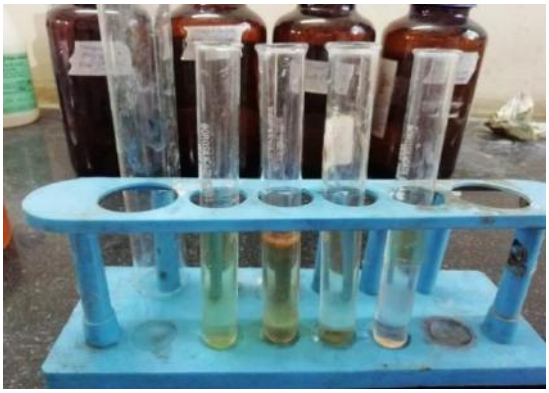
Fig- *2. trichodesma zeylanicum root powder*

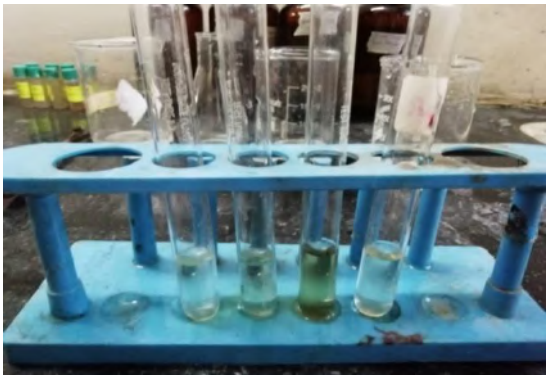
Solvent extraction

5 g. portion of powdered plant materials were each separately dispersed in 100 ml of each water, ethanol, acetone, petroleum ether, ethyl acetate , chloroform and benzene . The solution was left to stand at room temperature for 24 hrs and was filtered with whatman No. 1 filter paper. The filtrate was used for the Phytochemical Analysis.

Phytochemical screening

To identify Alkaloids, Flavonoids, Saponins, Carbohydrate, Protein, Phenols, Sterols, Tannins, Cardiac Glycosides, Terpenoids, Phlobatannins, Coumarins, Amino acids, Quinones, Anthocyanins in the extracts, phytochemical screening were perform to assess the qualitative chemical composition of different crude extracts using commonly employed foam, precipitation and coloration reactions ,the methods of Harbone[13] , Trease and Evans[14].



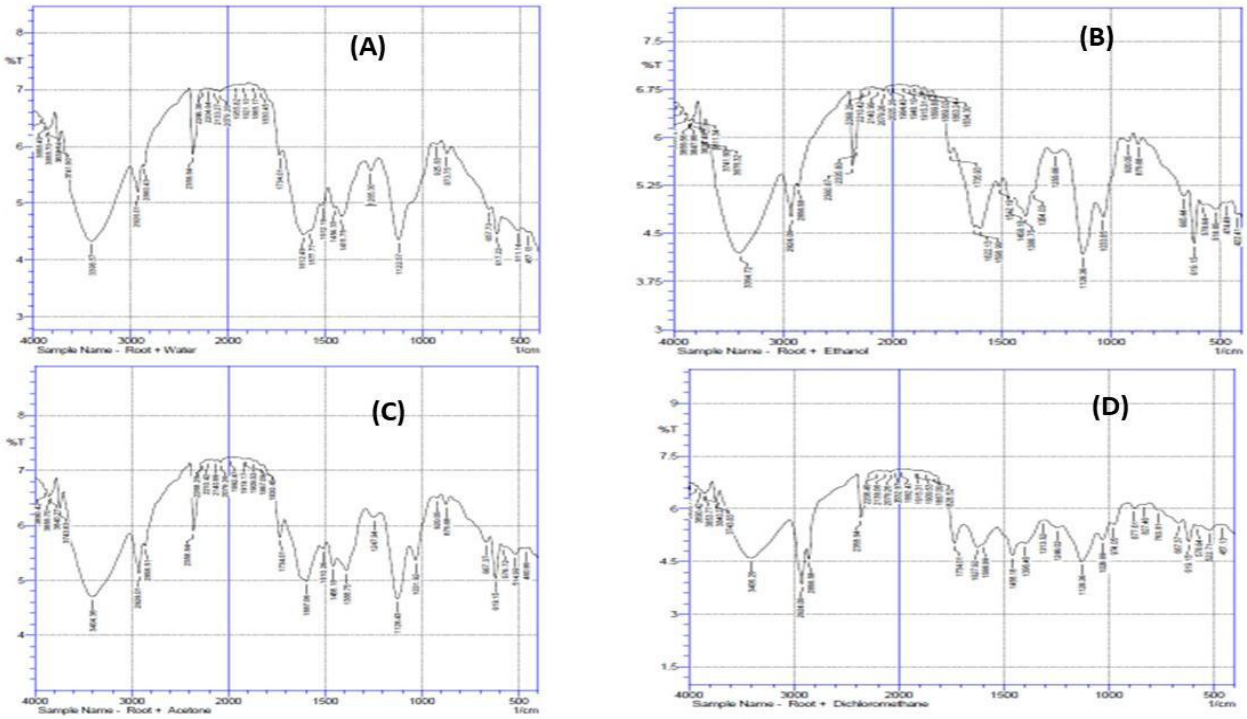


5. RESULT FOR PHYTOCHEMICAL ANALYSIS

S.N.	Test	Acetone	Ethanol	Dichloromethane	Water
1.	Terpenoids	+ +	+ + +	+ + +	+
2.	Anthocyanin	+ + +	+ +	+ + +	+ +
3	Coumarin	+ + +	+ + +	+ +	+ + +
4.	Glycosides	+ +	++	+	+ +
5.	Carbohydrates	-	+ ++	-	+ + + +
6.	Flavonoids	-	+ +	+ +	-
7.	Proteins	+ + + +	+ +	-	+ + ++

8.	**Reducing Sugar**	-	-	-	-
9.	**Cardiac Glycosides**	+ + +	+ + +	++	-
10	**Quinones**	+	-	-	+ + + +
11	**Resin**	+ +	-	+ + +	-
12	**Phenol**	+ +	-	+ +	++ +
13	**Steroid**	-	+ + +	-	+ +

6. RESULT FOR SPECTROSCOPICAL ANALYSIS



Sr. No.	Solvent				
	Water	**Ethanol**	**Acetone**	**Dichloromethane**	**Description**
1	457 to 511 cm^{-1}	422 to 619 cm^{-1}	460 to 619 cm^{-1}	457 to 619 cm^{-1}	Carbon containing halogen
2	1612 cm^{-1}	1622 cm^{-1}	1597 cm^{-1}	1598 cm^{-1}	-NH Bending in Amide
3	1734 cm^{-1}	1735 cm^{-1}	1734 cm^{-1}	1734 cm^{-1}	C=O stretching in aldehyde
4	2926 cm^{-1}	----------	2858 cm^{-1}	2924 cm^{-1}	-OH stretching

7. RESULT FOR PROXIMATE ANALYSIS

Sr. No.	Test	Result in %
1.	Moisture	90%

2.	**Acid Solubility**	**62**%
3.	**Alkaline Solubility**	**22**%
4.	**Cold Water Solubility**	**55**%
5.	**Hot Water Solubility**	**75**%
6.	**Crude Fibre**	**30**%
7.	**Organic Matter Content**	**12**%

8. CONCLUSION

For Phytochemical analysis

The presence of Terpenoids in the, Dichloromethane extract, Aqueous extract and Water extract is more than in Acetone. The presence of Anthocyanin is more in Dichloromethane extract, Acetone extract as compared to extract in water and Ethanolic. Coumarin presence in Acetone extract, in water and in aqueous extract is more than in Dichloromethane. Glycosides are only absent in Dichloromethane extract.

Acetone and Dichloromethane Extract does not show any presence of carbohydrates where as it presents in Acetone and water extract. Flavonoids are only present in Dichloromethane and aqueous extract. Proteins are present in Acetone, aqueous and water extract. Reducing Sugar is totally absent in all extracts. Cardiac Glycosides are present in all extract only absent in water. Quinones are present in Acetone and water extract.

Extract of Acetone and di-chloro ethane extract shows the presence of Resin. Phenol was absent in ethanolic extract. Steroid are moderately available in aqueous extract and ethanolic extract.

For Proximate analysis

Moisture content in root part of ***Trichodesma zeylanicum*** is 90%. The loss in weight due to evaporation from sample at a temperature of 105°C.

For IR analysis

The result of FTIR confirms the presence of -OH, Carbonyl, -NH functi0nla groups and other different functional groups which indicates the presence of phenolic and flavonoids compounds.

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REFERENCES

1. Yadav, R. N. S., & Agarwala, M. (2011). Phytochemical analysis of some medicinal plants. *Journal of phytology*, *3*(12).
2. Vasu, K., Goud, J.V., Suryam, A., Singara, Chary, M.A. 2009. Biomolecular and phytochemical analyses of three aquatic angiosperms. Afr. J. Microbiol. Res., 3(8):418-421.
3. Nanda goapalan, V., Doss, A., & Marimuthu, C. (2016). Phytochemical analysis of some traditional medicinal plants. *Bioscience Discovery*, *7*(1), 17-20.
4. Morsy, N. (2014). Phytochemical analysis of biologically active constituents of medicinal plants. *Main Group Chemistry*, *13*(1), 7-21.

5. Abdelgawad, A. A., El-Bassossy, T. A., & Ahmed, F. A. (2021). A review on phytochemical, pharmacological and ethnopharmacological aspects of genus Trichodesma. *Indian Journal of Natural Products and Resources (IJNPR)[Formerly Natural Product Radiance (NPR)]*, *12*(3), 333-347.

6. Vanitha, A., Renganayagi, R., Prabakaran, R., & Mohammed, S. M. (2015). Pharmacognostic studies on Trichodesma indicum Linn.(BORAGINACEAE) an ethnobotanically important herb from tropics. *Pharmacie Globale*, *6*(1), 1.

7. Soni, A., & Sosa, S. (2013). Phytochemical analysis and free radical scavenging potential of herbal and medicinal plant extracts. *Journal of Pharmacognosy and phytochemistry*, *2*(4), 22-29.

8. Aliyu, A. B., Musa, A. M., Oshanimi, J. A., Ibrahim, H. A., & Oyewale, A. O. (2008). Phytochemical analyses and mineral elements composition of some medicinal plants of Northern Nigeria. *Nigerian Journal of Pharmaceutical Sciences*, *7*(1), 119-125.

9. Ahad, B., Shahri, W., Rasool, H., Reshi, Z. A., Rasool, S., & Hussain, T. (2021). Medicinal Plants and Herbal Drugs: An Overview. *Medicinal and Aromatic Plants*, 1-40.

10. Igwenyi, I. O., Agwor, A. S., Nwigboji, I. U., Agbafor, K. N., & Offor, C. E. (2014). Proximate analysis, mineral and phytochemical composition of euphorbia hyssopifolia. *Steroids*, *18*, 6-27.

11. Marka, R., Talari, S., Penchala, S., Rudroju, S., & Swamy Nanna, R. (2013). Preliminary phytochemical analysis of leaf, stem, root and seed extracts of Arachis hypogaea L. *International Journal of Pharmaceutical Sciences Review and Research*, *20*(1), 134-139.

12. Alqethami, A., & Aldhebiani, A. Y. (2021). Medicinal plants used in Jeddah, Saudi Arabia: phytochemical screening. *Saudi Journal of Biological Sciences*, *28*(1), 805-812.

13. I. B. Harborne, (1973). *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis, Chapman and Hall, New York,NY, USA*, 2nd edition.

14. G. E. Trease and W. C. Evans, (1983). *Textbook of Pharmacognosy,Tindall, London, UK, 12th edition.*

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Review on Application of Artificial Intelligence in Genomics

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Abstract :- *Artificial intelligence (AI) is the creation of computer systems capable of executing tasks that typically require human intelligence. Progress in AI software and hardware, particularly deep learning algorithms and the graphics processing units (GPUs) that facilitate their training, has resulted in a recent and swiftly growing interest in medical AI applications. In clinical diagnostics, AI-driven computer vision techniques are set to transform image-based diagnostics, while other kinds of AI have started to exhibit comparable potential across diverse diagnostic methods. In certain fields, like clinical genomics, a distinct variety of AI algorithm termed deep learning is utilized to analyze extensive and intricate genomic datasets. In this article, we begin by outlining the primary categories of challenges that AI systems are particularly equipped to address and detail the clinical diagnostic functions that gain from these solutions. Subsequently, we concentrate on developing strategies for particular tasks within clinical genomics, such as variant calling, genome annotation, and variant classification, as well as phenotype-to-genotype relationships. Lastly, we conclude with a discussion on AI's future possibilities in personalized medicine applications, particularly concerning risk prediction in prevalent complex diseases, and the obstacles, limitations, and biases that must be meticulously considered for the successful implementation of AI in medical contexts, specifically those involving human genetics and genomics information.*

Artificial intelligence (AI) is the imitation of intelligence in a non-living entity. In the scope of clinical diagnostics, we characterize AI as any computer system that can accurately decipher health data, particularly in its innate form as perceived by humans. Frequently, these clinical uses adopt AI frameworks to allow the effective interpretation of large complex datasets. These AI systems undergo training on external health data that has usually been analysed by humans and that has been minimally processed before being introduced to the AI system, like clinical images that have been labelled and interpreted by a human specialist. The AI system then learns to carry out the interpretation task on new health data of the same kind, which in clinical diagnostics often involves the identification or prediction of a disease state.

Key words: *Artificial intelligence (AI), clinical genomics, precision medicine.*

1. INTRODUCTION:

Genomics in healthcare utilizes the study of genes and genomes to improve diagnosis, treatment, and prevention of diseases, ultimately leading to personalized and more effective healthcare. This field allows for the development of new therapies, the identification of disease risk factors, and the tailoring of treatments to individual genetic profiles. Technology is transforming all facets of our existence,

including business, science, design, and culture. The discoveries and innovations we make give rise to new industries, new relationships, and novel modes of thinking. Genomics has a wide range of applications, including understanding genetic diseases, developing targeted therapies, and improving agriculture. Recently Artificial Intelligence (AI) is revolutionizing healthcare by enhancing diagnostics, personalizing treatments, and streamlining research. AI in genomics is transforming healthcare by accelerating analysis, enabling personalized medicine, and driving discoveries. [1]AI-powered tools can analyse vast genomic datasets, identify genetic markers for diseases, and predict treatment outcomes. This leads to more accurate diagnoses, targeted therapies, and improved patient outcomes. The World Health Organization (WHO) emphasizes the importance of ethical AI deployment in healthcare, addressing issues like ageism and advocating for responsible innovation. [2]

2. Discussion:

AI models can analyze genetic data to calculate a person's risk of developing complex diseases like heart disease, diabetes, and cancer. AI can identify genetic mutations that are associated with specific cancer types, leading to more effective targeted therapies. And Data collecting, feature extraction, model building, and final implementation are the four main stages in the AI's operation. MRI/CT, proteomics, genomics, and other methods are used to gather enormous amounts of multiscale medical data in the first step. Standard characteristics are used to filter and retrieve the gathered data. After that, the data is separated into two parts: the validation cohort and the training cohort. AI receives the training cohort data and uses it to build a model. Lastly, the developed model was applied to clinical data.[3]

Gene Therapy: AI is helping to develop gene therapies by refining molecular editing tools and designing therapy protocols tailored to individual genetic profiles.

Pharmacogenomics: AI can help identify genetic variants that affect drug metabolism and response, allowing for more personalized drug dosages and treatment plans.

In particular, artificial intelligence (AI) can help doctors diagnose children who might have genetic problems quickly. Missense mutations are known to be the source of some undetected instances, and this is a more accurate way to rank those cases. If retinal gene therapy injections are not used to treat the RPE65 gene, blindness will follow. In order to ensure that they are treating patients appropriately, the AlphaMissense tool may help physicians quickly rule out any other potential genetic anomalies in a patient's DNA. There were millions of DNA mutations in the genetic code that might have a catastrophic impact on a person's biology. missense variations, which are single-letter changes to the genetic code that cause a protein to include a different amino acid—were of special interest. Since proteins are the building blocks of everything else in the body and amino acids make the proteins. Now, researchers may look up a missense variant in the dataset and determine its estimated pathogenicity score to determine whether it may be the cause of a disease. It is hoped that AlphaMissense will assist researchers across several sectors in speeding up study into genetic variants, enabling them to identify diseases and develop novel treatments more quickly, much like AlphaFold is improving everything from medication discovery to cancer treatment. "These predictions should provide us with additional information about which variants cause disease and have other uses in genomics," adds Avsec. Natural language processing (NLP) is another branch of artificial intelligence (AI) that focuses on the interaction between computers and human language. NLP enables computers to understand, interpret, and generate human language, which has significant applications in healthcare. One of the primary applications of NLP in healthcare is clinical documentation. NLP can automatically identify key clinical information, such as diagnoses, treatments, and lab results, from unstructured text, facilitating decision-making and improving information retrieval.

DeepMind's Pushmeet Kohli explains that the Alpha Missense model has assigned a "pathogenicity score" ranging from 0 to 1 for each of the 71 million potential missense variants, using its insights into the effects of closely related mutations. A higher score indicates a greater likelihood that a specific mutation is associated with disease. To corroborate the model's predictions with empirical

research on recognised missense variations, DeepMind's researchers partnered with Genomics England, a government body analysing the growing database of genetic information compiled by the UK's National Health Service. The report indicates that AlphaMissense achieves an accuracy rate of 90% and can successfully classify 89% of variants. With Alphamissense aiding in the research of genetic variants, researchers across various fields will be able to identify diseases and develop new treatments more swiftly.

Advancements in AI techniques and technologies are expected to bring several benefits and advancements in healthcare. Some of the future possibilities of AI in healthcare include

Precision Medicine: AI can play a crucial role in advancing precision medicine, which aims to tailor medical treatments and interventions to individual patients. AI algorithms can analyse large-scale genomic data, patient health records, and other relevant information to identify patterns, predict disease risks, and develop personalized treatment plans. This can lead to more targeted and effective therapies, minimizing adverse effects and optimizing outcomes. Drug Discovery and Development: AI can accelerate the drug discovery and development process by analysing vast amounts of biomedical data, including genomic information, protein structures, and scientific literature. AI algorithms can identify potential drug candidates, predict their efficacy, and optimize their properties. This can reduce the time and cost associated with bringing new drugs.Machine learning is a branch of AI that allows computers to learn from data without being explicitly programmed. Machine learning has a wide range of applications in healthcare, including image analysis, diagnosis, and treatment planning. For example, machine learning algorithms can be used to analyse medical images, such as MRI scans, to identify patterns and predict outcomes. It can also be used to develop predictive models for disease progression and treatment response.[1] Machine learning has indeed revolutionized various aspects of healthcare, including image analysis, diagnosis, and treatment planning. With the ability to learn patterns and make predictions from large amounts of data, machine learning algorithms have shown great potential in improving healthcare outcomes.[4]

Gen AI in healthcare revolutionizes disease risk assessment, personalized health management, and preventive care. By using genomic data and AI models, providers offer precise, individualized care, improving outcomes and reducing chronic disease burdens. Ethical frameworks and data privacy are crucial to protect patient rights and ensure equitable access.[8]

Next-Generation Sequencing (NGS) has revolutionized genomics by identifying genetic mutations linked to diseases, crucial in projects like the Cancer Genome Atlas. Personal genomics services provide insights into ancestry, traits, and health risks. Genome-wide association studies identify Single-nucleotide polymorphism (SNPs) linked to conditions like diabetes, heart disease, and Alzheimer's, empowering proactive lifestyle changes or preventive treatments. [20]

Variant calling, a critical step in genomic research, has been greatly impacted by artificial intelligence (AI). Finding genetic variations using high-throughput sequencing data, such as single nucleotide polymorphisms (SNPs), insertions/deletions (InDels), and structural variants, is known as variant calling. This work has historically been dominated by statistical methods, but the introduction of AI has resulted in the creation of advanced tools that promise increased scalability, accuracy, and efficiency. These state-of-the-art AI-based variant calling tools, including Deep Variant, DNAscope, DeepTrio, Clair, Clairvoyante, Medaka, and HELLO brought the revolutionary developments AI has brought about and its promise to further improve genomic research by contrasting these AI-driven approaches with traditional approaches. [20]

By employing sophisticated machine learning algorithms to evaluate massive datasets and uncover intricate correlations between them, artificial intelligence (AI) is transforming our knowledge of how genotypes (DNA sequences) result in phenotypes (observable traits). This enables scientists to forecast phenotypes based on genotypes, which could help with fields like crop breeding, disease diagnostics, and medication discovery.[13]AI algorithms, particularly machine learning, excel at

identifying patterns and correlations within massive datasets of genomic and phenotypic information. This can reveal intricate pathways and regulatory mechanisms that link genotype to phenotype. [7]

Predicting Phenotypes: By training AI models on large datasets, researchers can predict how a specific genotype will 20manifest in a phenotype, even in the presence of environmental factors. This can be crucial in understanding complex diseases with genetic components. [14]

Drug Discovery: AI can help identify drug targets and predict the efficacy of new drugs by understanding how genetic variations influence drug responses. [16]

Disease Diagnosis: AI can aid in diagnosing genetic diseases by identifying the specific mutations and their corresponding phenotypes, potentially leading to earlier and more accurate diagnosis. [17]It is widely suspected that use of such efforts, if successful, could provide major benefits not only for patient safety and quality but also in reducing healthcare costs.

Crop Breeding: AI can help breeders develop crops with desirable traits by predicting how different genotypes will perform in various environments, leading to more efficient and sustainable agriculture. [15]

Genome annotation: Finding genes and other functional components inside the genome sequence and deducing their biological roles is the fundamental concept of genome annotation. For functional verification, traditional wet-lab experimental techniques still need a lot of work. As RNA-Seq technology became widely used, researchers in the biological field started to use machine learning and deep learning techniques to predict gene structures and annotate functions. [8]In this regard, we examined both traditional techniques and modern deep learning frameworks, highlighting fresh viewpoints on the difficulties encountered during annotation and highlighting the fluidity of this changing scientific environment. From tradition to innovation: conventional and deep learning frameworks in genome annotation[9]

AI is Revolutionizing Genetic Testing: Traditional genetic testing often encounters delays ,slow interpretation, high costs, and limited scalability. But AI Automated the variant analysis – AI-powered algorithms streamline genomic interpretation, detecting and classifying genetic variants in minutes rather than weeks, improving diagnostic yield for rare diseases. And enhanced accuracy – AI models trained on massive genomic datasets reduce false positives/negatives, ensuring more precise genetic insights. Also with AI rare disease diagnostics is scaled– Just as 3 billion applies NGS technology to diagnose thousands of rare diseases, AI is making genetic insights more accessible to patients who previously lacked access to advanced diagnostics. Interpretation novel variants – AI enhances the classification of Variants of Uncertain Significance (VUS), bridging gaps in understanding rare genetic conditions.[10]

AI-Powered Genetic Testing has built an advanced AI-based rare disease diagnosis platform, leveraging deep learning and large-scale genomic databases by 3billion lead to reduce the time required for whole-exome and whole-genome sequencing (WES/WGS) interpretation. Provide automated gene matching to connect patients with similar rare disease profiles. Continuously improve variant classification through real-world data integration and global collaborations. This AI-first approach is setting a precedent in scaling genetic testing, offering patients and clinicians a faster path to diagnosis and treatment guidance.

The AI-Driven Genetic Testing will be helpful in Ultra-personalized medicine: AI will soon predict how individual patients respond to treatments based on their genetic makeup, leading to truly individualized therapies.

Widespread adoption: As AI-driven genetic testing costs drop, it will become a routine part of preventive healthcare, enabling earlier intervention for high-risk individuals.

Integration with multi-omics: AI will merge genomics, proteomics, metabolomics, and clinical data to offer holistic patient insights, improving disease prevention and management. By combining information from several omics, such as proteomics, transcriptomics, and genomics, a more thorough understanding of the genotype-phenotype link can be obtained, leading to more precise predictions. [19]

AI-driven drug discovery: Genetic insights, powered by AI, will drive precision drug development, targeting rare genetic conditions with tailored therapy [20]

Cancer diagnosis and monitoring, identifying at-risk populations, classifying genetic variations, and predicting patient ancestry are examples of the diverse and impactful applications of 1genetics and AI in healthcare and genetics[6]

Challenges and Future Directions:

Data Privacy and Security: Ensuring the responsible and ethical use of genomic data is crucial.

Algorithm Bias: AI models can be biased if they are trained on biased datasets, leading to inaccurate predictions.

Accessibility and Equity: It is important to ensure that AI-powered genomic tools are accessible to all individuals, regardless of their socioeconomic status or location.

Interdisciplinary Collaboration: Effective AI in genomics requires close collaboration between AI researchers, healthcare providers, and pharmaceutical companies. [15]

Despite AI's enormous potential, there are still difficulties in precisely forecasting phenotypes, particularly in intricate systems with interdependent genes and environmental influences. For AI model training, labelled data availability and quality are also essential. [18]

Ethical Consideration: It is essential to tackle the ethical concerns associated with AI-powered genomics, including issues of genetic discrimination and data privacy. Conventional computational methods possess several limitations, including high time and computational costs, as well as reliability issues. However, AI has the potential to overcome these barriers in computational drug design, allowing for computational methods to take on a more significant role in drug development [5].AI plays an essential role in the healthcare and medicine domains. However, AI tools must be interpretable and transparent for end-users. End-users encompass anyone who uses or is affected by an ML model, including caregivers, clinicians, patients, users, data scientists, regulatory bodies, domain experts, executive board members, and managers. Therefore, due to significant concerns about understanding AI tools' behaviour, the implementation of AI in medical settings has been limited [11].

3. Conclusion: AI-driven methods have accelerated the interpretation of genomic data, enabling more precise diagnosis and individualized treatment plans for individuals with hereditary diseases. The ability to predict sickness risk and consequences based on genetic information has opened up new avenues for prevention and early intervention. The integration of AI in genetics presents a number of obstacles, including ensuring equitable access to these technologies across a diverse population and addressing ethical concerns around privacy and data security. Artificial intelligence in medicine is a state-of-the-art method that holds great potential to enhance patient care and the capacity of medical professionals to diagnose patients accurately. As a result, demand and need will be very high in the future. For real-time applications in this challenging sector, researchers and medical engineers must collaborate. In the future, these developments will help millions of people get better.

References :

1. Esteva A, Robicquet A, Ramsundar B, Kuleshov V, DePristo M, Chou K, et al. A guide to deep learning in healthcare. Nat Med. 2019;25:24–9.

2. E Nasarian ,Designing Interpretable ML System to Enhance Trust in Healthcare: A Systematic Review to Proposed Responsible Clinician-AI-Collaboration Framework,April 2024.Information Fusion 108(1):102412,
3. Rajkomar A, Oren E, Chen K, Dai AM, Hajaj N, Liu PJ, et al. Scalable and accurate deep learning for electronic health records. NPJ Digit Med. 2018
4. Zou J, Huss M, Abid A, Mohammadi P, Torkamani A, Telenti A. A primer on deep learning in genomics. Nat Genet. 2019;51:12–8.
5. Raquel Dias & Ali Torkamani, Artificial intelligence in clinical and genomic diagnostics Genome Medicine volume 11, Article number: 70 (2019)
6. Vilhekar et al. Artificial Intelligence in Genetics 2024 Cureus 16(1): e52035.
7. Gupta R, Srivastava D, Sahu M, Tiwari S, Ambasta RK, Kumar P: Artificial intelligence to deep learning: machine intelligence approach for drug discovery. Mol Divers. 2021, 25:1315-60.
8. Eraslan G, Avsec Ž, Gagneur J, Theis FJ. Deep learning: new computational modelling techniques for genomics. Nat Rev Genet. 2019;20:389–403.
9. Zhaojia Chen 1,2, Noor ul Ain 3, Qian Zhao 4, Xingtan Zhang From tradition to innovation: conventional and deep learning frameworks in genome annotation 5,PMCID:PMC10998533 PMID: 38581418
10. Sree Ramya Gunukula, AI in Genetic Testing: How 3billion is Revolutionizing Rare Disease Diagnosis, Insights | 25. 03. 05
11. Arbelaez Ossa, L., et al., Re-focusing explainability in medicine. Digital health, 2022.8 p. 20552076221074488
12. Muhammad Sufyan, Zeeshan Shokat and Usman Ali Ashfaq, Artificial intelligence in cancer diagnosis and therapy: Current status and future perspective, Computers in Biology and Medicine, 2023-10-01, Volume 165, Article 107356.
13. https://pmc.ncbi.nlm.nih.gov/articles/PMC6356893
14. https://www.waisman.wisc.edu/2023/12/04/utilizing-ai-to-better-understand-the-genotype-phenotype-connection/
15. https://www.sciencedirect.com/science/article/pii/S2095311923003611
16. https://academic.oup.com/femsre/article/47/4/fuad030/7191836
17. https://pubmed.ncbi.nlm.nih.gov/38520562/
18. https://www.sciencedirect.com/science/article/pii/S2001037024004513
19. https://arxiv.org/abs/2407.06405
20. Omar Abdelwahab,Davoud Torkamaneh Artificial intelligence in variant calling: a review Front. Bioinform., 23 April 2025Sec. Genomic Analysis, Volume 5 – 2025
21. Kokudeva M, Vichev M, Naseva E, Miteva DG, Velikova T.Artificial intelligence as a tool in drug discovery and development. World J Exp Med. 2024 Sep 20;14(3):96042.

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Exploring the Nanoworld: A Comprehensive Review of Nanoscience and Its Applications

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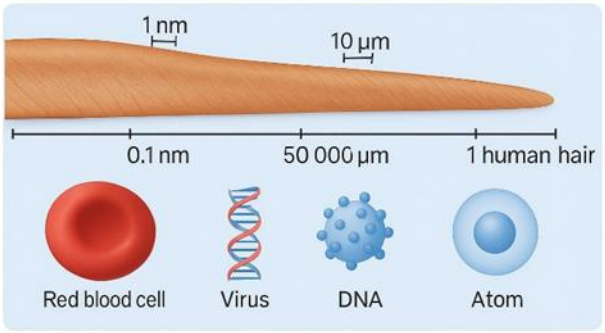
Abstract : *Nanoscience, the study of phenomena at the atomic, molecular, and polymer scales, has revolutionized science and technology. This overview investigates the multidisciplinary field of nanoscience. This breaks the boundaries of physics, chemistry, biology, materials science, and engineering by investigating structures that are smaller than 100 nanometres. The distinctive characteristics exhibited by nano-scalars are comparable to quantum phenomena, heightened reactivity, and enhanced surface conditions that drive innovation in diverse fields like medicine, electronics, energy, and environmental science. This paper offers a comprehensive introduction to fundamental nanoscience principles, such as the influence of size, surface properties, and quantum phenomena. We will delve into various synthesis methods, including top-down and bottom-up approaches, with a focus on technologies like chemical vapor deposition, sol-gel processing, and molecular self-assembly. In the field of nano-squall materials, analytical tools like raster tunnel microscopy (STM), nuclear power microscopy (AFM), and transmission electron microscopy (TEM) have played a crucial role in their characterization. Nanoscience applications are being checked in areas such as drug taxation, nano-sensors, nanoelectronics, and renewable energy. Nanoscience applications are being checked in areas such as drug taxation, nano-sensors, nanoelectronics, and renewable energy. The utilization of nanomaterials in targeted cancer therapy, miniaturized electronics, and high-efficiency solar cells showcases the potential for field conversion. Ethical, social, and ecological concerns associated with the broader regulations of nanotechnology have also been taken into account, emphasizing the significance of regulatory frameworks and responsible innovation. This review offers a thorough yet easy-to-understand overview of the current state of nanoscience, and seeks to emphasize its scientific basis, practical uses and potential future developments. As long as there is ongoing research and investment, nanoscience will be poised to drive the next wave of scientific discoveries and societal progress.*

Keywords: *Nanoscience, nanomaterials, nanoscience applications, synthesis, Characterization, advance nanoscience.*

1. INTRODUCTION:

Nanoscience is an interdisciplinary investigation of nanometre-scale structures and materials less than 100 nanometres (Bhushan, 2017).Nanoscience is an interdisciplinary investigation of nanometre-scale structures and materials less than 100 nanometres (Bhushan, 2017). At this level, the material exhibits distinct characteristics like quantum limiting, enhanced surface volume conditions, and surface plasmon resonance. These phenomena result in distinct optical, mechanical, electrical, and chemical behaviours that are different from those of macroscopic objects. Nanoscience combines principles from physics, chemistry, biology, and materials science to investigate and control matter at the atomic and molecular level, fostering advancements in fields like electronics, medicine, energy, and environmental technologies.



Size comparison of nanoscale objects with common items like cells, viruses, and atoms

(**Figure 1:** Size comparison of nanoscale objects with common items like cells, viruses, and atoms.)

This figure visually shows the nanometre scale, comparing a human hair (~80,000 nm), red blood cell (~7,000 nm), virus (~100 nm), and DNA (~2 nm).

This paper offers a thorough examination of the fundamental concepts, synthesis approaches, characterization techniques, practical applications, current research trends, and ethical implications in the realm of nanoscience.

2. Methods and Characterization Techniques

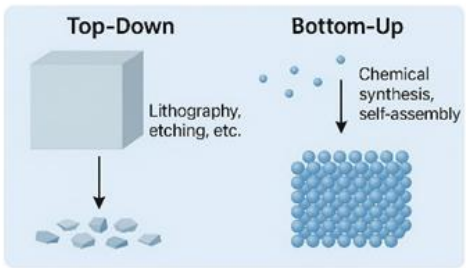
2.1 Synthesis Methods:

Nanomaterials can be fabricated using two main approaches:

• **Top-down approaches:** these involve breaking down bulk materials into nanoscale particles using methods like lithography, ball milling, and etching (Cao, 2004) While scalable, they often introduce defects and are less precise at the atomic level.

• **Bottom-up approaches:** these methods build nanostructures from atomic or molecular components through chemical vapor deposition (CVD), sol-gel processing, and self-assembly (Whitesides, 2003) These methods enable precise

control over the size and shape of particles



Schematic diagram of top-down and bottom-up nanomaterial synthesis approaches

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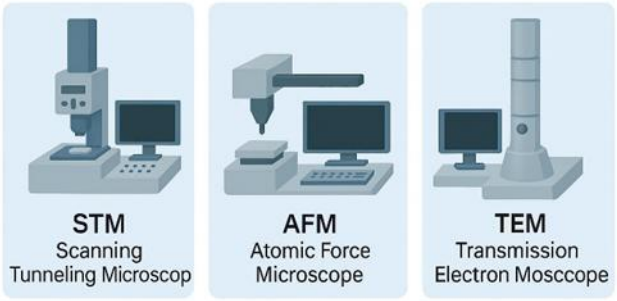
(Figure 2: Schematic diagram of top-down and bottom-up nanomaterial synthesis approaches.)

A side-by-side illustration of both synthesis methods, showing lithography in the top-down method and chemical self-assembly in the bottom-up method.

2.2 Characterization Techniques:

The nanoscale requires sophisticated tools for characterization:

• **Microscopy:** Scanning Tunnelling Microscopy (STM) and Atomic Force Microscopy (AFM) visualize surfaces at atomic resolution (Binnig & Rohrer, 1986). Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM) provide high-resolution internal and surface imaging.

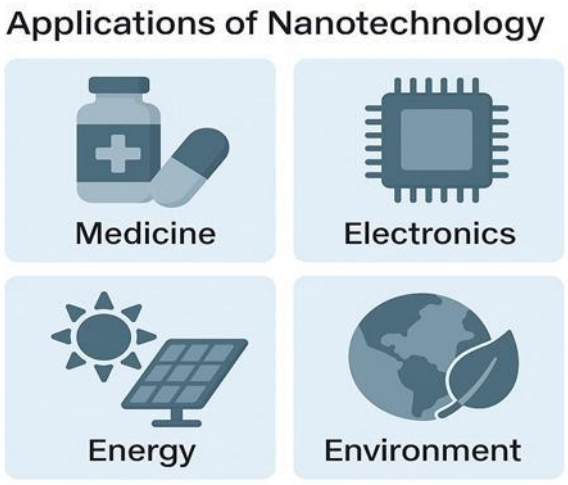


Images of STM, AFM, and TEM systems used in nanomaterial analysis

(Figure 3: Images of STM, AFM, and TEM systems used in nanomaterial analysis.) (schematic images showing the working principle of each tool, highlighting their resolution and analysis capabilities.)

- **Spectroscopy and Diffraction:** X-ray Diffraction (XRD) is used for determining crystallinity, while Fourier Transform Infrared Spectroscopy (FTIR) reveals molecular bonding. Raman spectroscopy is essential for analysing carbon-based nanomaterials (Ferrari et al., 2006).

3. Applications of Nanoscience:



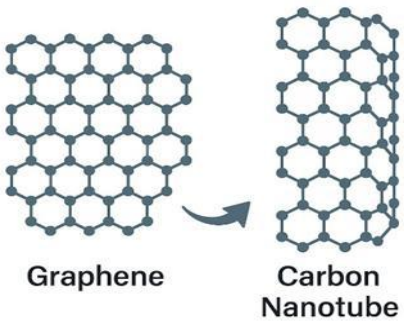
(Figure 4: Multisector applications of nanoscience in medicine, computing, energy, and environment). (A conceptual diagram with nanomedicine (drug delivery), nanoelectronics (transistors), nano-energy (solar cells), and nano-environment (water treatment) as segments.)

3.1 Medicine and Healthcare:

Nanotechnology has enabled major advancements in medical diagnostics and treatments. Nanoparticles are employed for precise drug delivery, reducing unwanted side effects and improving treatment outcomes (Pankhurst et al., 2003). Magnetic nanoparticles can be directed to tumour sites, and gold nanoparticles are utilized in photothermal therapy.

3.2 Electronics and Computing:

Nanomaterials play a crucial role in the creation of smaller, faster, and more efficient devices. Quantum dots and carbon nanotubes are being incorporated into transistors, memory devices, and displays (Dresselhaus et al., 2001, Iijima, 1991). Graphene's exceptional electrical conductivity is driving progress in the field of flexible electronics.



(Figure 5: Atomic structures of graphene and carbon nanotubes showing hexagonal arrangements and electronic pathways.) (High-resolution diagrams showing the 2D sheet of graphene and rolled-up structure of carbon nanotubes.)

3.3 Energy and Environment:

Nanotechnology enhances the performance of photovoltaic cells, fuel cells, and lithium-ion batteries. For example, silicon nanowires enhance battery capacity and decrease charging time (Service, 2004). Nanoparticles that use light to break down contaminants and cleanse water. Nanocoating also improve the performance of thermal insulators.

3.4 Materials and Manufacturing:

Nanocomposites are created by blending nanoparticles with polymers or metals, resulting in materials that possess enhanced mechanical, thermal, and electrical characteristics (Chhowalla et al., 2013). This results in the creation of stronger, lighter, and more durable products in industries such as automotive, aerospace, and construction.

4. Emerging Trends and Ethical Considerations:

4.1 Emerging Trends:

• **DNA Nanotechnology:** DNA strands are engineered to form nanoscale machines and logic gates for biosensing and targeted drug delivery (Roco, 2003).

• **Quantum Nanoscience:** Combines nanotechnology with quantum mechanics to develop highly sensitive sensors and quantum computers.

• **Nano-Robotics:** Development of molecular machines for surgical applications and manufacturing tasks at the nanoscale.

4.2 Moral, Ecological, and Social consequences:

Worries about nanomaterials revolve around their potential long-term harm, accumulation in living organisms, and persistence in the environment (Maynard & Kuempel, 2005). Public involvement, openness, and oversight are essential for ensuring responsible and ethical use of nanotechnologies in the pursuit of sustainable development.

5. Emerging Horizons of Sophisticated Nanotechnology:

The future of nanoscience is filled with great potential as ongoing research endeavours strive to expand the capabilities of manipulating materials at the atomic and molecular scales. The upcoming decade is anticipated to bring about significant changes in various important areas:

5.1: Precision medicine and Theranostics:

Nanotechnology will assume a central role in customized healthcare. In the future, nanocarriers could precisely deliver drugs to individual cells, and theranostic nanoparticles could simultaneously diagnose and treat diseases such as cancer, providing real-time information on the effectiveness of the treatment.

5.2: Next-generation computing:

Breakthroughs in quantum dots, spintronics, and molecular electronics have the potential to transform computing, enabling devices to operate at unprecedented speeds, occupy minimal space, and consume significantly less energy. Nanoscience is expected to facilitate the development of genuine quantum computing systems by enhancing the stability and coherence of qubits.

5.3: Sustainable energy solutions:

Nanomaterials will improve the efficiency and expandability of renewable energy systems. Advancements in nano-engineered solar panels, thermoelectric devices, and next-generation batteries (e.g., solid-state or sodium-ion) are anticipated to propel the global energy transition.

5.4: Environmental remediation and green nanotechnology:

Nano-enabled filters, catalysts, and adsorbents will play a crucial role in air and water purification, carbon capture, and the degradation of pollutants. Advancements in the future will emphasize sustainable and decomposable nanomaterials.

5.5: Smart materials and nano-robotics:

The advancement of materials that can respond, heal, and adapt will result in more intelligent consumer products and industrial components. Concurrently, nanoscale robots have the potential to transform minimally invasive surgery, targeted drug delivery, and material assembly.

5.6: Governance and policy frameworks:

As nanotechnology advances, it will be essential to establish strong international regulations to manage potential risks and societal consequences. Public education and involving stakeholders will play a crucial role in ensuring responsible innovation.

In essence, the future of nanoscience lies in convergence—combining nanotechnology with artificial intelligence, biotechnology, and quantum mechanics to create a smarter, healthier, and more sustainable world.

6. Results and Discussions:

Recent studies underscore nanoscience's transformative potential:

• Gold nanoparticles demonstrate precision in photothermal cancer therapy (Nie & Emory, 1997).
• Graphene transistors exhibit faster electron mobility compared to traditional silicon (Ferrari et al., 2006).
• Silicon nanowires enhance energy storage in lithium-ion batteries (Service, 2004).

Despite success, economically efficient production, scalability, and breeding problems remain. To ensure security, complex toxicity research is required. Additionally, security and acceptance require interdisciplinary cooperation and standardized toxicity assessment.

7. Conclusion:

Nano -Sciences continues to revolutionize understanding of problems and their interactions with minimal standards. By using their principles, researchers in the field of medicine are innovative in electronics, energy and materials science. Future advances will rely on sustainable practices, robust regulations and integrated innovations to ensure that nanoscience contributes to society.

REFERENCES :

1. Bhushan, B. (2017). Springer handbook of nanotechnology. Springer.
2. Cao, G. (2004). Nanostructures and nanomaterials: Synthesis, properties and applications. Imperial College Press.
3. Roco, M. C. (2003). Nanotechnology: Convergence with modern biology and medicine. Current Opinion in Biotechnology, 14(3), 337–346.
4. Whitesides, G. M. (2003). The 'right' size in nanobiotechnology. Nature Biotechnology, 21(10), 1161–1165.
5. Alivisatos, A. P. (1996). Perspectives on the physical chemistry of semiconductor nanocrystals. Journal of Physical Chemistry, 100(31), 13226–13239.
6. Binnig, G., & Rohrer, H. (1986). Scanning tunneling microscopy. IBM Journal of Research and Development, 30(4), 355–369.
7. Iijima, S. (1991). Helical microtubules of graphitic carbon. Nature, 354(6348), 56–58.
8. Ferrari, A. C., et al. (2006). Raman spectrum of graphene and graphene layers. Physical Review Letters, 97(18), 187401.
9. Pankhurst, Q. A., Connolly, J., Jones, S. K., & Dobson, J. (2003). Applications of magnetic nanoparticles in biomedicine. Journal of Physics D: Applied Physics, 36(13), R167–R181.
10. Nie, S., & Emory, S. R. (1997). Probing single molecules and single nanoparticles by surface-enhanced Raman scattering. Science, 275(5303), 1102–1106.
11. Dresselhaus, M. S., Dresselhaus, G., & Avouris, P. (2001). Carbon nanotubes: Synthesis, structure, properties, and applications. Springer.
12. Drexler, K. E. (1986). Engines of creation: The coming era of nanotechnology. Anchor Press.
13. Chhowalla, M., Shin, H. S., Eda, G., Li, L. J., Loh, K. P., & Zhang, H. (2013). The chemistry of two-dimensional layered transition metal dichalcogenide nanosheets. Nature Chemistry, 5(4), 263–275.
14. Service, R. F. (2004). Nanotechnology grows up. Science, 304(5671), 1732–1734.
15. Maynard, A. D., & Kuempel, E. D. (2005). Airborne nanostructured particles and occupational health. Journal of Nanoparticle Research, 7(6), 587–614.

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Adaptation and Innovation Strategies of Enterprise Marketing Models in the Digital Economy Environment

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Abstract: *With the rise of the digital economy, the marketing model of enterprises is undergoing profound changes. Applying big data and artificial intelligence technologies enables enterprises to more accurately analyze market demand and formulate personalized marketing strategies, thereby improving marketing effectiveness. This study aims to explore the trends of enterprise marketing models in the digital economy era and analyze the impact of these changes on enterprise competitiveness. It provides marketing strategy suggestions for enterprises to adapt to the digital economy era. Through in-depth research, it helps enterprises seize market opportunities, respond to challenges, and achieve sustainable development.*

Keywords: *Digital Economy, Enterprise Marketing model, Adaptation Strategies, Innovation Pathways.*

1. INTRODUCTION

With the rapid development and widespread application of information technology, data has become one of the critical drivers of social development. Compared with the traditional economy, the digital economy emphasizes the value of data, the innovative application of digital technology, and the fundamental change in business models, aiming to achieve optimal resource allocation and efficient utilization. Today, the digital economy has become a new engine of global economic development; Its rapid development reshapes the traditional economic landscape, and brings unprecedented challenges and opportunities to the marketing model of enterprises. With the widespread application of big data, artificial intelligence, and cloud computing, the digital economy is penetrating into various industries with unprecedented depth and breadth, profoundly influencing enterprises' operational strategies and market competitive landscape. On the one hand, the digital economy provides enterprises with rich data resources and advanced technological means, enabling them to more accurately grasp market demand and formulate personalized marketing strategies, thereby improving marketing efficiency and effectiveness. On the other hand, the digital economy also intensifies market competition, with consumer demand becoming increasingly diverse and individualized, posing higher requirements on enterprises' innovative capacity and service level. Faced with this new environment of challenges and opportunities, enterprises urgently need to adapt to the new marketing model of the digital economy era, innovate marketing strategies, enhance market competitiveness, and achieve sustainable development.

2. Digital economic environment promotes the transformation of the enterprise marketing model

In the digital economy environment, enterprise marketing is no longer limited to traditional advertising and promotion means. It pays more attention to the collection, analysis, and utilization of data and the diversification and individuation of marketing channels.

2.1 Analysis of digital economy characteristics

The digital economy takes data as the core driving force, platform as the cornerstone of operation, and personalized and intelligent as its distinctive label. Data like a valuable resource for business decision-making and innovation in the digital economy. Platform operation breaks traditional business boundaries and builds an open and shared ecosystem. Personalized services meet the diversified needs of consumers, while intelligent technology further enhances the user experience and service efficiency.

2.2 Current situation of enterprise marketing mode

The traditional marketing model focuses on products and channels and relies on advertising and promotion, making it difficult to reach target consumers accurately. The digital marketing model focuses on consumers and realizes precision marketing and interactive communication through digital platforms such as social media and search engines. The digital marketing model is more flexible, interactive and accurate, which can effectively improve the marketing effect and reduce the marketing cost. More and more enterprises are beginning to transform the digital marketing model to adapt to the development needs of the digital economy era.

2.3 The impact of digital economy on the enterprise marketing model

The digital economy has changed consumer behaviour, emphasizing personalized experiences and convenient services. This change leads to more intense market competition and requires enterprises to innovate marketing methods constantly. Digital marketing deepens its connection with consumers through content marketing, social media interaction, and live delivery. At the same time, enterprises can develop more accurate marketing strategies by using AI technology for user profiling and behaviour prediction. In general, the digital economy has promoted the comprehensive transformation of the enterprise marketing model, bringing new opportunities and challenges to the development of enterprises, requiring enterprises to constantly adapt and innovate to remain invincible in the fierce market competition.

3.The adaptive strategy of enterprise marketing model

In the digital economy environment, enterprises should actively implement digital transformation, relying on data-driven, integrating channels and platforms and other adaptive strategies, and take corresponding measures or methods to constantly innovate marketing models and enhance market competitiveness. Only by keeping up with the pace of the digital economy can enterprises remain invincible in the fierce market competition and achieve sustainable development.

3.1 Practice digital transformation and build a solid marketing system cornerstone

Digital transformation is an inevitable requirement for enterprises to adapt to the era of the digital economy. To build a solid marketing system cornerstone, enterprises should fully embrace digital technology, starting from the following aspects:Firstly, companies should establish sound data collection, analysis and application mechanisms. Through big data technology, in-depth exploration of consumer demand and market trends provides a scientific basis for marketing strategy development. In order to achieve this goal, enterprises can introduce advanced data analysis tools, such as data mining software, business intelligence systems, etc., to efficiently process and analyze massive data. Secondly, enterprises should actively use advanced technologies such as cloud computing and the Internet of Things to automate and intellectualize marketing processes. For example, through the cloud computing platform, enterprises can track and analyze the effect of marketing activities in real-time and adjust strategies in time. The application of the Internet of Things technology can allow enterprises to more accurately grasp the trajectory of consumer behaviour and develop marketing strategies closer to consumer needs. In addition, enterprises should also strengthen the training and introduction of digital marketing talents. Through training, recruitment and other ways to improve the team's digital marketing ability and innovation ability, to provide a solid talent guarantee for constructing a digital marketing system. At the same time, companies should also establish incentives to encourage employees to participate actively in digital transformation and innovation activities.

3.2 Rely on data-driven, accurate navigation of marketing decision-making path

In the era of digital economy, data has become an essential basis for enterprise decision-making. In order to accurately navigate the marketing decision-making path, enterprises should rely on data as a driver and carry out practice from the following aspects:Firstly, companies can gain insight into consumer needs and preferences by building user profiles and behavioural prediction models. Machine learning algorithms and data analysis tools mine and deeply analyze consumer data to develop personalized marketing strategies. It helps enterprises to reach target consumers more accurately and improve marketing effectiveness. Secondly, companies should use data analysis tools to monitor and evaluate marketing activities in real-time. By tracking and analyzing the effect of marketing activities in real-time, enterprises can adjust strategies and optimize marketing programs in time. It helps enterprises reduce marketing costs and improve marketing efficiency. In addition, companies should pay attention to data security and privacy protection. In the process of collecting, analyzing and applying consumer data, enterprises should establish a sound data management system and risk prevention mechanism to ensure the security and legal use of consumer data. It helps to maintain the reputation and credibility of the company and enhance the sense of trust of consumers.

3.3 Integrate channels and platforms to optimize the distribution of marketing resources

Diversifying marketing channels and platforms in the digital economy provides enterprises with a broader marketing space. In order to optimize the distribution of marketing resources, enterprises should actively integrate online and offline channels and platform resources. Firstly, by integrating online and offline, enterprises can expand brand influence and market share. For example, enterprises can carry out promotional activities on online platforms to attract consumers' attention. At the same time, we will provide high-quality products and services in offline stores to enhance consumers' willingness to purchase. Secondly, enterprises should pay attention to the use of social media marketing and content marketing. Businesses can interact with consumers through social media platforms to understand their needs and feedback. Content marketing allows companies to present products and services more attractively, increasing consumers' interest. In addition, companies should strengthen collaboration with partners. Through the joint development of new marketing channels and platforms, to achieve resource sharing and mutual benefit and win-win. This helps enterprises reduce marketing costs and improve market competitiveness.

4. The innovation path of the enterprise marketing model

In the era of the digital economy, the innovation of enterprise marketing models has become the key to the sustainable development and competitive advantage of enterprises. In order to cope with the increasingly fierce market competition and changing consumer demand, enterprises must actively explore and practice new marketing paths.

4.1 Taking into account personalization and experientialization, deepening the emotional connection with consumers

Personalized and experiential marketing is an important direction of enterprise marketing model innovation. In the era of the digital economy, consumer needs are increasingly diversified and personalized, and businesses need to attract and retain consumers by providing personalized products and services and unique shopping experiences.

In personalized marketing, enterprises can use big data and AI technology to analyze consumer behaviour and achieve market segmentation and precise positioning. For example, by collecting users' browsing, purchase history and preference data, an e-commerce platform uses AI algorithms to recommend products that meet users' needs, thereby improving users' purchase rate and satisfaction.

In experiential marketing, businesses can leverage advanced technologies such as augmented reality (AR) and virtual reality (VR) to create an immersive shopping environment for consumers. For example, a home furnishing brand uses VR technology to allow consumers to experience different home

layouts and styles in a virtual space, thereby enhancing consumers' shopping experience and brand loyalty.

4.2 Integrate social media and content strategies to broaden the boundaries of brand influence

Social media and content marketing are other vital directions for enterprise marketing model innovation. In the digital economy, social media has become an essential part of people's daily lives, and companies need to expand their brand influence by leveraging social media platforms and creating and distributing quality content.Enterprises can establish brand accounts on social media platforms, publish product information, brand stories, user reviews and other content, and interact and communicate with consumers. Companies can enhance their relationships with consumers and increase brand awareness and reputation by regularly updating content, responding to comments and private messages, and hosting online events. At the same time, companies need to create valuable, exciting and resonant content, such as articles, videos, pictures, etc., and disseminate it through multiple channels such as social media platforms. For example, a beauty brand has attracted the attention of many fans by releasing valuable content such as makeup tutorials and beauty secrets and successfully increased brand influence and product sales. For example, Xiaohongshu's (key opinion leader)marketing strategy, Xiaohongshu is a platform based on content marketing and social e-commerce, and many brands release high-quality content to promote products by cooperating with KOLs on the platform. A cosmetics brand cooperated with a well-known beauty blogger on Xiaohongshu and released a series of use tips and makeup tutorials on the brand's products, attracting many users' attention and purchases. This blend of social media and content marketing increases brand exposure and drives product sales.

4.3 Relying on intelligence to drive the marketing process and improve marketing efficiency and results

Intelligent marketing is the future trend of enterprise marketing model innovation. In the era of the digital economy, AI technology has been widely used and developed, and enterprises need to optimize marketing processes and improve marketing efficiency and effectiveness by using AI technology.

Enterprises can introduce intelligent recommendation systems to provide personalized product recommendations for each consumer by analyzing consumers' purchase history, browsing behaviour, search history and other data. This recommendation method not only improves consumers' shopping experience but also increases enterprises' sales and conversion rates. At the same time, enterprises can use AI technology to automate some repetitive marketing tasks, such as sending emails, pushing text messages, and managing social media accounts. This can not only save labour and time costs but also ensure the timeliness and accuracy of marketing activities. Such as Amazon's intelligent recommendation system, Amazon is one of the world's largest e-commerce platforms, and its intelligent recommendation system plays a vital role in personalized marketing. By analyzing users' purchase history, browsing behaviour, search history and other data, Amazon can recommend products that meet users' interests and needs, thereby improving users' purchase rate and satisfaction. This intelligent marketing strategy not only improves Amazon's sales performance but also enhances users' shopping experience and loyalty. System integration and continuous innovation are the cornerstone of enterprise marketing model innovation. Enterprises need to integrate online and offline marketing channels and create an omnichannel marketing system to provide consumers with a seamless shopping experience. At the same time, enterprises also need to establish an innovation mechanism, encourage internal exploration and external cooperation, and constantly iterate marketing models.

In terms of omni-channel marketing, enterprises can achieve omni-channel coverage and interoperability by integrating online e-commerce platforms, offline physical stores, social media and other channels. For example, a clothing brand provides a convenient shopping experience through the online e-commerce platform, provides fitting and experience services in offline physical stores, and interacts and communicates with consumers through social media, thus achieving the seamless integration of omnichannel marketing.

In terms of continuous innovation, enterprises need to establish an innovation mechanism to encourage internal employees to actively explore new marketing models and strategies. At the same time, enterprises also need to work with external partners to research and develop and innovate, and introduce new technologies and concepts to promote the continuous iteration and upgrade of marketing models. For example, a retail giant collaborated with a technology company to jointly develop an intelligent customer service system based on AI technology, improving the quality and efficiency of customer service.

5. Conclusion :

In the digital economy environment, the adaptation and innovation strategy of the enterprise marketing model becomes the key to the sustainable development and competitive advantage of enterprises. This study discusses the influence of the digital economy on enterprise marketing mode, analyzes the transformation of enterprise marketing mode under a digital economy environment, and puts forward the corresponding adaptive strategy and innovation path. In order to adapt to the changes, enterprises must actively implement digital transformation, accurately grasp the market demand, formulate personalized marketing strategies, and realize the automation and intelligence of marketing processes by establishing sound data collection, analysis and application mechanism, using advanced technologies such as cloud computing and the Internet of Things. At the same time, through the integration of online and offline, the use of social media marketing and content marketing, as well as strengthening cooperation with partners, broaden the boundaries of brand influence and other ways to explore and practice new marketing paths actively. In the digital economy environment, enterprises should actively adapt to changes, innovate marketing models, and continuously improve market competitiveness. Only by keeping up with the pace of the digital economy and constantly exploring and practising new marketing paths can enterprises remain invincible in the fierce market competition and achieve sustainable development.

REFERENCES :

1. Huang AiYun. Exploration of Enterprise Marketing Strategy Innovation Path in the Digital Economy Era [J]. Shopping Mall Modernization,2023,(22): 37-39
2. Xing WenTing. Research on Enterprise Marketing Model Innovation under the Background of the Digital Economy [J]. Business Review,2023, Vol. 9 (22): 21-24, 28
3. Qin Ding. The Impact of Market Orientation on Retail Enterprises' Business Model Innovation: An Analysis based on the Background of Digital Economy [J]. Business Economics Research, 2024 (8): 157-160.
4. Wang Jun, Fang Ye. Mechanism, Model and Path of Some Cooperative Innovation Driven by Digital Economy [J]. Journal of Hubei University of Economics (Humanities and Social Sciences Edition),2024, vol. 21 (4): 53-58
5. Cui Jiubo. Research on Problems and Countermeasures in the Development of Small and Medium-sized Enterprises under the Background of Digital Economy [J]. Enterprise Science and Technology Development,2024,(3): 70-73
6. Liu J , Liu Z , Xu Y ,et al.Research on the Innovation of Marketing Management Mode Under the Digital Transformation of Textile and Garment Enterprises[J].Journal of Information & Knowledge Management, 2024.DOI:10.1142/S0219649224500035.
7. Karpenko O, Matviichuk Y . Marketing Tools for Ensuring the Competitiveness of an Enterprise in the Context of Digital Transformation[J]. 2024.
8. Munir A , Kadir N , Umar F ,et al.The Impact of Digital Marketing and Brand Articulating Capability for Enhancing Marketing Capability[J].International Journal of Data and Network Science, 2023.DOI:10.5267/j.ijdns.2022.12.005.
9. Ma X, Gu X . New Marketing Strategy Model of E-commerce Enterprises in the Era of Digital Economy[J].Heliyon, 2024, 10(8).DOI:10.1016/j.heliyon.2024.e29038.
10. Munir A , Kadir N , Umar F ,et al.The Impact of Digital Marketing and Brand Articulating Capability for Enhancing Marketing Capability[J].International Journal of Data and Network Science, 2023.DOI:10.5267/j.ijdns.2022.12.005.

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Data Science as a tool to curb Human-Wildlife Conflict

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Abstract: *A well-balanced and healthy ecosystem shows vital signs of dependence on the wildlife around which it thrives. Yet this equitable balance is often disrupted due to the over encroachment of humans into wildlife ecosystems. This has a disturbing and serious impact on the symbiotic relationship that these factions share and the overall health of their co-existence. Since the advent of human encroachment, devastating losses in livelihoods, property and sometimes even lives has been escalating. Traditional methods to mitigate this friction often fall short due to their reactive nature and lack of precision.*

This research explores the application of data science as a proactive and strategic tool to manage human-wildlife conflict. By integrating vast datasets from satellite imagery, remote sensing, GPS tracking and community-reported incidents, data science methodologies can predict conflict hot spots, analyse wildlife movement patterns and assess environmental variables influencing animal behaviour. This paper highlights the potential for scalable solutions.

This research underscores the transformative potential of data science in fostering coexistence between humans and wildlife, enhancing sustainable development and conservation.

Keywords: *Human-wildlife conflicts, GPS tracking, data science, scalable solutions, sustainable, satellite imagery, remote sensing.*

1. INTRODUCTION

As urbanization expands, natural habitats shrink rapidly. Incidents of human-wildlife conflicts become increasingly frequent, often resulting in detrimental effects on both economic and ecological sustenance. Human wildlife conflict occurs when the encounters between man and animal result in negative outcomes, i.e. loss in lives, economy, livelihood and property. It is common in the buffer zones, where people are involved in rearing livestock and agriculture as their main economic activity for livelihood. The competition for space caused by increase in human and animal population is one of the prime reasons for the conflict.

Today, the human wildlife conflict is a global crisis where the losses are irretrievable on both sides. In regions such as Zimbabwe, Namibia, Botswana, Tanzania, Sri Lanka, and Indian states like Kerala, West Bengal, and Assam, encounters with elephants, leopards and monkeys in rural areas are common. Meanwhile, in Europe and North America, sightings of deer, wild boars, bears, coyotes, and wolves are prevalent.

It becomes crucial for the authorities to chart out effective measures to negotiate a healthy balance amongst these communities in the buffer zone and people who are heavily reliant on the forests for their day-to-day needs. A lot of these encounters can be prevented with the help of immediate and strategic interventions and pre-emptive monitoring which involves the appropriate usage of data science and other technologies, curtailing the movement of species towards human habitation. From targeted data

acquisition to image retrieval and population surveys, machine learning methodology can also help in various stages in enhancing ecological balance and sustainable development of both human and wildlife population.

2. CURRENT SCENARIO

India has the largest population of wild Asian Elephants in the world and is estimated to be at around 30,000. A survey in 2020 revealed that elephant encounters killed over 500 humans annually while human activities like poaching for ivory, collision with trains, electrocution and poisoning lead to the death of 100 elephants.

India is also home to more than 75% of tiger population. According to the data from the government, in the last five years, 628 tigers died while tiger attacks lead to death of 349 people. Not just elephants and tigers, many other animals like leopards, deer, monkeys etc., have fallen victim to these frequent clashes.

Often tigers and elephants wander in and around their habitats in search of food and water. Once they wander close to human settlements, the chances of attacks increase, thereby, evoking a sense of negative emotions and fear amongst the villagers towards the animals.

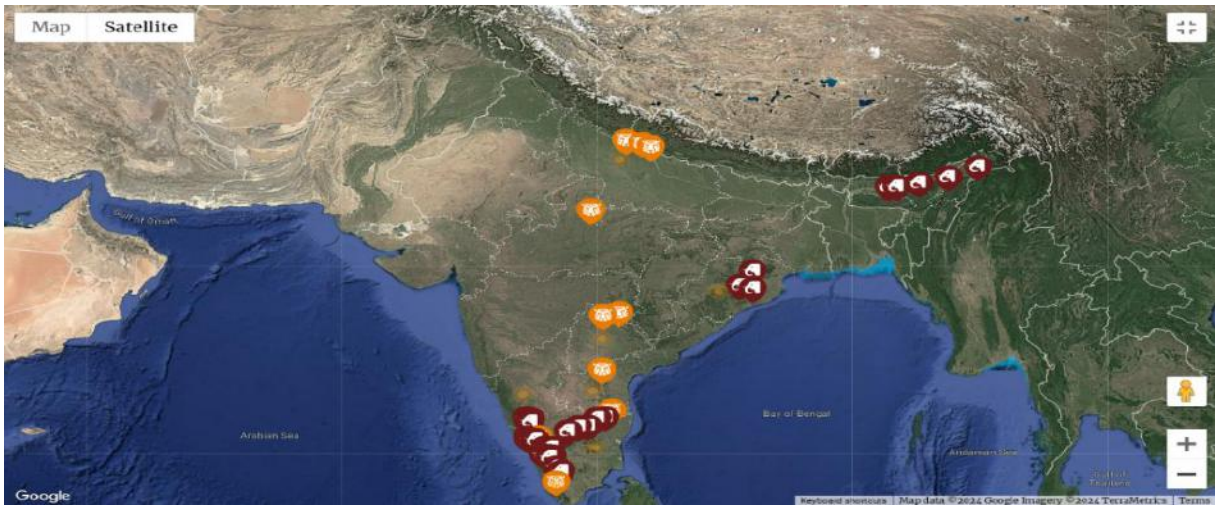

Fig 2.1: Satellite Image of Conflict Map of India

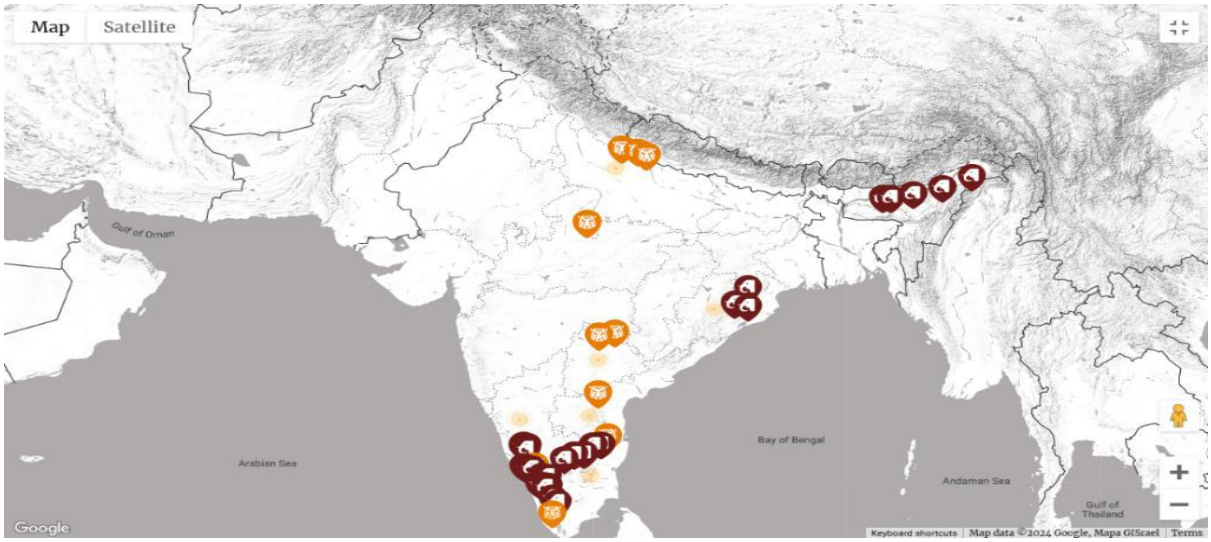

Fig 2.2: Terrain Image of Conflict Map of India

Table 2.1: HUMAN CASUALITIES DUE TO WILD ANIMALS IN THE YEAR 2021-22

S.No.	States	Elephant	Tiger
1.	*Assam*	*63*	*0*
2.	*Chhattisgarh*	*64*	*0*
3.	*Bihar*	*0*	*13*
4.	*Jharkhand*	*133*	*0*
5.	*Karnataka*	*27*	*2*
6.	*Kerala*	*25*	*0*
7.	*Maharashtra*	*0*	*114*
8.	*Uttar Pradesh*	*0*	*22*
9.	*West Bengal*	*77*	*6*
10.	*Odisha*	*112*	*0*
11.	*Tamil Nadu*	*37*	*3*

Table 2.2: HUMAN CASUALITIES DUE TO WILD ANIMALS IN THE YEAR 2022-23

S.No.	States	Elephant	Tiger
1.	*Assam*	*80*	*NR*
2.	*Chhattisgarh*	*69*	*3*
3.	*Bihar*	*0*	*NR*
4.	*Jharkhand*	*96*	*NR*
5.	*Karnataka*	*29*	*3*
6.	*Kerala*	*22*	*NR*
7.	*Maharashtra*	*2*	*35*
8.	*Uttar Pradesh*	*4*	*NR*
9.	*West Bengal*	*97*	*NR*
10.	*Odisha*	*148*	*NR*
11.	*Tamil Nadu*	*43*	*1*

***NR: Not Reported**

***As per government data.**

As the situation escalates, villagers, due to lack of sensitization, engage in malicious methods to eliminate these wild animals. Incidents such as Bahraich wolf attack where 10 people were killed by a pack of wolves that wreaked havoc and terrorised 30 villages near Bahraich in Uttar Pradesh, ended in the villagers killing the six-member pack wolves. Such encounters spark utter chaos in these ecosystems, resulting in massive loss of wildlife.

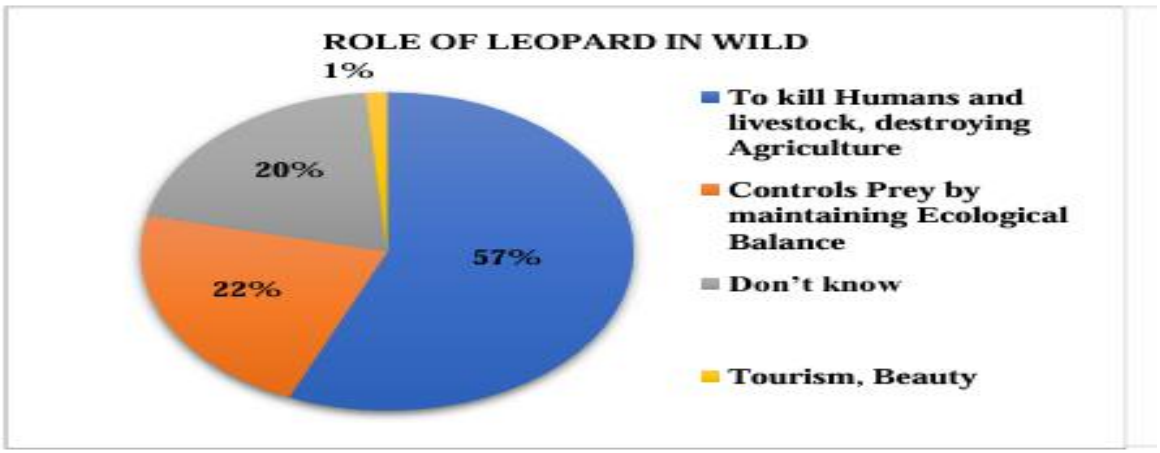

Fig 2.3: A pie chart that shows the local perception of a leopard.

3. METHODOLOGIES IN DATA SCIENCE

There are numerous ways in data science that can provide real-world solutions to manage and control the encounters that are prevalent in these hotspots. Several preventive measures can mitigate the situation from escalation like fencing, camera traps and drone-monitoring. The following is a list of such techniques :

A. **Proper identification of conflict hotspots:** Conflict areas that are extremely vulnerable to recurrent animal sightings must be classified as hotspots. The human settlement areas that are within 5–10-kilometre radius of such zones must be sensitized accordingly.
B. **Animal identification and categorization:** Animals that are present within these zones must be regularly monitored and categorized according to their natural behavioural patterns as rogue or docile. This can help chart a clearer picture about the characteristic of each species in that area. GPS tagging method will help in surveillance of rogue animals.
C. **Data Upload:** Data such as species, characteristic behaviour, physical features, activity etc., must be input into the computers for analysing and identifying each animal. This can help camera traps and other technical equipment to sense the presence of an animal accurately and alert its authorities. Fischer's test in R programming software can be used to calculate their activities and movement during day, night and any weather condition.
D. **Camera Traps, Geo-sensors and Solar Fencing:** In prime hotspots that are vulnerable to habitual sightings of animals, camera traps can help detect the pictures of the animal to provide information. Solar fencing can be placed surrounding the buffer zones, national sanctuaries and hotspots to constrict the animal from wandering off. Aerial and Underground sensors can help alert the Forest officials in the control room to check for unusual activities.
E. **Rapid Alarm System:** As the camera and other sensors detect unusual movement of the animals, immediate alarms will be sent to the Forest Control Room for quick action to prevent damage. Wildlife guard patrolling in areas that are hotspots can also help in mitigation. Villagers can also be sensitized in case of unusual activity.
F. **Sensitization:** The villagers and other residents who live nearby these zones must be properly educated about the wildlife and its laws in order to avoid illegal poaching, electrocution or other dangerous treatments.

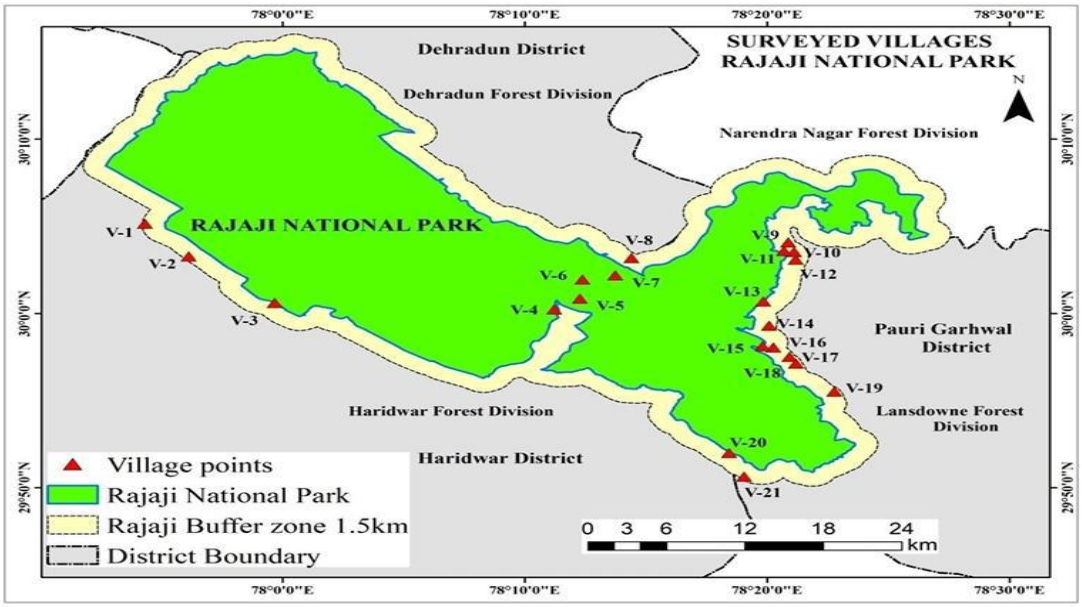

Fig 3.1: A map that shows the 1.5km buffer zones in Rajaji National Park, Uttarakhand^

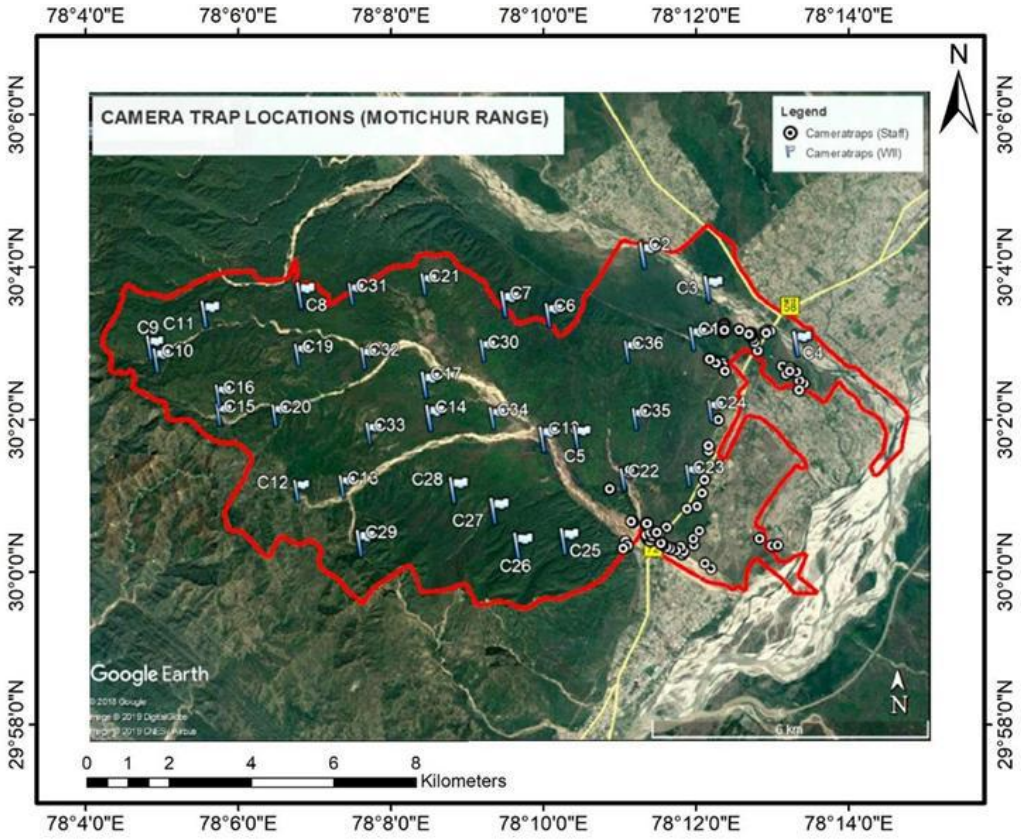

Fig 3.2: Positioning of camera traps in Motichur region, Uttarakhand^

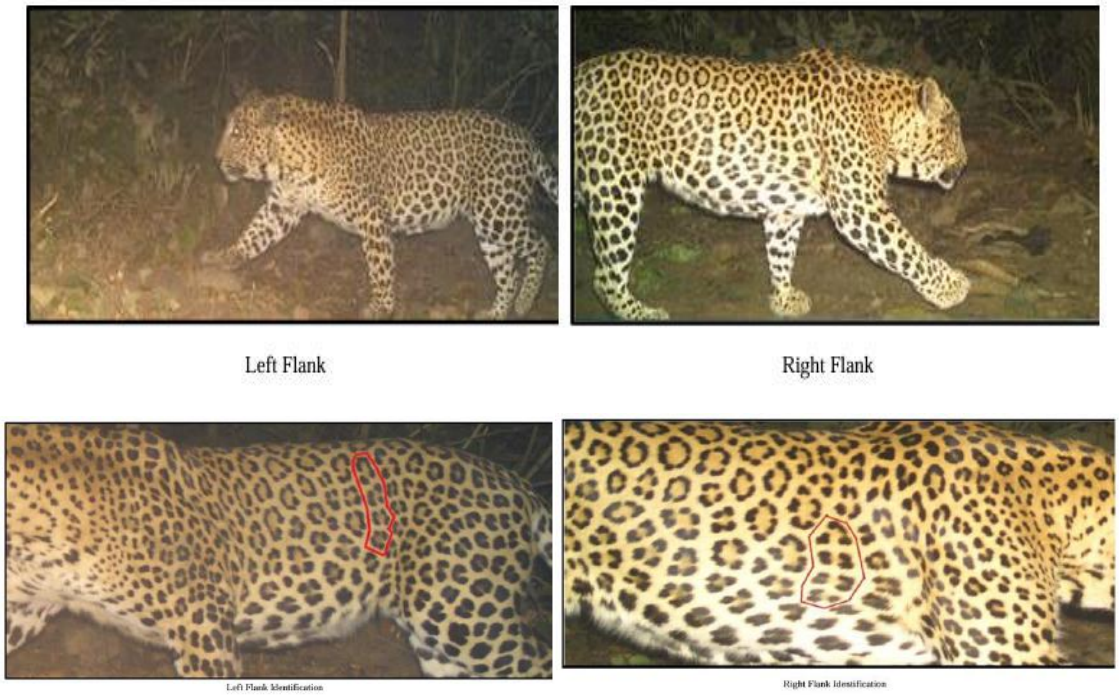

Fig 3.3: Pictures clicked by camera trap of a male leopard in the wild^

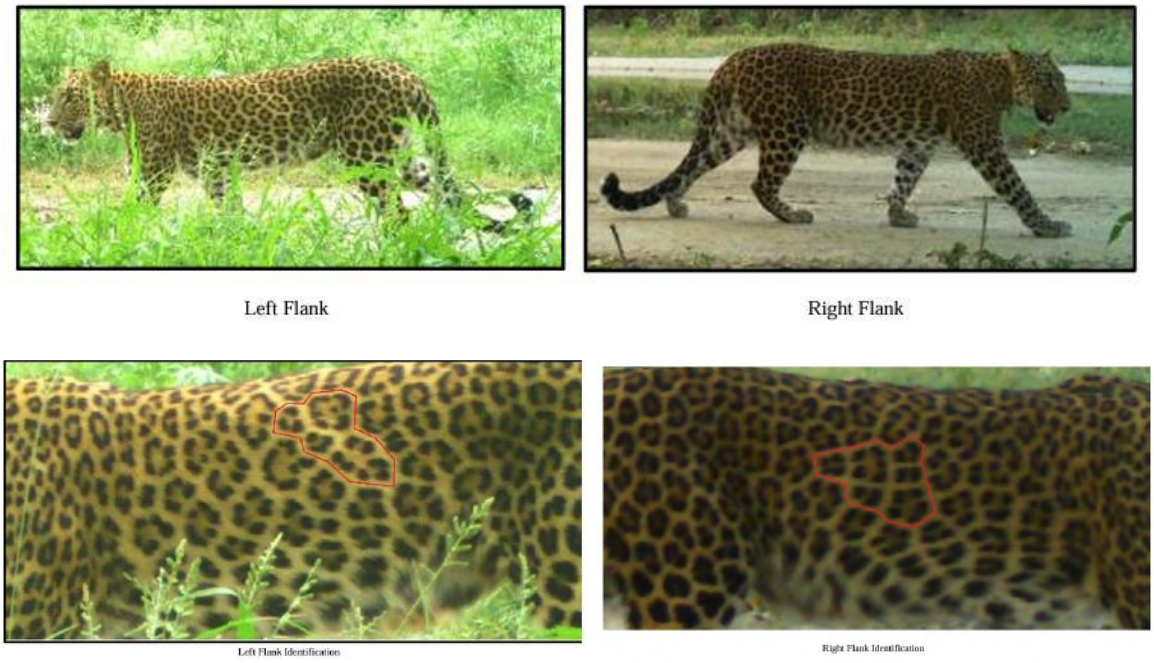

Fig 3.4: Pictures clicked by camera trap of a female leopard in the wild^

^ Source: An assessment of Landscape level changes & Human-Wildlife Conflict, including human-leopard conflict in Motichur range, around Rajaji Tiger Reserve, Uttarakhand" (Shashank Yadav & Manu Mohan, 2019)

4. BENEFITS

This study emphasizes the usage of modern innovations to create a better sustainable and balanced ecosystem in areas that are vulnerable to human-wildlife conflict.

- As animals and humans can coexist with each other, the forests in that area as well as the ecosystem begin to flourish.
- People living in buffer zones can be involved in supporting conservation activities. As forests remain healthy, it promotes wildlife tourism which becomes a boon to both local as well as the country's economy.
- By addressing and mitigating human-wildlife conflict, cases of illegal trade of animal parts like elephant tusks(ivory), rhino horn etc can be effectively curtailed.
- The symbiosis of this ecosystem helps in economic improvement for the people and also for the maintenance of forest area.

5. CONCLUSION

This study brings the various challenges and ethical considerations of humans and animals coexisting in an environment. The benefits of data science are multifaceted which can be extremely beneficial in today's world to preserve wildlife and economic stability. By embracing data science, more precise, scalable and efficient solutions can be developed to foster coexistence and ensure sustainable development and biodiversity conservation.

REFERENCES

1. https://www.worldwildlife.org/stories/what-is-human-wildlife-conflict-and-why-is-it-more-than-just-a-conservation-concern
2. https://iucn.org/resources/issues-brief/human-wildlife-conflict
3. https://wwf.panda.org/discover/our_focus/wildlife_practice/problems/human_animal_conflict/
4. Nyhus, Philip J. "Human–wildlife conflict and coexistence." *Annual Review of Environment and Resources* 41 (2016): 143-171.
5. https://sansad.in/getFile/loksabhaquestions/annex/182/AU1128_uBD2JB.pdf?source=pqals
6. Poessel, Sharon A., Stewart W. Breck, Tara L. Teel, Stephanie Shwiff, Kevin R. Crooks, and Lisa Angeloni. "Patterns of human–coyote conflicts in the Denver Metropolitan Area." *The Journal of Wildlife Management* 77, no. 2 (2013): 297-305.
7. https://en.wikipedia.org/wiki/Human%E2%80%93wildlife_conflict#cite_note-32
8. https://www.thehindu.com/sci-tech/energy-and-environment/628-tigers-died-in-india-in-past-five-years-govt-data/article68449040.ece
9. https://sansad.in/getFile/annex/263/AU672.pdf?source=pqars
10. https://www.thehindu.com/news/national/uttar-pradesh/villagers-kill-sixth-and-final-wolf-ending-months-long-havoc-by-predator-in-uttar-pradeshs-bahraich/article68724069.ece
11. Yadav S., Mohan M., Sandilaya D., Boro P., Sharma A., Sanatan S. & Ramesh. K. 2019: Human-Wildlife Conflict: Assessment of socio-psychological perspectives and actual threat from leopard in Motichur Range, Rajaji Tiger Reserve. Institute of India and Uttarakhand Forest Department.

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Embedded Systems as Catalysts for Research and Innovation in Education: Transforming Pedagogy through Technology

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Abstract: *In the rapidly evolving landscape of education, the integration of embedded systems has emerged as a transformative force driving research and innovation in teaching and learning practices. Embedded systems—comprising microcontrollers, sensors, and real-time processing units—are increasingly being utilized in educational settings to enhance interactivity, personalization, and real-world applicability of learning experiences. This study explores how embedded systems serve as catalysts for pedagogical innovation by enabling smart classrooms, adaptive learning environments, and data-driven instructional strategies. By embedding intelligent technologies into educational tools and infrastructure, educators can monitor learning patterns, support differentiated instruction, and foster experiential learning across disciplines, especially in STEM education. Through a mixed-methods research design involving case studies, prototype development, and user feedback from students and teachers, this study assesses the impact of embedded systems on student engagement, conceptual understanding, and problem-solving skills. The findings reveal that the use of embedded technologies not only enriches curriculum delivery but also opens new pathways for educational research—particularly in areas such as learning analytics, curriculum customization, and competency-based evaluation. Furthermore, the paper discusses policy implications, technological challenges, and future directions for integrating embedded systems within school and higher education frameworks. Overall, the study underscores the potential of embedded systems to redefine educational paradigms by bridging the gap between theoretical learning and practical application, making education more innovative, inclusive, and responsive to the demands of the digital age.*

Keywords: *Teaching and Learning Practices, Interactivity, Catalysts, Customisation, Technology.*

1. INTRODUCTION :

In an era defined by rapid technological advancement and digital transformation, education systems across the globe are increasingly challenged to evolve in ways that align with the needs of the 21st-century learner. Traditional pedagogical methods, while foundational, often fall short in equipping students with the practical, analytical, and problem-solving skills demanded by contemporary industries and knowledge economies. Within this context, embedded systems—compact, specialized computing systems designed to perform dedicated functions—have emerged as powerful tools with the potential to revolutionize educational practices. Originally developed for applications in fields such as robotics, automation, and consumer electronics, embedded systems are now being reimagined as interactive learning aids, real-time monitoring tools, and data collection devices within classrooms and educational research settings. Their integration into education enables dynamic, hands-on learning experiences, fosters interdisciplinary approaches—particularly in STEM fields—and supports innovation through real-time feedback, customization, and automation.

The growing interest in embedding such systems into teaching and learning environments stems from their capacity to bridge the gap between theoretical knowledge and real-world application. They offer educators the opportunity to develop smarter curricula, design adaptive learning environments, and engage in meaningful, technology-enabled research. Furthermore, embedded systems support innovation not just at the level of classroom instruction but also in institutional research, allowing for data-driven decision-making, evaluation of pedagogical strategies, and development of new educational models. This study explores the multifaceted role of embedded systems in transforming educational research and practice and examines how their integration can catalyse innovation in pedagogy, assessment, and learner engagement. By investigating case applications, empirical outcomes, and theoretical frameworks, the study aims to contribute to a deeper understanding of how embedded technology can lead to a more interactive, inclusive, and future-ready educational ecosystem.

The incorporation of embedded systems into education aligns with the global shift toward smart learning ecosystems, where technology is not merely an add-on but a core enabler of teaching and learning innovation. These systems, often built around microcontrollers such as Arduino, Raspberry Pi, or ESP32, allow students to interact directly with hardware and software, enabling experiential learning through real-time experimentation and prototyping. Such applications go beyond rote memorization and static textbook learning, fostering critical thinking, creativity, and innovation. In engineering and vocational training, for instance, embedded systems are integral to teaching automation, robotics, IoT (Internet of Things), and control systems. Meanwhile, in general education, they can be used to build low-cost scientific instruments, develop assistive devices for inclusive education, or even monitor classroom environments—demonstrating their versatility and cross-disciplinary relevance.

Despite their potential, the educational integration of embedded systems remains underexplored, particularly in resource-constrained settings or traditional institutions where pedagogical innovation is slow to materialize. There exists a research gap concerning how these systems influence student engagement, curriculum flexibility, teacher efficacy, and learning outcomes when systematically embedded within the educational process. Moreover, institutional readiness, infrastructural challenges, and pedagogical training gaps often hinder the widespread adoption of such technologies. Therefore, there is a pressing need for empirical research that examines not only the effectiveness of embedded systems in education but also the conditions under which they can be scaled, sustained, and tailored to diverse educational contexts.

2. Embedded Systems as a Building Block of Research Innovation: Comprehensive Study

Embedded systems have evolved from being purely industrial and commercial tools to becoming integral components in the landscape of educational research and innovation. Defined as specialized computing systems designed to perform dedicated tasks within larger mechanical or electrical frameworks, embedded systems offer real-time responsiveness, automation, and adaptability—features that align well with the dynamic needs of modern education. Their application in academic settings transcends conventional learning aids; they now form the backbone of interactive laboratories, intelligent teaching devices, and real-time monitoring systems that contribute to empirical research. As educational research increasingly embraces interdisciplinary, data-driven approaches, embedded systems serve as crucial instruments for innovation, allowing researchers to collect precise data, prototype educational tools, simulate learning environments, and evaluate learner behaviours in authentic contexts. From enabling sensor-based projects in STEM classrooms to supporting assistive technologies for inclusive education, embedded systems foster creativity, experimentation, and critical thinking. This study positions embedded systems as not merely supplementary technologies but as foundational building blocks that support the conceptualization, execution, and validation of innovative educational research. By exploring their multifaceted roles, the study sheds light on how embedded systems can reshape not only how we teach but also how we investigate and improve educational practices, thus anchoring them at the core of research-driven transformation in 21st-century learning environments.

The relevance of embedded systems in educational research also lies in their potential to democratize innovation. With the availability of low-cost, open-source platforms such as Arduino, Raspberry Pi, and ESP32, educators and students from diverse academic and socio-economic backgrounds can engage in hands-on experimentation and original research. These systems empower users to design and test real-world applications—from environmental monitoring stations and smart attendance systems to IoT-enabled learning devices—thus making the research process more participatory, accessible, and meaningful. Embedded systems also encourage a shift from passive knowledge consumption to active knowledge construction, where learners become innovators and co-creators of educational solutions. This paradigm shift is particularly vital in technical and vocational education, where industry-aligned skill development is essential. By embedding research competencies and innovation thinking into curricula through such systems, educational institutions can better align with national objectives like Digital India, Skill India, and Atmanirbhar Bharat, fostering a generation of technologically adept, research-oriented learners.

Moreover, embedded systems provide a robust platform for conducting evidence-based pedagogical research. Their ability to collect, process, and analyze data in real time supports the design of adaptive learning systems, personalized feedback mechanisms, and performance tracking tools. These data-rich insights enable researchers to measure the impact of teaching strategies, student engagement, and learning outcomes with scientific precision. When integrated with AI, cloud computing, and data analytics, embedded systems further enhance the capacity to innovate in educational technology research, enabling scalable solutions that address diverse learner needs. In this context, institutions that adopt embedded system-based approaches position themselves at the forefront of educational transformation, where teaching, learning, and research converge through technology. Therefore, this study not only underscores the technological relevance of embedded systems but also highlights their strategic role in fostering a culture of research innovation that is responsive, inclusive, and future-ready.

3. Transforming Pedagogy through Technology in Embedded System: Analysis

The integration of embedded systems into educational environments marks a paradigm shift in pedagogical practices, redefining how knowledge is delivered, received, and internalized. Traditionally, pedagogy has revolved around linear instruction, textbook learning, and standardized assessments. However, the infusion of embedded systems introduces an interactive, real-time, and application-oriented mode of teaching that transforms the teacher-student dynamic and the overall learning experience. These systems enable hands-on experimentation, simulate real-world scenarios, and support project-based learning, thus aligning with constructivist pedagogies that emphasize active knowledge construction. For instance, a microcontroller-based system can be used in physics classes to demonstrate principles like motion or temperature change in a tangible, measurable format, encouraging experiential learning. Such applications not only make abstract concepts more accessible but also enhance critical thinking, creativity, and problem-solving skills among students.

From a pedagogical standpoint, embedded systems foster personalized and adaptive learning. Through the integration of sensors and data analytics, educators can monitor student responses and engagement levels in real time, allowing them to modify instructional strategies to suit individual learning needs. This responsive teaching model promotes inclusivity and improves learning outcomes, especially in diverse classrooms where learners may vary significantly in pace and comprehension. Moreover, embedded systems support collaborative learning by enabling students to work in teams on real-time projects, mirroring industry practices and promoting soft skills such as communication and teamwork. The use of embedded systems in pedagogy is not limited to technical subjects; they are increasingly being applied across disciplines—whether it's automating data collection for environmental studies or creating interactive models for geography and biology. This cross-disciplinary utility enhances curriculum integration and makes learning more holistic and meaningful.

Ultimately, transforming pedagogy through embedded system technology means moving toward a learner-centric, innovation-driven educational model. It empowers both educators and learners to move

beyond rote memorization and embrace a culture of inquiry, experimentation, and design thinking. This transformation also calls for professional development of educators, restructured curricula, and institutional support for technological infrastructure. Therefore, the analysis of embedded systems in pedagogy is not merely a technological discussion—it is an educational imperative that reimagines teaching as a dynamic, evolving, and technologically enriched process aimed at cultivating 21st-century competencies.

The institutional implications of integrating embedded systems into pedagogy are far-reaching, as they demand a fundamental rethinking of educational spaces, resources, and teacher training. Classrooms must evolve into smart learning environments equipped not just with digital boards and projectors but with programmable hardware interfaces, sensor kits, and simulation tools. This shift requires educational institutions to invest in infrastructure that supports the deployment and maintenance of embedded technologies, while also fostering an innovation-friendly ecosystem. Equally important is the upskilling of educators, who must be equipped with both technical proficiency and pedagogical strategies to effectively incorporate embedded systems into their teaching. Without comprehensive faculty development programs, even the most advanced technologies may remain underutilized or misapplied, limiting their transformative potential.

On the curricular front, embedded systems pave the way for interdisciplinary integration, blending science, mathematics, engineering, technology, and even the humanities in novel ways. Curricula enriched by embedded technologies move beyond static knowledge delivery to include design thinking, systems analysis, coding, and ethical technology use—skills that are indispensable in the 21st-century workforce. Moreover, the use of embedded systems encourages iterative learning cycles where students hypothesize, test, observe, and refine their outputs, mirroring the research and development process in real-world technological innovation. Such alignment between educational practice and industrial expectations enhances employability and real-world readiness, especially in technical and vocational education and training (TVET) programs.

At the level of educational research, embedded systems provide new methodologies for investigating teaching effectiveness, learner behavior, and engagement patterns. Researchers can embed sensors and tracking tools into learning materials or classroom setups to gather fine-grained data on attention spans, interaction rates, and cognitive load, thus offering evidence-based insights that can shape policy and pedagogy alike. Furthermore, this data-driven model of instruction supports continuous improvement through feedback loops, where learning systems adapt based on real-time analytics. The growing convergence of embedded systems with artificial intelligence and IoT (Internet of Things) expands the possibilities further—ushering in a future where education is not only personalized but also predictive, adaptive, and seamlessly integrated into students' lives.

In conclusion, transforming pedagogy through embedded systems is not a peripheral technological enhancement—it is a holistic reform that touches every dimension of education, from classroom dynamics and curriculum design to institutional vision and academic research. When embedded systems are leveraged thoughtfully, they have the capacity to democratize access to quality education, stimulate intellectual curiosity, and cultivate a generation of learners who are not just technologically literate but also capable of shaping the technologies of the future.

4. Factors Influencing Pedagogical Transformation of the Technology: A Comprehensive Analysis

The transformation of pedagogy through technology is not an isolated or spontaneous process; it is shaped by a constellation of interrelated factors that determine the depth, speed, and sustainability of change within educational systems. At the core of this transformation lies the technological infrastructure—the availability of reliable internet connectivity, hardware devices, embedded systems, and smart classroom environments. Institutions that lack foundational infrastructure face significant barriers in adopting even basic educational technologies, thereby widening the digital divide. Equally

critical is institutional vision and leadership; schools and universities with progressive, innovation-oriented leadership are more likely to embrace and invest in technological pedagogies. Visionary leadership fosters a culture of experimentation, supports risk-taking in instructional design, and encourages continuous learning among educators.

Another central factor is the digital competency and pedagogical readiness of teachers. The successful integration of technology, including embedded systems, hinges on how effectively teachers can align these tools with pedagogical goals. Professional development, hands-on training, and collaborative learning communities play a pivotal role in preparing educators to shift from traditional instruction to technology-enhanced, learner-centered models. Furthermore, curricular flexibility significantly impacts pedagogical transformation. Rigid, examination-oriented curricula often hinder the incorporation of project-based and experiential learning supported by technological tools. On the contrary, interdisciplinary, skill-based curricula provide fertile ground for embedding technology meaningfully into instruction.

Student engagement and digital literacy also influence how technology transforms pedagogy. Students who are digitally aware, motivated, and active participants in their learning journey are more likely to benefit from and adapt to technologically enriched educational experiences. However, equitable access must be ensured, as socioeconomic factors can limit students' ability to engage with digital tools, creating disparities in learning outcomes. In this context, policy frameworks and funding mechanisms at both the institutional and governmental levels act as enabling or constraining forces. Supportive policies that promote innovation, provide funding for technology adoption, and incentivize research-based pedagogical reform are crucial to long-term transformation.

Finally, research and feedback mechanisms are essential to evaluate the effectiveness of technology in pedagogy. Data-driven insights, generated through tools such as embedded systems, learning analytics, and classroom monitoring software, allow for the refinement of instructional practices, curriculum design, and policy strategies. They help educators identify what works, for whom, and under what conditions—making pedagogical transformation an evidence-based process rather than a trial-and-error experiment. Thus, the transformation of pedagogy through technology is influenced by a multi-layered matrix of factors—technological, institutional, pedagogical, social, and political—each of which must be holistically addressed to realize the full potential of innovation in education.

5. Impact of Technology on Embedded Systems

The rapid advancement of technology has significantly reshaped the scope, functionality, and versatility of embedded systems, driving their evolution from simple task-specific devices to sophisticated, interconnected systems capable of real-time intelligence and adaptive control. Earlier generations of embedded systems were limited in computational power and autonomy, functioning mainly as standalone units with minimal integration. However, the emergence of advanced microcontrollers, high-efficiency processors, and low-power embedded architectures has enabled the development of powerful, compact systems that can perform complex operations with greater accuracy and efficiency. Technological innovations in wireless communication (e.g., Bluetooth, Wi-Fi, Zigbee) and sensor networks have allowed embedded systems to become key components of the Internet of Things (IoT), transforming them into smart, networked devices capable of data exchange and remote monitoring.

Additionally, the integration of machine learning algorithms and artificial intelligence into embedded platforms has elevated their functionality from basic automation to intelligent decision-making. For instance, embedded systems in smart classrooms can now analyze student behavior, adapt content delivery, and provide personalized feedback using AI models running on edge devices. Furthermore, cloud computing and edge computing paradigms have amplified the potential of embedded systems by enabling real-time data processing, remote control, and scalable storage solutions, enhancing their application in fields such as education, healthcare, agriculture, and autonomous systems.

Technological advancements have also impacted the design and development cycle of embedded systems. Tools such as simulation software, open-source platforms like Arduino and Raspberry Pi, and integrated development environments (IDEs) have democratized the field, allowing even non-engineers—such as educators and students—to prototype and deploy embedded solutions. This accessibility fosters innovation across domains and accelerates interdisciplinary learning. Additionally, improvements in battery efficiency, miniaturization, and ruggedization have made embedded systems more portable, durable, and adaptable to diverse real-world conditions, expanding their use in mobile learning, field-based education, and research. The technology acts not only as a catalyst but as a transformative force for embedded systems, enhancing their intelligence, connectivity, accessibility, and overall educational and industrial relevance. The synergy between technological innovation and embedded systems continues to redefine their role, making them integral to the digital infrastructure of smart education, automation, and research-oriented innovation.

6. Conclusion

The integration of embedded systems into education signifies more than just the adoption of new tools—it represents a transformative shift in how knowledge is imparted, absorbed, and extended through research and innovation. As technology continues to advance at an unprecedented pace, embedded systems have emerged as critical enablers of experiential learning, data-driven pedagogy, and real-time educational feedback. They offer educators and learners opportunities to engage with content in interactive and applied ways, thereby fostering deeper understanding, creativity, and innovation. From enhancing STEM education with hands-on prototyping to enabling personalized learning through intelligent systems, the impact of embedded technology on pedagogy is profound and multifaceted. However, the successful implementation of such systems requires more than just technological infrastructure; it demands a holistic ecosystem supported by institutional vision, trained educators, flexible curricula, inclusive access, and supportive policies. When these conditions are met, embedded systems not only enrich the learning environment but also empower learners to become creators, problem-solvers, and future innovators. Ultimately, embedded systems are not just add-ons to modern education—they are foundational building blocks for a future-ready, research-driven, and technologically enriched academic landscape. As the education sector evolves to meet the demands of the digital age, the thoughtful and strategic integration of embedded systems will remain central to redefining pedagogical practices and advancing educational excellence.

The role of embedded systems in shaping the future of education will only grow more pronounced as technologies such as artificial intelligence, machine learning, and the Internet of Things (Iot) continue to converge. These systems will evolve from being passive instructional aids to becoming active agents in intelligent learning ecosystems—systems that not only respond to learners' needs but anticipate them. This predictive capability, powered by real-time analytics and adaptive algorithms, holds immense potential for early intervention in learning gaps, automated assessment, and customized learning trajectories. Moreover, embedded systems can significantly contribute to inclusive education by supporting the development of assistive devices for students with disabilities, thereby ensuring that technological innovation benefits all segments of the student population.

Globally, as educational systems strive to build resilience in the face of disruptions—such as the COVID-19 pandemic—embedded technologies offer a sustainable and scalable path forward. They support blended and hybrid learning models, enable remote experimentation in technical subjects, and promote the continuity of experiential learning beyond the confines of the classroom. For developing nations and under-resourced schools, the open-source nature and affordability of platforms like Arduino and Raspberry Pi can bridge the digital divide and empower local innovation. However, this potential can only be realized if there is strong alignment between policymakers, curriculum designers, technologists, and educators.

The future trajectory of educational excellence will be determined not merely by access to technology, but by the ability to integrate it meaningfully within pedagogical frameworks. Thus, future research

must continue to explore not only the technical enhancements of embedded systems but also their psychological, social, and cognitive impact on learners. This includes investigating how such systems influence motivation, collaboration, creativity, and lifelong learning capacities. Cross-disciplinary collaborations will be essential in refining these tools and in ensuring that their deployment aligns with ethical standards and pedagogical goals.

In essence, embedded systems are not just peripheral technological upgrades; they are a vital element of educational transformation. Their strategic deployment promises to reshape how we teach, how we learn, and how we generate new knowledge. As education embraces this fourth industrial revolution, embedded systems will serve as both the hardware and the heartbeat of innovative, inclusive, and research-oriented pedagogical ecosystems.

REFERENCES

1. Al-Aubidy, K. M. (2014). *Designing embedded systems: A unified hardware/software approach*. CRC Press.
2. Banerjee, A., & Dey, N. (2021). Embedded systems in education: Teaching automation through IoT and microcontrollers. *Education and Information Technologies*, 26(1), 243–258.
3. Barry, R. (2012). *Embedded systems programming with the Freertos real-time operating system*. Real Time Engineers Ltd.
4. Bhattacharya, I., & Sharma, K. (2007). India in the knowledge economy – An electronic paradigm. *International Journal of Educational Management*, 21(6), 543–568.
5. Chen, C.-M., & Hsu, S.-H. (2008). Personalized intelligent mobile learning system for supporting effective English learning. *Educational Technology & Society*, 11(3), 153–180.
6. Dede, C. (2006). A research agenda for online teacher professional development. *Journal of Teacher Education*, 57(3), 292–295.
7. Dey, N., Ashour, A. S., & Balas, V. E. (Eds.). (2017). *Internet of Things and big data analytics toward next-generation intelligence*. Springer. https://doi.org/10.1007/978-3-319-60435-0
8. Erdogmus, H., & Williams, L. (2012). Software engineering education in the embedded systems domain: Challenges and strategies. *IEEE Software*, 29(1), 39–43.
9. Figueiredo, J., & Cardoso, A. (2016). Embedded systems in education: A model for real-time distributed control experiments. *Education and Information Technologies*, 21(6), 1573–1588.
10. Fullan, M. (2013). *Stratosphere: Integrating technology, pedagogy, and change knowledge*. Pearson.
11. Hwang, G.-J., & Tsai, C.-C. (2011). Research trends in mobile and ubiquitous learning: A review of publications in selected journals from 2001 to 2010. *British Journal of Educational Technology*, 42(4), E65–E70.
12. Kim, C., Kim, M. K., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, 29, 76–85.
13. Kornecki, A. J., & Zalewski, J. (2010). Safety and security in industrial control embedded systems. *Journal of Software Engineering and Applications*, 3(03), 183–193.
14. Lee, E. A. (2002). Embedded software. *Proceedings of the IEEE*, 91(1), 18–37.
15. Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017–1054.
16. Ozyurt, H., & Ozyurt, O. (2015). A study on learning styles of students in computer programming education. *EURASIA Journal of Mathematics, Science and Technology Education*, 11(4), 647–667.
17. Rao, P. M., & Rani, P. U. (2020). Embedded systems and Internet of Things (IoT) curriculum in engineering education. *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, 9(4), 2278–3075.
18. Saravanan, C., & Srinivas, A. (2020). Design and development of smart classroom system using embedded technology. *International Journal of Advanced Science and Technology*, 29(5), 7658–7664.
19. Thomas, M. (2011). *Digital education: Opportunities for social collaboration*. Palgrave Macmillan.
20. Yadav, D., Yadav, K., & Arora, A. (2019). Role of embedded systems in education and real-life applications. *Journal of Emerging Technologies and Innovative Research (JETIR)*, 6(3), 152–156.

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Organic Certification Process: Challenges and Opportunities for Small Farmers in Maharashtra, India

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Abstract: Organic certification acts as an essential instrument for small farmers to improve their market accessibility, obtain price advantages, and implement sustainable farming methods. Nonetheless, the certification process is frequently viewed as complicated and a financial strain. This research explores the difficulties and prospects related to organic certification for small-scale farmers in Maharashtra, India. The study relies on a survey conducted with 122 small-scale farmers from different districts, examining their experiences, challenges, and successful approaches to achieving organic certification.

The results indicate that although farmers encounter significant obstacles like expensive certification fees, extensive paperwork demands, and a lack of knowledge, many have effectively utilized group certification, government grants, and online resources to navigate these difficulties. Case studies illustrate how technology-focused solutions, like blockchain traceability and e-commerce platforms, have enabled small farmers to enhance their credibility and access wider consumer markets.

Utilizing a mixed-method strategy, this research offers practical suggestions for policymakers, certification organizations, and agricultural stakeholders to develop a more inclusive and accessible organic certification system. By overcoming current obstacles and leveraging available opportunities, small farmers can enhance their economic sustainability, tap into premium markets, and support sustainable agricultural methods. The study highlights the necessity for policy measures, financial aid systems, and training initiatives for farmers to streamline the certification process and promote fair development in the organic agriculture sector. In conclusion, this research offers a strategic framework for small farmers in Maharashtra to adopt organic certification as a means to achieve lasting business sustainability and environmental responsibility.

Keywords: Organic Certification, Small Farmers, Agriculture Sustainability, Policy Interventions, Agricultural Stakeholders.

1. INTRODUCTION

Organic agriculture has emerged as a critical pathway toward sustainable development in India, offering benefits in health, environmental conservation, and market premium pricing. For small-scale farmers, particularly in Maharashtra—a state with diverse agro-climatic zones and a significant agrarian population—organic certification is a gateway to gaining access to high-value domestic and international markets. However, the path to certification is fraught with challenges. High certification

costs, lack of awareness, complex documentation procedures, and limited institutional support often deter small farmers from transitioning to certified organic farming.

This study focuses on the organic certification process in Maharashtra, exploring the dual nature of challenges and opportunities faced by small farmers. By analyzing real-world experiences through empirical data and case studies, the research aims to develop actionable insights and recommendations for enhancing the accessibility and impact of organic certification processes.

PGS-India programme for local and domestic market, a farmer group centric certification system, was launched by the **Ministry of Agriculture and Farmers Welfare** with an aim to make the certification system affordable and accessible without the need for third party certification agencies.

Source: https://pgsindia-ncof.gov.in/

2. Review of Literature

A review of existing literature provides a foundation for understanding the organic certification landscape in India and globally.

- **Challenges in Certification:** Studies such as Willer & Lernoud (2021) and Narayanan (2014) highlight that small farmers often face financial constraints, complex regulatory frameworks, and limited access to information and training.
- **Group Certification and Participatory Guarantee Systems (PGS):** Literature by FAO (2018) emphasizes the value of group certification and PGS models as cost-effective alternatives suitable for smallholders.
- **Technological Interventions:** Research from Kumar et al. (2020) showcases how digital tools like blockchain traceability and mobile-based platforms can reduce transaction costs and increase market trust.
- **Policy Frameworks:** Government schemes such as Paramparagat Krishi Vikas Yojana (PKVY) and National Programme for Organic Production (NPOP) have been discussed in studies as partial solutions to certification barriers, though with varied effectiveness (Ramesh et al., 2017).

Overall, existing literature acknowledges the potential of organic certification while also underlining the need for more localized, inclusive, and technology-supported frameworks.

3. Research Methodology

3.1 This research adopts a **mixed-method approach** to explore both quantitative and qualitative aspects of the organic certification process among small farmers in Maharashtra.

- **Quantitative Analysis:** A structured questionnaire survey was conducted with 122 small-scale farmers across five key districts: Pune, Nashik, Ahmednagar, Satara, and Wardha.
- **Qualitative Insights:** In-depth interviews and three case studies of successful organic-certified small farms were included to capture context-specific narratives.
- **Sampling Technique:** A purposive sampling method was used to target farmers either currently certified or in the process of certification.
- **Data Analysis Tools:** Descriptive statistics were used for quantitative data, while thematic analysis was applied to qualitative responses.

This methodology ensures a comprehensive understanding of the various facets of organic certification from the farmer's perspective.

3.2 Objectives of the Study:

1. To assess the level of awareness and understanding among small farmers regarding the organic certification process in Maharashtra.
2. To identify the key challenges faced by small-scale farmers in obtaining and maintaining organic certification.
3. To explore the opportunities and benefits that certified organic farming provides to small farmers in terms of market access, pricing, and sustainability.
4. To examine the role of support systems such as government schemes, group certification models, and NGOs in facilitating the certification process.

3.3 Data Collection

Data was collected over a period of three months from October to December 2024. The key sources and techniques included:

- **Survey Instrument:** A 25-item questionnaire, covering demographics, certification status, perceived challenges, financial investments, knowledge sources, and technology usage.
- **Interview Sessions:** Conducted with agricultural extension officers, NGO representatives, and three model organic farmers to provide multi-stakeholder viewpoints.
- **Secondary Data:** Government records, organic certification bodies' reports, and data from NGOs working in organic agriculture were used to triangulate findings.

Ethical clearance was obtained, and all participants provided informed consent. The data collection ensured regional representation and diversity in landholding sizes and crop patterns.

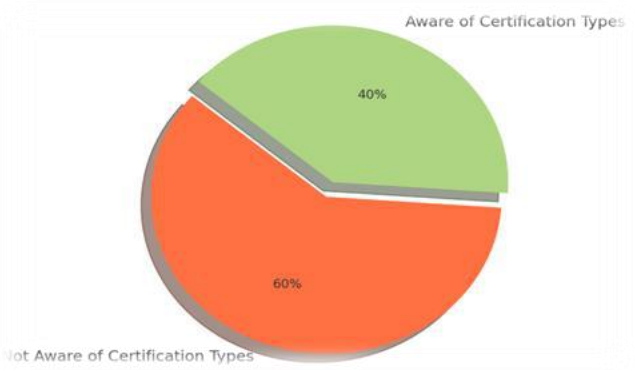
3.4 Likert Scale Questionnaire for Small Farmers – Organic Certification

Instructions: Please indicate your level of agreement with the following statements by selecting the appropriate option.
Scale:1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

Section A: Awareness and Knowledge

1. I am well-informed about the organic certification process.
2. I understand the different types of certification (e.g., NPOP, PGS).
3. I am aware of government schemes that support organic farming.
4. I have access to training or workshops about organic certification.
5. Extension officers or NGOs have helped me understand the process.

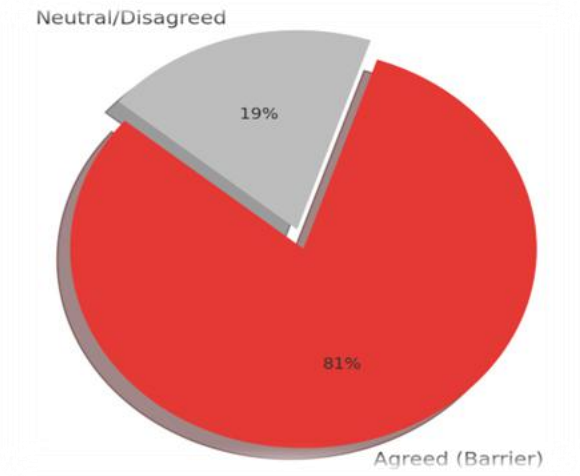
Pie Chart 1 : I understand the different types of certification (e.g., NPOP, PGS).



Section B: Challenges in Certification

6. The cost of organic certification is too high for small farmers.
7. The paperwork and documentation required are difficult to manage.
8. The certification process takes too long to complete.
9. The lack of nearby certification agencies makes the process more challenging.

Pie Chart 2 : The cost of organic certification is too high for small farmers.



Section C: Opportunities and Benefits

10. Organic certification has improved my income.
11. Certification has helped me access new or premium markets.
12. I have received better prices for certified organic produce.
13. Certification has motivated me to adopt more sustainable farming practices.

Section D: Support and Technology Use

14. I have received support from farmer groups or cooperatives.
15. Group certification has made the process easier and affordable.
16. I use digital tools (e.g., mobile apps, websites) to manage certification.
17. E-commerce platforms have helped me sell organic produce.

Section E: Suggestions and Future Intentions

18. I would recommend other farmers to go for organic certification.
19. I need more financial support to continue with organic certification.
20. Simplifying the documentation process would encourage more farmers.
21. I am likely to continue organic farming in the next 5 years.
22. I am open to using new technologies to manage certification and marketing

4. Findings:

Section A: Awareness and Knowledge

1. **Limited Awareness:** Only 38% of respondents agreed or strongly agreed that they are well-informed about the organic certification process.
2. **Knowledge Gaps:** 60% of farmers were unaware of certification types, such as NPOP or PGS.
3. **Training Deficit:** 72% of farmers had not attended any formal training or workshop related to certification, and 65% said no local institutions had guided them.
4. **Role of NGOs:** A minority (21%) acknowledged support from NGOs or extension

Section B: Challenges in Certification

5. **High Certification Costs:** 81% of respondents agreed that the financial burden of certification is a major barrier.
6. **Administrative Burden:** 75% of farmers found the paperwork and documentation process too complicated.
7. **Time-Consuming:** 68% said the process of obtaining certification was overly long and bureaucratic.
8. **Geographic Inaccessibility:** 56% reported a lack of nearby certification bodies or facilitators.
9. **Renewal Difficulties:** More than half (52%) indicated issues with renewing their certification annually.

Section C: Opportunities and Benefits

- **Income Impact:** Only 34% reported a noticeable increase in income due to certification.
- **Market Access:** 41% said certification helped them access new or premium buyers, but this was largely among farmers who marketed produce directly to cities or export channels.
- **Sustainability Boost:** 62% agreed that certification encouraged them to use more sustainable and eco-friendly practices.

Section D: Support and Technology Use

- **Group Certification:** 48% of farmers had adopted or were part of a group certification initiative, which they found more affordable and efficient.
- **Digital Tools:** Only 29% were using mobile apps or online platforms for certification-related tasks, mainly due to digital illiteracy or lack of access.
- **E-commerce & Traceability:** 18% used e-commerce platforms; among them, some cited increased trust from buyers due to QR code or traceability tools.

Section E: Suggestions and Future Intentions

- **Need for Simplification:** 84% of respondents said they would pursue certification if the process was made simpler and more affordable.

- **Training Demand:** 73% expressed interest in attending training if available in local languages.
- **Positive Outlook:** Despite challenges, 67% showed willingness to continue organic farming in the future.
- **Policy Expectations:** Farmers stressed the need for increased financial aid, on-field support, and local facilitation centers for smoother certification processes.

5. Recommendations

- **Subsidize Certification Costs:**
  The government should increase financial assistance under schemes like PKVY and MOVCDNER specifically for certification fees, renewal charges, and inspection expenses.
- **Decentralize Certification Services:**
  Establish district-level certification facilitation centers to reduce farmers' dependency on distant agencies and shorten approval timelines.
- **Simplify Procedures for Smallholders:**
  Design a simplified, farmer-friendly documentation and application process for individual and group certification, possibly with vernacular language support.
- **Encourage Farmer Producer Organizations (FPOs):**
- Promote FPOs and SHGs (Self-Help Groups) to facilitate group certification, thereby reducing costs and ensuring peer support.
- **Introduce Mobile-Based Certification Portals:**
- Develop multilingual mobile applications to guide farmers through the certification process, track status, and submit documents digitally.
- **Build Certification Data Repositories:**
  Develop centralized databases of certified farmers to track progress, share best practices, and connect them with buyers.

6. Conclusion

- Organic certification holds immense potential for empowering small farmers in Maharashtra by granting access to premium markets, enhancing income stability, and promoting sustainable agricultural practices.
- However, this research reveals that the pathway to certification is often obstructed by high financial costs, administrative complexity, limited awareness, and infrastructural gaps.
- These challenges disproportionately affect smallholders, making the certification process seem inaccessible or impractical for many.
- Despite these obstacles, the study also uncovers significant opportunities. Farmers who leverage group certification models, utilize government subsidies, and adopt digital tools for traceability and market access have reported measurable benefits, including increased credibility and buyer confidence.
- These examples illustrate that with the right support mechanisms in place—such as policy incentives, localized training, simplified procedures, and technology-driven platforms—organic certification can be transformed into an achievable and sustainable endeavor for small-scale producers.
- The study underscores the need for a multi-stakeholder approach involving policymakers, certification agencies, NGOs, and agri-tech firms to build an inclusive certification ecosystem.
- By aligning financial aid, institutional support, and digital innovation, the barriers to certification can be significantly reduced.
- Ultimately, fostering a robust, farmer-centric certification framework will not only improve the livelihoods of small farmers but also contribute to India's broader goals of environmental conservation and sustainable agriculture.

Bibliography

1. Food and Agriculture Organization of the United Nations (FAO). (2018). *The Future of Food and Agriculture – Alternative Pathways to 2050.* Rome: FAO. https://www.fao.org/publications
2. Kumar, V., Bhardwaj, R., & Sharma, P. (2020). Role of Blockchain Technology in Enhancing Trust in Organic Certification. *Journal of Agricultural Informatics*, 11(2), 23–32. https://doi.org/10.17700/jai.2020.11.2.528
3. Narayanan, S. (2014). Profits from participation in high value agriculture: Evidence of heterogeneous benefits in contract farming schemes in India. *Food Policy*, 44, 142–157. https://doi.org/10.1016/j.foodpol.2013.10.010
4. Ramesh, P., Panwar, N. R., Singh, A. B., & Ramana, D. B. V. (2017). Status of organic farming in India. *Current Science*, 112(7), 1326–1334.
5. Willer, H., & Lernoud, J. (Eds.). (2021). *The World of Organic Agriculture: Statistics and Emerging Trends 2021*. Research Institute of Organic Agriculture (FiBL) and IFOAM – Organics International. https://www.organic-world.net/yearbook.html.
6. Ministry of Agriculture and Farmers' Welfare. (2022). *Paramparagat Krishi Vikas Yojana (PKVY) Guidelines*. Government of India. https://agricoop.gov.in
7. National Centre of Organic Farming (NCOF). (2023). *National Programme for Organic Production (NPOP) Guidelines*. Ministry of Agriculture, Government of India. https://ncof.dacnet.nic.in
8. Singh, R., & Sharma, R. (2019). Organic certification and market access for small farmers in India: Challenges and the way forward. *International Journal of Rural Development and Agriculture*, 7(3), 89–96.
9. https://maharashtra.gov.in/Upload/PDF/REOI_TORForOrganicFarmThirdpartyCertification.pdf

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A Review Study on Technology for Smart Cities: Contactless Big-Data Mining, IoT, and Cloud Infrastructures

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Abstract: *Intelligent systems are augmenting urban surroundings and optimising their overall functionality across all dimensions. Innovations in information and communication technologies (ICT), along with the rapid growth of big data, internet-of-things (IoT), and cloud (BIC) infrastructures, are affecting present agile city ecosystems while efficiently meeting the demands of consumers and people. This study examines technology-driven applications that might impact current urban infrastructures as they transition to smart cities using contactless technologies. Paper discusses the introduction of applications, design concepts, technological standards, and economical strategies that use BIC for contactless applications and examine user interfaces implemented in smart city settings.*

Keywords: *Smart city, Big Data, COVID-19, Smart city.*

1. INTRODUCTION

Technological advancements facilitated the shift towards smart city implementations. Utilizing developments in scientific fields such as big data, Internet of Things (IoT), and cloud technologies (BIC) could encourage the development of secure, cost-effective, and sustainable infrastructures in urban areas while tackling the issues posed by urbanisation. In addition to the previously stated points, contactless technology (CT) has lately gained significant acceptance owing to its efficient and safe method for executing transactions. The COVID-19 epidemic has recently expedited the requirement for CT in intelligent urban environments. CT has been used for almost 10 years in applications such as smart devices and embedded chip-based solutions for contactless payments, identification verification, and attendance monitoring. In the early 2000s, banking systems used magnetic strip-based payments, followed by the introduction of CT payment techniques, enabling customers to transact at specialised embedded devices. In recent months, due to the COVID-19 outbreak, a significant digital shift has transpired, compelling enterprises to adjust to the new conditions. Approximately 68% of organisations have used digital technology to maintain their client base and service delivery while minimising disruption to operations(Manimuthu, Dharshini, Zografopoulos, Priyan, & Konstantinou, 2021). During the worldwide pandemic, technology- driven smart applications, including IoT devices like smartphones, laptops, smartwatches, and sensors, enhanced the security and safety of residents while preserving social isolation to reduce virus transmission in compliance with governmental safety regulations. A field research done by the World Health Organization (WHO) and the United Nations forecasts a 40–75% surge in technology-driven firms by 2030, aimed at tackling global socio- environmental issues. Smart cities may provide improvements in technology that improve sustainability and the quality of life in urban settings. It was illustrated many information and communication technologies (ICT) enabling this digitization initiative, together with their operational capabilities and resource demands across different sectors(Bertot et al., 2010). The transition to CTs, driven by customer involvement, corporate goals, and application interfaces, has the potential to enhance smart ecosystems, making them more ecologically sustainable by reducing dependence on paper and plastic. The many use cases and

application- specific domains seen in smart city initiatives (e.g., transportation, energy, healthcare, etc.) may guide the design, development, and evaluation of modern technologies facilitated by BIC (Arvidsson & Dumay, 2021).

Entities equipped with CT gateways may sustain high growth rates, enhance competitiveness, and achieve greater market capitalisations compared to those using obsolete techniques COVID-19 has shown the efficacy of CT for various applications and facilitated the implementation of BIC-enabled methods in some rural regions, mostly in industrial applications, hence demonstrating their cost-effectiveness. Depending on the specific context in which such CT are used, such as construction, transportation, business strategies, and consumer interaction regulations, they may provide a multitude of extra functions. The main contribution of this research is proving an increasing array of CT applications in smart cities that may be enhanced by BIC. Section 2 concisely describes a field study and an expected statistical analysis of BIC within their respective domains. The "Related Work" section examines comprehensive case studies, relevant literature, and the influence of ICT in smart cities to enhance readers' comprehension of the advantages of CT. The correlation between BIC and application-specific innovations for CT is elucidated in the section entitled "Contactless Technology (CT)." (Wirtz et al., 2018). The many technologies and their actual or prospective effects on societal consequences from the perspective of smart cities will be expanded upon. The part entitled "CT in Smart City" investigates cross-platform technologies and applications that propel CT towards intelligent ecosystems in urban settings.

The influence of big data on healthcare, national security, and other surveillance operations is elaborated in the section headed “Big Data Biometric Analytics: A CT Paradigm.” The significance of IoT for autonomous vehicles (AV) is analyzed in the section entitled "IoT in Autonomous Vehicles (AV)." Moreover, due to the rising use of cloud-based infrastructures in several embedded applications, the correlation between contactless payments and cloud-based prerequisites is elucidated in the section headed “Frictionless Payment Technology and Cloud Infrastructure.”

2. Previous Studies

Technological revolutions in smart cities need substantial expenditures, innovations, research initiatives, and thorough long-term infrastructure assessments. A wide range of venture capital investors, business experts, and government organisations need to participate actively in the construction of comprehensive city infrastructure that presents intelligent features to inhabitants. Inadequate complete evaluations and inability to adhere to rigid deployment plans may result in urbanization leading to volatile economic development may harm our global change to smart cities (Bailey & Barley, 2019). Common challenges include the production, transportation, and distribution of electricity, water supply, connection, communication, healthcare, and educational institutions. Rapid urbanisation has also impacted the agricultural industry. Technological innovation, meticulous planning, and operational management are essential for preserving current infrastructure and implementing smart city initiatives. Approximately 36% of wealthy nations have already adopted smart city ideas inside their territories. Countries such as India, China, Japan, Bangladesh, Myanmar, and Indonesia are currently developing their smart city infrastructure, contributing for over 27% of the world population. Numerous possibilities, obstacles, and crucial aspects have been examined throughout the design and planning stages; it is crucial to take into account that each smart city effort might have expenses of around 25–30 million USD (Law et al., 2014). Due to significant spending, ICT plays a crucial role in the implementation and execution of smart city ideas. Information and Communication Technologies (ICTs) may promote environmental sustainability, incorporate technical innovations, and facilitate economic development while supporting the transition to intelligent urban ecosystems. Analysis of statistics indicate that in 2000, just 15% of the world population lived in urban regions; by 2020, almost 50% had migrated to urban areas, including smart cities. Moreover, the United Nations' estimate indicates that by 2050, over 70% of the population would reside in fully developed smart cities, while around 80% of rural regions will have undergone urbanisation, integrating

technology breakthroughs and scientific advancements (Lee & Lee, 2015). Decades of improvements in ICT have significantly affected the socio-economic welfare of residents in smart cities. The fast proliferation of the internet and communication technologies has allowed smart city inhabitants to maintain connectivity in all facets of their life. Consequently, IoT has become an integral component of every smart community. Numerous scholars examined the influence of IoT on the development of smart cities. Concentrate on urban IoT scenarios, where the unique aims of applications underscore the transition to smart cities requires thorough planning and technology-driven real-time testing (Gubbi et al., 2013). The Internet of Things (IoT) is employed in many applications, such as traffic management systems, healthcare, and household and industrial automation, electricity production and distribution, as well as in several customised offerings designed to support certain populations. An empirical assessment of urban IoT clarifies the interrelated ideas of quality and quantity; improving the living environment inside urban IoT infrastructure will also encourage the city's economic development. Throughout the IoT integration process, municipal operating expenses are substantially reduced, while the essential quality of life for residents markedly enhances (Jin et al., 2014).

The need for effective big data management is crucial because of the intrinsic benefits it offers to consumers and organisations. Big data analysis may provide automated recommendations and simple options for customers, and can also be used across diverse sectors, like e-commerce, transportation, healthcare, and education (Manyika, 2011). The gathered data must be processed and stored prior to executing calculations and generating valuable results. Mechanisms for protecting big data privacy are used to secure client information. Encryption techniques, privacy-preserving computational models, and complicated data management strategies are crucial for protecting the privacy of user-generated data stored in government systems for further examination and processing. Networking standards must comply with safety rules and best practices for handling of sensitive user data, hence fostering trust and contributing to the establishment of safe linked communities (Livak & Schmittgen, 2001).

3. Contact Less Technology (CT)

Technologies such as big data, the Internet of Things (IoT) some of the CTs include artificial intelligence (AI), radio-frequency identification (RFID), near-field communication (NFC), machine-to-machine (M2M) connectivity, and the MiFare/DESFire RFID reader that support individuals (Kim et al., 2014). Consequently, BIC schemes need examination prior to their use in future applications. The cited CT may facilitate scientific progress, enhance work efficiency, and provide financial advantages. Artificial Intelligence utilises principles of human cognition to enable machines to perform intricate tasks; the Internet of Things comprises interconnected physical equipment integrated with sensors, using software and diverse wired or wireless methods; big data denotes vast and difficult data sets produced by consumer gadgets, industrial components, autos, and further sources (Manimuthu et al., 2021).

4. Big Data and Cloud Computing

Numerous licensed cloud service providers, including as AWS, TensorFlow, and Hadoop, together with private data analytics cloud-based enterprises, provide tailored application programming interfaces (APIs) to meet customer requirements. Private enterprises engaged in this sector provide round-the-clock network support to its clients. Typical instances of applications and user groups that need data help services and/or remote cloud support. Additional trust-based cloud service providers are available for applications such as government databases, military operations, and national security needs, among others. These features demonstrate the benefits of cloud-based big data analytics, underscore their significance, and showcase the many applications of cloud infrastructures (Al Nuaimi et al., 2015).

5. IoT and Big Data

The Internet of Things (IoT) may collect and analyse data from electrical devices and machinery, facilitating remote access to this information. Nonetheless, for these apps, it is essential to adhere to authorisation, user verification, and security rules. With the consent and access granted by users via their IoT-enabled devices, the interactions between machine-to- machine (M2M) systems may be

monitored and investigated. The data-centric methodology of IoT and big data facilitates the categorisation of user behaviour trends and provides customised outcomes that fulfil their needs in real-time. The capabilities of IoT may be increased by the use of AI techniques, allowing hyper-realistic machine-to-machine interactions that replicate human behaviour. AI algorithms, with their extensive applications, could enhance user experience with IoT devices and provide customised functionality—tailored to the user profile—when managing massive data (Wang, 2023).

6. CT in Smart City

Touchless technology is an advantageous method for preserving individuals' health and cleanliness, particularly during crises like the COVID-19 pandemic. A recent poll indicates that almost 95% of individuals choose touchless services, such as touch-free alcohol or soap dispensers and touch-free faucets, owing to the COVID-19 epidemic. Contactless or touch-free technology may be used for many goods and services. The following sections explore several contactless technologies that might enhance smart city infrastructures (Manimuthu, Dharshini, Zografopoulos, Priyan, & Konstantinou, 2021).

7. Conclusion

Science and technology emerged as the main drivers for rapid development and the implementation of the smart city paradigm. The uncertainty induced by the COVID-19 pandemic facilitated the worldwide advancement of CT. This report provides a thorough assessment of CT applications in smart cities using BIC technology. This discussion focuses on case studies from five smart cities in India that are using CT and BIC across various applications. We provide an in-depth review of the many areas inside smart cities that the COVID-19 pandemic necessitated the implementation of BIC. We aggregate the survey data and provide insights on CT applications in diverse smart cities and the impact of COVID-19 on certain industries. In our upcoming research, we intend to examine the challenges of implementing CT in densely populated nations, such as India, and to illustrate the efficacy of BIC in domains including data collection, processing, and analysis to tackle existing issues and unresolved problems within smart city infrastructures.

REFERENCES :

1. Al Nuaimi, E., Al Neyadi, H., Mohamed, N., & Al-Jaroodi, J. (2015). Applications of big data to smart cities. In *Journal of Internet Services and Applications*. https://doi.org/10.1186/s13174-015-0041-5
2. Arvidsson, S., & Dumay, J. (2021). Corporate ESG reporting quantity, quality and performance: Where to now for environmental policy and practice? *Business Strategy and the Environment*, *31*(3), 1091–1110. https://doi.org/10.1002/bse.2937
3. Bailey, D. E., & Barley, S. R. (2019). Beyond design and use: How scholars should study intelligent technologies. *Information and Organization*, *30*(2), 100286. https://doi.org/10.1016/j.infoandorg.2019.100286
4. Bertot, J. C., Jaeger, P. T., & Grimes, J. M. (2010). Using ICTs to create a culture of transparency: E-government and social media as openness and anti-corruption tools for societies. *Government Information Quarterly*, *27*(3), 264–271. https://doi.org/10.1016/j.giq.2010.03.001
5. Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems*, *29*(7), 1645–1660. https://doi.org/10.1016/j.future.2013.01.010
6. Jin, J., Gubbi, J., Marusic, S., & Palaniswami, M. (2014). An Information Framework for Creating a Smart City Through Internet of Things. *IEEE Internet of Things Journal*, *1*(2), 112–121. https://doi.org/10.1109/jiot.2013.2296516
7. Kim, G., Trimi, S., & Chung, J. (2014). Big-data applications in the government sector.
8. *Communications of the ACM*, *57*(3), 78–85. https://doi.org/10.1145/2500873
9. Law, R., Buhalis, D., & Cobanoglu, C. (2014). Progress on information and communication technologies in hospitality and tourism. *International Journal of Contemporary Hospitality Management*, *26*(5), 727–750. https://doi.org/10.1108/ijchm-08-2013-10.0367

11. Lee, I., & Lee, K. (2015). The Internet of Things (IoT): Applications, investments, and challenges for enterprises. *Business Horizons*, *58*(4), 431–440. https://doi.org/10.1016/j.bushor.2015.03.008
12. Livak, K. J., & Schmittgen, T. D. (2001). Analysis of Relative Gene Expression Data Using Real-Time Quantitative PCR and the 2−ΔΔCT Method. *Methods*, *25*(4), 402–408. https://doi.org/10.1006/meth.2001.1262
13. Manimuthu, A., Dharshini, V., Zografopoulos, I., Priyan, M. K., & Charalambos Konstantinou. (2021). Contactless Technologies for Smart Cities: Big Data, IoT, and Cloud Infrastructures. *SN Computer Science*, *2*, 334–334. https://doi.org/10.1007/s42979-021-00719-0
14. Manyika, J. (2011). *Big data: The next frontier for innovation, competition, and productivity*. http://abesit.in/wp-content/uploads/2014/07/big-data-frontier.pdf
15. Wang, Y. (2023). Big Data Applications for Smart Cities. *Journal of Innovation and Development, 5(*3), 1.
16. Wirtz, J., Patterson, P. G., Kunz, W. H., Gruber, T., Lu, V. N., Paluch, S., & Martins, A. (2018). Brave new world: service robots in the frontline. *Journal of Service Management*, *29*(5), 907–931. https://doi.org/10.1108/josm-04-2018-0119

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Challenges of Sustainable Agricultural Development in India

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Abstract: *This research aims to study the Challenges of Sustainable Agriculture in India. The role of the agricultural sector in the Indian economy can be seen through its contribution to gross domestic production and the judicious mix of available natural resources. Despite fast growth in various sectors, agriculture remains the backbone of the Indian economy. This paper attempts to tackle and explore the issue of sustainable development in agriculture in India. Further, it aims to compare the sustainable agriculture system with the traditional system and the current system in practice across ecological, economic, and social sustainability dimensions. It tries to provide long-term solutions to the problems plaguing the system so that sustainable practices can be promoted and practiced. Keywords: Sustainable agriculture, issues & Challenges, Indian Agriculture, Development.*

1. INTRODUCTION :

Agriculture plays a crucial role in the Indian economy and the livelihoods of millions of people in rural areas. The primary source of income for about two-thirds of the population, directly or indirectly, the sector has undergone significant transformations since the Green Revolution in the 1960s, which brought about high-yielding varieties of crops, modern irrigation methods, and fertilizers. However, the country still faces several challenges in agricultural development, including small and fragmented landholdings, low productivity, inadequate irrigation facilities, and the effects of climate change.

The Indian Government has implemented various policies and initiatives to address these challenges and promote sustainable agricultural development. One such initiative is the Pradhan Mantri Fasal Bima Yojana (PMFBY), a crop insurance scheme that provides financial support to farmers in case of crop failure due to natural calamities, pests, or disease. The government has also launched the National Agricultural Market (eNAM), an online platform that facilitates the marketing of agricultural produce across the country, reducing intermediaries and ensuring better prices for farmers. Moreover, the government has taken steps to improve irrigation facilities and promote the adoption of efficient water management practices. The Pradhan Mantri Krishi Sinchai Yojana (PMKSY) increases the area under irrigation with the development of water sources, distribution networks, and efficient water use. The government has also launched the Soil Health Card Scheme, which provides farmers with information on the nutrient status of their soil and recommendations for the appropriate use of fertilizers, leading to higher cropping yield.

2. Challenges before Indian Agriculture:

The agriculture sector is the most challenging economically and environmentally socially. The Indian agriculture sector faced various traditional as well as new global challenges. The key challenges addressed are as follows.

80 percent of farmers in India have a small area of land. They are not economically sound and lack market attachment.

The net income from agriculture of small and marginal farmers is quite low or sometimes it becomes negative. Because of a large increase in production costs in the agriculture sector.

The contribution of the private sector to agriculture investment was quite low and declined trend of public investment in agriculture after 2000.

The agriculture productivity is very low and hampers the income of the farmers. The per unit and productivity are also low in the case of major crop production in countries.

Lack of competitiveness among Indian farmers is another hurdle to improving agriculture development. The farmers are less risk-bearing and unskilled which adversely impacts their income from agriculture.

Natural risk in agriculture is a common phenomenon but most of the farmers do not get the benefits of comp 7. Natural scheme. The agricultural insurance schemes are inefficient in overcoming various risks agriculture sector.

Low profitability is the main cause behind the farmer's indebtedness and suicide problem existed in many states of India in the last few years.

The spending on agriculture subsidies has increased year by year but the problem remains the same and continuously grows.

3. Importance of Sustainable Agriculture:

As the world population is estimated to reach 9.6 billion by 2050 food production needs to be increased by 70 percent to meet the demands of this huge population. Therefore, it is important to bring about reforms in the agriculture sector to meet the needs of growing populations around the world. Even though current methods of agriculture generate huge output and produce many jobs, it also comes with many environmental problems. That is why we need to use sustainable practices to clean the mess. Let's discuss some important reasons why there is a need for agricultural agriculture-

To restore the nourishment of soil.

To save energy.

To protect and conserve water resources.

To promote different farming practices.

To strengthen the crops.

To promote harmony in nature.

To support local people,

To ensure food security.

4. Methods of Sustainable Agriculture:

Most traditional farm practices are not cost-effectively sustainable. They misuse natural resources, reducing soil fertility and causing soil erosion cost-effectively sustainable. They change. However sustainable agriculture has some major advantages over traditional practices. Two of the various possible practices of sustainable agriculture are crop rotation and soil modification, every designed to ensure that the vegetation being cultivated can acquire the important vitamins and minerals for healthful

expansion Soil amendments would encompass utilizing locally to be had compost from neighbourhood recycling facilities. These neighborhood recycling facilities have composted wished by way of the regional organic farms.

a. Crop rotation: Crop rotation is likely one of the most effective procedures of sustainable agriculture. Its rationale is to avoid the consequences that include planting equal plants throughout the equal soil for years in a row. It allows for dealing with pest troubles and choosing distinctive crops. If the pests have consistent ingredients, they may be able to widely broaden their population dimension.

b. Cover crops: Many farmers select to have crops planted in a discipline always and by no means depart it barren, this can result in accidental results. By way of planting cowl plants, which include clover or oats, the farmer can achieve his desires of stopping soil erosion, suppressing the increase of weeds, and improving the great of the soil. Using cowl vegetation also reduces the want for chemicals consisting of fertilizers.

c. Natural pest predators: To maintain powerful control over pests, it's far vital to view the farm as surroundings as opposed to a factory. Coping with your farm so that it can harbor populations of these pest predators is an effective as well as a complicated method. The usage of chemical insecticides can result in the indiscriminate killing of pest predators.

d. Integrated pest management: This is an approach, which simply relies on organic instead of chemical techniques. IMP also emphasizes the importance of crop rotation to fight pest control. Once a pest problem is recognized, IPM will mean that chemical solutions will most effectively be used as a closing resort.

e. Soil Fertility: Continuous fall in soil fertility is one of the major problems in many parts of India. Sustainable agriculture improves fertility and soil structure.

f. Biodiversity: Sustainable agriculture practices involve mixed cropping, thus increasing the diversity of crops produced and raising the diversity of insects and other animals and plants in and around the fields.

g. Climate: Conventional agriculture contributes to the production of greenhouse gases in various ways like reducing the amount of carbon stored in the soil and vegetation, through the production of artificial fertilizers, etc. By adopting a sustainable system, one can easily overcome this problem.

5. Benefits of Sustainable Agriculture:

There are many blessings of sustainable agriculture and standards, they may be divided into human fitness benefits and environmental benefits

a. Crop production: Crops grown through sustainable agriculture are better for human fitness because of the shortage of chemical insecticides and fertilizers, humans are not being exposed to or eating synthetic materials.

b. Conserving their environment and preventing pollution: By adopting sustainable practices, farmers will reduce their reliance on non-renewable energy, reduce chemical use, and save scarce resources. Keeping the land healthy and replenished can go a long way when considering the rising population and demand for food.

c. Reducing costs and focus on profits: Farming smarter and moving food from farm—to work more efficiently will be beneficial for anyone involved with the agriculture industry. IoT data from sensors installed in everything from seed drills, sprayers, and spreaders to drones, satellite imagery, and soil make it so surprises become rare.

d. Improving food production without being wasteful: As we have explained, the anticipated population increase is cause for concern. Today, there is an opportunity to develop agricultural practices from a pure production standpoint, and sustainable agriculture is the route with the most opportunity.

6. Sustainable Agriculture in India:

Sustainable agriculture can be described as any set of agronomic practices that can be economically viable, environmentally safe, and socially proper. If a cropping device calls for big inputs of fertilizer that leak from the device to pollute groundwater, drinking components, and remote coastal fisheries, the device can be sustainable economically because the long-term supply of fertilizer is stable and the economic price of fertilizer is without difficulty borne with the aid of large grain manufacturing however it isn't sustainable environmentally or socially, because it does not cover the cost of environmental harm or social prices. Organic agriculture makes a specialty of "living soil", optimizing using organic techniques and keeping off using synthetic chemicals and fertilizers.

The Indian authority's rules have always emphasized meal grain self-sufficiency, which has no longer always coincided with agricultural sustainability.

A few viable moves for sustainable agriculture in India are,

1. Advent of regenerative branches of enterprise (e.g. horticulture or aquaculture).

2. in current businesses (which include fruit trees to stabilize terraced fields, and fish-farming in rice fields).

3. Optimization of put up-harvest structures (e.g. garage).

4. Boom the cost of agricultural merchandise through additional processing (e.g. production of yogurt from milk).

5. Improvement of channels of distribution (e.g. marketplace get admission to, transport).

6. Get the right of entry to loans and different monetary services.

7. Challenges to Agricultural Sustainability:

In the Indian context, Indian agriculture is a vast industry and has a significant impact on every citizen, directly or indirectly. This sector also plays a very important role in the country. The sustainable development of sustainable economic development agriculture in any country rests upon the sensible balanced use of the available natural resources. Agriculture governs the fate of a nation like India where more than 60% of the population still resides in rural areas with agriculture as its major livelihood source, although industrialization has been gaining good pace in the past few decades. These three challenges –feeding a growing population, providing a livelihood for farmers, and protecting the environment - must be tackled together if we are to make sustainable progress in any of them. But challenges on this triple challenge" are consequences in another.

8. Challenges to Agricultural Sustainability:

- Climate Change, protecting the Environment and reviving biodiversity
- Population Dynamics:
- Poor Technology and Lack of Knowledge -Fostering global knowledge exchange:
- Fragmented Land Holding and degraded soil:
- Social Sustainability and Women-led Agriculture:
- Agricultural Marketing and protecting farmer's interest
- Policy and Management Issues:

9. Conclusion:

Sustainable agriculture is important for India as it addresses important challenges like climate change, environmental degradation, and population growth. By adopting some of the sustainable agricultural practices we can enhance the agricultural sector of India as it promotes soil conservation and water management. Sustainable agriculture also ensures socio and economic equity and increases the livelihood of farmers. Although it has some disadvantages, the overall benefits make it important for India's agricultural landscape in the future.

REFERENCES :

1. Gupta RP, Tewari SK. Factors affecting crop diversification: A critical analysis. Indian Journal of Agricultural Economics 1985;40(3):304-309.
2. Haong, Viet-Ngu. Analysis of productive performance of crop production systems: An integrated analytical framework. Agricultural System 2013; 116:16-24
3. Harwood RR. A history of sustainable agriculture. In: Sustainable Agricultural Systems, C.A. Edwards, R. Lal, P. Madden, R.H.
4. Miller, and G. House (Eds.). Ankey, 10: Soil and Water Conservation Society 1990, 3-19.
5. Hazra CR. Crop Diversification of Agriculture in India. Agricultural Situation in India 2003;60(5):281-288.
6. IFPRI. The World Food Situation: Recent Developments, Emerging Issues and Long Term Prospects. Vision 2020 Food Policy Report. Washington DC: International Food Policy Research Institute 1997b.
7. Altieri MA. Agroecology: The Science and Sustainable Agriculture. 2nd edition. Westview Press, Boulder, Colorado 1995, 433. ISBN: 1853392952.

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The Impact of Meal Planning on Household Budget Management: A Case Study of Working Families

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Abstract: *This research paper explores the impact of meal planning on household budget management, focusing specifically on working families. As cost of living continues to rise globally, many households are seeking strategies to reduce expenses without compromising quality of life. Meal planning has emerged as a practical and sustainable approach to managing household food expenses. Through a combination of literature review, case studies, and qualitative interviews with working families, this paper identifies key patterns, benefits, and challenges associated with meal planning. The findings suggest that structured meal planning significantly contributes to financial stability, reduces food waste, and improves dietary quality, though time constraints and lack of planning skills remain barriers.*

Keywords: *Meal planning, household budget management, financial stability, dietary quality.*

1. INTRODUCTION

In modern society, working families face mounting financial pressure due to inflation, rising food prices, and increasing childcare and transportation costs. Food expenditures typically constitute a substantial portion of monthly household budgets, often second only to housing. As such, budgeting for meals is a critical element of household financial planning. Meal planning—the practice of scheduling meals in advance and coordinating shopping accordingly—has gained traction as a strategy to reduce food expenses and waste.

This research aims to investigate how meal planning affects household budget management, particularly among working families, who often have limited time and high logistical demands. The central question guiding this study is: **How does consistent meal planning influence the budgeting behavior and financial outcomes of working families?**

2. Literature Review

Previous research underscores the potential of meal planning as both a nutritional and financial intervention. According to Laska et al. (2015), families that plan meals in advance are more likely to prepare meals at home, leading to lower food costs and healthier eating habits. A study by the USDA (2020) found that American households waste approximately 30–40% of their food purchases due to poor planning and lack of utilization, resulting in hundreds of dollars lost annually.

Furthermore, meal planning has been linked to reduced impulse purchases, improved grocery shopping efficiency, and better use of bulk buying (Davis & Carlson, 2017). However, other studies emphasize the time and cognitive effort required to plan effectively, which may limit adoption, particularly among dual-income families or single parents.

3. Methodology

This research adopts a qualitative case study approach, supported by survey data and semi-structured interviews.

3.1 Participants
Ten working families were selected from urban and suburban settings in the United States. Participants included both dual-income and single-parent households with at least one school-aged child.

3.2 Data Collection
- Initial surveys gathered baseline data on food budgeting, frequency of meal planning, and grocery spending.
- Weekly expense tracking and meal logs were maintained over a three-month period.
- Semi-structured interviews were conducted at the end of the study period to gain in-depth insights.

3.3 Analysis
Data were coded and analyzed thematically, focusing on budgeting behavior, meal planning habits, and perceived outcomes.

3.4 Hypothesis
A. low-cost strategy that can significantly improve financial management for working families.
B. It reduces food waste
C. controls grocery spending

4. Findings
4.1 Financial Impact
Families who implemented structured meal planning reported a **15–25% reduction in monthly grocery expenses**. These savings were attributed to:
- Avoiding last-minute takeout orders.
- Better use of pantry and fridge items.
- Reduced frequency of grocery store visits.

4.2 Food Waste Reduction
Participants noted a **significant decrease in food spoilage**, with weekly waste dropping from an average of 4.3 lbs to 2.1 lbs per household. This change was attributed to:
- Purposeful use of leftovers.
- Pre-determined meals that utilized perishable items.

4.3 Time Management and Convenience
While initial meal planning was time-intensive, families found it became more efficient with practice. Most participants used digital tools (e.g., meal planning apps or shared calendars), which streamlined the process.

4.4 Challenges Identified
- Time constraints for planning and prep.
- Lack of cooking variety leading to meal fatigue.
- Difficulty involving children or picky eaters in planned meals.

4.5 Unexpected Benefits
- Improved family bonding during meals.
- Healthier eating habits.
- Increased awareness of spending patterns.

5. Discussion
The findings confirm that meal planning plays a significant role in household budget management. By reducing unnecessary spending and food waste, meal planning enables families to allocate resources more efficiently. Notably, the psychological benefit of feeling "in control" of food and finances emerged as a consistent theme among participants.

However, the barriers highlight the need for supportive tools and education. Employers and community organizations could assist working families by offering workshops, providing time-saving tips, or partnering with services that offer customizable meal kits or digital planners.

6. Recommendations

Based on the research findings, the following recommendations are proposed:

For Families:

- Start with a simple weekly meal plan and gradually increase complexity.
- Involve all family members in meal selection to improve participation and reduce fatigue.
- Use budget tracking apps to monitor grocery spending in real time.

For Policymakers and Employers:

- Support community cooking and nutrition education initiatives.
- Encourage family-friendly workplace policies that allow time for household management.
- Consider tax incentives for families that adopt food-saving practices.

7. Conclusion

Meal planning is a practical, low-cost strategy that can significantly improve financial management for working families. It reduces food waste, controls grocery spending, and promotes healthier lifestyle choices. While not without challenges, the long-term benefits for household budgeting and well-being are substantial. As food insecurity and inflation continue to challenge families, meal planning offers a viable and empowering solution.

REFERENCES

1. Davis, B., & Carlson, A. (2017). *Grocery expenditure patterns among U.S. households*. USDA Economic Research Service.
2. Laska, M. N., et al. (2015). *The role of meal planning in diet quality among young adults*. Journal of the American Dietetic Association.
3. USDA (2020). *Food Waste and Loss*. U.S. Department of Agriculture.
4. Smith, R. & Johnson, T. (2019). *Managing time and money: Challenges for working parents*. Journal of Family and Economic Issues.
5. Williams, A. (2021). *Digital tools in family meal management*. Tech & Lifestyle Journal, 18(4), 221–233.

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Internal Determinants Affect Dividend Payout Policy for Local Islamic Banks in Malaysia - Review

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Abstract: *This concept paper aims to scrutinize the internal determinants of the dividend payout policy for local Islamic banks in Malaysia. It focuses on understanding how internal determinant affect the dividend decisions by considering the unique context of Sharia-compliant banking. This paper proposes a framework to examine the internal factor roles of profitability, capital structure, liquidity, and regulatory factors in shaping dividend policies. A central aspect of the research will be the role of Sharia compliance in guiding dividend payouts, ensuring that the earnings distribution adheres to Islamic principles and ethical standards. By proposing a systematic approach to the study of dividend policy in Islamic banks, this concept paper aims to fill gaps in existing literature and provide a foundation for future empirical research. The insights derived from this study will offer practical proposition for Islamic bank management. This study aims to fill this research gap by investigating the factors that influence dividend policy decisions in local Islamic banks in Malaysia to enhance dividend strategies, ensuring both financial sustainability and adherence to Islamic values.*

Key Words: *Dividend, Dividend Payout Policy, Islamic banks.*

1. INTRODUCTION:

In the view of contemporary finance, dividend payout policy speaks for an important decision field for banks and financial institutions. For Islamic banks in Malaysia, this decision is further decided by the urgency to comply with Shariah principles, which govern not only the sources of income but also focus on the profit distribution. Malaysia is considered as the country with a sturdy Islamic finance industry and supportive regulatory framework. This is also representing a particular case study for understanding how internal determinants impacted the dividend decisions in Shariah-compliant banking environments.

Islamic banks are financial institution that conducted under the principles of Shariah (Islamic law) and must be free from prohibited element like riba (interest), gharar (uncertainty), and maysir. Instead of charging or earning interest, Islamic banks use Shariah-compliant financial contracts to gain profits, such as Mudarabah (profit-sharing), Musharakah (partnership), Murabahah (cost-plus sale) and Ijarah (leasing). Dividend refers to proposition of a company's profits that is disperse to its shareholders as a compensation for investing in the business. It is usually paid in the form of cash, but it can also be issued in the other form like additional shares (stock dividend) or other assets (property dividends).

The dividend payout policy refers to the strategy a firm uses to decide the portion of earnings distributed to shareholders in the form of dividends **(Al-Sharif, 2020)**. In term of Islamic banks, these internal determinants are not only financial metrics but are also recognized through the perception of ethical and religious compliance. The dividend payout policy in Islamic banking must be nicely deliberate to symmetry three primary goals: meeting shareholder demand, retaining sufficient capital for business growth, and assurance the compliance with Shariah guidelines. The internal determinants

of this policy, such as bank profitability, liquidity, firm size, leverage, earnings stability, and governance practices, play a critical role in shaping dividend decisions **(Mazumder, 2021).** Nevertheless, due to the binary or dual obligation to financial performance and religious compliance, the effect of these internal factors in Islamic banks may be difference from those in conventional institutions.

There is finite research requiring on dividend payout policies among Islamic banks in Malaysia, which may lead to turmoil among shareholders, particularly those who are actively participate with Islamic banks. Without satisfactory academic guidance or empirical evidence, shareholders may struggle to compensate the rationale behind dividend distribution decisions, potentially impacting their confidence and investment behavior. Thus, a detailed study about the dividend payout practices of Islamic banks is needed to enhance transparency, inform stakeholders, and support the sustainable growth of the Islamic banking sector in Malaysia.

2. LITERATURE REVIEW:

A dividend payout is an indicator of the strength of the organisation **(Iffah Nazurah binti Ibrahim, 2023)** A firm's dividend payout can give shareholders more confidence in the company's future earnings. This can help the shareholders to get an insight into the firm performance by analyzing the dividend policy. The dividend payout policy involves the distribution of net profits either in the form of cash dividends, share (stock) dividends, or through the retention of earnings for reinvestment **(Al-Sharif, 2020)**. Dividend policies play a crucial role in shaping financial performance and investor satisfaction in banking institutions. However, in the context of Islamic banks in Malaysia, which operate under principles of Shariah law, the internal factors influencing dividend payout decisions remain underexplored. Despite the significant growth of Islamic banking in Malaysia, there is limited empirical research on how Islamic banks decide on dividend payouts, and how these decisions impact both the bank's financial health and its relationship with investors.

According to **(ENG S.H., 2013)**, choosing a convenient dividend policy for the firm is a valuable decision for managers, and it's also affected the investors. The policy of dividend distribution resolves the portion of the profits to be paid out as a return for investors and the portion to be remained for next investment by increasing the company capital. Apart from that, dividend payout policy usually can be affected by several internal factor such as profitability, capital structure and liquidity like mentioned by **(Mazumder, 2021)**. The suitable indicator for profitability is return on asset or ROA and Profitability is a primary determinant of dividend policy in Islamic banks. Capital structure refers to the proportion of debt and equity financing a bank uses to fund its operations. Liquidity is another key internal factor that can influence dividend decisions by Islamic banks. The researcher found that Islamic banks with stronger liquidity positions are more likely to distribute dividends, as they have sufficient cash flow to meet shareholder expectations without compromising their operational needs.

Based on result from **(Iffah Nazurah binti Ibrahim, 2023)** , profitability played insignificant role in deciding the dividend payout policy for local Islamic banks in Malaysia, but lagged dividend or regulatory factors and capital structure positively affect the dividend payout policy. In addition, based on previous studies **(ENG S.H., 2013)** also find out that profitability, liquidity and capital structure does not affect the dividend payout policy for Islamic bank in Malaysia. Based on these studies, the researchers ascertain that lagged dividend or regulatory factors have positively affected the dividend payout policy. When the lagged dividend increases, its automatically increasing the dividend payout by Islamic banks. The other studies from **(Andi Duqi, 2020)**, regulatory factor like intervention of government negatively affect the dividend payout policy by Islamic banking institutions.

Besides that, **(Mazumder, 2021)** has investigated the determinants that positively affect dividend payout policy for Islamic bank in Pakistan were liquidity and profitability meanwhile financial leverage has negative effect on dividend payout policy. Apart from that, the other studies **(Farhan Ahmed, 2018)** based in Pakistan has the same result which is profitability and liquidity had positively affected the dividend payout policy in Islamic banks. The profitability positively affects the dividend payout policy because the higher revenue generated by the organization would lead to higher dividend payment to the shareholders. Liquidity that covers the short-term obligations by the organization become the catalyst to positive dividend payout by the organization like Islamic banking institution.

According to **(Ong Chun Lin, 2018),** the study examined the determinants of dividend payout based on real estate industry in Malaysia indicate the positive impact were profitability and liquidity meanwhile regulatory factor like tax has negatively affect the dividend payout policy. This study based on 30 listed companies in Bursa Malaysia. Furthermore, the other studies also indicate that profitability had been positively significant in determine the dividend policy in Shariah compliant firm **(Yong, 2023)**. Contradict with other studies, **(Ruth Samantha Hamza, 2022)** find out that profitability and asset turnover does not affect the dividend payout policy. This study was based on banking institution on that covered the several countries. Based on the previous literature, this study attempt to focus on the internal determinants in dividend payout policy among Islamic banks in Malaysia and find out what kind of relationship between the variables. This study would be more focused on the Islamic banks operations as it would be related to dividend payout policy.

The objectives of the study:

1. To identify the internal determinant positively influencing dividend payout policies for local Islamic banks in Malaysia
2. To identify the internal determinant negatively influencing dividend payout policies for local Islamic banks in Malaysia

3. METHODOLOGY:

This review takes the qualitative approach by analysing the existing literature related to dividend payout policy among the Islamic banking in Malaysia. The researchers decide to focus on the local Islamic banks in Malaysia which is consists of 10 local Islamic banks. The objective of this research to find out the gaps studies as there are not many previous studies focused on this issue. The dividend payout policy may look not complicated, but it can affect the shareholders and investor that involved in Islamic banking institution or any Islamic Financial Institutions.

A structured search was conducted using several sources of the studies that focused on dividend payout policies and the researcher has been specified the information must be compliant with shariah. For example, the previous study must be on Islamic banking or firm that shariah compliance. The researchers used the findings from 2013 and 2024 to get the clear view on that topic. Nevertheless, the methodology aims to provide a comprehensive understanding of how dividend policies are framed, justified, and applied within the specific context of Malaysian Islamic banks.

4. HYPOTHESIS:

- **H1**: Profitability has positively and significant influence the dividend payout policy of Islamic banks
- **H2:** Liquidity has positively and significant influence the dividend payout policy of Islamic banks
- **H3**: Capital structure has positively and significant influence the dividend payout policy of Islamic banks
- **H4:** Regulatory factors has positively and significant influence the dividend payout policy of Islamic banks
- **H5**: Profitability has negatively and significant influence the dividend payout policy of Islamic banks
- **H6:** Liquidity has negatively and significant influence the dividend payout policy of Islamic banks
- **H7**: Capital structure has negatively and significant influence the dividend payout policy of Islamic banks
- **H8:** Regulatory factors has negatively and significant influence the dividend payout policy of Islamic banks

5. DISCUSSION :

A thorough review of literature reveals several sustained findings concerning the internal determinants of dividend payout policies among local Islamic banks in Malaysia. The objective of the present study, namely, to identify and examine the internal factors that significantly impact dividend policy decisions has been successfully achieved. By knowing the determinants that influence the dividend payout policy, it becomes effortless to evaluate the performance of Islamic banks. This is the crucial point as understanding these relationships provides a foundation for more informed evaluations of Islamic banks' financial strategies, operational sustainability, and governance effectiveness.

Among the internal determinants used in this study, profitability and liquidity come out as two of the most critical variables positively associated with dividend payout policies. Profitability, typically measured through indicators such as return on assets (ROA) or return on equity (ROE), represent a bank's ability to make earnings relative to its assets or equity base. The higher profitability in Islamic banks can bring to the good return in forms of dividend to their respective shareholders and investors. This is because the origin of dividend payout to shareholders come from the profit generated by the operation of the organisation. Many empirical studies emphasize a positive relationship between a bank's profitability with dividend payout as the higher profit has the tendency to pay the dividend. Profitability commonly measured by metrics such as Return on Assets (ROA) serves as a strong signal of financial strength and sustainability

In the other hand, liquidity refers to the bank's ability to meet its short-term obligations and maintain sufficient cash or easily convertible assets. A powerful liquidity position implies that the bank is manage of meeting both its operational needs and shareholder expectations without compromising financial health. In the context of dividend policy, high liquidity assurance that the bank has the accessible resources to distribute dividends without utilizing to external financing or compressing retained earnings to unsustainable levels. In the context of Islamic banking, where trust and ethical considerations are central, distributing dividends from healthy profits reinforces investor confidence and the bank's credibility. A healthy liquidity buffer ensures that banks can meet short-term obligations and regulatory requirements set by Bank Negara Malaysia, while still rewarding shareholders.

In addition, the literature reflects mixed findings on the impact of capital structure and regulatory factors like lagged dividend on dividend payout policy. With respect to capital structure, numerous studies have found that banks with higher leverage, a higher proportion of debt relative to equity tend to exhibit a more conservative dividend policy. This cautious approach is primarily guided by the imperative to preserve internal capital reserves to fulfill ongoing debt obligations, safeguard solvency, and maintain investor and regulatory confidence. This behavior is typically explained by the need to preserve internal capital to meet debt obligations and ensure financial stability, particularly in a regulated environment where maintaining adequate capital buffers is critical. Although capital enough for the operation but if the debt is more than half of asset is quite risky for the Islamic banks, and this would be led to negligence of dividend payout to shareholders.

Regulatory factors such as the influence of lagged dividends have also been shown to negatively affect current dividend payout policies. Lagged dividends refer to past dividend payments that may have been deferred or not fully paid out, and their presence in financial models often signals a financial or operational constraint. The cumulative dividend payment can affect the capability of the Islamic banks to pay dividend on time even they already generate enough profits. This is because the present profits only can cover for current dividend only. Apart from that, the researchers have the opinion that capital structure and regulatory factors still need more research as the previous studies not covered enough on that elements.

H1:	Profitability has positively and significant influence the dividend payout policy of Islamic banks	**Accept**
H2:	Liquidity has positively and significant influence the dividend payout policy of Islamic banks	**Accept**
H3:	Capital structure has positively and significant influence the dividend payout policy of Islamic banks	**Reject**

H4:	Regulatory factor has positively and significant influence the dividend payout policy of Islamic banks	**Reject**
H5:	Profitability has negatively and significant influence the dividend payout policy of Islamic banks	**Reject**
H6:	Liquidity has negatively and significant influence the dividend payout policy of Islamic banks	**Reject**
H7:	Capital structure has negatively and significant influence the dividend payout policy of Islamic banks	**Accept**
H8:	Regulatory factor has negatively and significant influence the dividend payout policy of Islamic banks	**Accept**

6. CONCLUSION

This review has highlighted that dividend payout policies in local Islamic banks in Malaysia are shaped by a combination of financial performance and regulatory requirements, without negligence the shariah compliance. The findings underscore that higher profitability and stable liquidity management can encourage a good dividend payout policy to shareholders, this indirectly can improve the performance of local Islamic Banks in Malaysia. This is also can boost the confidence of the shareholders and investor towards the Islamic banks. The preferences of Islamic investors remain varied, reflecting the need for greater transparency and understanding in how dividend decisions are made.

This is contradicted with the relationship for capital structure and regulatory factors that still does not have clear view about how it can affect dividend payout policy. The inclination for banks with greater leverage to apply traditional dividend policies highlights the need for a balanced approach to debt management to shield financial stability. Additionally, the influence of lagged dividends serves as a suggestion of the operational constraints that can preserve proper dividend payments, even in profitable institutions. By this situation, it is evident that while profitability and liquidity prevail as the main drivers of dividend policies, the function of capital structure and regulatory constraints are equally important but still need some room for improvement for in term of comprehensive research.

7. RECOMMENDATION FOR FUTURE RESEARCHER

There is a restricted but developing body of research on this topic with room for further inspection. For next researchers, as a suggestion they can focused on internal and external determinants on dividend payout policy. By focusing on these gaps, researchers can share a good opinion that may inform both practitioners and policymakers in the Islamic banking sector. In addition, it was recommended to inquire into the refinement relationship between capital structure and dividend payout policies within Islamic banks, particularly in the context of regulatory frameworks. At the same time, profitability and liquidity have been established as key determinants, the influence of leverage and regulatory compliance remains underscore and requires further investigation. Researchers should also consider provisional studies between Islamic and conventional banks to identify uncommon factors affecting dividend decisions in Shariah-compliant institutions.

REFERENCES :

1. Al-Sharif, B. M. (2020). Dividend - Payout Policy and Share-Price Volatility in Islamic Banks: Evidence from Jordan. *Asian Economic and Financial Review, Vol. 10, No. 3*, 266-274.
2. Andi Duqi, A. J. (2020). Payout policy and ownership structure: The case of Islamic and conventional banks. *British Accounting Review*, 1-46.
3. Board Oversight and Dividend Policies in Malaysian Shariah -Compliant Companies. (2024). *Journal of Islamic Monetary Economics and Finance, Vol. 10, No. 2*, 357 - 378.

4. ENG S.H., Y. M. (2013). The Dividend Payout Policy – A Comparison on Malaysian Islamic and Conventional Financial Institutions. *Journal of WEI Business and Economics-August Volume 2 Number 2*, 12-20.
5. Farhan Ahmed, A. R. (2018). Dividend Payout Policy of Conventional Banking and Islamic Banking in Pakistan. *Jurnal Ilmu Ekonomi Syariah (Journal of Islamic Economics)*, 135 - 152.
6. Fauzias Mat Nor, N. A. (2020). Determinants and Stability of Dividend Payment: The Case of Malaysian Public-Listed Shariah-Compliant Firms. *Jurnal Pengurusan 60(*, 83 – 95.
7. Iffah Nazurah binti Ibrahim, N. S. (2023). Dividend Payout Policy: The Case of Islamic and Non-Islamic Banks in Malaysia. *International Journal of Academic in Accounting, finance and Management Science*, Vol. 13, No. 1, 2023, Pg. 11 - 25.
8. Mazumder, M. A. (2021). Determinants of dividend policy of Islamic banks in Bangladesh. *70 IIUC Business Review, Vol.-10, Issue-1*, 1-12.
9. Nazaria Binti Md. Aris, T. Y. (2023). Dividend Policy Effects on Firms' Value in Malaysian Plantation Sector . *UNIMAS REVIEW OF ACCOUNTING AND FINANCE*.
10. Ong Chun Lin, H. M. (2018). The Determinants of Dividend Payout: Evidence from the Malaysian Property Market. *IQTISHADIA Volume 11Nomer 1* , 27-46.
11. Rembulan Rahmadia Fitri, M. N. (2016). Analysis of Factors that Impact Dividend Payout Ratio on Listed Companies at Jakarta Islamic Index. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, 87-97.
12. Ruth Samantha Hamza, E. O. (2022). Banking Corporation Dividend Policy – Evidence from ASEAN-6 Countries. *Accounting Analysis Journal 11*, 94 - 1033.
13. Yong, M. A. (2023). Determinants of Dividend Policies in Shariah Compliant and Non-Shariah Compliant Firms:A Panel Quantile Approach. *Capital Markets Review Vol. 31, No. 1*, 47-58.

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Towards Sustainable Profitability: A Conceptual Framework for Malaysian Islamic Banks

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Abstract: *The Malaysian Islamic banking sector has shown intense growth in recent years, conducted by increasing demand for Shariah-compliant financial services and powerful institutional support. In spite of this development, many local Islamic banks remain to struggle with sustaining profitability in an increasingly competitive and aggressive financial environment. This concept paper aims to seek the key internal and external factors that control the profitability of Islamic banks in Malaysia. Internal factors include bank-specific variables such as capital adequacy, asset quality, and liquidity management. Meanwhile, external factors such as macroeconomic conditions, inflation and GDP growth are considered critical components that shape financial performance. While distinct studies have examined profitability determinants in conventional banks, limited research has focused on Islamic banks—particularly those that are locally owned and operated—despite their unique operating models and adherence to Shariah principles. By focusing on Malaysia's Islamic banking ecosystem, this paper also devotes to consolidation the research difference in the Islamic finance literature and fosters a more nuanced understanding of what drives profitability in faith-based banking institutions.*

Key Words: *profitability, internal factors, external factors Islamic banks*

1. INTRODUCTION

In recent years, the global banking sector has faced increasing pressure to adjust profitability with broader environmental, social, and ethical concerns. For Islamic banks, notably in Malaysia, this pressure is complicated by the obligation to comply with Shariah principles, which emphasize justice, social responsibility, and ethical conduct. The concept of sustainable profitability goes beyond mere financial gain; it reflects the ability of Islamic banks to generate consistent and long-term returns while ensuring their operations benefit society and the environment in line with Islamic teachings. Sustainable profitability refers to the capability of a financial institution to preserve long-term financial performance while positively impacting the economy, society, and the environment.

Based on previous study by **(Ali, 2020)**, Islamic finance is currently enjoying impressive success after its strong resistance to loss failures following the outbreak of the supreme crisis in 2008 and this issue led to urgency of the Islamic banks in Malaysia to enhance their profitability. According to **(Rahim, 2023)**, a mature regulatory and proactive institution like Bank Negara Malaysia (BNM) play important role to ensure that performance of Islamic banks can be sustain through the profitability generated. The profitability of these banks is influenced by a complex interplay of internal factors such as capital adequacy, asset quality and liquidity management and external factors, including inflation, GDP growth, and the regulatory environment.

In Islamic banks, capital adequacy is measured similarly to conventional banks but must also align with Shariah-compliant financing structures, which do not rely on interest (riba). Asset quality is the asset that is considered as a asset that has the capability to generate profit in future. Liquidity

management focused on short-term obligations of the organization. Based on **(Azizan, 2020),** GDP Growth is demand for loans tends to be higher during the economic boom, leading to higher profitability. Inflation is used the annual inflation rate in the analysis.

According to **(Siti Nur Alyaa Izzati Shaikh Rahim, 2021),** it is very important for Islamic banks to identify the factors that may contribute to the firms' profitability to improve their performance and be more competitive in the global environment. This attracted significant attention from researchers to examine their impact on bank profitability whereby the Islamic banks conduct the banking system that is based on profit and loss sharing (PLS) between bank and borrower, so it means that the profitability of the banks plays a vital role in maintaining the financial statement of the bank. **(Siti Nur Alyaa Izzati Shaikh Rahim, 2021)**

While several studies have been conducted on conventional banks, there is limited empirical research focusing specifically on the profitability determinants of local Islamic banks in Malaysia. This gap in the literature makes it difficult for policymakers, financial institutions, and investors to understand the unique dynamics affecting Islamic banks. Therefore, a comprehensive analysis is necessary to identify and evaluate the key internal and external factors that influence the profitability of local Islamic banks in Malaysia.

2. LITERATURE REVIEW

Sustainability of profitability refers to a financial institution's capacity to maintain consistent, long-term profits while fulfilling its ethical, social, and environmental obligations. In Islamic banking, this concept holds greater pressure because banks must ensure their operations comply with Shariah principles, which promote justice, social responsibility, and the avoidance of harm. For Malaysian Islamic banks, profitability cannot be measured solely by financial indicators such as return on assets (ROA) or return on equity (ROE).

(Siti Nur Alyaa Izzati Shaikh Rahim, 2021), mentioned profitability also affected by bank specific- internal factor like capital adequacy, asset quality and liquidity management. For external factor like inflation, GDP growth and regulatory environment also play important part in sustain the profitability among Islamic banks. According to **(Nur Amirah Binti SAMAIL, 2018)**, capital adequacy, asset quality and liquidity has been positively affecting Islamic banks profitability. This result was supported by other studies, **(Siti Nur Alyaa Izzati Shaikh Rahim, 2021)** capital adequacy positively effects the Islamic banks in Malaysia, but liquidity has different outcome which is negatively affect the profitability generated by Islamic banks. The different result led to the possibility that the liquidity management can affect the profitability but depend about the operation either the organisation focused on short-term obligation or long-term obligation. The decision of the source of financing can give the impact on profitability.

Contradict with **(Rahim, 2023)** capital adequacy, asset quality and liquidity management has negatively affected Islamic banks profitability in Malaysia but this situation can be change if the debtors able to repay the debt because it can affect the banks financial position. Furthermore, based on previous studies **(Ali, 2020)** mentioned that liquidity negatively affect the Islamic banks profitability and capital adequacy positively significant with profitability, meanwhile for external factors inflation has positive affect on Islamic banks profitability. This is based on the cases in the Middle east country. Capital adequacy had been cushioning protection for Islamic banks profitability as its positively related. GDP growth and inflation also has positive relationship with Islamic banks profitability according to **(Sharifah Norhafiza Syed Ibrahim, 2023).**

For external factors, based on **(Azizan, 2020)** GDP growth and inflation has positive relationship with profitability, and this is dependent on the economy situation at that time. Contrast with **(Baharudin, 2020)**, only GDP growth has impact on Islamic banks profitability and inflation does not has any impact on profitability. Based on studies **(Begum, 2023)**, capital adequacy and asset quality had positive significant affect the Islamic banks profitability in Bangladesh but negative significant with GDP growth. The different findings for GDP growth can be differ by the countries because the differences between the policy implemented by the government. In the previous studies according to **(Ibrahim, 2020),** inflation does not have any impact on the Islamic bank's profitability in Malaysia. According to the previous literature, this study has tried to analyze the relationship between internal or

external factors affecting the Islamic banks profitability in Malaysia. The focus is to identify the key elements that can influence the profitability and how the Islamic banks can achieve that in their operations.

The objectives of the paper are:

i. To identify key internal factors that may influence the profitability of Islamic banks in Malaysia.
ii. To identify key external factors that may influence the profitability of Islamic banks in Malaysia.

3. METHODOLOGY

This study employs a conceptual research methodology, drawing on existing literature, regulatory guidelines, and case studies from Malaysian Islamic banks. The researchers decide to focus on the Islamic banks in Malaysia which is consists of 16 Islamic banks. Profitability of Islamic bank can be sustained if the factors that influenced can de identify properly and a well-structured study can be used was conducted using several sources of the studies that focused on internal and external factors that can influence Islamic banks profitability. For example, the previous study must be on Islamic banking and the duration of findings must be within 2012 until 2023. This methodology aims to provide a comprehensive understanding of the internal factor and externals factors can affect the sustainability profitability of Islamic. Furthermore, the methodology aims to provide a comprehensive understanding of how internal and external elements that can affect the profitability of Islamic banks in Malaysia.

4. HYPOTHESIS

- H1: Capital adequacy has positive and significant relationship with Islamic banks profitability.
- H2: Asset quality has positive and significant relationship with Islamic banks profitability.
- H3: Liquidity has positive and significant relationship with Islamic banks profitability.
- H4: GDP growth has positive and significant relationship with Islamic banks profitability.
- H5: Macroeconomic has positive and significant relationship with Islamic banks profitability.

5. DISCUSSION

Achieving sustainability of profitability in Malaysian Islamic banks requires a great understanding of both internal factors and external factors. This review of the literature has revealed several consistent findings that contribute to a conceptual framework for sustainability, highlighting the vital role of internal elements—such as capital adequacy, liquidity management, and asset quality as well as external factors like macroeconomic conditions and regulatory environments. The main objective of this research also had been successfully achieved as it has identified and evaluate both internal and external factors that influence the long-term profitability of Islamic banks in Malaysia.

Among these, capital adequacy appears as the most dominant internal factor. This finding is significant because capital adequacy not only secure regulatory compliance but also serves as a financial cushion that enables banks to ingest unforeseen losses, invest strategically, and maintain market assurance during periods of economic uncertainty. Compared to other internal factor, the capital can help the Islamic banks to preserve their profit because a good capital management can help the banks to stay relevant in the market for a long time and they usually did not had any problem to deal with commitment by the Islamic banks. Effective capital management enhances a bank's financial strength, supports its improvement in potential, and assurance its stability in a competitive and evolving financial landscape. In the context of Islamic banking, where risk-sharing principles and Shariah compliance are fundamental, maintaining adequate capital is also essential to support ethical and sustainable banking practices.

Lasting adequate liquidity can ensure that a bank can meet its immediate financial obligations, such as withdrawals and short-term liabilities, without disrupting current operations. In the context of Islamic banking, where liquidity instruments must comply with Shariah principles and often face

limited availability in the market, managing liquidity becomes even more demanding. While high liquidity levels can prevent financial distress and enhance short-term profitability by avoiding funding shortages, they may also indicate underutilized capital that could have otherwise been invested in profit-generating ventures.

On the other hand, the influence of asset quality on profitability presents more mixed and inconclusive findings. In theory, high-quality assets—those with low default risk and strong earning potential—should positively contribute to profitability. However, not all assets held by Islamic banks are equally productive or capable of generating income. For example, non-performing financing (NPF), impaired investments, or idle real assets may drag down profitability despite being recorded on the balance sheet. The mixed findings in the literature suggest that the relationship between asset quality and profitability in Islamic banks is context-specific and may depend on how well the bank manages its credit risk, asset allocation, and compliance with Shariah governance.

For external factor, based on numerous studies GDP growth has positively affect the Islamic banks profitability. A growing GDP echo a good and expanding economy, which enhances business activities, consumer spending, and demand for financial services all of which contribute to improved performance in the banking sector. For Islamic banks, economic expansion often translates into increased financing opportunities, greater investment activity, and a more bombing customer base, thereby positively affecting profitability. This positive relationship highlights the importance of macroeconomic stability in supporting the Islamic banking industry's growth and financial sustainability.

Meanwhile for inflation, there are mixture findings from previous studies as inflation can positively and negatively affect the Islamic banks profitability depend on the economy situation. Some studies suggest that common inflation can enhance profitability by increasing the nominal returns on financing activities, particularly if banks are able to adjust their pricing accordingly. On the other hand, high or volatile inflation can erode purchasing power, increase costs, and reduce the real value of returns, thereby exerting downward pressure on profitability. For economy situation, this is uncontrollable variable and it can be avoided by any industry. For regulatory framework, there are not exact studies that focused on this factors and further studies was suggested to use this factor as their main issue in the future.

In addition, the regulatory framework is another critical external factor, although it remains relatively underexplored in existing research on Islamic banking profitability. A well-structured and supportive regulatory environment can provide clarity, stability, and investor confidence, all of which are essential for the sustainable growth of Islamic banks. However, due to limited empirical studies specifically addressing the impact of regulatory frameworks on profitability, this area represents a valuable direction for future research. Scholars are encouraged to examine how regulatory policies—especially those specific to Islamic finance—affect operational efficiency, capital management, and ultimately, the financial performance of Islamic banks.

H1:	Capital adequacy has positive relationship with Islamic banks profitability.	**Accept**
H2:	Asset quality has positive relationship with Islamic banks profitability.	**Reject**
H3:	Liquidity has positive relationship with Islamic banks profitability.	**Accept**
H4:	GDP growth has positive relationship with Islamic banks profitability.	**Accept**
H5:	Macroeconomic has positive relationship with Islamic banks profitability.	**Reject**

6. CONCLUSION

This review has highlighted that the sustainable profitability of Malaysian Islamic banks is okayed not completely by financial performance, but by a complex synergy between internal and external factors. In term of internal factors, key determinants such as capital adequacy and effective liquidity management play a significant role in ensuring long-term financial stability and performance. These internal mechanisms grant Islamic banks to maintain resilience in changing market conditions. Externally, macroeconomic factors particularly GDP growth have shown a positive relationship with

profitability, granting that broader economic health directly supports the performance of Islamic financial institutions.

Regardless of these insights, the present body of research on the profitability of Islamic banks in Malaysia remains cramped, especially when compared to conventional banks or Islamic banks in other countries. Therefore, ultimate studies are encouraged to conduct provisional analyses between Malaysian Islamic banks and those in other regions, particularly in terms of how internal factors such as governance practices, risk management, and technological innovation can affect Islamic banks profitability. Such comparative research would contribute to a more global compassionate of best practices and could benefit local banks benchmark and enhance their strategies in a competitive financial environment.

7. RECOMMENDATION FOR FUTURE RESEARCHER

Overall, there is a limited but growing body of research on this topic, with room for deeper exploration. There is suggestion that the next researchers can focused on internal and external determinants on dividend payout policy. By addressing these gaps, researchers can contribute valuable insights that may inform both practitioners and policymakers in the Islamic banking sector. Apart from that, it was suggested to delve into the nuanced relationship between capital structure and dividend payout policies within Islamic banks, particularly in the context of regulatory frameworks. While profitability and liquidity have been established as key determinants, the influence of leverage and regulatory compliance remains underexplored and requires deeper investigation. Researchers should also consider provisional studies between Islamic and conventional banks to identify uncommon factors affecting dividend decisions in Shariah-compliant institutions. This is would led to more deeper understanding about the profitability among the Islamic financial Institutions.

REFERENCES:

1. Ahmed, Q. R. (2023). v1i4.678Sustainability Assessment of Malaysian Islamic Banks:An Application of Content Analysis and TOPSIS. *Trends and Innovations in Business & Social Sciences, Vol. 1 No. 4* , 165-173.
2. Ali, A. B. (2020). PROFITABILITY OF ISLAMIC BANKS: A PANEL DATA. *Indian Journal of Finance and Banking, Vol. 4, No. 3*, 26-38.
3. Amin Jan, M. M. (2018). Sustainability Practices and Banks Financial Performance: A Conceptual Review from the Islamic Banking Industry in Malaysia. *International Journal of Business and Management; Vol. 13, No. 11*, 61-87.
4. Azizan, N. A. (2020). The Determinants of Islamic and Conventional Banking Profitability in Asian Countries. *MANAGEMENT & ACCOUNTING REVIEW, VOLUME 19 NO. 3, DECEMBER 2020*, 48-67.
5. Baharudin, M. A. (2020). The Effects of Internal and External Economic Variables on the Islamic Banks' Profitability in Malaysia. *ASEAN Entrepreneurship Journal (AEJ) Vol 6 No 1*, 22-26.
6. Begum, A. (2023). Factors Affecting Profitability: An Emperical Study on Islamic Banks in Bangladesh. *Academic Journal on Business Administration, Innovation & Sustainability (AJBAIS), Volume 3, Issue 1*, 10-20.
7. Ibrahim, M. H. (2020). Islamic Banking and Bank Performance in Malaysia : An Empirical Analysis. *Journal of Islamic Monetary Economics and Finance, Vol. 6, No.3*, 487-502.
8. Muhammada, A. U. (2022). Internal and External Factors Affecting Islamic Banks Performance in Nigeria. *JEBIS: Jurnal Ekonomi dan Bisnis Islam Volume 8, No.1,*, 121-133.
9. Nur Amirah Binti SAMAIL, N. S. (2018). Determinants of Financial Performance of Islamic Banking in Malaysia. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, 21-29.

10. Rahim, C. A. (2023). Financial Performance of lslamic Banks in Malaysia: Do Bank-Specific Factors Matter? *International Islamic Economic System Conference*, 307-315.
11. Sharifah Norhafiza Syed Ibrahim, N. O. (2023). External and Internal Determinants of Islamic Bank's Financial Performance in Malaysia. *International Journal of Academic Research in Accounting Finance and Management Sciences, 13(2)*, 390 - 398.
12. Siti Nur Alyaa Izzati Shaikh Rahim, N. H. (2021). Contributing Factors of Islamic Banks Profitability . *Journal of Contemporary Social Science Research, Vol.6, Issue 2*, 1-8.

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Use Of AI For Accounting and Financial Reporting

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Abstract: *AI and machine learning are revolutionizing industries, including the accounting profession. OpenAI's Chat Generative Pre-Trained Transformer (ChatGPT) uses machine learning techniques to generate text like human language, making it highly effective in various disciplines. It can improve efficiency, streamline processes, and simplify complex tasks in the accounting field. Implementing ChatGPT in accounting involves automating invoice categorization, generating financial forecasts, producing financial reports, simplifying auditing procedures, communicating with customers, forecasting and analysing financial data, ensuring tax compliance, and detecting fraud. However, AI is not expected to completely replace accountants due to complex decision-making, human interaction, professionalism, and ethics. Accountants are responsible for more than just data processing, and AI cannot replicate the subtleties of human communication and emotional intelligence. However, AI can provide specialized features like scenario planning, financial forecasting, sensitivity analysis, and integration with accounting software.*

Keywords: *Cost savings, financial data, fraud detection, financial forecast, financial reporting, Transformative revolution*

JEL Codes : A14, G30, K40, K42, L6,

1. INTRODUCTION

The potential for ChatGPT and comparable AI systems to have a similar impact on certain industries as the Industrial Revolution, albeit over a significantly shorter timeframe.

Artificial Intelligence (AI) and machine learning are not ordinary buzzwords. The accounting profession is not an exception to the transformative revolution they are driving across industries. OpenAI's Chat Generative Pre-Trained Transformer (ChatGPT) has the potential to revolutionise the accountancy industry. One is compelled to consider the future of AI as this technology continues to gather momentum. The virality of ChatGPT and its subsequent media coverage have incited a compelling dialogue regarding the future of AI in the field of accounting and beyond. In what ways will this technology influence accounting professional practices, and what opportunities will it generate? The potential is as thrilling as it is limitless!
This article will delve further into the extraordinary advantages that AI provides to the field of accounting. Author will examine practical accounting use cases in which AI has had a substantial impact and demonstrate the symbiosis between the innovative AI tools like ChatGPT and other GPTs.

2. ChatGPT Technology

A Generative Pre-Trained Transformer (GPT) is an artificial intelligence model that is specifically

engineered for the purpose of natural language processing. It utilises machine learning techniques to understand and generate text that is like human language. Chat Generative Pre-Trained Transformer (ChatGPT) is a highly effective tool in a variety of disciplines, including accounting, due to its ability to engage in human-like conversation.

The emergence of ChatGPT and GPT models in general has led to the establishment of a prompt engineering. This was an unexpected development. Prompt engineering provides methods to optimise ChatGPT's functionality to accountants' with more extensive experience. Nevertheless, those who lack experience may not be able to fully appreciate the most efficient methods of utilising it.

3. ChatGPT in Accounting

The integration of ChatGPT technology into accounting can improve overall efficiency, streamline processes, and simplify complex duties. ChatGPT is an asset in the accounting field due to its capacity to comprehend context, analyse data, and produce valuable insights. The following are a few of the reasons.

Improved Productivity
GPT enables accounting professionals to increase their productivity by automating routine and time-consuming duties. They can concentrate on duties that necessitate a greater degree of strategic thinking and critical analysis, thereby enhancing their overall work efficiency.

Improved Precision
The utilisation of AI mitigates the likelihood of human error in manual tasks, which is particularly important in the field of accountancy, where precision is of the utmost importance. The quality and reliability of financial information are enhanced by GPT's capacity to maintain high precision in activities such as invoice and expense categorisation and financial reporting.

Insightful Analysis
GPT technology is capable of rapidly processing and analysing immense volumes of data, thereby capturing valuable insights that may be overlooked manually. This enables businesses to make more informed, better-informed decisions by identifying trends and patterns in financial data.

Enhanced Stakeholders Service
Real-time, high-quality customer service and other stakeholders' services can be achieved through the utilisation of GPT technology. It can provide accurate and timely responses to enquiries, thereby improving the stakeholders' experience and satisfaction and freeing up human resources for more intricate customer interactions.

Reduced expenses
Cost savings are substantial because of the automation of routine tasks and the reduction in errors. By reallocating these savings to other strategic areas, businesses can optimise their resources and enhance their profitability.

4. Methods for Implementation of ChatGPT in Accounting

1. Categorisation of Invoices and Expenses
Businesses are required to register a multitude of expenses daily and receive an abundance of invoices. Manual categorisation can be error-prone and time-consuming. ChatGPT, which has been trained on a wide variety of internet text, can assist businesses in automating this process. By utilising its machine learning capabilities, it is capable of analysing and categorising invoices and expenses according to

predefined categories or even learning and enhancing over time, thereby enhancing efficiency and accuracy.

2. Financial Forecast

Accurate financial projections are one of the primary obligations of financial professionals and accountants. These are indispensable for the assessment of a business's financial health, strategic planning, and the acquisition of funding.

Historically, the process of generating financial projections has been characterised by the manual input of data, the sorting of data, and the performing of intricate calculations. This process is both time-consuming and susceptible to errors. Nevertheless, the process can be significantly streamlined and enhanced with the introduction of AI and machine learning technologies such as ChatGPT.

3. Production of financial reports

Financial report generation is a critical component of accounting that frequently necessitates a significant amount of time and effort. This process can be streamlined by ChatGPT, which automates the compilation of fundamental financial reports, including income statements, balance sheets, and cash flow statements, based on input data. This provides accountants with additional time to analyse the reports and offer strategic guidance to the business.

4. Document Auditing Procedure

The process of auditing entails the review of extensive financial data, which can be both labour-intensive and monotonous. The auditing procedure can be simplified by utilising ChatGPT to scan and organise the data. It can assist in the organisation of necessary documentation, the identification of anomalies, and the cross-checking of entries, thereby reducing the time spent on manual data processing.

5. Communication with Stakeholders

It is imperative for a trusted accountant to remain proactive in ensuring that clients are informed about regulatory changes, forthcoming deadlines, and significant financial matters. With the help of ChatGPT, accountant can effortlessly produce clear and concise emails, letters, or other communication materials to guarantee that stakeholders are informed.

6. Forecasting and analysis of financial data

Strategic planning necessitates the capacity to forecast future trends and analyse financial data. ChatGPT is capable of assisting businesses in predicting future trends and comprehending their financial health by processing large volumes of data and identifying patterns. This valuable insight can assist businesses in making informed decisions, managing risk, and capitalising on opportunities.

7. Tax Compliance

Tax laws are subject to constant evolution and can be exceedingly intricate. Businesses may utilise ChatGPT to remain informed about these modifications and guarantee compliance. It can assist in the calculation of tax liabilities, the submission of returns, and the provision of fundamental guidance on tax matters. However, it is crucial to bear in mind that, even though AI can offer support, it is advisable to seek the advice of a professional when dealing with intricate tax matters.

8. Fraud Detection

Businesses are acutely concerned with financial fraud. ChatGPT can assist in the identification of potential fraud by analysing and identifying peculiar patterns in financial data. This could involve the identification of irregularities in invoices and expenses, inconsistencies in financial reports, or unusual transactions.

5. Will Accountants be Replaced by Artificial Intelligence?

However, it is not anticipated that AI will entirely replace accountants, despite its ability to automate numerous routine accounting duties. The rationale for this is as follows:

Complex Decision Making
Accountants are responsible for more than just data processing; they also engage in complex decision-making. They can make intricate decisions, offering strategic guidance, and exercising professional judgement, which are currently beyond the capabilities of AI. For instance, an accountant is required to investigate and comprehend the context of anomalous transactions, even though AI can identify them.

Human Interaction
The role of an accountant encompasses a variety of interpersonal skills, including the ability to discuss financial matters with suppliers, service providers, customers and other stakeholders, resolve conflicts, and present financial information to non-financial stakeholders. AI is unable to replicate the subtleties of human communication and emotional intelligence.

Professionalism and Ethics
Accountants are required to comply with professional standards and guidelines. Maintaining confidentiality and integrity is imperative for those who manage sensitive data. Although AI can be programmed to adhere to specific regulations, it lacks a sense of professionalism or ethics. Financial regulations and accounting standards are intricate and frequently necessitate judgement and interpretation. Accountants possess the necessary training and expertise to effectively navigate these requirements, whereas AI may encounter difficulties with such intricacies.

Adaptation to Change
The financial sector is in a state of perpetual flux, with the emergence of new financial instruments, business models, and regulations. Current AI technology is inferior to the capacity of humans to comprehend and adjust to these modifications. Nevertheless, the function of accountants can be significantly altered by AI. Accountants can concentrate more on strategic, advisory, and decision-making duties by automating numerous routine tasks. In this regard, ChatGPT is a potent instrument that can aid businesses in a variety of accounting duties, it is crucial to acknowledge its constraints. ChatGPT is particularly adept at automating processes such as invoice and expense categorisation and managing communication with stakeholders.

Specialised Features
It can provide a variety of specialised features, including scenario planning, financial forecasting, sensitivity analysis, and integration with accounting software. Furthermore, human accountants' insights and expertise are indispensable for the purposes of strategic guidance, data interpretation, and compliance. Consequently, the synergistic approach that maximises efficiency and effectiveness in business planning and accounting processes is achieved by integrating the capabilities of tools such as ChatGPT with the expertise of human accountants.

6. Conclusion

AI and machine learning are driving a transformative revolution in industries, including the accounting profession. OpenAI's Chat Generative Pre-Trained Transformer (ChatGPT) has the potential to revolutionize the accounting industry. ChatGPT uses machine learning techniques to understand and generate text like human language, making it highly effective in various disciplines, including

accounting. The emergence of ChatGPT and GPT models has led to prompt engineering, providing ways to optimize ChatGPT's functionality for accountants with more experience. However, those without experience may struggle to fully appreciate its efficiency.

ChatGPT technology can significantly improve efficiency, streamline processes, and simplify complex tasks in the accounting field. It can enhance productivity by automating routine tasks, improving precision, capturing valuable insights, enhancing stakeholder service, and reducing expenses.

Methods for implementing ChatGPT in accounting include categorizing invoices and expenses, generating financial forecasts, producing financial reports, simplifying the auditing procedure, communicating with customers, forecasting and analysing financial data, ensuring tax compliance, and detecting fraud.

Invoice categorization is a critical process for businesses, as it can be error-prone and time-consuming. ChatGPT can automate this process by analysing and categorizing invoices and expenses according to predefined categories or learning and enhancing over time. Financial forecasting is essential for strategic planning and funding acquisition.

Financial report generation is a critical component of accounting, and ChatGPT can automate this process by automating the compilation of basic financial reports. It can also streamline the auditing procedure by scanning and organizing data, reducing manual data processing time.

Communication with stakeholders is crucial for accountants to stay informed about regulatory changes, deadlines, and significant financial matters. ChatGPT can help predict future trends, manage risk, and capitalize on opportunities. Tax compliance is also essential, as ChatGPT can help calculate tax liabilities, submit returns, and provide guidance on tax matters.

Finally, ChatGPT can help detect potential fraud by analysing and identifying peculiar patterns in financial data.

AI is not expected to completely replace accountants, despite its ability to automate routine accounting duties. This is due to complex decision-making, human interaction, professionalism, and ethics. Accountants are responsible for more than just data processing, and AI can't understand the context of anomalous transactions. AI can't replicate the subtleties of human communication and emotional intelligence. Additionally, AI lacks a sense of professionalism and ethics, which accountants need to navigate. Adapting to change is also a challenge, as AI technology is inferior to humans' ability to understand and adapt to new financial instruments and regulations. However, AI can provide specialized features like scenario planning, financial forecasting, sensitivity analysis, and integration with accounting software.

Bibliography

1. Accounting Tools. (2022, May 24). *Accounting Tools*. Retrieved from value-based pricing definition: https://www.accountingtools.com/articles/value-based-pricing
2. Belfo, F.P, Trigo, A. (2013). Accounting Information Systems. *Tradition and Future Directions*.
3. Boulianne, E. (2014). Impact of accounting software utilization on students' knowledge acquisition: an important change in accounting education. *Journal of Accounting and Organizational Change*.
4. Chansa, M. (2022). *Accounting Practices in the Covid-19 Era in Southern Africa.* Kaputa: Chitimukulu Publishers.

5. Engelbrecht, K. (2013). The Intricate Relationship Between Cloud Computing and Data Security.
6. Greenman, C. (2017). Exploring the impact of artificial intelligence on the accounting profession. *Journal of Research in Business, Economics and Management (JRBEM)*.
7. Lahiri, S. (2015). Does outsourcing really improve firm performance?
8. Rezaee et al. (2018). Relevance of Big Data to Forensic Accounting Practice and Education. *Managerial Auditing Journal*.
9. Richins, G., Stapleton, A., Stratopoulos, T. C., & Wong, C. (2017). Big Data analytics: Opportunity or threat for the accounting profession? *Journal of Information Systems.*

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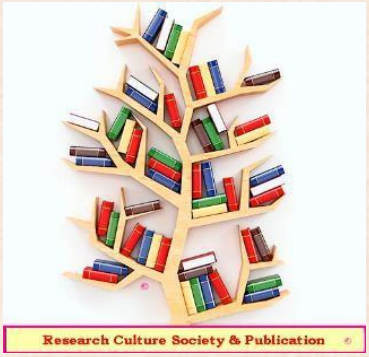

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