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MESSAGE FROM EDITORS' DESK

It gives us an immense pleasure in bringing out the eighth volume of International Journal of Science and Humanities with your incessant support. International Journal of Science and Humanities being published by Islamiah College has been successfully marching towards its sixth year by providing a platform for authors in exhibiting their talents in the form of their research articles on various disciplines such as English, Chemistry, Bio-Chemistry, Commerce, Management, History, Sociology, Public Administration, Political Science, Physics, Economics and Mathematics.

Since it is the International Journal, we are invariably committed to do our best by ensuring that the articles published by the authors of various disciplines are free from error, plagiarism and biased. However, we will never compromise on the quality of journal as our journal is subjected to peer review. All the papers of different disciplines are thoroughly scrutinised by our peer review members who are employed in various reputed institutions all over the world.

Therefore, we humbly request you to provide your valuable suggestions in further strengthening this Journal and always extend your support by publishing your quality articles in our reputed International Journal of Science and Humanities.

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APPEAL

I am delighted to introduce this issue of International Journal of Science and Humanities (IJSH) to the students and research community on behalf of Islamiah College (Autonomous), Vaniyambadi, a century old institution serving for the cause of education to socially, economically and educationally weaker sections of the society. The IJSH, is a peer reviewed research journal of interdisciplinary nature that cater the needs of the teaching and research society. The aim of the journal is not only to provide a space for leading research work but also provide a platform for the budding researchers to publish their maiden attempt in the field of science and humanities. The objective of IJSH is to publish up-to-date, high-quality and original research papers alongside relevant and insightful reviews.

The initiative to start this journal was taken by Janab L.M Muneer Ahmed, the Secretary & Correspondent of this College with an aspiration to keep the research vibrant in this campus. Now, the torch is handed over to me from June 2016 onwards to run this journal on non-profitable basis without compromising its aims and objectives. At this juncture, I appeal to all teaching and research communities to concentrate on both teaching and research relevant to society, which are symbolically related as the two faces of the same coin. I also appeal to all reviewers and editors not to compromise with the quality of the input and promote this journal to the next level with excellent output. Finally, I pray Almighty to provide guidance for development and success of this journal. Best wishes and thanks for your contribution to the IJSH.

Mr. L.M. MUNEER AHMED
Secretary & Correspondent
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Table of Contents

Part A: Science

Part B: Humanities

Part A:

SCIENCE

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GREEN SYNTHESIS OF TiO_2 NANOPARTICLES USING *CHROMOLAENA ODORATA* AND *JUSTICIA BETONICA* EXTRACTS

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Abstract

An eco-friendly approach for green synthesis of Titanium nanoparticles using leaf extract of *Chromolaena odorata* and *Justicia betonica* were investigated in the present research. Field Emission Scanning Electron Microscopy (FE-SEM) and Gas Chromatography Mass Spectrometer (GC-MS) analysis were used to characterize the synthesized Titanium nanoparticles. SEM imageries established that produced TiO_2 NPs remained tetragonal in shape. The Nanoparticles shows physical and spatial morphology, particle size and feature proportion of the synthesized NPs in the deepest and uppermost exaggeration of 30 and 70 kX correspondingly and size is 5 μm and 2.5 μm are *C. odorata* and *J. betonica* respectively. GC–MS outcomes, displayed the occurrence of 9 dissimilar composites in the Methanolic plant extract of *C. odorata* and *J. betonica*. The phytoconstituents remained acknowledged by corresponding the developed mass spectra with individuals originate in the NIST phantom database.

Keywords: *C. odorata*, *J. betonica*, FE-SEM, GC-MS, TiO_2 NPs.

1. INTRODUCTION

Nanotechnology means "any technology that is performed on a nanoscale". It is defined by Royal Society, UK, as design, description, making, and solicitation connected with arrangements, plans and organisms by monitoring their size and shape at the nanometre scale. It originated beginning the Greek name Nano which resources 'dwarf' which is 10-9 nm. This subdivision of science and technology covenants through resources consuming at tiniest one 3-D dimension in the size range of 1 to 100 nm. Nanoparticles are bunches molecules in the range of size is 1-100 nm. Ability to

design and build complex things on an ever-smaller scale is now transforming pre-existing devices to produce novel materials. Developing innovative applications is a key issue within the fast-growing fields for modern and evolving society. Amid the pitches that proficient imposing advance, Nano science and technology consume remained enduring the furthermost tense evolution. Technology of Nano has proved toward be a boon for semiconductor technology (Korvink & Greiner 2002), information technology (Rainer Wasser 2008), cellular and molecular biology (Bogunia-Kubik & Sugisaka 2002), material technology (Alexandra Navrotsky 2003), bio-technology (Mazzola 2003), energy production and storage (Stein 2011), (Garcia-Martinez 2010), manufacturing, instrumentation (Geim et al. 1998), environmental applications and security (Wiesner & Bottero 2017), Nano electronics (Geller et al. 2008), medicine and health care (Sahoo et al. 2007), genomics (Mohamadi et al. 2006), robotics (Brown 2010), communications (Minoli & Wiely 2006), etc.

Chemical synthesis method outcomes in the occurrence of poisonous chemical engrossed on the superficial that might consume an inauspicious influence on the therapeutic applications. Among the two methods, green synthesis method affords a little cost, environmental approachable and effortlessly scale up route. (Hoffmann MR et al 1995, Fujishima A, et al 2000) wrasses, predominantly to shield casing from UV rays, paleness, opaqueness to yields such as paints, food colorants, papers, inks and toothpastes (Trouiller B et al 2009). The contemporary attention in the investigators due to the emergent microbial battle in contradiction of metallic, antibiotics and the growth of resilient straining and the TiO_2 NPs consume established noteworthy antiseptic action (Allahverdiyev AM et al 2011). TiO_2 used in antiseptic coverings and wastewater fumigation consumes remained inspected as an anti-cancer agent. The biotical polymer functionalized TiO_2 NPs unveiled heightened embarrassment of microbial progress in contradiction of Escherichia coli and Staphylococcus aurous in evaluation to the primeval TiO2 NPs (Kong H et al 2010). In green synthesis technique there is no essential to usage of temperature, energy, high force and noxious substances. TiO_2 takes elongated remained acknowledged as partaking an inhibitory consequence on microorganisms contemporary in medicinal and developed process (Hongbo Shi et al 2013). Catalytic reactivity and other relevant belongings such as biological and chemical motion in TiO2NPs are the main significant factor in forming accurate surface area.

Plants are photosynthetic producer of first level which is predominant in food chain. They utilize about 78% of light energy sun which transform chemical energy to glucose. The usages of these plant lives are much more advantageous than production of nanoparticles using Physic/chemical methods which involves the usage of poisonous chemicals which are detrimental to both humans and atmosphere. Scientists and researchers are encouraged to take initiative to employ green chemistry method of synthesis of nano materials than the use of poisonous compounds for lessening and stabilization of metallic nanoparticles. Naturally occurring products have enzymes

that can interact with bimolecular synthesis besides having a strong effect against bacteria and other disease causing organisms. When nano particles are synthesized by this method, they become even more effective and facilitated more applications in pharmaceutical, textile, catalyst and biomedical fields. Various secondary metabolites like proteins are usually synthesized using metal nano particles obtained from plant components eg. In bioaccumulation, metal nano particles are involved in the localization of proteins involved. Green way synthesis of TiO_2 NPs are straight connected to the mechanism of nanotechnology and eco and green chemistry. Green synthesis of nanoparticles can involve both plants and microorganisms. However Plant based biosynthesis of nano particle is preferred because of its high reaction rate. It does not require the maintenance of specific conditions thus making it highly preferable method of synthesis over others.

Titanium dioxide (TiO_2) nanoparticles (NPs) are mass-produced global trendy enormous capacities aimed at uses in the extensive choice of various solicitations in all kind of domain. TiO_2 NPs have diverse physicochemical assets accompanying to their fine element analogues, which influence modify their biological activity. And also include the respirational organisation, viewing the prominence of breathing for example the primary track for TiO_2 NPs acquaintance in the workstation. TiO_2 has stayed comprehensively used as an ecologically pleasant-sounding and clean photo catalyst, as of its ocular assets, extraordinary substance composure and nontoxicity. TiO_2 NPs stand one of the utmost momentous properties for pharmaceuticals and cosmetics areas. TiO_2 NPs might translocate to complete structures beginning the gastrointestinal tract and lung even though the rate of translocation seems low. Maximum dermal acquaintance studies, whether *in vitro* or *in vivo*, explosion that TiO_2 NPs do not infiltrate the division corneum. In the arena of nanomedicines, SC administration vaccination can deliver TiO_2 NPs carriers straight into the human body. The use of ecologically affable properties like plant extract (Andeani et al. 2013), microorganisms (Minaeia et al. 2008), mildews (Mukherjee et al. 2001) and enzymes (Meyer et al. 2008) aimed at the amalgamation of TiO_2 NPs bids various advantages of ecologically and cohesiveness for medicinal chemistry and pharmaceutical applications.

In this study, aqueous extract of *C. odorata* and *J. J. betonica* stood used for the synthesis of TiO_2 NPs and to estimate the reducing influence of the extract via the green way of TiO2 NPs production. Scanning Electron Microscopy (SEM) and Gas Chromatography Mass Spectrometry (GC-MS) were used to study the effect of extract size and analyse its various applications.

2. MATERIALS AND METHODS

2.1. Selection of Plant Source

Investigations have been carried out successfully cutting-edge individual plants which consume advantageous special effects from those that are noxious (or) purely non-effective.

The WHO estimates showed 75 % of the populace in emergent kingdoms rely on old-style medications. Habitually plant drugs are exploited for healthiness precaution needs and the predominant hazard to prevailing plant wealth coerces for an instantaneous systematic valuation of the medicinal belongings of plant. Universally nearby an enlarged concentration to recognize plant based composites that are pharmacologically effective partaking negligible side effects for use in healing purposes.

Two of such plants were carefully chosen for synthesis of TiO_2 particles. The need for synthesis of the metal nanoparticles from these plants are discussed.

2.2. Taxonomy and Collection of leaf of *Chromolaena odorata*

Chromolaena odorata Linn (L.) formerly known as *Eupatorium odoratum* L. It is appropriate to the biggest domestic blossoming florae, which encompasses about 900 class and 13,000 species (Heywood et al 1977). *C. odorata* is too recognised as Eupatorium conyzoides Vahl, C. odorata is a verbose in addition motocross recurring plant that raises to a tallness of 3 to7 m in the exposed (Irobi ON 1992). It is an inexhaustible wildflower that flourishes in the mainstream of soil categories, is originate in profusion on exposed wilderness and beside road and foils the instituting of additional plants (Warea O 2004) (**Fig**. 1.1).

2.3. Taxonomy and Collection of Leaf of *Justicia betonica*

Justicia betonica is classes of blossoming plant, a flower in the family Acanthaceae. It spirits by the common name Hill Justicia, Squirrel's Tail, White Shrimp Pant and paper plume. The Tamil name of the plant is Velimungil. The plant is stunning piebald bracts yield light elaborate flowers, construction them a position out exquisiteness in the garden. In India, a bandage of the crumpled garden-fresh leaves is practical to help with swellings (**Fig**. 1.2).

2.3.1 *CHROMOLAENA ODORATA*

Family: Asteraceae
Order: Asterales
Scientific Name: *Chromolaena odorata*

Figure 1: *Chromolaena Odorata*

2.3.2 *JUSTICIA BETONICA*

Family: Acanthaceae
Order: Lamiales
Scientific Name: *Justicia betonica L*

Figure 2: *Justicia betonica*

2.4. Extraction of Phytochemicals

2.4.1 Extraction of phytochemicals from the leaf of *C. odorata and J. betonica*

The plant *C. odorata* and *J. betonica* were collected from Village near Alangayam and it is authentic by Dr. N. P. M. Mohamed Tariq, Assistant professor of Biotechnology, Islamiah College (Autonomous), Vaniyambadi. After documentation, a plants *C. odorata* and *J. betonica* material were treated for abstraction. The *C. odorata* and *J. betonica* remained systematically eviscerated with purified H_2O to eliminate powder elements and gumshoe dehydrated at chamber temperature and concentrated to abrasive gunpowder using a motorised blender. To 10 gm of the powder in 100ml of Water was auxiliary and stimulated infrequently in orbital shaker (Prasad and Venkateswarlu (2014) and Farook M. A. et al. 2017). The combination was strained on the 2nd day and the aqueous was vanished to acquire a rock-solid mass, which are kept in freezer (4 $^{\circ}$C) for further use.

2.5. Synthesis of Metal Nanoparticles

All the Glasswares used for the synthesis of TiO_2 NPs were washed using Aqua regia to remove salt deposits. In mixture of HCl: HNO3 in the ratio of 3:1.

2.5.1 Synthesis of TiO_2 NPs using plant extracts (C. *odorata)*

Titanium tetraisopropoxide (1 N) was ready consuming purified H_2O and a colourless solution was attained. Following, 25 ml of *C. odorata* extract additional to 0.1 N TtIp solutions. The colour of the combination transformed from pale yellow to gradually turn to sandal afterward six hours of unremitting stirred. This colour transformation is owing to the construction of TiO_2 NPs. The manufactured NPs were detached by centrifuged and dehydrated in a hot air oven at 100°C for four hours. The NPs were categorised by, SEM and GCMS studies.

2.5.2 Synthesis of TiO_2 NPS using plant extracts (*J. betonica*)

Titanium tetraisopropoxide (1 N) was ready consuming purified H_2O and a colourless solution was attained. Following, 25 ml of *J. betonica* extract additional to 0.1 N TtIp solutions. The colour of the combination transformed from pale yellow to gradually turn to sandal afterward six hours of unremitting stirred. This colour transformation is owing to the construction of TiO_2 NPs. The manufactured NPs were detached by centrifuged and dehydrated in a hot air oven at 100°C for four hours. The NPs were categorised by, SEM and GCMS studies.

2.6. Characterization of Phytochemically synthesized TiO_2 nanoparticles

2.6.1 Scanning electron microscopy (SEM)

SEM imaginings of metal nanoparticles and their Nano composites were obtained from OXFORD Instruments G2S-TWIN, 250Kv, FEI. The samples were diluted in 1:10 ratio and dried after which the samples were loaded in the grid size 400 mesh. The grid was loaded in the instrument for analysis. EDAX was also analysed to check the morphological features of the synthesized TiO2 NPs.

2.6.2 Gas Chromatography Mass Spectrometry (GC-MS)

GC–MS examination was conceded available to uniqueness the ingredients contemporary in the extract of *C. odorata and J. betonica*. The technique was completed by vaccinating 1 μL of sample into Furnace Opening temp 60°C for 2 min, incline 10°C/min to 300°C, hold 6 min, Transfer Temp=240°C, Font Temp=240°C, Scan: 40 to 600Da, Column 30.0m x 250μm, oxford GCMS and Helium (1 mL/min) remained cast-off as transporter vapour. The temperature inclination package was used as tracks 60 °C for 2 min which was additional augmented to 300 °C at a proportion of 10 °C per min and as a final point 6 min at 300 °C. The mass to charge proportion appearances of the flush segments was represented clinched uttermost data which was complementary with the supernatural collection of the conforming organic compounds (S.E. Stein et al 1999).

2.6.3 Identification of Chemical Components

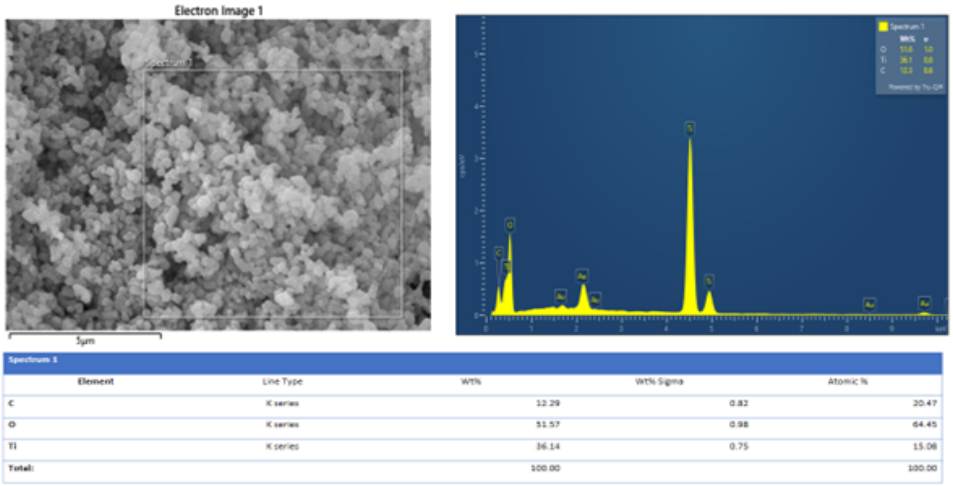
The compound constituents existing in the crude extract from the leaf of *C. odorata and J. betonica* was acknowledged constructed on the GC-MS retaining time. The mass spectrum was corresponding through the principles accessible in the prevailing CPU library (M.A. Hossain et al 2016) the constructions of the acknowledged composites remained resultant using Chem Draw Professional 18.0 software.

3. RESULTS AND DISCUSSION

3.1. Scanning Electron Microscopy (SEM), Gas Chromatography Mass Spectrometry (GC-MS) of TiO_2 Nanoparticles Prepared Using Leaf extract of *C. odorata* and *J. betonica*

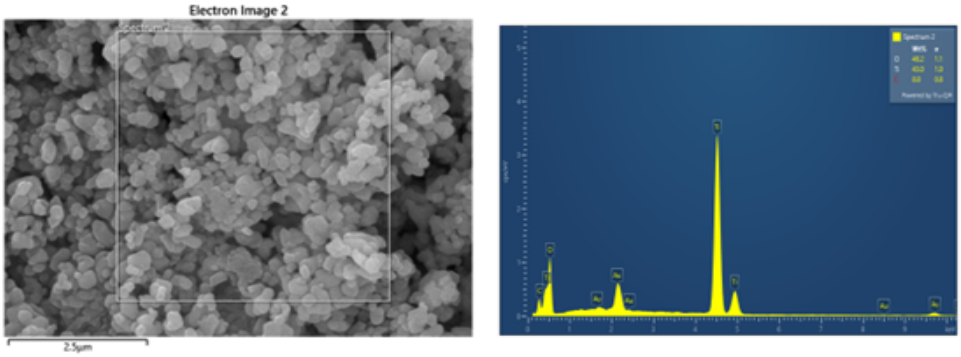
3.1.1 Scanning Electron Microscopy (SEM) Analysis

The superficial morphological structures of the blended TiO_2 NPs remained considered by SEM analysis. SEM imageries established that produced TiO_2 NPs remained tetragonal in shape. **Fig. 3.1 and 3.2** displays the physical and spatial morphology, particle size and feature proportion of the synthesized NPs in the deepest and uppermost exaggeration of 30 and 70 kX correspondingly and size is 5 μm and 2.5 μm are *C. odorata* and *J. betonica* respectively.



Spectrum 1				
Element	Line Type	Wt%	Wt% Sigma	Atomic %
C	K series	12.29	0.82	20.47
O	K series	51.57	0.98	64.45
Ti	K series	36.14	0.75	15.08
Total:		100.00		100.00

Figure 3: SEM Analyses of *C. odorata*



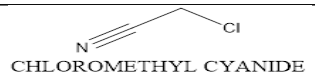
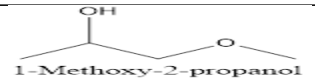
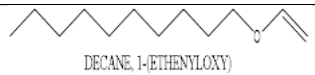
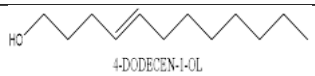
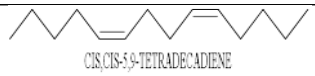
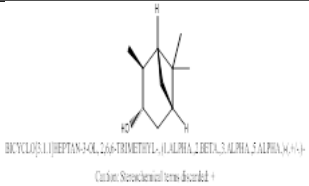
Spectrum 2				
Element	Line Type	Wt%	Wt% Sigma	Atomic %
C	K series	8.76	0.82	15.72
O	K series	48.19	1.12	64.92
Ti	K series	43.04	0.97	19.37
Total:		100.00		100.00

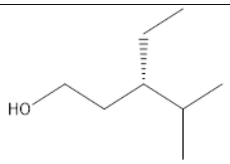
Figure 4: SEM Analyses of *J. betonica*

3.1.2 Gas Chromatography Mass Spectrometry (GC-MS)

The leaf extract of *C. odorata* & *J. betonica* was analyzed consuming mass spectrometry involved through gas chromatography. GC–MS outcomes, displayed the occurrence of 9 dissimilar composites in the Methanolic plant extract of *C. odorata* and *J. betonica*. The phytoconstituents remained acknowledged by corresponding the developed mass spectra with individuals originate in the NIST phantom database. The substance constructions resulting in Chem Draw Professional 15.0 was documented and presented in **Table 3.1**.

Table 1: GC-MS Analysis of *C. odorata* & *J. betonica leaf extracts*

S. No	Plant Material	Component Name	Chemical Structure	RT	Mass
1	***C. odorata***	**CHLOROMETHYL CYANIDE**		**1.484**	**75**
2	***J. betonica***	**2-PROPANOL, 1-METHOXYO**		**1.69**	**90**
3	***J. betonica***	**DECANE, 1-(ETHENYLOXY)**		**19.071**	**184**
4	***J. betonica***	**4-DODECEN-1-OL**		**19.511**	**184**
5	***C. odorata***	**1,12-TRIDECADIENE**		**19.516**	**180.34**
6	***J. betonica***	**CIS,CIS-5,9-TETRADECADIENE**		**19.671**	**194.36**
7	***C. odorata***	**BICYCLO[3.1.1] HEPTAN-3-OL, 2,6,6-TRIMETHYL- (1.ALPHA.,2.BETA., 3.ALPHA.,5.ALPHA.)- (.+/-.)-**		**19.686**	**154.25**

8	***J. betonica***	**(S)-3-ETHYL-4-METHYLPENTANOL**	 (S)-3-ETHYL-4-METHYLPENTANOL	**22.362**	**130.23**

3.2. Documentation of Biochemical Constituents

The biochemical constituents existing in the leaf extracts of *C. odorata* and *J. betonica* were identified based on the GC retention time. The spectra were recorded using the ideals accessible in the obtainable computer library (Hossain, M.A., et al 2014). The structures of the composites were obtained using ChemDraw Professional 15.0. The compounds found in the biochemical constituents of the leaf extract were as follows: 1. Chloromethyl cyanide does not combine with strong oxidizing agents, acids, moisture, or water 2. 2-propanol, 1-methoxyo are used in industrial and commercial applications; they are also used as printing/writing inks, coatings, carriers, paints, and solvents. 3. decane, 1-(ethenyloxy), are 1 (HIV-1) protease inhibitors (PIs) such as human immunodeficiency virus

Accessing the target compounds in silico; 4. 4-dodecen-1-ol is a chemical compound with antioxidant, hypoglycemic, hypolipidemic, analgesic, antimicrobial, anticancer, anxiolytic, anti-inflammatory, and anticonvulsant activities 5. 1, 12-tridecadiene is a natural substance and an extractives 6. Cis,cis-5,9-tetradecadiene is a similar product to fossil fuels that can be used as an alternative fuel for a more sustainable and cleaner environment 7. Bicyclo [3.1.1]heptan-3-ol and 2,6,6-trimethyl (1. alpha.,2.beta.,3.alpha.,5.alpha.)-(.+/-.) It appears as a colorless oily liquid with a mild odor, 8.(s)-3-ethyl-4-methylpentano is used in industrial applications such as wastewater treatment and chemical mixing.

4. CONCLUSION

C. odorata and *J. betonica* can be effectively castoff as active reducing agents for the synthesis of TiO_2-NPs. Such synthesized nanoparticles could be significantly used in various therapeutic applications like treatment of bacterial infections, antiproliferative agents and effective drug delivery systems. The considerably small size of the synthesized nanoparticles suggests that it can be used an effective targeted drug delivery system. Traditionally *C. odorata* and *J. betonica* are used against antifungal skin infections and eczema; hence the nanoparticles could be used in the formulation of antiseptic wound dressings. Green synthesis of nanoparticles provides an alternate way to treat various disorders with reduced risk of side effects and increased effectiveness. Antioxidant property of the synthesized nanoparticles serves the basis for its anticancer

potential. Thus, the nanoparticles could be studied for its cancer curing potential and as a potent anticancer drug delivery agent. From the technical opinion of TiO_2-NPs consume to obtained prospective solicitations in the biomedical. This modest technique has numerous gains such as cost-effectiveness', Biocompatibility for therapeutic and pharmaceutical applications as well as huge gauge profitable manufacture.

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MOBILE CLOUD ENVIRONMENT RANDOM SELF-GENERATIVE SCHNORR CERTIFICATELESS SIGNCRYPTION BASED SECURED DATA SHARING

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Abstract

Cloud computing on the go choose to offer their application on mobile devices via cloud computing. Data from the cloud server is shared with authorised users through the usage of cloud computing. The capacity to spread data resources among several users or applications is known as data sharing. A data-sharing system and access policy for an authorised user are the most challenging issues in cloud computing, despite the fact that many algorithms have been analysed. For enhancing data secrecy in a mobile cloud context, a novel method known as Random Self-Generative Schnorr Certificateless Signcryption based Secured Data Sharing (RSGSCS-SDS) is developed. Users of the mobile cloud must first register with the mobile cloud server in order to access various services. The mobile cloud server then uses Random Self-Generative Schnorr Certificateless Signcryption to generate the private and public keys for every registered user. For effective data access, the user submits the request to the mobile cloud server after creating the key. The cloud server assesses whether or not the requested mobile cloud user is authorised based on the policy characteristic. Finally verifies in order to decode the contents. When the signature is legitimate and authorised users are able to access the original data, protected data access is enhanced. Storage overhead, calculation time, and data confidentiality rate are the three metrics used in the experimental estimation of the proposed RSGSCS-SDS approach.

Keywords: Mobile Cloud Computing, Cloud Server, Data Confidentiality, Random Self-Generative Schnorr Certificateless Signcryption, Ciphertext, Signature.

1. INTRODUCTION

With the advent of cloud computing, businesses have been able to safely and effectively store their data on the cloud and distribute it to authorised employees. Yet, there are significant difficulties with sensitive data sharing in the cloud, such as ensuring data privacy and performing light operations on mobile terminals with limited resources. With a smaller key size, more security, and faster calculation, Cloud computing was introduced using Multi-Authority Ciphertext Policy Attribute Based Encryption with Elliptic Curve Cryptography (MA-CPABE-ECC) in [1]. The MA-CPABE-ECC approach did not, however, increase data secrecy.

For mobile cloud computing, a lightweight data sharing system (LDSS) was created in [2]. In a cloud environment, LDSS uses CP-ABE together with access control technologies. In-depth access control tree transition from mobile devices to external proxy servers was heavily used by LDSS. Nevertheless, LDSS did not lower the storage overhead. In [3], the MGPV protocol was established to prevent any potential attacks. The MGPV protocol decreased computing complexity and made sure that only authorised group users could view the documents. Although the complexity of the computation was lowered, the amount of time required was not able to reduce.

For the exchange of medical records, Medi-Block was created in [4] with a tamper-proof and anonymous identity management approach. During the authentication step, the proposed block used bilinear mapping concepts to get over the third party trust issues. The use of biocomputing as a solution approach was first described in [5] to address data security concerns. For ensuring the data's secrecy and integrity, a technique based on polymerase chain reaction and primer creation concepts was introduced.

For data-sharing schemes, privacy-preserving decision-making was presented in [6]. The planned system was in charge of enhancing data sharing security without duplicating resources across communicating users. Based on the cloudlets idea, an effective hybrid mobile cloud computing paradigm was presented in [7]. The processing and analysis of huge data was done using P2P Cloud System (P2PCS). Yet, the effective hybrid mobile cloud computing paradigm did not result in a decrease in data confidentiality rates.

The Federated Learning based Secure data Sharing (FL2S) method for the Internet of Things was introduced in [8]. A hierarchical asynchronous federated learning (FL) system based on sensitive task decomposition was introduced for secure data transmission. The FL2S method did not, however, reduce the storage overhead.

A privacy-preserving data access control approach based on Ciphertext-Policy attribute-based signcryption was proposed in [9] in order to enable multi-authority cloud storage systems with fine-grained control mechanisms and attribute privacy protection. Yet, the privacy-preserving data access control mechanism has no effect on the computational complexity. In [10], a cryptographic method was developed that encrypts client-side data before uploading to the cloud. The DNA cryptography is a

prerequisite for the multifold symmetric-key cryptography technique. Yet, the use of cryptographic techniques did not lessen the difficulty of processing.

The issues found in the aforementioned research include increased computational complexity, increased storage overhead, increased calculation time, decreased data secrecy, decreased security, and others. The Random Self-Generative Schnorr Certificateless Signcryption based Secured Data Sharing (RSGSCS-SDS) Method is used to solve these issues in the context of mobile clouds.

The RSGSCS-SDS Technique's primary contribution is to raise the bar for data secrecy in a mobile cloud context. Users of the mobile cloud must register with the server in order to access various services.

- The Random Self-Generative Schnorr Certificateless Signcryption The mobile cloud server uses technology to generate the private and public keys for each registered user. After creating the key, the user sends the request to the mobile cloud server.
- The Cloud servers utilise the policy property to verify their authenticity. The user of the mobile cloud is then given the requested data in ciphertext along with a signature by the mobile cloud server.
- To decrypt the data, the user must verify the signature. When the signature is legitimate and authorised users are able to access the original data, the RSGSCS-SDS Method has enhanced protected data access.

There are six distinct sections in the paper. The associated efforts of a secure data sharing cloud environment are reviewed. RSGSCS-SDS Methododology is provided in section 3 along with a clear graphic. In section 4, an experimental evaluation is carried out using three factors. Part 5 presents the findings and a discussion about to current state-of-the-art techniques.

2. RELATED WORKS

[11] Created an effective and security and accessibility for sharing resources context. The DHT network received the ciphertext shares. Unfortunately, an effective and secure access control approach did not lessen the complexity of the storage. In [12], a PEKS technique for string search was developed. Depending on their responsibilities, any number of individuals can search for and access the encrypted data. In order to outsource the data designcryption process and decrease the processing overhead on the user side, PROUD was introduced in [13] with ABSC solution. By reducing designcryption overhead, PROUD enabled end users to accept partly designcrypted data from edge servers with confidence. However PROUD did not speed up the computation.

End-to-end encryption (E2EE), which is based on a hybrid cryptographic algorithm, was created in [14] with the goal of enhancing the integrity and secrecy in a multimedia cloud computing environment. Although the rate of data secrecy increased, the cost of calculation remained same.

A secure data access and sharing architecture for cloud storage was presented in [15] as a solution to the data access issues. The cloud storage provider may be accessed by the user who has the correct biometrics and password. The time for exchanging data was not shortened, despite the secure data access and sharing technology.

In [16], an anonymous attribute-based broadcast encryption (A2B2E) technique with concealed access policy features was presented. The planned solution allowed the data owner to comply with the access policy by sharing their data with a number of participants. Yet, the A2B2E technique did not minimise the complexity of calculation.

In [17], a thorough and practical method was established, with cloud computing as the means by which cloud users share information. Cloud customers get the server services from cloud service providers (CSPs) via data centres. Yet, a thorough and practical method did not lower the computing complexity.

In order to offer customizable user revocation and data access control in a cloud context, an attribute-based secure data sharing (ASDS) approach was established in [18]. The planned strategy withstood the replay and collusion attacks. Yet, the ASDS approach did not lower the storage overhead.

In [19], a CP-ABE system with authority verification and secret keys of constant size was developed. The planned approach achieved n-BDHE problem decisional selective security. Yet, the privacy-preserving CP-ABE approach did not result in a decrease in data confidentiality rates.

In order to provide security when employing asymmetric key in the cloud context, a new system was implemented in [20] to avoid key exposure for file sharing. Nevertheless, the system's design did not lessen temporal complexity.

3. SECURED DATA SHARING WITH RANDOM SELF-GENERATIVE SCHNORR CERTIFICATELESS SIGNCRYPTION (RSGSCS-SDS)

The digital signature and encryption operations are carried out using Random Self-Generative Schnorr Certificateless Signcryption, public-key cryptography. A more efficient solution that increases the security of data in mobile clouds is Schnorr Signcryption. Data confidentiality is the key component of cloud data sharing from servers to mobile users. Secrecy is increased by using digital signature verification and encryption. As a consequence, the recommended RSGSCS-SDS Method was able to achieve higher secrecy thanks to the creation and verification of digital signatures using public key encryption mechanism utilised in it.

The suggested RSGSCS-SDS Technique's architectural design is shown in Figure 1 in order to provide more data secrecy in mobile clouds. For safe data sharing, the cloud-based architecture consists of three entities: the data owner (DO), the mobile cloud server (MCS), and the number of mobile cloud users (mcu 1, 2, 3,.....mcu n).

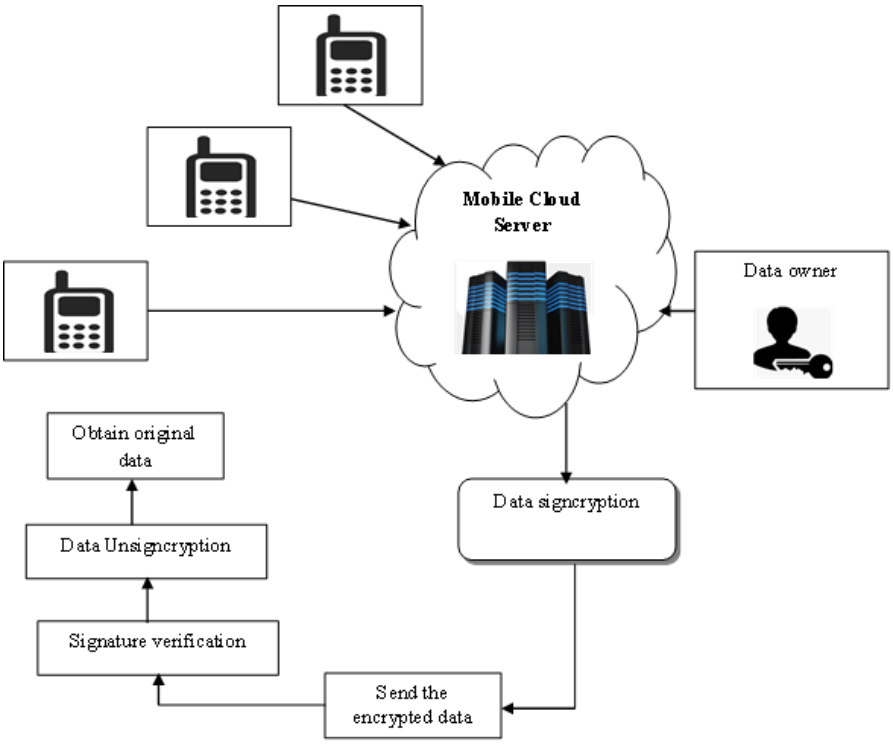

Figure 1: Architecture Diagram of Certificateless Signcryption based Data Sharing in Mobile Cloud

The owner of the data sends it to the mobile cloud server. The cloud owner checks the user identification of the mobile cloud user when they need to access the data. The mobile cloud server provides the user's signature and any encrypted data after user authentication. To get the actual data, the mobile cloud user decrypts and verifies signatures. In the sections that follow, the various steps of the suggested RSGSCS-SDS Method are discussed.

Registration and Key Generation

There are two phases in the RSGSCS-SDS method. Registration and key creation are them. The user enters their information into the mobile cloud server during the registration phase. The user information is then saved in the database of the mobile cloud server. The one-time password (OTP) is sent to the registered user by the cloud service provider. The user then enters the obtained OTP within the specified window of time. Because the created OTP is only valid for a certain amount of time, if the OTP is not supplied by the user at a set time instant, the user must login again and submit their information. The cloud server sends the correctly registered messages to the mobile user when they input the OTP.

The suggested RSGSCS-SDS technique's registration and key generation procedures are described.

$$\text{mcu} \xrightarrow{\text{Details}} \text{MCS} \tag{1}$$

According to (1), "MCS" stands for the mobile cloud server, and "mcu" for the mobile cloud user. The OTP is sent to the registered cellphone number by the mobile cloud server.

$$\text{MCS} \xrightarrow{\text{OTP}} \text{mcu} \tag{2}$$

In step two, the user of the mobile cloud inputs the OTP within the window of time specified by the mobile cloud server. The mobile cloud server then issued the mobile user a Successfully Registered Message (SRM). At that moment, the mobile cloud server produced the keys and saved their information. Let's assume that the Schnorr key generation process is used to create the secret signature key, or private key, "PI," which is a positive integer.

$$Pri_{Key} = \text{PI} \tag{3}$$

From (3), 'Pri_{Key}' represents the private key where the letter "PI" was chosen at random. The public verification key is obtained as soon as the private key is generated,

$$Pub_{Key} = f(\text{PI}) \tag{4}$$

$$f(\text{PI}) = \text{PI} + 1 \bmod 16. \tag{5}$$

From (4) and (5), 'f(PI)'. The one-way function is represented. The words "Pub Key" stand for the public verification key acquired from "PI." As the User id, public key verified and used. The registered user receives the user id, which is regarded as the public key. The mobile cloud server creates many policy characteristics throughout the Id generating procedure. To registered mobile users in the mobile cloud environment, the keys are given out.

Signcryption

Depending on the policy parameters, the RSGSCS-SDS approach conducts the signcryption for effective data transfer to the authorised organisation. A public-key cryptosystem featuring data encryption and digital signature capabilities is called Signcryption. The receiver's public key is used for encryption, whereas the receiver's private key is used for decryption. Data encryption changes a file's original format so that only authorised users may read it. When a registered mobile user accesses a resource mobile cloud server, the registered user must log in. The mobile cloud server checks to see whether the policy characteristics established during registration are still valid. Figure 2 depicts the policy attribute-based data access procedure.

The registered mobile user must provide a valid User Id in the login box each time they need to access data on the mobile cloud server. The mobile cloud server then confirms the mobile user ID entered matches the mobile user ID recorded in the server

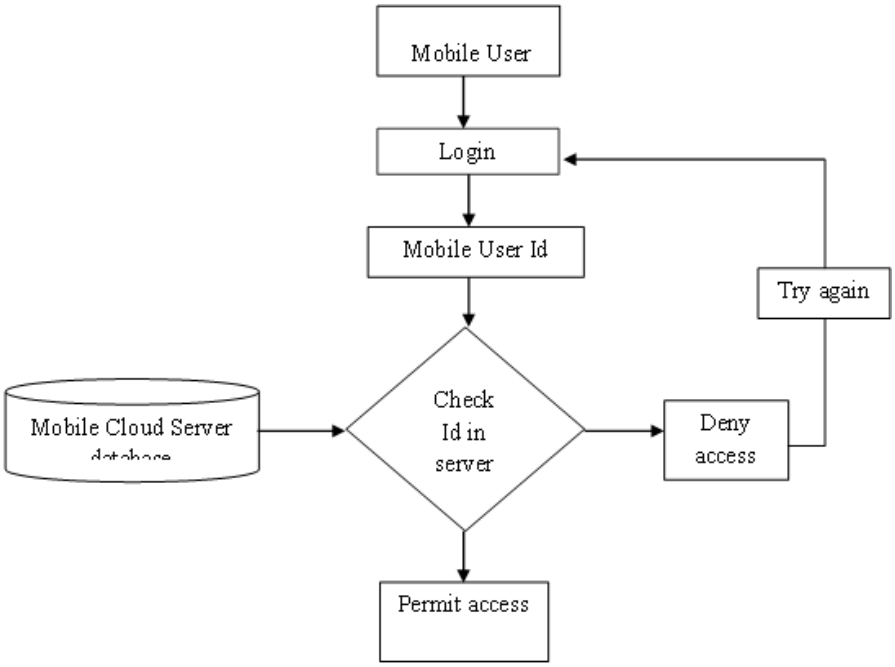

Figure 2: Policy Aspect Method for Schnorr Certificateless Signcryption

database during the registration procedure. Using policies that integrate the features, the mobile cloud server grants users access rights. The ”if-then” rules are then used by Policy Attribute Schnorr Certificateless Signcryption. The authorised user requests and mobile cloud server grants access whe entered Id matches the Id recorded in the database of the mobile cloud server. A mobile cloud server would then be refused access and the mobile user would be accused of being an illegal user. The data is shared as ciphertext once the mobile cloud server has verified the mobile user's identity. The encrypted data is sent to the authorised user via the mobile cloud server.

The architecture of the Signcryption Process is shown in Figure 3.

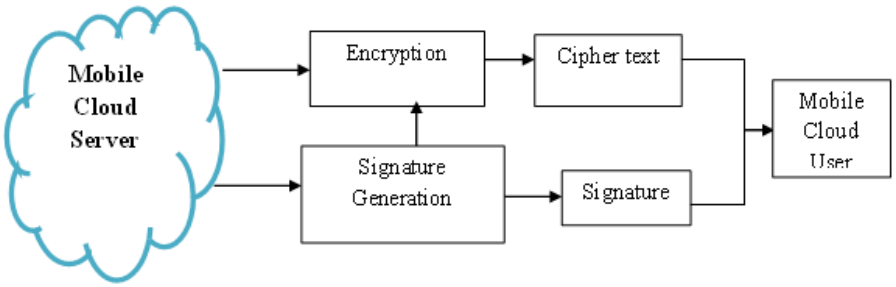

Figure 3: Signcryption Process

Let's assume that the data is represented as d 1, d 2, d 3, ..., d n'. The data provided by the mobile cloud server's ciphertext is as follows.

$$Cipher(d) \leftarrow Encryption\langle Pub_{Key}, d\rangle. \tag{6}$$

Cipher(d) in (6) denotes the ciphertext of the data 'd'. Using the receiver's user Id as the recipient's public key, encryption is performed. With the sender's private key, a digital signature is produced. A genuine digital signature provides the assurance that data was produced by the acknowledged sender (a mobile cloud server, for example) and was not changed by outsiders. The Schnorr Certificateless Signcryption algorithm uses a private key to operate. Consider the data d=d 1, d 2, d 3,..., d mbe (0, 1) and the formulation for signature generation.

$$Signature_d = h(PI||d). \tag{7}$$

'Signature d' in (7) refers to the signature of mobile cloud data 'd'. "( )" stands for the concatenation. The letter "h" stands for the cryptographic hash function. The word "PI" stands for the positive integer. The mobile cloud server transmits the ciphertext and signature after creating the signature.

Unsigncryption

The RSGSCS-SDS technique does the unsigncryption based on the signature verification and decryption in order to restore the original data. The signature verification is done using Schnorr Certificateless Signcryption.

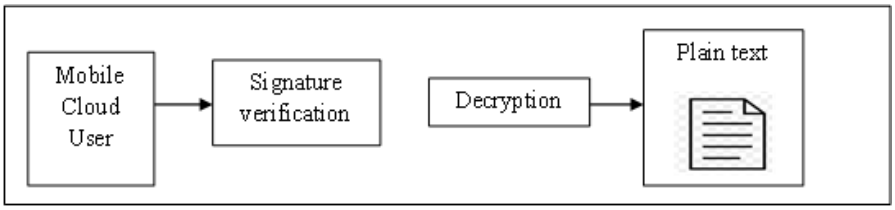

Figure 4: Unsigncryption Process

The block diagram of the decryption and signature verification processes is shown in Figure 4. To obtain the plain text, the public key is used to verify the signature.

$$Signature''_d = h(PI_v||d) \tag{8}$$

$$f(x) = \begin{matrix} if(Signature_d = Signature''_d); signatureisvalid \\ otherwise; \quad signatureisnotvalid \end{matrix} \tag{9}$$

From (8) and (9), "Signature d" denotes the signature created at the receiver's end, and "f(x)" denotes the signature's one-way function. "PI v" stands for a positive integer, while "h" stands for a cryptographic hash function. Lastly, the created signature is

checked and the public key "Pub Key" verify it. The ciphertext is decrypted by the mobile cloud user once both signatures have been verified as authentic. If not, the signature cannot be matched and is thus invalid. The ciphertext is not decrypted by the mobile cloud user. The ciphertext is decrypted by the authorised user, who then obtains the original data as,

$$d \leftarrow Decryption\langle Pri_{Key}, Cipher(d)\rangle \tag{10}$$

'd' stands for an initial data in (10). The term "Pri Key" refers to the mobile user's private key. After decryption, the original data is finally obtained, and the output is shown at the output layer. The authorised user can access the data from the mobile cloud server using the RSGSCS-SDS method. In this way, the RSGSCS-SDS approach enhances data confidentiality.

The random self-generative Schnorr certificateless signcryption procedure is described in detail in Algorithm 1 for secured data exchange. The number of mobile cloud users is first provided as an input. The RSGSCS-SDS approach is used to generate keys for users and register them. To identify the authorised user, random self-generative Schnorr certificateless signcryption is then used. The mobile cloud user must first log into the system with their Id if they wish to access the data.

The mobile cloud user recognises that the entered user is permitted and grants access when the Ids are appropriately matched. If not, the user of the mobile cloud is regarded as an unauthorised user. The mobile cloud server executes signcryption and gives access to the authorised user.

//Algorithm 1 Secured Data Sharing with Random Self-Generative Schnorr Certificateless Signcryption

Input: Number of mobile cloud users $mcu_1, mcu_2, mcu_3, ..., mcu_n$, data $d_1, d_2, d_3, ..., d_m$
Output: Increases data access security
Begin
    Number of users $mcu_1, mcu_2, mcu_3, ..., mcu_n$ **taken as input at input layer**
// **Registration and key generation**
Every individual mobile cloud user mcu_i
    server details registration
    Mobile cloud server sends OTP
    User enters 'OTP' at specific time period 't'
    If mcu_i enter 'OTP'
        MCS sends 'SRM' to mcu_i
        End if
            For each registered 'mcu_i'
                MCS generates the private and public key
            End for
    End for

```
// Signcryption
    If mobile cloud user access the data then
        Login to the mobile cloud server with valid 'Id'
    End if
            If (Id matched with server database) then
                Mobile Cloud User (unauthorized user)
                    MCS permits access
            else
                Mobile Cloud User (unauthorized user)
                    MCS denied access
            End if
        Encrypt the data using public key
        Generate the digital signature
            Send to the authorized user
// Unsigncryption
```

4. EXPERIMENTAL ANALYSIS

Java is used to implement the experimental study of the proposed RSGSCS-SDS technique and CloudSim network simulator. For research purposes, a sample dataset from Amazon is used to test safe data access and sharing in a mobile cloud environment. The dataset is collected from the UCI machine learning repository https://archive.ics.uci.edu/ml/datasets/Amazon+Access+Samples. The dataset would include a sample of organisation access that had been masked. The dataset's main goal is to give maximum response access to historical data. The dataset will be generated for the user for read and write access on the cloud server and includes several policy attributes, namely System Support ID, Person Attribute, Group ID, and Resource ID.

5. RESULT ANALYSIS

Three metrics–storage overhead, computation time, and data confidentiality–are used in an experimental comparison of the proposed RSGSCS-SDS technique and two already-in-use algorithms, Multi-Authority Ciphertext Policy Attribute Based Encryption with Elliptic Curve Cryptography (MA-CPABE-ECC) [1] and lightweight data sharing scheme (LDSS) [2].

5.1. Impact of Storage Overhead

To improve data security in a mobile cloud context, storage overhead is the amount of memory used during the key generation process. As seen below, the storage overhead is calculated.

$$\text{Storage}_{\text{Over}} = \text{Number of data} * \text{Memory [private key + public key]}. \quad (11)$$

From (11), '$Storage_{Over}$' denotes the storage overhead.

Table 2: Tabulation of Storage Overhead

Number of Data (Number)	Storage Overhead (KB)		
	MA-CPABE-ECC	**LDSS**	**RSGSCS-SDS Technique**
25	385	354	300
50	398	365	315
75	415	379	328
100	426	391	340
125	437	412	355
150	452	435	380
175	473	458	400
200	496	479	421
225	507	495	445
250	519	512	459

Table 1 shows the storage requirements for three approaches utilising a range of 25 to 250 data points. According to the obtained data, the suggested RSGSCS-SDS Method has a lower storage overhead than the other two approaches. Let's assume that the maximum number of data that may be shared from the mobile cloud server is 25. By using the suggested RSGSCS-SDS Method, the storage overhead obtained is 300KB, compared to 385KB and 354KB for the current Multi-Authority Ciphertext Policy Attribute Based Encryption with Elliptic Curve Cryptography (MA-CPABE-ECC) [1] and lightweight data sharing scheme (LDSS) [2]. The nine different findings are also obtained and displayed in the graph below.

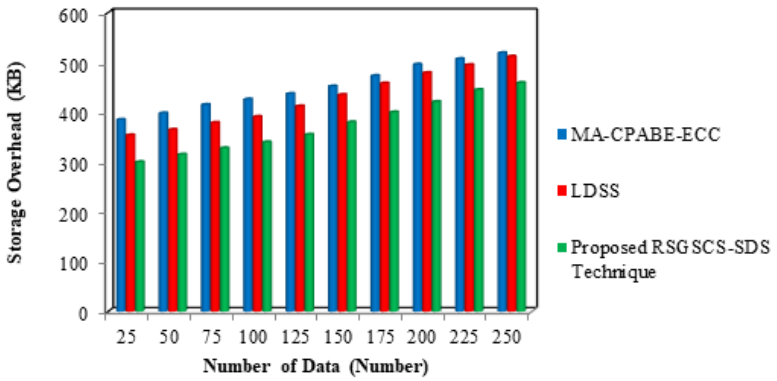

Figure 6: Measurement of Storage Overhead

Figure 6 shows the comparison of storage overhead results based on the volume of data. The storage overhead of three methods—the RSGSCS-SDS Method, the MA-CPABE-ECC [1] and the LDSS [2]—is depicted in the graph in three distinct colours, blue, red, and green. The outcome demonstrates that the suggested RSGSCS-SDS Method reduces storage overhead in comparison to the current approaches. This is due to the random self-generative schnorr certificateless signcryption performed by the proposed RSGSCS-SDS Method.

The mobile cloud user authenticates their identity for safe data sharing whenever they need to access data from the cloud. Depending on the user's identification, the data owner performs the authentication. The suggested RSGSCS-SDS Method, when compared to the current MA-CPABE-ECC [1] and LDSS [2], significantly decreases storage overhead by 17% and 13%, respectively, according to the average of comparative findings.

5.2. Impact of Computation Time

Computation time is the length of time required to carry out secure data sharing between the user and cloud servers. As follows are the computation times:

$$\text{Comp}_{\text{Time}} = [\text{ Number of data} \times \text{ Time consumed to share one data }]. \quad (12)$$

From (12), '$\text{Comp}_{\text{Time}}$' denotes the computation time.

Table 3: Tabulation of Computation Time

Number of Data (Number)	Computation Time (ms)		
	MA-CPABE-ECC	**LDSS**	**RSGSCS-SDS technique**
25	41	34	25
50	43	37	27
75	45	39	29
100	47	41	30
125	50	43	31
150	52	45	33
175	55	47	34
200	57	49	37
225	59	51	39
250	61	53	41

Table 2 shows the computation times for three approaches utilising the number of data collected between 25 and 250. According to the findings, the suggested RSGSCS-SDS Method requires less computing time than the other two approaches. Let's assume

that there are 25 data to share from the mobile cloud server. In comparison to the current Multi-Authority Ciphertext Policy Attribute Based Encryption with Elliptic Curve Cryptography (MA-CPABE-ECC) [1] and lightweight data sharing scheme (LDSS) [2], the calculation time gained by using the suggested RSGSCS-SDS Method is 25ms. The remaining nine findings are also obtained and displayed in the graph below.

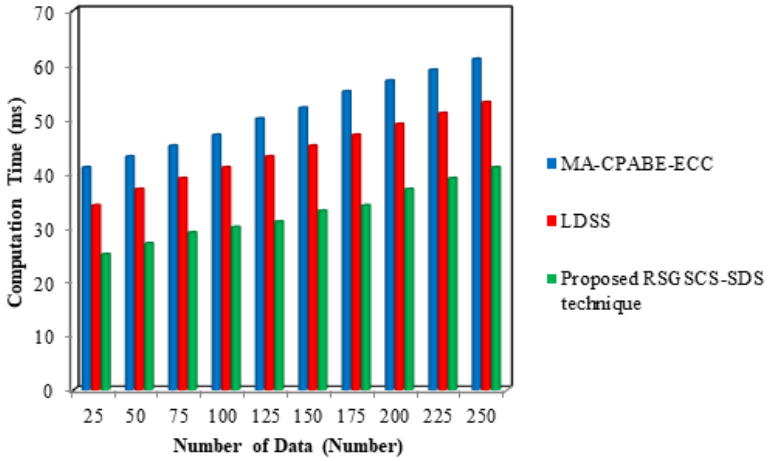

Figure 7: Measurement of Computation Time

The results of the computation time comparison with regard to the quantity of data are shown in Figure 7. As shown in the graph, the three techniques' calculation times—RSGSCS-SDS Method, MA-CPABE-ECC [1] and LDSS [2]—are each represented by one of three colors—blue, red, or green. The outcome demonstrates that the suggested RSGSCS-SDS Method takes less time to compute than the current approaches. This is so because the RSGSCS-SDS technique that was presented employed a random self-generative Schnorr certificateless signcryption method. When a user of a mobile cloud environment has to access data from that environment, that user authenticates themselves to allow for safe data exchange.

The data owner asks effective data sharing from the cloud server when the mobile user ID perfectly matches the ID that was already saved at the time of registration. This makes it possible for the proposed RSGSCS-SDS Method to quickly and reliably determine whether a mobile user is permitted or not. In comparison to the current MA-CPABE-ECC [1] and LDSS [2], the suggested RSGSCS-SDS Method decreases calculation time consumption by 36% and 26%, respectively, according to the average of comparison findings.

5.3. Impact of Data Confidentiality Rate

The cloud server's ability to keep the data secure from security breaches has an influence on data confidentiality rates. The ratio of all cloud data to information accessed by

authorised users is assessed to evaluate data confidentiality. In order to figure out the data confidentiality rate,

$$\text{Data Con}_{\text{Rate}} = \left[\frac{\text{Number of data accessed by the authorized users}}{\text{Total number of cloud data}}\right] \times 100 \qquad (5.1)$$

From (13), 'Data Con_{Rate} represent the impact of data confidentiality rate.

Table 4: Tabulation of Data Confidentiality Rate

Data in (Number)	Data Confidentiality Rate (%)		
	MA-CPABE-ECC	**LDSS**	**RSGSCS-SDS technique**
25	75	78	82
50	77	79	83
75	78	81	85
100	81	83	86
125	82	85	88
150	84	86	89
175	85	87	91
200	88	90	93
225	89	91	95
250	90	93	96

Table 3 displays the data confidentially rates for three approaches utilising a range of 25 to 250 data points. According to the results, the suggested RSGSCS-SDS Method has a greater percentage of data secrecy than the other two techniques already in use. Let's think about the 25 data that may be shared from the mobile cloud server. The data confidentially rate was 82% when utilising the suggested RSGSCS-SDS Method, compared to 75% and 78% for the current Multi-Authority Ciphertext Policy Attribute Based Encryption with Elliptic Curve Cryptography (MA-CPABE-ECC) [1] and lightweight data sharing scheme (LDSS) [2]. Similar findings are obtained for the next nine outcomes, which are displayed graphically for the data confidentially rate.

The comparison findings of the data confidentiality rate in relation to the volume of data are explained in Figure 8. As shown in the graph, the three techniques, RSGSCS-SDS Method, MA-CPABE-ECC [1], and LDSS [2], have various computation times that are shown by three different colours: blue, red, and green. The outcome demonstrates that employing the suggested RSGSCS-SDS Method over the currently used techniques increases the data confidentially rate. The use of the random self-generative Schnorr certificateless signcryption procedure is to blame for this. When a user of a mobile cloud environment accesses data from a mobile cloud environment, the user authenticates

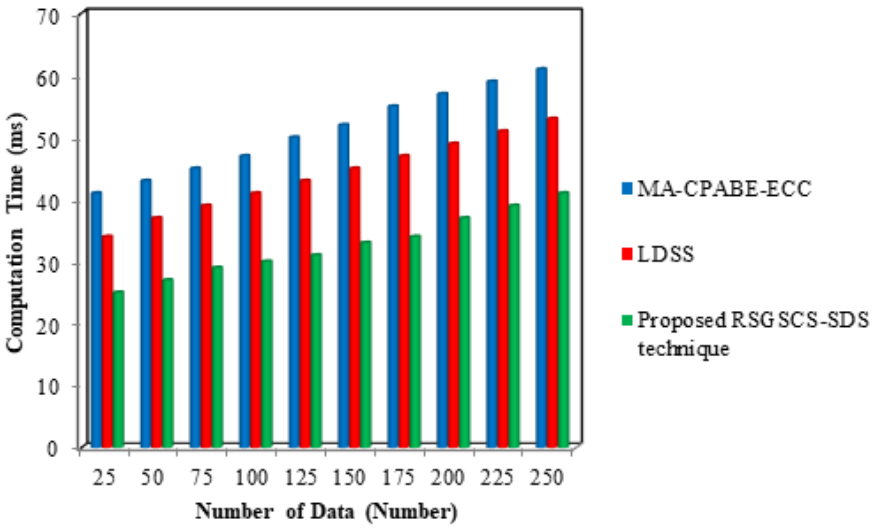

Figure 8: Measurement of Data Confidentiality Rate

themselves in order to undertake protected data exchange. Depending on the user's identification, the data owner performs the authentication. The data owner asks effective data sharing from the cloud server when the mobile user ID precisely matches the ID that was previously saved at the time of registration. With a greater rate of data secrecy, the RSGSCS-SDS Method accurately distinguishes between approved and illegitimate mobile users. In comparison to the current MA-CPABE-ECC [1] and LDSS [2], the suggested RSGSCS-SDS Method raises the data confidentially rate by 7% and 4%, respectively, according to the average of comparative findings.

6. CONCLUSION

For safe data sharing in mobile clouds with improved data secrecy, the RSGSCS-SDS methodology, a powerful cryptographic method, is introduced. Random Self-Generative Schnorr Certificateless Signcryption is used to securely share data between a mobile cloud server and a mobile cloud user. Every time a user wants to access data from a mobile cloud server, the data owner confirms the user's identity to increase cloud security. To protect data from unauthorised users and increase data confidentiality, signature creation and encryption are used. When the digital signature is still valid at the time of verification, the receiver decrypts the cypher text and obtains the original data. Using a sample dataset from Amazon Access, experimental assessment is conducted utilising several factors, including storage overhead, computation time, and data confidentiality. The mentioned results analysis reveals that the RSGSCS-SDS methodology delivers stronger data secrecy than state-of-the-art methods with the least amount of storage overhead and computing time.

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A STUDY ON PRODUCT OF ANTI FUZZY GRAPHS

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Abstract

The anti fuzzy graph is introduced by M.S.Sunitha, A.Vijayakumar, R.Muthuraj and A.Sasirekha. A new anti fuzzy graph can be obtained from two given anti fuzzy graphs using the operations, cartesian product, composition, tensor product and normal product. In this paper, we study about the degree of a vertex in anti fuzzy graphs which are obtained from two given anti fuzzy graph using the operations cartesian product, composition.

Keywords: Anti Fuzzy Graph, Cartesian Product, Composition.

1. INTRODUCTION

The concept of fuzzy graph was first introduced by Kaufmann from the fuzzy relation introduced by Zadeh. Although Rosenfield introduced another elaborated definition including fuzzy vertex and fuzzy edge and also introduced the notion of fuzzy graph. The operation of union, join, Cartesian product and composition on two fuzzy graphs were defined by Moderson J.N and Peng C.S. In this paper we study about the degree of a vertex in anti fuzzy graphs which are obtained from two given anti fuzzy graphs using the operations Cartesian product , Composition, Tensor product and Normal product.

2. PRELIMINARIES

Definition 2.1. *An anti fuzzy graph $\mathcal{A} = (\sigma, \mu)$ is a pair of functions $\sigma : V \to [0, 1]$ and $\mu : V \times V \to [0, 1]$ with $\mu(u, v) \geq \sigma(u) \vee \sigma(v)$ for all u, v in V where V is a finite non empty set and $\vee$ denote maximum.*

Definition 2.2. *The graph $\mathcal{A}^* = (V, E)$ is called the underlying crisp graph of an anti fuzzy graph $\mathcal{A}$ where $V = \{u/\sigma(u) \neq 0\}$ and $E = \{(u, v) \in V \times V/\mu(u, v) \neq 0\}$.*

Definition 2.3. *Let $\mathcal{A} = (\sigma, \mu)$ be an anti fuzzy graph. The degree of a vertex $\sigma(u)$ of an anti fuzzy graph is sum of degree of membership of all those edges which are incident on vertex $\sigma(u)$ and is denoted by $d_{\mathcal{A}}(\sigma(u)) = d(\sigma(u)) = \sum_{u \neq v} \mu(u, v) = \sum_{uv \in E} \mu(u, v)$.*

Definition 2.4. *The Cartesian Product of two anti fuzzy graph $\mathcal{A}_1$ and $\mathcal{A}_2$ is defined as a anti fuzzy graph $\mathcal{A} = \mathcal{A}_1 \times \mathcal{A}_2 : (\sigma_1 \times \sigma_2,\ \mu_1 \times \mu_2)$ on $\mathcal{A}^* : (V, E)$, where $V = V_1 \times V_2$ and $E = \{((u_1, u_2)(v_1, v_2))/u_1 = v_1, u_2v_2 \in E_2 (or\ ) u_2 = v_2, u_1v_1 \in E_1\}$ with*

$$(\sigma_1 \times \sigma_2)(u_1, u_2) = \sigma_1(u_1) \vee \sigma_2(u_2)\ \ \forall\, (u_1, u_2) \in V_1 \times V_2$$

and

$$(\mu_1 \times \mu_2)((u_1, u_2)(v_1, v_2)) = \begin{cases} \{\sigma_1(u_1) \vee \mu_2(u_2v_2)\,, & if\ \ u_1 = v_1, u_2v_2 \in E_2 \\ \{\sigma_2(u_2) \vee \mu_1(u_1v_1)\,, & if\ \ u_2 = v_2, u_1v_1 \in E_1. \end{cases}$$

3. Degree of vertex in Cartesian product

By the definition for any vertex (u_1, u_2) in $V_1 \times V_2$

$$\begin{aligned} d_{\mathcal{A}_1 \times \mathcal{A}_2}(u_1, u_2) &= \sum_{(u_1,u_2)(v_1,v_2) \in E} (\mu_1 \times \mu_2)((u_1, u_2)(v_1, v_2)) \\ &= \sum_{u_1 = v_1, u_2v_2 \in E_2} \sigma_1(u_1) \vee \mu_2(u_2v_2) + \sum_{u_2 = v_2, u_1v_1 \in E_1} \sigma_2(u_2) \vee \mu_1(u_1v_1) \end{aligned}$$

In the following theorem, we find the degree of (u_1, u_2) in $\mathcal{A}_1 \times \mathcal{A}_2$ in terms of those in $\mathcal{A}_1$ and $\mathcal{A}_2$ in some particular cases.

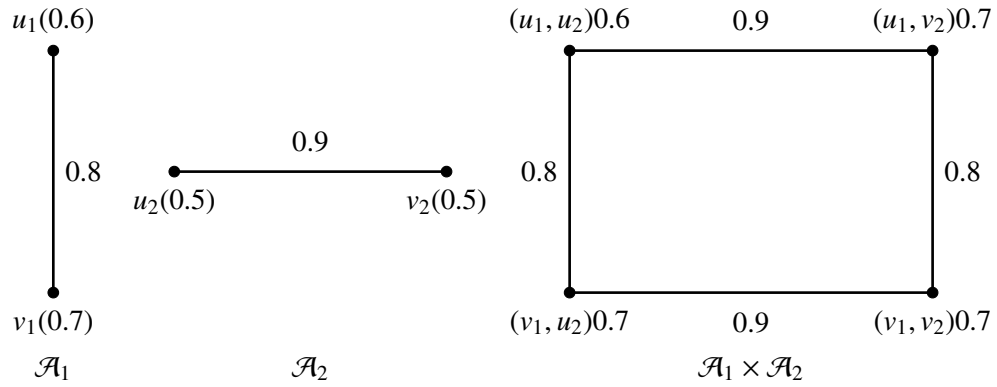
Theorem 3.1. *Let $\mathcal{A}_1(\sigma_1, \mu_1)$ and $\mathcal{A}_2(\sigma_2, \mu_2)$ be two anti fuzzy graphs. If $\sigma_1 \leq \mu_2$ and $\sigma_2 \leq \mu_1$ then $d_{\mathcal{A}_1 \times \mathcal{A}_2}(u_1, u_2) = d_{\mathcal{A}_1}(u_1) + d_{\mathcal{A}_2}(u_2)$.*

Proof. From the definition of a degree of vertex in Cartesian Product

$$d_{\mathcal{A}_1\times\mathcal{A}_2}(u_1,u_2) = \sum_{u_1=v_1,u_2v_2\in E_2} \sigma_1(u_1)\vee\mu_2(u_2v_2) + \sum_{u_2=v_2,u_1v_1\in E_1} \sigma_2(u_2)\vee\mu_1(u_1v_1)$$
$$= \sum_{u_2v_2\in E_2} \mu_2(u_2v_2) + \sum_{u_1v_1\in E_1} \mu_1(u_1v_1)$$

Since $\sigma_1 \le \mu_2$ and $\sigma_2 \le \mu_1$, $\quad d_{\mathcal{A}_1\times\mathcal{A}_2}(u_1,u_2) = d_{\mathcal{A}_1}(u_1) + d_{\mathcal{A}_2}(u_2)$. □

Example 3.1.



Cartesian product of $\mathcal{A}_1\&\mathcal{A}_2$ $(\mathcal{A}_1\times\mathcal{A}_2)$

Here $\mathcal{A}_1$ and $\mathcal{A}_2$ are two anti fuzzy graph, $\sigma_1 \le \mu_2$ and $\sigma_2 \le \mu_1$.

$$d_{\mathcal{A}_1\times\mathcal{A}_2}(u_1,u_2) = d_{\mathcal{A}_1}(u_1) + d_{\mathcal{A}_2}(u_2)$$
$$= 0.8 + 0.9 = 1.7$$
$$d_{\mathcal{A}_1\times\mathcal{A}_2}(u_1,v_2) = d_{\mathcal{A}_1}(u_1) + d_{\mathcal{A}_2}(v_2)$$
$$= 0.8 + 0.9 = 1.7.$$

Similarly we can find all the vertices of $\mathcal{A}_1$ and $\mathcal{A}_2$.

Definition 3.1. *The composition of two anti fuzzy graph $\mathcal{A}_1$ and $\mathcal{A}_2$ is defined as a anti fuzzy graph $\mathcal{A} = \mathcal{A}_1[\mathcal{A}_2] : (\sigma_1 o\sigma_2, \mu_1 o\mu_2)$ on $\mathcal{A}^* = (V,E)$, where $V = V_1\times V_2$ and $E = \{((u_1,u_2)(v_1,v_2)) / \ u_1 = v_1, u_2v_2 \in E_2$ (or) $u_2 \ne v_2, u_1v_1 \in E_1$ (or) $u_2 = v_2, u_1v_1E_2\}$ with*

$$(\sigma_1\circ\sigma_2)(u_1,u_2) = \sigma_1(u_1)\vee\sigma_2(u_2) \text{ for all } (u_1,u_2)\in V_1\times V_2.$$

$$(\mu_1\circ\mu_2)((u_1,u_2)(v_1,v_2)) = \begin{cases} \sigma_1(u_1)\vee\mu_2(u_2v_2) & \text{if } u_1 = v_1, u_2v_2\in E_2 \\ \sigma_2(u_2)\vee\mu_1(u_1v_1) & \text{if } u_2 = v_2, u_1v_1\in E_1 \\ \sigma_2(u_2)\vee\mu_1(u_1v_1) & \text{if } u_2\ne v_2, u_1v_1\in E_1. \end{cases}$$

4. Degree of a vertex in Composition

By the definition, for any vertex (u_1, u_2) in $V_1 \times V_2$

$$\begin{aligned} d_{\mathcal{A}_1[\mathcal{A}_2]}(u_1, u_2) &= \sum_{(u_1,u_2)(v_1,v_2)\in E} (\mu_1 o \mu_2)(u_1, u_2)(v_1, v_2) \\ &= \sum_{u_1=v_1, u_2v_2\in E_2} \sigma_1(u_1) \vee \mu_2(u_2v_2) + \sum_{u_2=v_2, u_1v_1\in E_1} \sigma_2(u_2) \vee \mu_1(u_1v_1) \\ &\quad + \sum_{u_2\neq v_2, u_1v_1\in E_1} \sigma_2(u_2) \vee \mu_1(u_1v_1) \end{aligned}$$

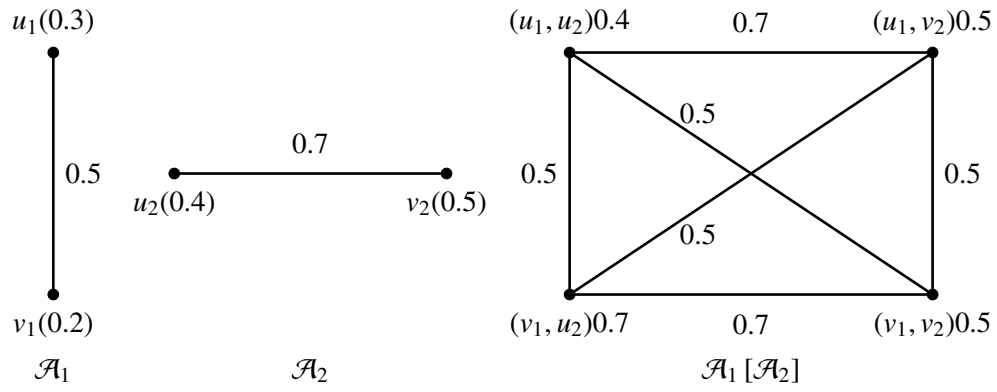
Theorem 4.1. *Let $\mathcal{A}_1 : (\sigma_1, \mu_1)$ and $\mathcal{A}_2 : (\sigma_2, \mu_2)$ be two anti fuzzy graphs. If $\sigma_1 \leq \mu_2$ and $\sigma_2 \leq \mu_1$ then $d_{\mathcal{A}_1[\mathcal{A}_2]}(u_1, u_2) = P_2 d_{\mathcal{A}_1}(u_1) + d_{\mathcal{A}_2}(u_2)$.*

Proof.

$$\begin{aligned} d_{\mathcal{A}_1[\mathcal{A}_2]}(u_1, u_2) &= \sum_{u_1=v_1, u_2v_2\in E_2} \sigma_1(u_1) \vee \mu_2(u_2v_2) + \sum_{u_2=v_2, u_1v_1\in E_1} \sigma_2(u_2) \vee \mu_1(u_1v_1) \\ &\quad + \sum_{u_2\neq v_2, u_1v_1\in E_1} \sigma_2(u_2) \vee \mu_1(u_1v_1) \\ d_{\mathcal{A}_1[\mathcal{A}_2]}(u_1, u_2) &= \sum_{u_1=v_1, u_2v_2\in E_2} \mu_2(u_2v_2) + \sum_{u_2=v_2, u_1v_1\in E_1} \mu_1(u_1v_1) \\ &\quad + \sum_{u_2\neq v_2, u_1v_1\in E_1} \mu_1(u_1v_1) \qquad \text{since } \sigma_1 \leq \mu_2 \text{ and } \sigma_2 \leq \mu_1 \\ &= d_{\mathcal{A}_2}(u_2) + |V_2| \sum_{u_1v_1\in E_1} \mu_1(u_1v_1) = d_{\mathcal{A}_2}(u_2) + P_2 d_{\mathcal{A}_1}(u_1). \end{aligned}$$

□

Example 4.1.



Composition of $\mathcal{A}_1 \& \mathcal{A}_2$ is $\mathcal{A}_1$ $[\mathcal{A}_2]$

Consider the anti fuzzy graph $\mathcal{A}_1$ and $\mathcal{A}_2$ with $\sigma_1 \leq \mu_2$ and $\sigma_2 \leq \mu_1$.

$$\begin{aligned} d_{\mathcal{A}_1[\mathcal{A}_2]}(u_1, u_2) &= P_2 d_{\mathcal{A}_1}(u_1) + d_{\mathcal{A}_2}(u_2). \\ &= 2(0.5) + 0.7 = 1.7 \\ d_{\mathcal{A}_1[\mathcal{A}_2]}(u_1, v_2) &= P_2 d_{\mathcal{A}_1}(u_1) + d_{\mathcal{A}_2}(v_2). \\ &= 2(0.5) + 0.7 = 1.7. \end{aligned}$$

Similarly we can find degree of all the vertices in $\mathcal{A}_1$ $[\mathcal{A}_2]$

Definition 4.1. *The tensor product of two anti fuzzy graphs (σ_i, μ_i) on $G_i = (V_i, X_i)$, $i = 1, 2$ is defined as a anti fuzzy graph $(\sigma_1 \otimes \sigma_2, \mu_1 \otimes \mu_2)$ on $\mathcal{A} = (V, X)$ where $V = V_1 \times V_2$ and $X = \{(u_1, u_2), (v_1, v_2) / (u_1, v_1) \in X_1, \ (u_2, v_2) \in X_2\}$. Anti fuzzy sets $\sigma_1 \otimes \sigma_2$ and $\mu_1 \otimes \mu_2$ are defined as*

$$(\sigma_1 \otimes \sigma_2))(u_1, u_2) = \sigma_1(u_1) \vee \sigma_2(u_2) \text{ for all } (u_1, u_2) \in V_1 \times V_2.$$

$$(\mu_1 \otimes \mu_2)\{(u_1, u_2), (v_1, v_2)\} = \{\mu_1(u_1 v_1) \vee \mu_2(u_2 v_2)\} \ \forall \ (u_1, v_1) \in X_1, (u_2, v_2) \in X_2.$$

5. Conclusion

In this paper, we have discussed about the anti fuzzy graph and product of anti fuzzy graph. We defined basic and important definitions on anti fuzzy graph. Also we discussed about the degree of vertex in Cartesian product and Composition.

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A STUDY ON BALANCED PRODUCT FUZZY GRAPHS

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Abstract

In this paper, the notion of maximal product of two fuzzy graphs was introduced by Radha and Arumugam in 2015 and the notion of balanced fuzzy graph was introduced by Al-Hawary in 2011. In this paper, we give a modification of the maximal product definition, which we call maximal strong product. We also introduce the relatively new notion of maximal-balanced fuzzy graphs. We give necessary and sufficient conditions for the maximal strong product of two balanced (resp., maximal-balanced) fuzzy graphs to be balanced (resp., maximal-balanced) and we prove that these two independent notions are preserved under isomorphism.

Keywords: Fuzzy Graph, Complete Fuzzy Graph, Maximal Strong Product, Balanced Fuzzy Graph, Maximal-Balanced Fuzzy Graph.

1. INTRODUCTION

Fuzzy graphs are very rich topic of applied mathematics, computer science, social sciences, medical sciences, engineering, etc. Fuzzy graph was introduced by Rosenfield in 1975. Fuzzy graphs can be used in traffic light problem, time table scheduling etc. Lots of works on fuzzy graphs have been done by Samanta, Pal, Rashmanlou, Nagoor Gani and many others. The operations union, join, Cartesian product and composition on two fuzzy graphs were defined by Mordeson and Peng. Later, Nirmala and Vijaya determined the degree of vertices in the new fuzzy graphs obtained from two fuzzy graphs using the operations Cartesian, tensor, normal product and composition on two

fuzzy graphs. Here, we have defined modular, homomorphic, box dot and star fuzzy graph product and proved some theorems related to each type of fuzzy graph product. Modular and homomorphic graph product were pre-defined in case of crisp graphs. We have defined them in case of fuzzy graphs. Box dot and star fuzzy graph products are newly defined fuzzy graph products. In general, the degree of a vertex in modular, homomorphic, box dot and star graph product of two fuzzy graphs G_1 and G_2 cannot be expressed in terms of the degree of vertices of G_1 and G_2.

2. BALANCED PRODUCT FUZZY GRAPHS

Definition 2.1. *The density of a fuzzy graph is* $D(G) = \dfrac{2\sum_{(x,y)\in E}(\mu(x,y))}{\sum_{x,y\in V}(\sigma(x)\wedge\sigma(y))}$. *$G$ is balanced if $D(H) \leq D(G)$ for any non-empty product fuzzy subgraphs H of G.*

We next provide a necessary and sufficient condition for the density of the maximal product of two fuzzy graphs to be equal to the density of both fuzzy graphs.

Lemma 2.1. *Let $G_1 : (\sigma_1, \mu_1)$ and $G_2 : (\sigma_2, \mu_2)$ be two complete fuzzy graphs. Then $D(G_1 \circledast G_2) \geq D(G_i)$ for $i = 1, 2$ if and only if $D(G_1) = D(G_2) = D(G_1 \circledast G_2)$.*

Proof. If $D(G_1 \circledast G_2) \geq D(G_i)$ for $i = 1, 2$, then

$$\begin{aligned}
D(G_1) &= \frac{2\sum_{x_1,x_2\in V_1}(\mu_1(x_1,x_2))}{\sum_{x_1,x_2\in V_1}(\sigma_1(x_1)\wedge\sigma_1(x_2))} \\
&\geq \frac{2\sum_{x\in V_1,y_1,y_2\in V_2}\sigma_1(x)\vee(\sigma_2(y_1)\wedge\sigma_2(y_2))}{\sum_{x\in V_1,y_1,y_2\in V_2}\sigma_1(x)\vee(\sigma_2(y_1)\wedge\sigma_2(y_2))} \\
&\geq \frac{2\sum_{x\in V_1,y_1y_2\in E_2}\sigma_1(x)\vee\mu_2(y_1,y_2)}{\sum_{x\in V_1,y_1,y_2\in V_2}(\sigma_1(x)\vee\sigma_2(y_1))\wedge(\sigma_1(x)\vee\sigma_2(y_2))} \\
&= D(G_1 \circledast G_2).
\end{aligned}$$

Other cases are similar.

The converse is trivial. □

Next, a necessary and sufficient condition for the maximal product of two balanced fuzzy graphs to be balanced is provided.

Theorem 2.1. *Let $G_1 : (\sigma_1, \mu_1)$ and $G_2 : (\sigma_2, \mu_2)$ be two balanced fuzzy graphs. Then $G_1 \circledast G_2$ is balanced if and only if $D(G_1) = D(G_2) = D(G_1 \circledast G_2)$.*

Proof. If $G_1 \circledast G_2$ is balanced, then $D(G_i) \leq D(G_1 \circledast G_2)$ for $i = 1, 2$ and $D(G_1) = D(G_2) = D(G_1 \circledast G_2)$.

Conversely, if $D(G_1) = D(G_2) = D(G_1 \circledast G_2)$ and H is a fuzzy subgraph of $G_1 \circledast G_2$, then there exist fuzzy subgraphs H_1 of G_1 and H_2 of G_2. As G_1 and G_2 are balanced and $D(G_1) = D(G_2) = n_1/r_1$, then $D(H_1) = a_1/b_1 \leq n_1/r_1$ and $D(H_2) = a_2/b_2 \leq n_1/r_1$. Thus $a_1r_1 + a_2r_1 \leq b_1n_1 + b_2n_1$ and hence $D(H) \leq (a_1 + a_2)/(b_1 + b_2) \leq n_1/r_1 = D(G_1 \circledast G_2)$. Therefore, $G_1 \circledast G_2$ is balanced. □

3. MAXIMAL-BALANCED FUZZY GRAPHS

In this section, we introduce the relatively new notion of maximal-balanced. We note that using this notion, we get better results than using balanced one.

Definition 3.1. *The maximal density of a fuzzy graph G is* $CD(G) = \dfrac{2\sum_{(x,y)\in E}(\mu(x,y))}{\sum_{x,y\in V}(\sigma(x) \wedge \sigma(y))}$.
G is maximal-balanced if $MD(H) \leq MD(G)$ for all fuzzy non-empty subgraphs H of G.

Theorem 3.1. *Let G be a fuzzy graph. Then $MDG) \leq 2$ if and only if and only if G is complete.*

Proof. Let G be a complete fuzzy graph. Then $MD(G) = \dfrac{2\sum_{x,y\in V}\sigma(x) \wedge \sigma(y)}{\sum_{x,y\in V}\sigma(x) \vee \sigma(y)} \leq 2$.
Conversely, suppose G is not complete with maximal-density less than or equals to 2. Then $MD(G) = \dfrac{2\sum_{(x,y)\in E}\mu(x,y)}{\sum_{x,y\in V}\sigma(x) \vee \sigma(y)} \leq 2$. So $\sum_{(x,y)\in E}\mu(x,y) \geq \sum_{x,y\in V}\sigma(x) \vee \sigma(y)$. Since G is not complete, $\mu(x,y) < \sigma(x) \wedge \sigma(y)$ for some $x, y \in V$. That means $\mu(\acute{x}, \acute{y}) > \sigma(\acute{x}) \vee \sigma(\acute{y})$ for some $\acute{x}, \acute{y} \in V - \{x, y\}$, a contradiction. □

Theorem 3.2. *Any complete fuzzy graph is maximal-balanced.*

Proof. Let G be a complete fuzzy graph. Then by Theorem $MD(G) \leq 2$. If H is a non-empty fuzzy subgraph of G, then we have two cases:

Case I

If H has less edges than G, then

$$\sum_{(x,y)\in E(H)} \mu(x,y) \leq \sum_{(x,y)\in E} \mu(x,y)$$

and

$$\sum_{x,y\in V(H)} \sigma(x) \vee \sigma(y) = \sum_{x,y\in V} \sigma(x) \vee \sigma(y).$$

Thus

$$MD(H) = \frac{2 \sum_{(x,y)\in E(H)} (\mu(x,y))}{\sum_{x,y\in V(H)} (\sigma(x) \vee \sigma(y))}$$

$$MD(H) = \frac{2 \sum_{(x,y)\in E(H)} (\mu(x,y))}{\sum_{x,y\in V} (\sigma(x) \vee \sigma(y))}$$

$$\leq \frac{2 \sum_{(x,y)\in E} (\mu(x,y))}{\sum_{x,y\in V} (\sigma(x) \vee \sigma(y))} \leq 2 \leq MD(G).$$

Case II

If H has vertices lass than G, then it is clear that H is a complete fuzzy graph. We conclude that $MD(H) = MD(G)$.

Thus G is maximal-balanced product fuzzy graph.

The converse of preceding result need not be true. □

Example 3.1. *Consider the fuzzy graph G such that $\sigma(x_1) = 0.1, \sigma(x_2) = 0.2 = \sigma(x_3)$, $\mu(x_1, x_2) = 0.01 = \mu(x_1, x_3)$ and $\mu(x_2, x_3) = 0.02$. Then G is a maximal-balanced fuzzy graph that is not complete.*

Theorem 3.3. *Every self-complementary fuzzy graph has maximal-density less than or equal to 1.*

Proof. Let G be self-complementary fuzzy graph. Then

$$\begin{aligned} MD(G) &= \frac{2\sum_{(x,y)\in E}\mu(x,y)}{\sum_{x,y\in V}(\sigma(x)\vee\sigma(y))} \\ &= \frac{2\frac{1}{2}\sum_{x,y\in V}(\sigma(x)\wedge\sigma(y))}{\sum_{x,y\in V}(\sigma(x)\vee\sigma(y))} \\ &= \frac{\sum_{x,y\in V}(\sigma(x)\wedge\sigma(y))}{\sum_{x,y\in V}(\sigma(x)\vee\sigma(y))} \leq 1 \end{aligned}$$

The converse of the above result need not be true. □

Example 3.2. *Consider the fuzzy graph G such that $\sigma(x_1) = 0.1, \sigma(x_2) = 0.2$, $\sigma(x_3) = 0.4, \mu(x_1, x_2) = 0.02, \mu(x_1, x_3) = 0$ and $\mu(x_2, x_3) = 0.05$. Then $MD(G) \leq 1$, but G is not self-complementary.*

Theorem 3.4. *Let $G : (\sigma, \mu)$ be a fuzzy graph such that $\mu(x, y) = \frac{1}{2}(\sigma(x)\sigma(y))$ for all $x, y \in V$. Then $MD(G) \leq 1$.*

Proof. By Lemma, G is self-complementary and $MD(G_1) \leq 1$. □

Lemma 3.1. *Let $G_1 : (\sigma_1, \mu_1)$ and $G_2 : (\sigma_2, \mu_2)$ be two complete fuzzy graphs. Then $MD(G_i) \leq MD(G_1 \circledast G_2)$ for $i = 1, 2$ if and only if $MD(G_1) = MD(G_2) = MD(G_1 \circledast G_2)$.*

Proof. If $D(G_i) \leq D(G_1 \circledast G_2)$ for $i = 1, 2$, then since G_1 and G_2 are complete fuzzy graphs, by Theorem,

$$MD(G_1), MD(G_2) \leq 2.$$

Now, $G_1 \circledast G_2$ is strong and hence by Theorem, $MD(G_1 \circledast G_2) < 2$. Thus $MD(G_i) \geq MD(G_1 \circledast G_2)$ for $i = 1, 2$ and so $MD(G_1) = MD(G_2) = MD(G_1 \circledast G_2)$.

The converse is trivial. □

Theorem 3.5. *Let $G_1 : (\sigma_1, \mu_1)$ and $G_2 : (\sigma_2, \mu_2)$ be two maximal-balanced fuzzy graphs. Then $G_1 \circledast G_2$ is maximal-balanced if and only if $MD(G_1) = MD(G_2) = MD(G_1 \circledast G_2)$.*

Proof. If $G_1 \circledast G_2$ is maximal-balanced, then $MD(G_i) \leq MD(G_1 \circledast G_2)$ for $i = 1, 2$ and $MD(G_1) = MD(G_2) = MD(G_1 \circledast G_2)$. Conversely, If $MD(G_1) = MD(G_2) = MD(G_1 \circledast G_2)$ and H is a fuzzy subgraph of $G_1 \circledast G_2$, then there exist fuzzy subgraph H_1 of G_1 and H_2 of G_2 such that $H \simeq H_1 \circledast H_2$. As G_1 and G_2 are maximal-balanced and say $MD(G_1) = MD(G_2) = \frac{n_1}{r_1}$, then $MD(H_1) = \frac{a_1}{b_1} \leq \frac{n_1}{r_1}$ and $MD(H_2) = \frac{a_2}{b_2} \leq \frac{n_1}{r_1}$. Thus $a_1 r_1 + a_2 r_1 \leq b_1 n_1 + b_2 n_1$ and hence $MD(H) \leq \frac{a_1 + a_2}{b_1 + b_2} \leq \frac{n_1}{r_1} = MD(G_1 \circledast G_2)$. Therefore $G_1 \circledast G_2$ is maximal-balanced. □

Theorem 3.6. *Let $G_1 : (\sigma_1, \mu_1)$ and $G_2 : (\sigma_2, \mu_2)$ be isomorphic fuzzy graphs. If one of them is maximal-balanced, then the other is maximal-balanced.*

Proof. Suppose G_2 is maximal-balanced and let $h : V_1 \to V_2$ be a bijection such that $\sigma_1(x) = \sigma_2(h(x))$ and $\mu_1(x, y) = \mu_2(h(x), h(y))$ for all $x, y \in V_1$. Thus $\sum_{x \in V_1} \sigma_1(x) = \sum_{x \in V_2} \sigma_2(x)$ and $\sum_{x,y \in E_1} \mu_1(x, y) = \sum_{x,y \in E_2} \mu_2(x, y)$. If $H_1 = (\acute{\sigma}_1, \acute{\mu}_1)$ is a fuzzy subgraph of G_1 with underlying set W, then $H_2 = (\acute{\sigma}_2, \acute{\mu}_2)$ is a fuzzy subgraph of G_2 with underlying set $h(W)$ where $\acute{\sigma}_2(h(x)) = \acute{\sigma}_1(x)$ and $\acute{\mu}_2(h(x), h(y)) = \acute{\mu}_1(x, y)$ for all $x, y \in W$. Since G_2 is maximal-balanced, $MD(H_1) \leq MD(G_2)$ and so

$$2\frac{\sum_{x,y \in E_1} \mu_2(h(x), h(y))}{\sum_{x,y \in V(H_2)} (\acute{\sigma}_2(x) \vee \acute{\sigma}_2(y))} \leq 2\frac{\sum_{x,y \in E_1} \mu_2(x, y)}{\sum_{x,y \in V_2} (\sigma_2(x) \vee \sigma_2(y))} \leq 2\frac{\sum_{x,y \in E_1} \mu_1(x, y)}{\sum_{x,y \in V_2} (\sigma_2(x) \vee \sigma_2(y))}$$

Therefore, G_1 is maximal-balanced. □

Next, we show that the notions of balanced and maximal-balanced are independent.

Example 3.3. *Consider the fuzzy graph G such that $\sigma(x_1) = 0.3, \sigma(x_2) = 0.2$, $\sigma(x_3) = 0.1, \mu(x_1, x_2) = 0.06, \mu(x_1, x_3) = 0.03$ and $\mu(x_2, x_3) = 0.02$. Then G is maximal-balanced, but is not balanced since $D(G) = 0.275$, but if we take $H = (x_1, x_3)$, then $D(H) = 0.6$.*

The fuzzy graph G with $\sigma(x_1) = 0.5, \sigma(x_2) = 0.7 = \sigma(x_3), \mu(x_1, x_2) = 0.1 = \mu(x_1, x_3)$ and $\mu(x_2, x_3) = 0.4$. is balanced, but is not maximal-balanced since if we take $H = (x_2, x_3)$, then $MD(H) = 1.14$ while $MD(G) = 1.04$.

Theorem 3.7. *Every balanced complete fuzzy graph is maximal-balanced.*

Proof. Let G be a balanced complete fuzzy graph and H be a non-empty fuzzy subgraph of G. Then as G is balanced, $D(H) \leq D(G)$. Since G is complete, G is maximal-balanced. □

4. Conclusion

We have proposed a balanced product fuzzy graph and also discussed about the maximal balanced product fuzzy graphs, we defined some important definitions also proved theorems.

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SOLVING NEUTROSOPHIC MULTI-OBJECTIVE LINEAR FRACTIONAL PROGRAMMING PROBLEM USING CENTRAL MEASURES – I

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Abstract

In this article, we introduce a new transformation method for addressing Neutrosophic Multi-Objective Linear Fractional Programming Problem (NMOLFPP). Our approach entails converting the NMOLFPP into Neutrosophic Single Objective Linear Fractional Programming Problem (NSOLFPP) and proposing an algorithm to find a solution. Furthermore, we provide a numerical example to illustrate the proposed method, and the results of our numerical analysis reveal that the Arithmetic Median Technique is a better optimal solution as compared to other techniques such as Mean, Median, and New Arithmetic Median Techniques.

AMS Subject Classification: 90C29, 90C70.

Keywords: Neutrosophic Multi-Objective Linear Fractional Programming Problem, Neutrosophic Triangular Number, Arithmetic Median techniques, and New Arithmetic Median techniques.

1. INTRODUCTION

We introduce a Neutrosophic MOLFPP and present an algorithm to solve it. Our proposed techniques have a lower computational burden, allowing us to generate the optimal solution regardless of the number of objectives. We demonstrate the effectiveness of our algorithm with a numerical example and compare it to other techniques.

2. Preliminaries

We recall some necessary definitions and results to make out the main thought.

Definition 2.1 (**Single Valued Triangular Neutrosophic Number (SVTNN)**). *A SVTNN is defined by* $\widetilde{A}^* = \left\{\left(a_1^l,\ b_1^m,\ c_1^u\right); \tau_a,\ i_a,\ \omega_a\right\}$ *whose three membership functions for the truth, indeterminacy, and a falsity of X are given by*

$$\tau_{\widetilde{A}^*}(x) = \begin{cases} \dfrac{\left(x - a_1^l\right)\tau_a}{b_1^m - a_1^l} & (a_1^l \le x < b_1^m) \\ \tau_a & (x = b_1) \\ \dfrac{\left(c_1^u - x\right)\tau_a}{c_1^u - b_1^m} & (b_1^m \le x < c_1^u) \\ 0 & Otherwise, \end{cases}$$

$$i_{\widetilde{A}^*}(x) = \begin{cases} \dfrac{\left(b_1^m - x\right)i_a}{b_1^m - a_1^l} & \left(a_1^l \le x < b_1^m\right) \\ i_a & (x = b_1^m) \\ \dfrac{\left(x - c_1^u\right)i_a}{c_1^u - b_1^m} & (b_1^m \le x < c_1^u) \\ 1 & Otherwise, \end{cases}$$

$$\omega_{\widetilde{A}^*}(x) = \begin{cases} \dfrac{\left(b_1^m - x\right)\omega_a}{b_1^m - a_1^l} & \left(a_1^l \le x < b_1^m\right) \\ \omega_a & (x = b_1^m) \\ \dfrac{\left(x - c_1^u\right)\omega_a}{c_1^u - b_1^m} & (b_1^m \le x < c_1^u) \\ 1 & Otherwise, \end{cases}$$

where $0 \le \tau_{\widetilde{A}^*}(x) + i_{\widetilde{A}^*}(x) + \omega_{\widetilde{A}^*}(x) \le 3,\ \ x \in \widetilde{A}^*$. *Additionally, when* $a_1^l > 0,\ \ \widetilde{A}^*$ *is called a positive SVTNN. Similarly, when* $a_1^l < 0,\ \ \widetilde{A}^*$ *becomes a negative SVTNN.*

Definition 2.2 (**Arithmetic Operations on Two Neutrosophic Numbers**). *Let* $\tilde{a}^n = \{(a_1^l, b_1^m, c_1^u); \tau_a, i_a, \omega_a\}$ *and* $\tilde{b}^n = \{(a_2^l, b_2^m, c_2^u); \tau_b, i_b, \omega_b\}$ *be two single valued triangular neutrosophic numbers. Then*

(*a*) ***Addition of Neutrosophic Numbers***

$$\tilde{a}^n + \tilde{b}^n = \{(a_1^l + a_2^l, b_1^m + b_2^m, c_1^u + c_2^u); \tau_a \wedge \tau_b, i_a \vee i_b, \omega_a \vee \omega_b\}$$

(*b*) ***Subtraction of Neutrosophic Numbers***

$$\tilde{a}^n - \tilde{b}^n = \{(a_1^l - c_2^u, b_1^m - b_2^m, c_1^u - a_2^m); \tau_a \wedge \tau_b, i_a \vee i_b, \omega_a \vee \omega_b\}$$

(*c*) ***Multiplication of Neutrosophic Numbers***

$$\tilde{a}^n.\tilde{b}^n = \left\{ \begin{array}{c} \left(Min(a_1^l a_2^l, a_1^l c_2^u, c_1^u a_2^l, c_1^u c_2^u), b_1^m b_2^m, Max(a_1^l a_2^l, a_1^l c_2^u, c_1^u a_2^l, c_1^u c_2^u)\right); \\ \tau_a \wedge \tau_b, i_a \vee i_b, \omega_a \vee \omega_b \end{array} \right\}$$

(*d*) ***Division of Neutrosophic Numbers***

$$\frac{\tilde{a}^n}{\tilde{b}^n} =$$
$$\left\{ \left(Min\left(\frac{a_1^l}{a_2^l}, \frac{a_1^l}{c_2^u}, \frac{c_1^u}{a_2^l}, \frac{c_1^u}{c_2^u}\right), \frac{b_1^m}{b_2^m}, Max\left(\frac{a_1^l}{a_2^l}, \frac{a_1^l}{c_2^u}, \frac{c_1^u}{a_2^l}, \frac{c_1^u}{c_2^u}\right)\right); \tau_a \wedge \tau_b, i_a \vee i_b, \omega_a \vee \omega_b \right\}$$

(*e*) ***Scalar Multiplication of Neutrosophic Number***

$$\gamma\tilde{a}^n = \left\{ \begin{array}{l} \{(\gamma a_1^l, \gamma b_1^m, \gamma c_1^u); \tau_a \wedge \tau_b, i_a \vee i_b, \omega_a \vee \omega_b\}, (\gamma > 0) \\ \{(\gamma c_1^u, \gamma b_1^m, \gamma a_1^l); \tau_a \wedge \tau_b, i_a \vee i_b, \omega_a \vee \omega_b\}, (\gamma < 0). \end{array} \right.$$

3. MOLFPP in Neutrosophic Number

The ratio objective function that has numerator and denominator, and is defined as follows:

$$\text{Max } \widetilde{Z}_i \text{ and Min } \widetilde{Z}_i = \frac{\widetilde{C}_i\widetilde{x}_i + \widetilde{\alpha}_i}{\widetilde{D}_i\widetilde{x}_i + \widetilde{\beta}_i} \quad \forall \begin{cases} \text{Max } \widetilde{Z}_i & if\ i = 1, 2, \ldots, r \\ \text{Min } \widetilde{Z}_i & if\ i = r+1, r+2, \ldots, s \end{cases} \tag{3.1}$$

subject to

$$\widetilde{A}_{ij}\widetilde{x}_i = \widetilde{b}_j \tag{3.2}$$
$$\widetilde{x}_i \geq \{(0,0,0); 1, 0, 0\} \tag{3.3}$$

where,
- $\widetilde{x}_i$ is a $n-$ decision variables
- r is the number of objective functions that is to be maximized
- $s - r$ is the number of objective functions that is to be minimized
- $\widetilde{C}_i$ and $\widetilde{D}_i$ $(\forall i = 1, 2, \ldots, r, r+1, \ldots, s)$ are $n-$ dimensional vector of SVTNN.
- $\widetilde{b}_j$ is $m-$ dimensional vector of SVTNN.
- $\widetilde{A}_{ij}$ is a $(m \times n)-$ matrix of co-efficient (SVTNN).
- $\widetilde{\alpha}_i$ and $\widetilde{\beta}_i$ are scalars.

4. Modified Simplex Algorithm in Neutrosophic Environment

We now give the required algorithm.

Step 1 Convert the inequality constraints to equations by introducing the non-negative slack or surplus variables. The coefficients of slack or surplus variables are always taken as zero in the objective function.

Step 2 Construct the simplex table by using the following notations. Let $\widetilde{x_i}$ be the initial basic feasible solution of the given problem such that

subject to $\widetilde{A}\widetilde{x_i} = \widetilde{B}$
$\widetilde{Z_1} = \widetilde{C_B}\widetilde{x_B} + \widetilde{\alpha}; \widetilde{Z_2} = \widetilde{D_B}\widetilde{x_B} + \widetilde{\beta}.$
where $\widetilde{C_B}$ and $\widetilde{D_B}$ are the vectors having their components as the coefficients associated with the basic variables in the numerator and denominator of objective function respectively and $\widetilde{\alpha}$ and $\widetilde{\beta}$ are neutrosophic numbers.

Step 3 First, we compute the values for $\widetilde{Z_1}$, $\widetilde{Z_2}$ and $\widetilde{Z} = \dfrac{\widetilde{Z_1}}{\widetilde{Z_2}}$,

where $\widetilde{Z_1} = \sum \left\{ \left(coefficient\ of\ C_j \right) \times \widetilde{B^n} \right\} + \widetilde{\alpha};$
$\widetilde{Z_2} = \sum \left\{ \left(coefficient\ of\ D_j \right) \times \widetilde{B^n} \right\} + \widetilde{\beta}.$

Step 4 Calculate $\widetilde{\delta_j^1} = \left(\sum C_B \widetilde{x_B^n} - C_j \right)$ for each variable x_j. Further, we calculate the values of $\widetilde{\delta_j^2} = \left(\sum D_B \widetilde{x_B^n} - D_j \right)$ for each variable x_j.

Step 5 Compute the evaluation $\widetilde{\delta_j}$for each variable x_j (Column vector x_j) by using the formula

$$\widetilde{\delta_j^1} = \widetilde{Z_2}\left(\sum C_B \widetilde{x_B^n} - C_j \right) - \widetilde{Z_1}\left(\sum D_B \widetilde{x_B^n} - D_j \right)$$

Step 6 Find the Entering variable, in the most positive value of δ_j.

Step 7 Find the minimum ration column $\dfrac{\widetilde{x_{ij}}}{\widetilde{y_{ij}}}$.

Step 8 Find the Leaving variable, by selecting the least positive value of the Minimum ratio $\dfrac{\widetilde{x_{ij}}}{\widetilde{y_{ij}}}$ column.

Step 9 If all $\delta_j \geq \{(0,0,0); 1,0,0\}$, the optimal solution is attained. Then we get the required solution. Finally stop the iteration.

Step 10 Otherwise, continue Step 3 to Step 9.

5. Different Kind of Techniques

Suppose we possess a unique numeric representation for each of the objective functions that are being optimized, which considers the limitations and constraints (2) and (3) specified below.

$$\text{Max } \widetilde{Z}_i \ (or) \ \text{Min } \widetilde{Z}_i = \widetilde{Z}_i \quad \forall \begin{cases} \text{Max } \widetilde{Z}_i & if\ i = 1, 2, \ldots, r \\ \text{Min } \widetilde{Z}_i & if\ i = r+1, r+2, \ldots, s \end{cases} \tag{5.1}$$

where, $\widetilde{Z}_1^{Max}$, $\widetilde{Z}_2^{Max}$, ... , $\widetilde{Z}_r^{Max}$, $\widetilde{Z}_{r+1}^{Min}$, ..., $\widetilde{Z}_s^{Min}$are the optimal values of the objective functions.

Here, we will be exploring different approaches and methods. The problem will be presented using the following notations.

$\widetilde{\varphi}_i^{Max} = |\widetilde{Z}_i^{\text{Max}}|$ = the value of objective function which is to be maximized.

$\widetilde{\varphi}_i^{Min} = |\widetilde{Z}_i^{\text{Min}}|$ = the value of objective function which is to be minimized.

$$SM = \sum_{i=1}^{r} \left(\frac{\text{objective functions}}{\text{it's optimum value}} \right) = \sum_{i=1}^{r} \left(\frac{\text{Max } \widetilde{Z}_i}{\widetilde{\varphi}_i^{\text{Max}}} \right)$$

$$SN = \sum_{i=r+1}^{s} \left(\frac{\text{objective functions}}{\text{it's optimum value}} \right) = \sum_{i=r+1}^{s} \left(\frac{\text{Min } \widetilde{Z}_i}{\widetilde{\varphi}_i^{\text{Min}}} \right)$$

• **Mean Technique**

$$\text{Max } \widetilde{Z} = S_1 - S_2 \tag{5.2}$$

where, $S_1 = \dfrac{SM}{VM}$ and $S_2 = \dfrac{SN}{VN}$

$$VM = \text{Mean } (\widetilde{\varphi}_i^{\text{Max}}) = \sum_{i=1}^{r} \frac{\widetilde{\varphi}_i^{\text{Max}}}{r}$$

$$VN = \text{Mean } (\widetilde{\varphi}_i^{\text{Min}}) = \sum_{i=r+1}^{s} \frac{\widetilde{\varphi}_i^{\text{Min}}}{s-r}$$

• **Median Technique**

$$\text{Max } \widetilde{Z} = S_1 - S_2 \tag{5.3}$$

where, $S_1 = \dfrac{SM}{WM}$

and $S_2 = \dfrac{SN}{WN}$

WM = Median of $\widetilde{\varphi}_i^{Max}$ middle value

WN = Median of $\widetilde{\varphi}_i^{Min}$

• **Arithmetic Median Technique**

$$\text{Max } \widetilde{Z} = \frac{SM - SN}{AV_2} \tag{5.4}$$

where, $AV_2 = \dfrac{WM + WN}{2}$ is arithmetic Median.

• **New Arithmetic Median Technique**

$$\text{Max } \widetilde{Z} = \frac{SM - SN}{AV_s} \tag{5.5}$$

where, $AV_s = \dfrac{WM + WN}{s}$ is new arithmetic average. And then s is the number of objective function.

6. Procedure for Determining of Combined Single Objective Function

The method utilized to find the solution for the Neutrosophic MOLFPP mentioned earlier can be outlined in the following steps.

Step 1 Utilize the modified simplex technique, outlined in section 4, to determine the optimal solution for individual objective functions in Linear Fractional Programming problems, whether they need to be maximized or minimized.

Step 2 Assess the practicability of the solution found in Step 1, if it is deemed feasible, proceed to Step 3, if not, apply the dual simplex method to eliminate the impracticality.

Step 3 There are various methods that can be utilized to attain the objective function.

(a) Calculate Neutrosophic SOLFPP equation (5.2), using Max $\widetilde{Z} = S_1 - S_2$

where, $S_1 = \dfrac{SM}{VM}$ and $S_2 = \dfrac{SN}{VN}$

(b) Calculate Neutrosophic SOLFPP equation (5.3), using Max $\widetilde{Z} = S_1 - S_2$

where, $S_1 = \dfrac{SM}{WM}$ and $S_2 = \dfrac{SN}{WN}$

(c) Calculate Neutrosophic SOLFPP equation (5.4), using Max $\widetilde{Z} = \dfrac{SM - SN}{AV_2}$

where, $AV_2 = \dfrac{WM + WN}{2}$ is arithmetic average.

(d) Calculate Neutrosophic SOLFPP equation (5.5), using Max $\widetilde{Z} = \dfrac{SM - SN}{AV_s}$ where, $AV_s = \dfrac{WM + WN}{s}$ is new arithmetic average. And then s is the number of objective function.

All other approaches and symbols are the same to be applied.

Step 4 Optimize the combined function under the same constraints (3.2) and (3.3) by repeating the Step-1 to Step-3.

7. Numerical Example

Solve the following MOLFPP in Neutrosophic environment.

$$\text{Max } \widetilde{Z}_1 = \frac{\{(4,\ 5,\ 6); .4, .6, .8\}\widetilde{x}_1 + \{(2,\ 3,\ 4); .5, .4, .7\}\widetilde{x}_2}{\{(1,\ 2,\ 3); .3, .5, .6\} \times \left(\widetilde{x}_1 + \widetilde{x}_2 + \widetilde{1}\right)}$$

$$\text{Max } \widetilde{Z}_2 = \frac{\{(8,\ 9,\ 10); .3, .2, .6\}\widetilde{x}_1 + \{(4,\ 5,\ 6); .4, .7, .5\}\widetilde{x}_2}{\{(3,\ 6,\ 9); .3, .5, .6\} \times \left(\widetilde{x}_1 + \widetilde{x}_2 + \widetilde{1}\right)}$$

$$\text{Max } \widetilde{Z}_3 = \frac{\{(3,\ 4,\ 5); .6, .4, .3\}\widetilde{x}_1 - \{(2,\ 3,\ 4); .5, .6, .9\}\widetilde{x}_2}{\{(1,\ 2,\ 3); .3, .5, .6\} \times \left(\widetilde{x}_1 + \widetilde{x}_2 + \widetilde{1}\right)}$$

$$\text{Max } \widetilde{Z}_4 = \frac{\{(2,\ 3,\ 4); .4, .7, .5\}\widetilde{x}_1 + \{(1,\ 2,\ 3); ..5, .4, .2\}\widetilde{x}_2}{\{(2,\ 4,\ 6); .3, .5, .6\} \times \left(\widetilde{x}_1 + \widetilde{x}_2 + \widetilde{1}\right)}$$

subject to

$$\{(1,\ 3,\ 7); .4, .6, .7\}\widetilde{x}_1 + \{(3,\ 6,\ 9); .5, .7, .3\}\widetilde{x}_2 \le \{(14,\ 18,\ 24); .6, .3, .5\}$$
$$\{(8,\ 9,\ 10); .6, .5, .4\}\widetilde{x}_1 + \{(1,\ 2,\ 4); .3, .6, .9\}\widetilde{x}_2 \le \{(20,\ 27,\ 32); .3, .4, .5\}$$
$$\text{and} \qquad \widetilde{x}_1,\ \widetilde{x}_2 \ge \{(0,\ 0,\ 0); 1, 0, 0\}$$

Now, we determine the Neutrosophic Single LFPP.

$$SM = \frac{\widetilde{W}\widetilde{x}_1 + \widetilde{X}\widetilde{x}_2 + \widetilde{\alpha}^{\text{Max}}}{common\ term \times \left(\widetilde{x}_1 + \widetilde{x}_2 + \widetilde{1}\right)},$$

where

$$\widetilde{W} = \frac{\widetilde{a}_1}{\widetilde{\varphi}_1} + \frac{\widetilde{b}_1}{\widetilde{\varphi}_2} + \frac{\widetilde{c}_1}{\widetilde{\varphi}_3} + \frac{\widetilde{d}_1}{\widetilde{\varphi}_4};\ \ \widetilde{X} = \frac{\widetilde{a}_2}{\widetilde{\varphi}_1} + \frac{\widetilde{b}_2}{\widetilde{\varphi}_2} + \frac{\widetilde{c}_2}{\widetilde{\varphi}_3} + \frac{\widetilde{d}_2}{\widetilde{\varphi}_4};\ \ \widetilde{\alpha}^{\text{Max}} = \frac{\widetilde{\alpha}_1}{\widetilde{\varphi}_1} + \frac{\widetilde{\alpha}_2}{\widetilde{\varphi}_2} + \frac{\widetilde{\alpha}_3}{\widetilde{\varphi}_3} + \frac{\widetilde{\alpha}_4}{\widetilde{\varphi}_4}$$

After finding the value of each individual objective functions, the results are given below

Table 1: Results of the Numerical Example by using Modified Simplex Technique

i	$\widetilde{\varphi}_i$	$\widetilde{x}_i$	$\lvert\widetilde{Z}_i^{Max}\rvert = \widetilde{\varphi}_i^{Max}$ $\forall i = 1, 2, 3, \ldots, r$	$\lvert\widetilde{Z}_i^{Min}\rvert = \widetilde{\varphi}_i^{Min}$ $\forall i = r+1, r+2, \ldots, s$
1	$\{(0.53,\ 1.87,\ 8); .3, .6, .8\}$	$\begin{pmatrix} \{(2,\ 3,\ 4); .3, .5, .5\}, \\ \{(0,\ 0,\ 0); 1, 0, 0\} \end{pmatrix}$	$\{(0.53,\ 1.87,\ 8); .3, .6, .8\}$	–
2	$\{(0.35,\ 1.12,\ 4.44); .3, .5, .6\}$	$\begin{pmatrix} \{(2,\ 3,\ 4); .3, .5, .5\}, \\ \{(0,\ 0,\ 0); 1, 0, 0\} \end{pmatrix}$	$\{(0.35,\ 1.12,\ 4.44); .3, .5, .6\}$	–
3	$\{(0.4,\ 1.5,\ 6.66); .3, .5, .6\}$	$\begin{pmatrix} \{(2,\ 3,\ 4); .3, .5, .5\}, \\ \{(0,\ 0,\ 0); 1, 0, 0\} \end{pmatrix}$	$\{(0.4,\ 1.5,\ 6.66); .3, .5, .6\}$	–
4	$\{(0.13,\ 0.56,\ 2.66); .3, .7, .6\}$	$\begin{pmatrix} \{(2,\ 3,\ 4); .3, .5, .5\}, \\ \{(0,\ 0,\ 0); 1, 0, 0\} \end{pmatrix}$	$\{(0.13,\ 0.56,\ 2.66); .3, .7, .6\}$	–

$\widetilde{\varphi}_1 = \{(0.53,\ 1.87,\ 8); .3, .6, .8\}$ $\quad \widetilde{p} = \{(1,\ 2,\ 3); .3, .5, .6\}$

$\widetilde{a}_1 = \{(4,\ 5,\ 6); .4, .6, .8\}$ $\quad \widetilde{a}_2 = \{(2,\ 3,\ 4); .5, .4, .7\}$

$\widetilde{\varphi}_2 = \{(0.35,\ 1.12,\ 4.44); .3, .5, .6\}$ $\quad \widetilde{q} = \{(3,\ 6,\ 9); .3, .5, .6\}$

$\widetilde{b}_1 = \{(8,\ 9,\ 10); .3, .2, .6\}$ $\quad \widetilde{b}_2 = \{(4,\ 5,\ 6); .4, .7, .5\}$

$\widetilde{\alpha} = \{(0,\ 0,\ 0); 1, 0, 0\}$ $\quad \widetilde{\varphi}_3 = \{(0.4,\ 1.5,\ 6.66); .3, .5, .6\}$

$\widetilde{r} = \{(1,\ 2,\ 3); .3, .5, .6\}$ $\quad \widetilde{c}_1 = \{(3,\ 4,\ 5); .6, .4, .3\}$

$\widetilde{c}_2 = \{(-4,\ -3,\ -2); .5, .6, .9\}$ $\quad \widetilde{\varphi}_4 = \{(0.13,\ 0.56,\ 2.66); .3, .7, .6\}$

$\widetilde{s} = \{(2,\ 4,\ 6); .3, .5, .6\}$ $\quad \widetilde{d}_1 = \{(2,\ 3,\ 4); .4, .7, .5\}$

$\widetilde{d}_2 = \{(1,\ 2,\ 3); ..5, .4, .2\}$ $\quad \widetilde{W} = \{(10.66,\ 13.5,\ 16.33); .3, .7, .8\}$

$\widetilde{X} = \{(-0.17,\ 2.66,\ 5.5); .4, .7, .9\}$ $\quad \widetilde{\alpha}^{\text{Max}} = \{(0,\ 0,\ 0); 1, 0, 0\}$

$\widetilde{1} = \{(1,\ 1,\ 1); 1, 0, 0\}$

$$SM = \sum_{i=1}^{4} \frac{\widetilde{Z}_i^{Max}}{\widetilde{\varphi}_i^{Max}} = \frac{\widetilde{W}\widetilde{x}_1 + \widetilde{X}\widetilde{x}_2 + \widetilde{\alpha}^{\text{Max}}}{common\ term \times \left(\widetilde{x}_1 + \widetilde{x}_2 + \widetilde{1}\right)}$$

$$SM = \frac{\{(10.66,\ 13.5,\ 16.33); .3, .7, .8\}\widetilde{x}_1 + \{(-0.17,\ 2.66,\ 5.5); .4, .7, .9\}\widetilde{x}_2}{\{(1,\ 2,\ 3); .3, .5, .6\} \times \left(\widetilde{x}_1 + \widetilde{x}_2 + \widetilde{1}\right)}$$

$$SN = \{(0,\ 0,\ 0); 1, 0, 0\}$$

For Mean Technique:

$$VM = \sum_{i=1}^{4} \frac{\widetilde{Z}_i^{Max}}{r} = \sum_{i=1}^{4} \frac{\widetilde{Z}_i^{Max}}{4} = \{(0.35,\ 1.26,\ 5.44); .3, .7, .8\}$$

$$VN = \{(0,\ 0,\ 0); 1, 0, 0\}$$

$$S_1 = \frac{SM}{VM} = \frac{\{(10.66,\ 13.5,\ 16.33); .3, .7, .8\}\widetilde{x}_1 + \{(-0.17,\ 2.66,\ 5.5); .4, .7, .9\}\widetilde{x}_2}{\{(0.35,\ 1.26,\ 5.44); .3, .7, .8\} \times \{(1,\ 2,\ 3); .3, .5, .6\} \times \left(\widetilde{x}_1 + \widetilde{x}_2 + \widetilde{1}\right)}$$

$$= \frac{\{(1.95,\ 10.71,\ 46.65); .3, .7, .8\}\widetilde{x}_1 + \{(-0.48,\ 2.11,\ 15.71); .3, .7, .9\}\widetilde{x}_2}{\{(1,\ 2,\ 3); .3, .5, .6\} \times \left(\widetilde{x}_1 + \widetilde{x}_2 + \widetilde{1}\right)}$$

$$S_2 = \frac{SN}{VN} = \{(0,\ 0,\ 0); 1, 0, 0\}$$

$$\text{Max } \widetilde{Z} = S_1 - S_2$$

$$= \frac{\{(1.95,\ 10.71,\ 46.65); .3, .7, .8\}\widetilde{x}_1 + \{(-0.48,\ 2.11,\ 15.71); .3, .7, .9\}\widetilde{x}_2}{\{(1,\ 2,\ 3); .3, .5, .6\} \times \left(\widetilde{x}_1 + \widetilde{x}_2 + \widetilde{1}\right)}$$

subject to

$$\{(1,\ 3,\ 7);.4,.6,.7\}\widetilde{x_1} + \{(3,\ 6,\ 9);.5,.7,.3\}\widetilde{x_2} \le \{(14,\ 18,\ 24);.6,.3,.5\}$$
$$\{(8,\ 9,\ 10);.6,.5,.4\}\widetilde{x_1} + \{(1,\ 2,\ 4);.3,.6,.9\}\widetilde{x_2} \le \{(20,\ 27,\ 32);.3,.4,.5\}$$
$$\text{and} \qquad \widetilde{x_1},\ \widetilde{x_2} \ge \{(0,\ 0,\ 0);1,0,0\}$$

After solving it, we get the required optimal solution.

$$\text{Max}\ \widetilde{Z} = \{(0.26,\ 4.02,\ 62.2);.3,.7,.8\}$$
$$\widetilde{x_1} = \{(2,\ 3,\ 4);.3,.5,.5\} \qquad \widetilde{x_2} = \{(0,\ 0,\ 0);1,0,0\}$$

For Median Technique:

$\widetilde{\varphi}_i^{Max}$as:

$$\{(0.53,\ 1.87,\ 8);.3,.6,.8\},\ \{(0.35,\ 1.12,\ 4.44);.3,.5,.6\},$$
$$\{(0.4,\ 1.5,\ 6.66);.3,.5,.6\},\ \{(0.13,\ 0.56,\ 2.66);.3,.7,.6\}$$

$$WM = \frac{\{(0.35,\ 1.12,\ 4.44);.3,.5,.6\} + \{(0.4,\ 1.5,\ 6.66);.3,.5,.6\}}{2}$$
$$= \{(0.37,\ 1.31,\ 5.55);.3,.5,.6\}$$

$\widetilde{\varphi}_i^{Min}$ as:

$$WN = \{(0,\ 0,\ 0);1,0,0\}$$
$$SM = \frac{\{(10.66,\ 13.5,\ 16.33);.3,.7,.8\}\widetilde{x_1} + \{(-0.17,\ 2.66,\ 5.5);.4,.7,.9\}\widetilde{x_2}}{\{(1,\ 2,\ 3);.3,.5,.6\} \times \left(\widetilde{x_1} + \widetilde{x_2} + \widetilde{1}\right)}$$
$$SN = \{(0,\ 0,\ 0);1,0,0\}$$
$$S_1 = \frac{SM}{WM} = \frac{\{(10.66,\ 13.5,\ 16.33);.3,.7,.8\}\widetilde{x_1} + \{(-0.17,\ 2.66,\ 5.5);.4,.7,.9\}\widetilde{x_2}}{\{(0.37,\ 1.31,\ 5.55);.3,.5,.6\} \times \{(1,\ 2,\ 3);.3,.5,.6\} \times \left(\widetilde{x_1} + \widetilde{x_2} + \widetilde{1}\right)}$$
$$S_2 = \frac{SN}{WN} = \{(0,\ 0,\ 0);1,0,0\}$$
$$\text{Max}\ \widetilde{Z} = S_1 - S_2$$
$$= \frac{\{(1.92,\ 10.3,\ 44.13);.3,.7,.8\}\widetilde{x_1} + \{(-0.45,\ 2.03,\ 14.86);.3,.7,.9\}\widetilde{x_2}}{\{(1,\ 2,\ 3);.3,.5,.6\} \times \left(\widetilde{x_1} + \widetilde{x_2} + \widetilde{1}\right)}$$

subject to

$$\{(1,\ 3,\ 7);.4,.6,.7\}\widetilde{x_1} + \{(3,\ 6,\ 9);.5,.7,.3\}\widetilde{x_2} \le \{(14,\ 18,\ 24);.6,.3,.5\}$$
$$\{(8,\ 9,\ 10);.6,.5,.4\}\widetilde{x_1} + \{(1,\ 2,\ 4);.3,.6,.9\}\widetilde{x_2} \le \{(20,\ 27,\ 32);.3,.4,.5\}$$
$$\text{and} \qquad \widetilde{x_1},\ \widetilde{x_2} \ge \{(0,\ 0,\ 0);1,0,0\}$$

After solving it, we get the required optimal solution.

$$\begin{aligned}\text{Max } \widetilde{Z} &= \{(0.25,\ 3.86,\ 58.84); .3, .7, .8\}\\ \widetilde{x_1} &= \{(2,\ 3,\ 4); .3, .5, .5\}\\ \widetilde{x_2} &= \{(0,\ 0,\ 0); 1, 0, 0\}\end{aligned}$$

For Arithmetic Median Technique:

$\widetilde{\varphi}_i^{Max}$ as:

$$\{(0.53,\ 1.87,\ 8); .3, .6, .8\},\ \{(0.35,\ 1.12,\ 4.44); .3, .5, .6\},$$
$$\{(0.4,\ 1.5,\ 6.66); .3, .5, .6\},\ \{(0.13,\ 0.56,\ 2.66); .3, .7, .6\}$$

$$WM = \{(0.37,\ 1.31,\ 5.55); .3, .5, .6\}$$

$\widetilde{\varphi}_i^{Min}$ as:

$$\begin{aligned}WN &= \{(0,\ 0,\ 0); 1, 0, 0\}\\ AV_2 &= \frac{WM + WN}{2} = \frac{\{(0.37,\ 1.31,\ 5.55); .3, .5, .6\}}{2}\\ &= \{(0.18,\ 0.65,\ 2.77); .3, .5, .6\}\\ SM &= \frac{\{(10.66,\ 13.5,\ 16.33); .3, .7, .8\}\widetilde{x_1} + \{(-0.17,\ 2.66,\ 5.5); .4, .7, .9\}\widetilde{x_2}}{\{(1,\ 2,\ 3); .3, .5, .6\} \times \left(\widetilde{x_1} + \widetilde{x_2} + \widetilde{1}\right)}\\ SN &= \{(0,\ 0,\ 0); 1, 0, 0\}\\ \text{Max } \widetilde{Z} &= \frac{SM - SN}{AV_2}\\ &= \frac{\{(10.66,\ 13.5,\ 16.33); .3, .7, .8\}\widetilde{x_1} + \{(-0.17,\ 2.66,\ 5.5); .4, .7, .9\}\widetilde{x_2}}{\{(0.18,\ 0.65,\ 2.77); .3, .5, .6\} \times \{(1,\ 2,\ 3); .3, .5, .6\} \times \left(\widetilde{x_1} + \widetilde{x_2} + \widetilde{1}\right)}\\ \text{Max } \widetilde{Z} &= \frac{\{(3.84,\ 20.76,\ 90.72); .3, .7, .8\}\widetilde{x_1} + \{(-0.94,\ 4.09,\ 30.55); .3, .7, .9\}\widetilde{x_2}}{\{(1,\ 2,\ 3); .3, .5, .6\} \times \left(\widetilde{x_1} + \widetilde{x_2} + \widetilde{1}\right)}\end{aligned}$$

subject to

$$\begin{aligned}\{(1,\ 3,\ 7); .4, .6, .7\}\widetilde{x_1} + \{(3,\ 6,\ 9); .5, .7, .3\}\widetilde{x_2} &\le \{(14,\ 18,\ 24); .6, .3, .5\}\\ \{(8,\ 9,\ 10); .6, .5, .4\}\widetilde{x_1} + \{(1,\ 2,\ 4); .3, .6, .9\}\widetilde{x_2} &\le \{(20,\ 27,\ 32); .3, .4, .5\}\\ \text{and} \qquad \widetilde{x_1},\ \widetilde{x_2} &\ge \{(0,\ 0,\ 0); 1, 0, 0\}\end{aligned}$$

After solving it, we get the required optimal solution.

$$\begin{aligned}\text{Max } \widetilde{Z} &= \{(0.38,\ 2.97,\ 31.57); .3, .7, .8\}\\ \widetilde{x_1} &= \{(2,\ 3,\ 4); .3, .5, .5\}\\ \widetilde{x_2} &= \{(0,\ 0,\ 0); 1, 0, 0\}\end{aligned}$$

For New Arithmetic Median Technique:
$\widetilde{\varphi}_i^{Max}$ as:

$$\begin{aligned} &\{(0.13,\ 0.56,\ 2.66);.3,.7,.6\}, \quad \{(0.35,\ 1.12,\ 4.44);.3,.5,.6\},\\ &\{(0.4,\ 1.5,\ 6.66);.3,.5,.6\}, \quad \{(0.53,\ 1.87,\ 8);.3,.6,.8\}\\ WM = &\{(0.37,\ 1.31,\ 5.55);.3,.5,.6\} \end{aligned}$$

$\widetilde{\varphi}_i^{Min}$ as:

$$\begin{aligned} WN &= \{(0,\ 0,\ 0);1,0,0\}\\ AV_4 &= \frac{WM+WN}{4} = \frac{\{(0.37,\ 1.31,\ 5.55);.3,.5,.6\}}{4} = \{(0.09,\ 0.32,\ 1.38);.3,.5,.6\}\\ SM &= \frac{\{(10.66,\ 13.5,\ 16.33);.3,.7,.8\}\widetilde{x_1} + \{(-0.17,\ 2.66,\ 5.5);.4,.7,.9\}\widetilde{x_2}}{\{(1,\ 2,\ 3);.3,.5,.6\}\times\left(\widetilde{x_1}+\widetilde{x_2}+\widetilde{1}\right)}\\ SN &= \{(0,\ 0,\ 0);1,0,0\}\\ \text{Max } \widetilde{Z} &= \frac{SM-SN}{AV_4}\\ &= \frac{\{(10.66,\ 13.5,\ 16.33);.3,.7,.8\}\widetilde{x_1} + \{(-0.17,\ 2.66,\ 5.5);.4,.7,.9\}\widetilde{x_2}}{\{(0.09,\ 0.32,\ 1.38);.3,.5,.6\}\times\{(1,\ 2,\ 3);.3,.5,.6\}\times\left(\widetilde{x_1}+\widetilde{x_2}+\widetilde{1}\right)}\\ \text{Max } \widetilde{Z} &= \frac{\{(7.72,\ 42.18,\ 181.44);.3,.7,.8\}\widetilde{x_1} + \{(-1.88,\ 8.31,\ 61.11);.3,.7,.9\}\widetilde{x_2}}{\{(1,\ 2,\ 3);.3,.5,.6\}\times\left(\widetilde{x_1}+\widetilde{x_2}+\widetilde{1}\right)} \end{aligned}$$

subject to

$$\begin{aligned} \{(1,\ 3,\ 7);.4,.6,.7\}\widetilde{x_1} + \{(3,\ 6,\ 9);.5,.7,.3\}\widetilde{x_2} &\le \{(14,\ 18,\ 24);.6,.3,.5\}\\ \{(8,\ 9,\ 10);.6,.5,.4\}\widetilde{x_1} + \{(1,\ 2,\ 4);.3,.6,.9\}\widetilde{x_2} &\le \{(20,\ 27,\ 32);.3,.4,.5\}\\ \text{and} \qquad \widetilde{x_1},\ \widetilde{x_2} &\ge \{(0,\ 0,\ 0);1,0,0\} \end{aligned}$$

After solving it, we get the required optimal solution.

$$\begin{aligned} \text{Max } \widetilde{Z} &= \{(1.02,\ 15.81,\ 241.92);.3,.7,.8\}\\ \widetilde{x_1} &= \{(2,\ 3,\ 4);.3,.5,.5\}, \quad \widetilde{x_2} = \{(0,\ 0,\ 0);1,0,0\} \end{aligned}$$

Table 2: Comparison between results of the Numerical results

S. No.	Techniques	Numerical Example
1	Mean Technique	{(0.26, 4.02, 62.2); .3, .7, .8}
2	Median Technique	{(0.25, 3.86, 58.84); .3, .7, .8}
3	Arithmetic Median Technique	{(0.38, 2.97, 31.57); .3, .7, .8}
4	New Arithmetic Median Technique	{(1.02, 15.81, 241.92); .3, .7, .8}

8. CONCLUSION

In this paper, Mean, Median, and Arithmetic Median Techniques were defined and then a comparison was made with the New Arithmetic Median Technique. This comparison was based on the objective functions. Upon solving the numerical example, it was found that our technique, the Arithmetic Median Technique, provided a better optimal solution.

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STUDY OF FIELD DISTRIBUTION AND SCATTERING EFFICIENCY OF GaN CYLINDER USING COMSOL

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Abstract

Metasurfaces possess the ability to finely adjust the amplitude, phase, and polarization of incoming light, enabling design of diverse polarization devices. Here, we propose a metasurface of the novel dielectric material gallium nitride (GaN) on Al_2O_3 substrate and study the characteristic using COMSOL multiphysics software to realize the functioning of the devices across the entire visible spectrum range. The total scattering efficiency of individual GaN cylinder of radius 150 nm and length 300 nm was studied, we observe that scattering efficiency monotonically decreases for longer wavelengths, the sharper and strongest peak observed at λ = 830 nm is mainly due to a MD resonance, as it can be inferred from the field distribution.

Keywords: Metasurfaces, Field Distribution, Polarization, High-Efficiency.

1. INTRODUCTION

Metasurfaces are two-dimensional structures composed of subwavelength resonant elements that can manipulate electromagnetic waves with high efficiency and precision [1]. Conventional optical elements such as lenses or mirrors, which rely on the refraction or reflection of light, in contrast metamaterials are uniquely shaped scattering elements exhibit precise phase and polarization shifts on incoming waves [2 – 3]. Metamaterials were first proposed as a means of achieving negative refractive index [4], and also shows some unique electromagnetic responses like, zero index materials [5], ultra high index materials [6 – 7]. Metasurfaces are a more recent development in the field of metamaterials, and they offer several advantages over bulk metamaterials. The two dimensional metasurfaces is easier to be fabricate and utilized.

Metasurfaces are only one or two wavelengths thick, they can be integrated with other optical elements and can be easily fabricated on a variety of substrates using lithographic techniques. This makes metasurfaces highly versatile and enables a wide range of potential applications, from sensing and imaging to telecommunications and quantum optics. Metal nanostructures show low transmission under visible light region due to Joule losses [8].

The semiconductor- based dielectric metasurfaces shows high transmission and demonstrated higher performance in many applications [9 – 12]. However, optical system shows some limitation for practical applications of refractive metasurfaces, transmitted dielectric metasurfaces with high index used to overcome the optical limitations such as silicon [13 – 16] and TiO-titanium oxide [17 – 18].

In this work, we construct dielectric metasurface based on gallium nitride (GaN) nanocylinder (refractive index of 2.4) for manipulating orthogonal linear polarizations at wavelength of 530 nm. GaN was chosen because of its wide band gap of 3.4 eV and there is no intrinsic absorption in the visible spectrum [19, 20].

The polarization beam splitter (PBS) and metalens were designed based on the geometry of the GaN nanocylinder to meet the corresponding required phases.

2. SIMULATION SOFTWARE AND METHODOLOGY

The simulation software called COMSOL Multiphysics is used. In the COMSOL a virtual cylindrical form of GaN nano resonator is created. The transverse electric and magnetic field and their distribution were also studied. One of the most widely used simulation tools for GaN metasurfaces is COMSOL Multiphysics. This software allows for the simulation of various physical phenomena, such as electromagnetic, structural mechanics, and fluid dynamics, among others.

In the case of GaN metasurfaces, COMSOL can be used to simulate the behavior of light and electromagnetic waves as they interact with the metasurface structure. This can help in the design and optimization of the metasurface to achieve desired optical properties, such as high transmission or absorption. COMSOL also allows for the simulation of the electrical properties of GaN metasurfaces, such as conductivity and carrier mobility. This is important for understanding the performance of the metasurface in electronic applications, such as sensors and transistors.

Other computational methods and tools that can be used for GaN metasurface design and simulation include finite element analysis, rigorous coupled wave analysis, and Fourier modal method, among others. These methods can provide valuable insights into the behavior and properties of GaN metasurfaces, helping to optimize their performance for various applications.

3. Design and simulation of GaN

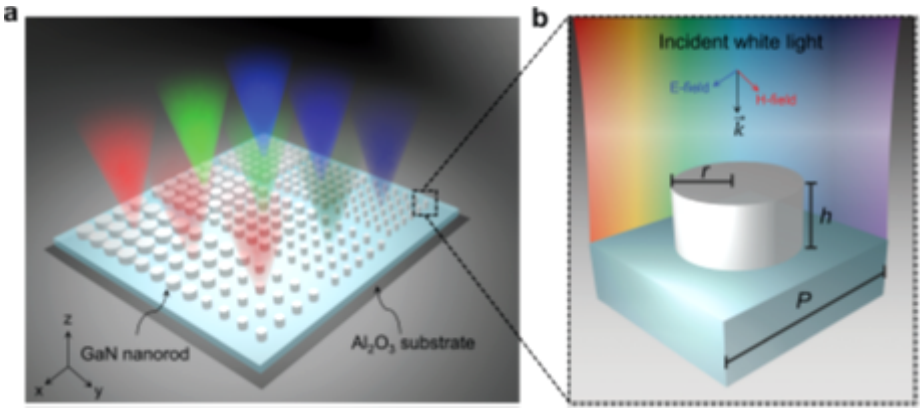

Figure 1: Schematics of the GaN metasurfaces (a) GaN metasurfaces composed of an array of GaN nanorods on an Al_2O_3 substrate. (b) The unit cell consists of GaN nanorods with height h, radius r, and periodicity P, arranged in a square lattice.

In our study we investigated the scattering characteristics of GaN cylinders at near-IR wavelengths by using finite element method simulations in COMSOL. As shown in Figure 1(a), the incident light was a plane wave with a wave vector, k, parallel to the cylinder axis and the electric field, E, polarized along the x-axis.

The scattering efficiency (defined as Qsca = Csca/πr^2 where Csca is the scattering cross-section and r is the cylinder radius) calculated for a cylinder suspended in air with radius $r = 150$ nm and height $h = 300$ nm as shown in Fig. 1. We can observe that several resonant peaks appear at wavelengths shorter than about $\lambda = 830$ nm while, for longer wavelengths, the scattering efficiency monotonically decreases. In particular, the sharper and strongest resonance observed at $\lambda = 830$ nm is mainly due to a MD resonance, as it can be inferred from the field distribution shown in the inset of Fig. 3. Because the incident electric field was x-polarized, the main components of the electric field inside the cylinder are along the x and z directions. The broader resonance at $\lambda = 650$ nm is of electric dipole type while higher-order multipoles contribute to the resonances observed at shorter wavelengths (see Fig. 2). This configuration reflects the case of the antennas fabricated onto a sapphire substrate. We can see that the effect of the substrate on the scattering efficiency is small (e.g. for $r = 150$ nm the MD resonance wavelength is about 830 nm in the case without the substrate and 830 nm with the substrate).The sharper and strongest resonance observed at $\lambda = 580$ nm is mainly due to a MQ resonance. The broader EQ resonance at $\lambda = 555$ nm is of electric quadrupole type while higher-order multipoles contribute to the 31 resonances observed at shorter wavelengths (see Fig. 1(a)). The presence of the substrate does not radically alter the scattering efficiency of the cylinder.

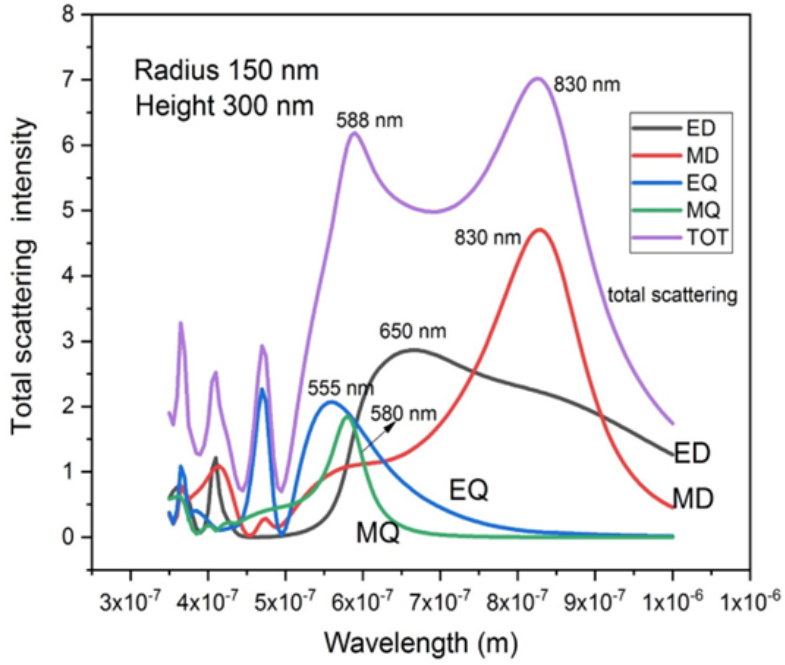

Figure 2: Scattering efficiency Qsca, decomposed in magnetic dipole (MD), electric dipole (ED), magnetic quadrupole (MQ), and electric quadrupole (EQ) contributions, as a function of wavelength calculated for $r = 150$ **nm and** $h = 300$**nm.**

4. TRANSVERSE ELECTRIC AND MAGNETIC MODES

Different types of TE (Transverse Electric) and TM (Transverse Magnetic) modes were formed while studying the GaN dielectric resonator. Depending on the radius, length and wavelength, different types of modes were formed. In the transverse electric and magnetic modes, depending on the maxima and minima the modes were named. Two maximas mean that there is one cyclic variation. One maxima and one minima mean the cyclic variation takes place inside the maxima only. So, depending on the same thing, three cyclic variations mean six maxima and one minima. According to the number of maxima and minima, the TE and TM modes were named.

5. DISTRIBUTION OF TRANSVERSE MAGNETIC FIELD

Figure set 3 (a) shows the final result of the dielectric resonator with transverse magnetic field distribution. This is the high scattering and Q-factor structureand this forms the T mode. It has eight maxima and one big minima in the center of the cylinder, and another minima is surrounded by the maxima.

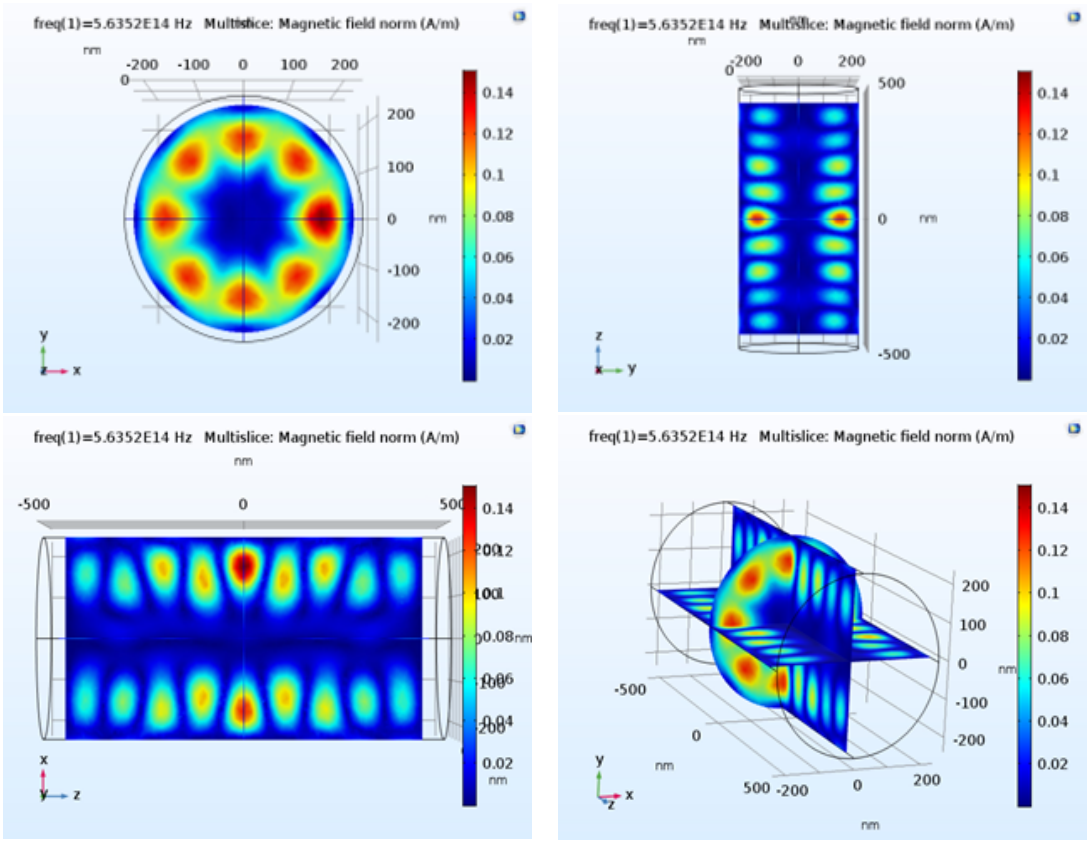

Figure 3 (a): Transverse magnetic field distribution of the GaN dielectric cylinder

The TM mode of the structure is shown in the image in a different plane, XY, XZ, and YZ axis views of the resonator.

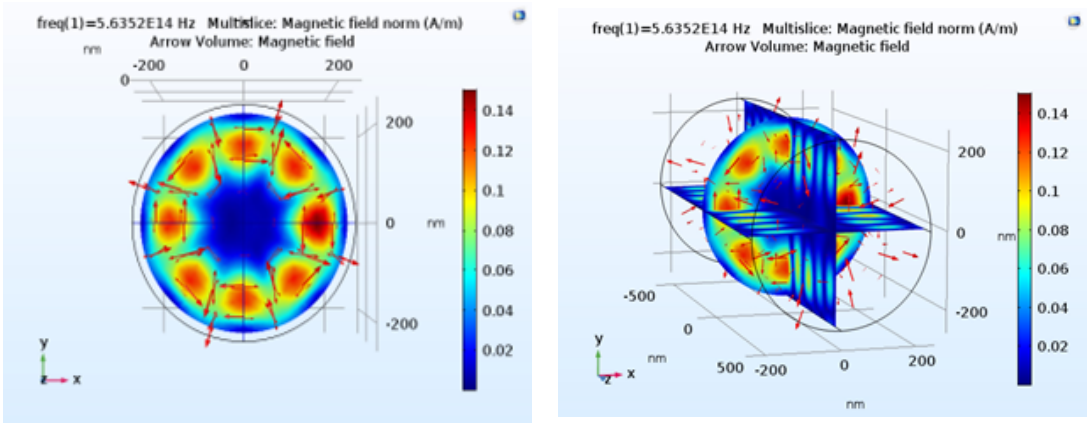

Figure 3 (b): Direction of the transverse magnetic field

Figure set 3(b) shows the transverse magnetic field with the arrows to study how the magnetic field takes place in the resonator. And the arrows indicate the direction of the cyclic variation. The transverse magnetic mode is taking place inside the resonator only. The second minima of the cylinder show die transverse magnetic field that takes place inside the resonator.

6. DISTRIBUTION OF TRANSVERSE ELECTRIC FIELD

Figure set 4a shows the final result of the dielectric resonator with transverse electric field distribution. This high scattering and Q-factor structure form the TE mode. It has eight maxima and one big minima in the center of the cylinder. The TE mode of the structure shown in the image on a different plane, XY, XZ, and YZ axis views of the resonator.

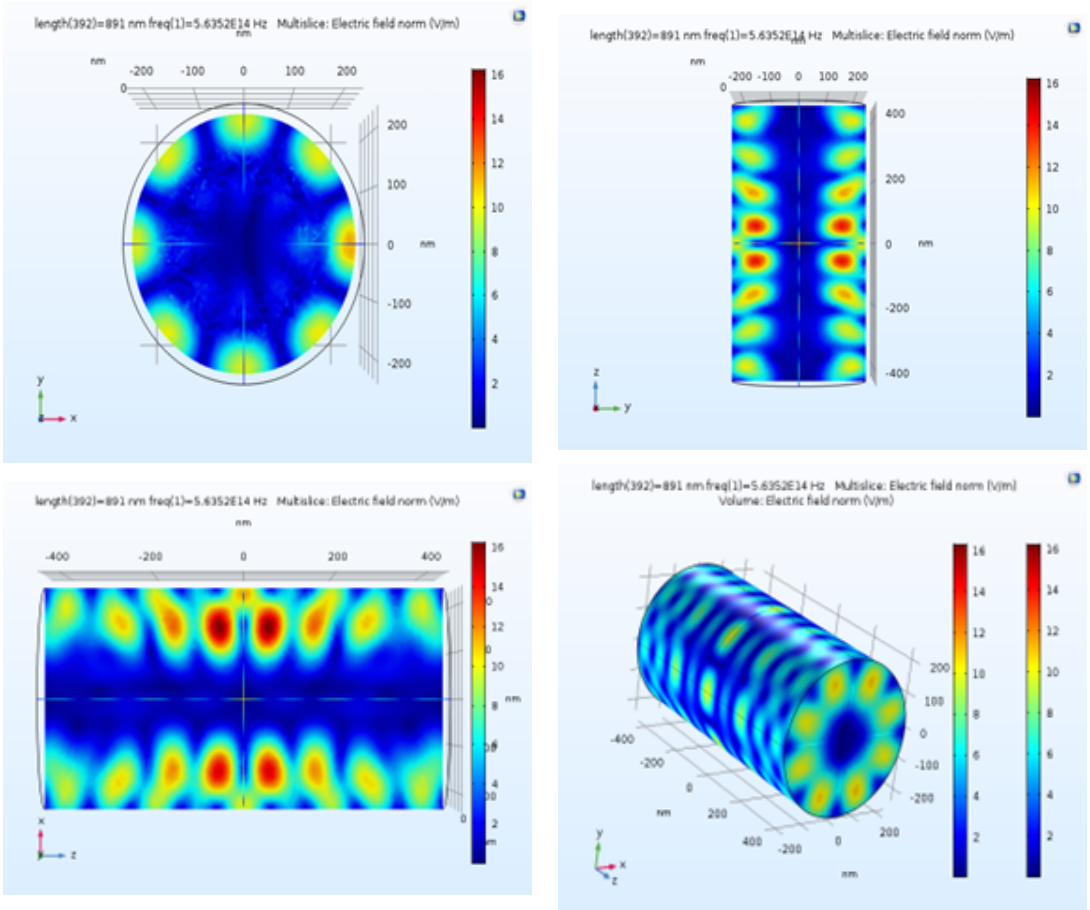

Figure 4 (a): Transverse electric field distribution of the GaN dielectric cylinder

From the XZ and YZ plane view, we can observe that the intensity of the electric field is higher in the middle of the cylinder, and gradually decreases towards the ends. In Figure set 4(a) the final image shows the outer surface of the dielectric nano resonator, this shows how the resonator looks on the outer surface in the transverse electric field.

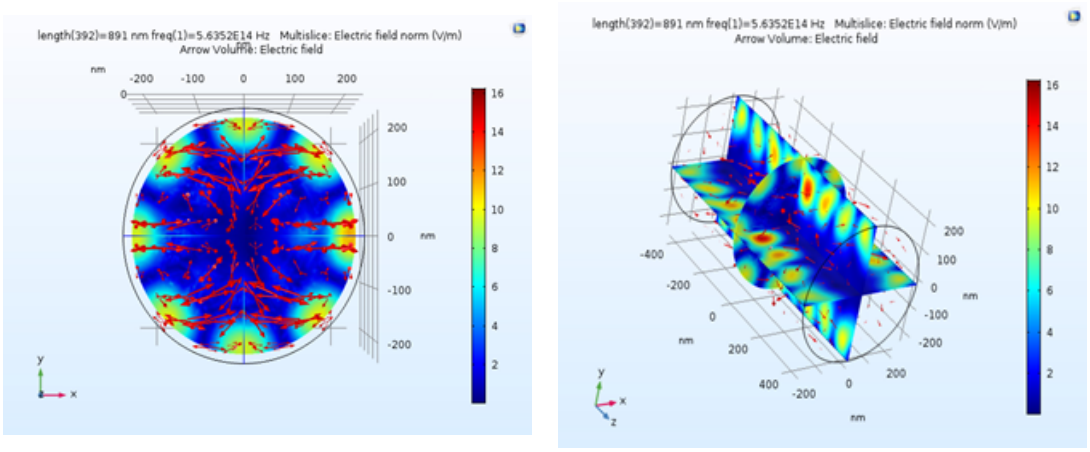

Figure 4 (b): Direction of the transverse electric field

Figure set 4(b) shows the transverse electric field is shown with arrows to show how the electric field takes place in the resonator. While varying the radius and length the TE and TM modes were repeated after the high peak again starting from the lower modes with two maxima and then four maxima, like that six and eight maxima were formed. This cycle continued for the radius and length. Depending on the modes the grape peak also varies like foe lower modes, the scattering cross-section is low and for higher modes, the scattering cross-section is also high. For the 150 nm radius and given length, the modes formed were very perfect and accurate.

7. CONCLUSION

The GaN cylinder of radius 150 nm and length of 300 nm were design and studied their characteristic using COMSOL software. The dielectric resonators are found with a higher scattering cross-section and high Q-factor. The transverse electric and magnetic modes were analyzed and observed. Depending on the TE and TM modes the cyclic variation was observed. With this dielectric nano resonator, we can make a metasurface in the quantum field. This single cylinder gives high scattering and Q-factor. The metasurface using GaN cylinder structure can make very high scattering and nearly infinite Q-factor. In order to explore and achieve the high scattering efficiency, we can perform the experiment with different dimension and arrangement of GaN metasurface.

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Part B:

HUMANITIES

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IMPACT ON CONSUMER'S AWARENESS ON GREEN BANKING INITIATIVES IN SELECTED PUBLIC AND PRIVATE SECTOR BANKS WITH SPECIAL REFERENCE TO RANIPET DISTRICT

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Abstract

The banking industry has made significant Developments and Investments in recent years.Most banks are implementing a green banking initiative. Banks apply a variety of environmental practices to their daily activitiesBusiness operations on environmental issues to maintain environmental balance. Green Banking Concept Green banking creates a cleaner and greener future because it directly affects the environment. In this article, this was done to investigate the level of customer awareness of green bankinginitiatives carried out by various Public and private sector banks in Ranipet District.

Keywords: Green banking, RBI, Consumer Awareness and Environment friendly.

1. INTRODUCTION

Industry is a rapidly changing market economy where competition is intensifying due to market globalization Vulnerable to harsh government policies, serious lawsuits or consumer boycotts. The most important topic of the 21st Century is green security and sustainable ecological balance. In order not to fall into such a trap, the impulse 'Green Life' flows faster than the blood flowing through the veins of Indian companies. Sustainability and Conservation The environment is now recognized worldwide as a major issue protecting the planet from destruction by mankind. Therefore, society is demanding that businesses take responsibility for protecting the environment and society. From tech giants to luxury hotels, automobiles to airlines, mutual funds to banks to corporate deliveries, maniacally moves forward with green initiatives. All state and commercial banks are working on a 4G. Green banking is not only a corporate

CSR activity, but also To create a better society to live in without major damage. This includes approval and implementation. Environmental and social responsibility, but the provision of excellent banking services in this context, this study It focuses on customer awareness of the green banking practices of individual commercial banks in Ranipet District.

2. CONCEPT OF GREEN BANKING

Green banking means using all the resources of a bank responsibly and carefully avoiding waste and prioritizing choices that take into account sustainability. It is also known as eco-friendly banking, ethical banking or Sustainable banking. According to the Association of Indian Banks, a green bank is like a normal bank all social and environmental factors aimed at protecting the environment and conserving natural resources. Because banking experts, green banking related to sustainability principles, ethical lending, conservation and energy Effective. Green banking products include ATMs, mobile banking, remote deposit, green money, market accounts, green checking accounts, online banking, green credit cards, green loans, green savings accounts, green mortgages, green channel counters, green homes, etc.

3. REVIEW OF LITERATURE

Atiur Rahman (2010) studied the monetary and credit policies of Bangladesh Bank towards attaining broaderfinancial enclosure. Bangladesh Bank is carry forwardingwith technology driven, innovative, environment and lowcost banking approach; conveying a qualitative change in banking, application of advanced banking technology, anduse of information and communication technology to extend financial services to the door step of common people. Toensure access to financial services for all, various initiatives have been taken like trade finance; digitalization of thefinancial sector, channeling liquidity into productive and supply augmenting investments including agriculture, SMEs,green banking and CSR activities; expected to inclusive growth and therefore lessen poverty; required for pushing thecountry on course to the targeted vision of digital Bangladesh by 2021.

Krebsbach (2005) stated that banks which adopted socially and environmentally responsible lending and investing were altering their processes of bond underwriting, investment banking and corporate lending. These banks were enjoying a competitive advantage over others as society is aware about the environmental issues. The author suggested that banks should adopt the green lending principles in such a way that a customer base will not be affected. The author said credibility comes from having high standards. He concluded that environmental management in the banking sector is like risk management because it reduces the credit risk, improves the asset quality

and increases the enterprise value.

If Indian banks want to penetrate the global market, it is important that they realize their environmental responsibility and social responsibility. Acknowledging global warming warning, State Bank of India has declared a state of emergency measures to combat climate change by reducing the bank's own carbon footprint and increasing awareness among its customersapply low carbon practices (Sharma, N., 2011).

4. OBJECTIVES OF THE STUDY

- Find out customer attitudes toward "green" banking practices at individual commercial banks.
- Proposal of plans to expand green banking for commercial banks selected based on the following Conclusion of the study.
- To know about the green banking products.
- To check the awareness of green banking among the general public and consumers.

5. RESEARCH METHODOLOGY

Research Area: Research to understand customer attitudes toward green banking Choose a commercial bank in the Ranipet Region.

Green Banking Practices

Society is facing most complicated issues of climate change. People nowadays are more conversant with global warming and its inherent consequences on human life. So change is the need of the hour for the survival and continuous efforts should be made for the environmental management in a sustainable manner. It is not only the concern of the government and the direct polluters but also of other stakeholders like financial institutions such as banks, which are playing a fundamental role in the development of the society. Banking activities are not physically related to the environment, but the external impact of their customer activities is substantial. So there is need for banks to adopt green strategies into their operations, buildings, investments and financing strategies. The purpose of this paper is to highlight the rating standards given by RBI, the World Bank's environmental and social norms, the initiatives taken by public and private sector banks in India in the adopting practices and to enlist the significant strategies for adoption Banking.

GREEN BANKING PRODUCTS AND SERVICES

- Retail banking
- Corporate investment banking
- Asset management

- Insurance.

A. Retail Banking

(1) Green Mortgages This facility helps the individual customer to get a lower interest rate green loan than market rate, who is ready to purchase new energy efficient homes. This facility also allows them to invest in energy efficient appliances.

(2) Green Home Equity Loans Reduced rate home equity loans sometimes referred to a second mortgages can help motivate households to install residential renewable energy (Power or thermal), technologies.

(3) Green Commercial Building Loans From the above study we conclude that, green banking initiatives like solar ATM, banking environment policy, green loans, are not familiar among the customers. Environment protection is the duty of every citizen, including Attractive loans designs and arrangements have started to emerge for green commercial building characterized by lower energy consumption reduced waste and less pollution than traditional building.

(4) Green Car Loans With below market interest rate many green car loans encourage the purchase of cars that demonstrate high fuel efficiency.

(5) Green Cards A broad family of green products includes debit and credit cards linked to environmental activities. This green cards offered by large credit card companies offer to make nongovermenent organizations donations equal to approximately One-half percent of every purchase, balance transfer or cash advance made by the card owner.

B. Corporate Investment Banking

(1) Green Project Finance A number of banks are now ready to accept large scale renewable energy project. For this they have to create service divisions also to help those companies who under take large scale renewable energy system.

(2) Green Securitization A variety of environmental securitization techniques have begun to emerge, including forest bond, eco securitization pilot program and green mortgage-backed securities.

(3) Green Venture Capital and Private Equity While issuing finance through capital market, we can see that, high consideration paid to environmental issues. In particular banks can play a vital role in assisting with IPO for clean technology providers, carbon credit developers, and other firms marketing environmental product and services.

(4) Green Index Some banks have currently developed index that fluctuate as future environmental opportunities' and challenges.

C. Asset Management

(1) Green Fiscal Fund By purchasing shares in a green fund or investing money in a green bank, citizens are exempted from paying capital gain tax and receive a discount on income tax.
(2) Green Investment Fund Sustainable investment funds have evolved through three generations, where the complexity of assessing investment eligibility rises at easy level.
(3) Carbon Fund Collaboration between multi lateral development banks and private financial institutions has led to the emergence of a variety of carbon funds to help finance GHC emissionreduction projects to curb climate changes.

6. SUGGESSTION

1. Selected commercial banks should publish the following independent green annual reportThe accepted format is the Global Reporting Initiative targeting their stakeholders. RBI should remind responsibility of all commercial banks in protecting the environment and interpret the various measures according toGreen banking can help protect the environment. Reserve Bank of India should recognize and reward banks offer environmentally conscious green loans every year.

2. Positive green banking initiatives should be rewarded. In this context, green rating agencies should be established to provide green analysis of green loan lenders and users through various ratings. Green Rating Indexes like Dow The Jones Sustainability Group indicators can be developed in India.This will promote selectedcommercial banks more conscious because they will have a direct impact on their performance evaluation.

3. Selected commercial banks should invest in a project after an environmental or climate risk assessment. Invest should only be used after ensuring proper management of these harmful ingredients. Selection commercial banks can incorporate environmental impact assessments into their project appraisals during financing the project measures the level of impact on the environment and proposes measures to reduce environmental risks.

7. CONCLUSION

As concerns about global warming and environmental conservation grow, Indian banks are also becoming more active. We respond to our customers' environmental aspirations. Because India has committed to reducing its carbon intensity by: 2025% of 2005 levels by 2020, banks are working to develop a low-carbon economy. Green

Banking has continued to evolve in recent years and is expected to become an even bigger driver. Green banking provides more than just financial benefits to banks. Benefits include reputation, increased customer base, positive environmental impact and ease of banking. process. Green banking requires a paradigm shift in thinking about economy, business, and finance. how Green Banks are concerned, Banks of India are outdated and it's time to seriously think about it. sustainable growth of the country. Therefore, individual commercial banks must adopt an effective strategy for the green. We view banking as a strategic imperative. Possible policy actions, legal and regulatory frameworks and initiatives the promotion of green banking in India has become a necessity of the times.

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ONLINE SHOPPING BEHAVIOUR OF COLLEGE STUDENTS – A STUDY WITH REFERENCE TO SELECTED COLLEGES IN TIRUPATTUR DISTRICT

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Abstract

Our method of shopping in our online store using our mobile phones or laptops is called online shopping. Technology has transformed many brick-and-mortar stores into online stores. All products available in physical stores can also be seen in online stores and can be purchased online with one click. There are many websites like Amazon.com, e-bay, Flipkart, Paytm Mall, Snapdeal, Myntra, Jabong.com, Bigbasket.com, Urbanclap, etc that allow online shopping. We just need to visit these online stores with our mobile phone or computer and choose the product we want to buy and order it. Courier will deliver our products as soon as possible. This shopping method is known by various names such as online shopping, digital shopping, e-commerce, online shopping, internet shopping, etc.

Keywords: Online Shopping, PDA, CEO and HUL.

1. INTRODUCTION

With the exponential increase in Internet usage, our lifestyle is also improving, where we can reach every market in a flash. Initially, the Internet was reserved only for privileged families and for military purposes. Usage is also limited to transferring data and sending e-mails. The advent of the Internet and WWW in the early 1990s changed humanity's life alongside the advancement and friendliness of electronics. All aspects of our lives have undergone drastic changes from homes, offices and other economic activities. Traditional household chores, office work, marketing tools have been replaced by electronic machines and tools that are simple and easy to handle. The long queue for reserve train tickets has ended. Now, with the use of internet, we can book reserve tickets without any other hard and difficult queuing tools.

2. OBJECTIVES OF THE STUDY

1. To study the online shopping behavior of the College students from Tirupattur District.
2. To study the influencing factors for purchasing online shopping.

3. STATEMENT OF THE PROBLEM

The World Wide Web and internet has transformed the traditional marketing system into more of internet friendly E-commerce system. The E-commerce in India is at the nascent stage but the present young dynamic and internet savvy shows great interest and passion for the internet activities. In India from 137 million internet users, 102 million internet users are below the age of 35. So the young customers of internet show great potential market for E-commerce. Tirupattur District has become a hub of the knowledge institutions in South India with many Arts and Science College and Engineering colleges. Thousands of the students are studying in the various colleges situated in and around Tirupattur District. Many of the students are the part of those 102 million internet users below the age of 35. The past two years schemes of giving laptop to college students by the ruling state party gave the students to the privilege of the modern technology.

4. NEED OF THE STUDY

The present estimated strength of internet users is at 2.4 billion. The majority of the internet users are located in Asia as per the sources of Internet Users Stats. Indian internet users are the major shares in that majority of internet users in Asia. India has estimated of 140 million internet users. Internet is playing very important role in the everyday life of Indian consumers whether for office or home use. The internet has a great impact on the daily life of an individual. The younger and more gadget savvy are eager to follow an unconventional and radical paths rather than the old path that lay by their elders.

The traditional ways of shopping brick and mortar are now become part of our yester years shopping. Visiting the shopping malls during weekend and the festive and seasonal offers is diminishing day by day with the upcoming of e-commerce. For the sellers the e-commerce provides the comfort of easy commerce activities without shelling extra bucks on the overhead expenditure and other costs. Online shopping gives the advantages of better deals, lower price, saves time and convenience of shopping for the customer.

5. SCOPE OF THE STUDY

Internet is widely used tool for many daily activities in our life. Every office and homes are connected to internet in doing many daily offices works and other personal works. Online shopping is capturing the new market as fast as wide fire. The market share of e-commerce is augmenting year after year. The future of the shopping spheres is through online shopping. Online shopping provides the luxury of saving time, convenience and comfort for the shoppers and sellers.

The study provides the surface knowledge in knowing the impact of online shopping on the college students in Tirupattur District with special reference to **five selected colleges**. Here it tries to gain more knowledge about what the college students' annual spending through online, the influencing factors to purchase online, the problem encountered and the suggestions from the respondents for further growth of online shopping. The study facilitates in identifying the factors which influence the college students going online shopping, problems faced, the most buy products online and the further suggestions to make the online shopping more enjoyable and customer friendly and for its growth in future.

6. REVIEW OF LITERATURE

Deccan Chronicle (2021) the Show staying pattern in India is significant test for the retailer stores particularly in the electronic items like PDAs, shopper gadgets and extravagance things. Show living alludes to the training when a customer visits a store to look at a result of his decision however buy it just from online fundamentally because of less expensive cost and comfort. It represent the greatest danger for the retailers as the current cost delicate purchasers visit the show space to actually take a look at just the actual items and get it from online with less expensive cost and more comfort.

The Economic Times (2020) underlined on learning the craft of computerized as the Rs 22,000 crore Hindustan Unilever's CEO Nitin Paranjpe cited in his own statement, "Today there is an age of buyers growing up just in the advanced space", Paranjpe told ET in December 2012. "As the CEO of an organization whose business spins around the buyer, how could I not be enlightened to it?" As the on the web and computerized drive is upsetting the latest thing of showcasing and business the back end is intended to siphon the front end, which is quick changing in character. HUL's spending and piece of the pie in computerized space is additionally expanding and getting the force to stay up with the latest thing of business.

India Today, (2020) distributed the information of the past web clients in India, the current situation of web clients and the web clients in five metro urban areas of India. In 1992 there were simply 1.3 million PC associated with the web all over the planet. In Indian situation, there were just 180000 web clients in 1998. The Worldwide E-trade business in 1998 was 80 million. The web-based informal community will grow as web

entrance increment. At present they are 137 million complete web clients in India and 0.15 million new web clients added consistently. From that 102 million web clients are under 35 years.

7. RESEARCH METHODOLOGY

Research methodology is a systematic and scientific way of solving the research problem. The methodology adopted for the present investigation undertaken the study on Impact of online shopping on College students from Tirupattur District is conducted through scientific way of collecting the primary and secondary data. The tools for the collection of the data used were **questionnaire**. The sampling procedure used for the study was **Convenience sampling technique**; the sample size is 150. The population frame is the students studying in the colleges in Tirupattur District which covers Ambur, Vaniyambadi, Tirupattur District. The representatives of the population of the students are selected from five colleges in Tirupattur District namely

1. Sacred Heart College
2. Maruthar Kesari Jain College
3. Islamiah College
4. Islamiah College for Women
5. Mazharool Uloom College

The students of the above colleges are considered for conducting the research work.

8. DATA ANALYSIS AND INTERPRETATION

Mean Ranking

Table 1: The frequency distribution of the respondents on each factor influencing the buying decision by the student's online buying in percentage analysis

Sr. No	Particulars	1	2	3	4	5	Total
1	High convenience and easy shopping	11.3	6	26.7	**34.7**	21.3	100
2	Product availability	1.3	11.3	28	**40.7**	18.7	100
3	Genuine and quality product	6.7	7.3	22	**38.7**	25.3	100
4	Product description and aided images	1.3	12	29.3	**39.4**	18	100
5	Price and offers	4	6.7	13.3	**44**	32	100

6	Saves times	5.3	10.7	17.3	**39.4**	27.3	100
7	Payment process is simple to follow	5.3	8	20	**40**	26.7	100
8	Flexible delivery timing	2	6	24	**43.3**	24.7	100
9	Privacy of information	3.4	9.3	25.3	**40**	22	100
10	Guarantees and warrantees	8.7	4.7	21.3	**40.7**	24.6	100
11	Reputation of the company	2	7.3	26.7	**42**	22	100
12	Quality of customer services	-	6	14	**52**	28	100
	Total	**51.3**	**95.3**	**267.9**	**494.9**	**290.6**	**1200**
	Total in per cent	**4.28**	**7.94**	**22.32**	**41.24**	**24.22**	**100**

(1 – Strongly disagree, 2 – Disagree, 3 – Neutral, 4 – Agree and 5 – Strongly Agree)

Descriptive Interpretation

Twelve attributes or factors related with the online shopping are considered for the analysis part of the chapter with reference to previous studies. Most of the respondents agree with the each factor that they do influence their purchase decision through online as most of the response represent in percentage of the total are concentrated in the state of agreement (41.24%) and strongly agree represented by (24.22%) for all the twelve statements. By the each statement most of the respondents agree with that each factors do direct them to shop online. Minimal respondents are in strongly disagree (4.28%) and disagree (7.94%) with the statements and about 22.32% of the respondents neither agree, nor disagree with the factors.

Table 2: The Frequency Distribution of the Respondents on each statements of risks and problems associate with online shopping in Percentage

The frequency distribution of the respondents on each factor influencing the buying decision of the student online buying

Sr. No	Particulars	1	2	3	4	5	Total
1	Risk of wrong transactions	16.7	**38**	27.3	12	6	100
2	Risk of identity theft	10	29.3	**38.7**	18.7	3.3	100
3	Difficulty in returning policy	30	30	24.7	14.7	.7	100
4	Risk of not getting what paid for	13.3	**38.7**	27.3	19.3	1.3	100
5	Lack of trustworthiness of vendors	23.3	26	33.3	17.3		100

6	Complex compare to traditional shopping	8	30.7	36	19.3	6	100
7	Not being able to touch the product	27.3	36	26.7	8	2	100
8	Discrepancy in the image shown and real	25.3	36	21.3	16	1.3	100
9	Product not delivered on time	10	**43.3**	32	11.3	3.3	100

(1 – Strongly disagree, 2 – Disagree, 3 – Neutral, 4 – Strongly agree and 5 – Strongly Agree)

The above table shows the agreement of the students on each statement of risks and problems associated with the online shopping. Majority of the respondents felt that the risk of wrong transaction, difficulty in returning policy, risk of not getting what paid for and product delivered on time is very less as most of them disagree with the above statement. Another aspect is that many are in undecided or neutral state when it comes to the risk of identity, lack of trustworthiness of vendors and complex compare to traditional shopping.

Factor Analysis

Factor analysis is a statistical procedure used to identify a small number of factors that can be used to represent relationships among set of interrelated variables. Factor analysis extracts maximum common variance from all variables and puts them into a common score. In the Total Variance Explained table we see that 3 factors have been extracted that have Eigen value greater than 1. Eigen values explain the variances of the factors and values greater than one represent considerable variance, forming significant factors.

Table 3 (a): KMO and Bartlett's Test for Factor Analysis for the Factors Influencing Purchase Decision through Online

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.824
Bartlett's Test of Sphericity	Approx. Chi-Square	614.147
	Df	66
	Sig.	.000

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy is a statistics that indicates the proportion of variance in variable that might be caused by underlying factors. High values (close to 1.0) generally indicate that a factor analysis may be useful with data. If the value is less than 0.50, the result of the factor analysis probably won't be very useful. In this study, the value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.824 (82.4%) which is adequate.

Bartlett's tests the hypothesis that correlation matrix is an identity matrix, which would indicate that variables are unrelated and therefore unsuitable for structure detection. A small value (less than 0.05) of the significance level indicates that a factor analysis may be useful with data.

Table 3 (b): Total Variance Explained for the Factors Influencing Purchase Decision through Online

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.719	39.327	39.327	2.824	23.535	23.535
2	1.329	11.078	50.405	2.736	22.798	46.333
3	1.040	8.667	59.072	1.529	12.739	59.072
4	.854	7.113	66.185			
5	.786	6.553	72.738			
6	.708	5.903	78.641			
7	.615	5.128	83.769			
8	.525	4.371	88.140			
9	.467	3.892	92.032			
10	.395	3.289	95.322			
11	.329	2.738	98.059			
12	.233	1.941	100.000			

Inference - The above table shows that the total variance explained is 59.072%. This is appropriate for factors analysis. The 59.072% variance was explained by the 3 extracted components.

Table 3 (c): Rotated Component Matrix for the Factors Influencing Purchase Decision through Online

	Component		
	1	2	3
Quality of customer services	.765		
Genuine and quality product	.746		
Payment process is simple to follow	.740		
Privacy of information	.564		
Product availability	.562		

High convenience and easy shopping	.526		
Price and offers		.780	
Guarantee and warrantees		.722	
Saves time		.667	
Good product descriptions with images		.572	
Reputation of the company			.856
Flexible delivery time			.640

1. Utilitarian Factor

The first major influencing factors for online purchase can be grouped under a one factor as the utilitarian factor which is the core usage of the online shopping for the customers. As in the previous studies they have categorically study the utilitarian factor of online shopping, here by doing factor analysis the various factors such as the quality of customer services, genuine and quality of the product, easy payment process, product availability, privacy of information, high convenience and easy shopping are grouped under one factor of utilitarian factor. It is the main factor which influences the respondents to shop online. These factors are the basic necessities that of any online shopping players have to provide for their customers. Most of the online stores facilities the basic utilitarian of above features to enhance their special features to attract more online customers. Customers too initially look for the basic utilitarian factor of the online shopping to purchase online.

2. Beneficiary Factor

The customers are drives by the beneficiary factors associates with the online shopping. As compare with traditional stores the online shopping have the added benefits of easy information search with image display, saves time and money, offering the best prices and deals and the guarantee of the product from the online players. Online shopping provides the luxury of shopping from anywhere and anytime and the best deals and offers with the lowest price. Such added features and benefit of online shopping influence the customers to purchase through online. These benefits of the online shopping create the cutting edge from the offline store visiting and buying.

3. Other Factor

Many of the customers are easily influence by the reputation of the company and its other policy of flexible delivery timing and other augmented benefits which drives them to purchase through online shopping. Many foreign and local players are actively creating their own market niche and target customers in the online market zone. The well established and reputed players like ebay, amazon are predominant players with huge customers following which increase their sales volume around the world.

The brand conscious customers are incline to make purchase through such reputed companies and other their customer friendly policy make them visit again and again and shop for more.

Thus with the use of the factor analysis the various factors of influencing to purchase online shopping are grouped into three independent groups under the head of utilitarian, beneficial and other factors of influencing.

Table 4 (a): KMO and Bartlett's Test for Factor Analysis for the risks and problems associated with online shopping

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.724
Bartlett's Test of Sphericity	Approx. Chi-Square	215.573
	Df	36
	Sig.	.000

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy is a statistics that indicates the proportion of variance in variable that might be caused by underlying factors. High values (close to 1.0) generally indicate that a factor analysis may be useful with data. If the value is less than 0.50, the result of the factor analysis probably won't be very useful. In this study, the value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.724 (72.4%) which is adequate. Bartlett's tests the hypothesis that correlation matrix is an identity matrix, which would indicate that variables are unrelated and therefore unsuitable for structure detection. A small value (less than 0.05) of the significance level indicates that a factor analysis may be useful with data.

Table 4 (b): Total Variance Explained for the risks and problems associated with online shopping

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.749	30.541	30.541	2.135	23.727	23.727
2	1.292	14.359	44.900	1.821	20.234	43.961
3	1.139	12.654	57.554	1.223	13.593	57.554
4	.903	10.029	67.584			
5	.737	8.192	75.776			
6	.685	7.617	83.392			
7	.545	6.051	89.444			
8	.493	5.473	94.917			
9	.457	5.083	100.000			

Factor analysis extracts maximum common variance from all variables and puts them into a common score. In the Total Variance Explained table we see that 3 factors have been extracted that have Eigen value greater than 1. Eigen values explain the variances of the factors and values greater than one represent considerable variance, forming significant factors.

Inference

The above table shows that the total variance explained is 57.554%. This is appropriate for factors analysis. The 57.554% variance was explained by the 3 extracted components.

Table 4 (c): Rotated Component Matrix of Risks and Problems associated with online shopping

Sr No	Particulars	Component		
		1	2	3
1	Not being able to touch the product	.797	-	-
2	Difficult in returning the product	.760	-	-
3	Lack of trustworthiness of the vendors	.610	-	-
4	Risk of not getting what paid for	.488	-	-
5	Risk of wrong transaction	-	.758	-
6	Product not delivery on time	-	.695	-
7	Risk of identity theft	-	.690	-
8	Complex as compare to traditional shopping	-	-	.892
9	Discrepancy in the image shown and real	-	-	.508

From the above table 5.4 we can extract three main independent factors from the nine variables as below –

1. Risks and problems associated with product

The first factor identified from the factor analysis is the problems and risks relates with the product that purchase from online vendors. Many of the online products are only virtually available with images and description where the touching of the product is absents. Few vendors also deceive the customers with showing unrelated images of the real products to attract customers which lead to loss in trust for the vendors in the next purchase. Such misleading images left with customers with not getting what they paid for and are dissatisfied. Few vendors' returning policy also takes very unusual long time and very difficult to reclaim the refund amount. Thus these all above problems and risks of online shopping can be grouped under one head of product related risks and problems face by the customers.

2. Risks and problems associated with the procedure

While we are purchasing the product online there is every chance of risk of wrong transaction, risk of identity theft, once we register with the online vendors and in the final process non delivery of the product on time. Such risks and problems are associated with the processing problems. The risks of identity theft is the biggest concern in the developed world as opening of account with the online vendors opens the gate for accessing our detail information and so take place the hacking and invasion of privacy. Lots of spam received and also unwanted calls from different tele callers makes your daily life mess up. Then the wrong transaction entered while shopping lead to deduction of amount the account or charging of the price without any real purchase of the goods. Sometimes the purchase products are not delivered on time.

3. Basic problems associated with the online shoppers

Newly online shoppers initially find the online shopping very complex as compare with the traditional shopping where it takes a lengthy procedure and have to give few confidential details. Also there lack of prior experience made them believe that the image shows in the webs are true and in reality find many discrepancies. The traditional shoppers have the preconceived notion that online shopper mislead them with images and others unexpected difficulties.

Thus with the help of the factor analysis the large number of nine variables are grouped into three independent factors as shown above.

9. FINDINGS

1. Around 64.5 per cent of the respondents are influenced by the different factors of the online shopping features. With the help of the factor analysis the various factors are grouped into three independent factors. There is no significance relationship between the factors influencing online purchase and the independent variables of age, gender and education qualification.

2. Still the risks and problems aspects of the online shopping are yet to face by the most the respondents as it is clearly indicated from the data that majority of the students disagree with the given statements. It is found that most of the students are not familiar or faced much risk and problems associated with online shopping.

3. The post purchase behavior and satisfaction level of the students are very positive as 51.78 per cent of the respondent were satisfied with online shopping experience, another 33.49 were in neutral state and only 14.73 were dissatisfied. Majority of the students are satisfied with the online shopping experience and they are likely to make more shopping online in the future.

10. SUGGESTIONS

1. The study covered the surface level of the online shopping but the mechanism of it is not include in the study so a complete packages of online shopping mechanism is good suggestion for future study.
2. Few basic statistical tools are used in the analysis part of the study so in order to make the analysis part more validity, the researchers can put in use more tools to tests the data and its analysis.
3. Only the method of questionnaire is used for data collection and the target respondents are students. To extend more knowledge on online shopping they can use difference methods of data collections and also uneducated shoppers should include know what they thinks about the online shopping.
4. To make the online shopping more attractive, the students suggested that –
    - The real and true image should be display with full description of the products so to not deceive the customers.
    - The shipping charges from foreign e-retailers should be reduced and the delivery man should check the quality and condition of those fragile goods properly before delivery it to the customers.
    - The retailers should secure the confidence of the customers by providing the safety and assurance aspects of the online shopping.

11. CONCLUSION

The research shows that online shopping has very bright future in India. The mercurial rise of the smart phones and internet penetration aids in getting the momentum of the online shopping. It is known from the data collected that internet has become an integral part of our life. As compare with traditional brick and mortar shopping, click and mortar shopping have many added advantages which become the competitive edge from the traditional shopping. The various benefit of the online shopping of saving time, money and others help in influencing the students online purchase decision. The students to some extend are not much expose with the risks and problems associated with the online shopping. Many of them show their disagreement with the risks and problems factors of online shopping.

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A STUDY ON THE IMPACT OF IMPORT AND EXPORT ON LEATHER INDUSTRY POST COVID WITH REFERENCE TO KAREEM INTERNATIONAL, VELLORE AND TIRUPATTUR DISTRICTS

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Abstract

Leather is one of the most generally exchanged wares universally. The development sought after for Leather is driven by the design business, particularly footwear. Aside from this, furnishings and inside plan ventures, as well as the auto business likewise request calfskin. The Leather business has a position of unmistakable quality in the Indian economy because of significant commodity profit and development.

India's Leather industry is one of its most seasoned assembling businesses. It is put at an unmistakable situation in India's commodity tasks and is one of the 8 significant ventures that produce trade income for the country. From being a simple provider of natural substance, to one of the main enterprises of its sort, India's cowhide and non-calfskin industry has seen inconceivable change after some time.

Keywords: Leather Industry, Kareem International, CLRI and GDP.

1. INTRODUCTION

Bringing in and Exporting are method for Foreign Trade. Unfamiliar exchange is done in labor and products which incorporates imports, sends out, and the equilibrium of unfamiliar exchange is introduced independently for merchandise and for administrations. The complete imports, products, and equilibrium of unfamiliar exchange are introduced as synopses of labor and products. The following are the list of benefits of Import and Export

- It is one of the most straightforward courses of going into the worldwide exchange and import and product create gigantic work open doors.

- Requires less interest as far as time and cash when stood out from other techniques for going into the worldwide exchange.
- Is nearly safer when contrasted and various courses of entering in worldwide business.
- As no country can be 100 percent independent, import and commodity are exceptionally vital for the working and development of that country.

2. INDIAN LEATHER INDUSTRY

Leather is one of the most generally exchanged wares universally. The development sought after for cowhide is driven by the design business, particularly footwear. Aside from this, furnishings and inside plan ventures, as well as the auto business likewise request calfskin. The cowhide business has a position of unmistakable quality in the Indian economy because of significant commodity profit and development.

India's Leather industry is one of its most seasoned assembling businesses. It is put at an unmistakable situation in India's commodity tasks and is one of the 8 significant ventures that produce trade income for the country. From being a simple provider of natural substance, to one of the main enterprises of its sort, India's cowhide and non-calfskin industry has seen inconceivable change after some time.

3. LEATHER INDUSTRY IN VELLORE AND TIRUPATTUR DISTRICT

Tamil Nadu accounts for 60% of leather tanning processes of India and 38% of all leather footwear, garments and components. Hundreds of leather tanneries are located around Vellore and nearby towns, such as Ranipet, Ambur and Vaniyambadi. The Vellore district is the top exporter of finished leather goods in the country. Central Leather Research Institute (CLRI), a CSIR research laboratory, is located in Chennai.

4. COMPANY PROFILE

Kareem International was established with the sole aim of providing the quality products to its clients. Keeping in view the competition from the other aggressive suppliers within and outside the country, the company always concentrates on quality and customer satisfaction in order to meet the requirements of the foreign markets. The success of the company is based on the satisfied, dedicated, experienced and specialized staff in the respective fields. From the buying of the raw material to the finished product each and every step is supervised by the specialized staff which makes us able to maintain and produce standard quality products to meet the international markets requirements.

5. STATEMENT OF RESEARCH PROBLEM

Leather Industry came in to existence during monarch era. Be it the mughal rule or british monarch, this leather trade was conducted by Indians across the globe. It was

assumed to generate major chunk of income in ancient time. Present Scenario of Leather Industry has shrunken its contribution of income and GDP to the national economy due to the emergence of competitors all over the world. The people those who have relied on this industry have started facing downturn trend and export of leather products to the overseas have drastically come down due to lack of realization of best prices for the products and competition also has eaten in to the share of its income to the Indian Economy. Political Environment in India changes from time to time and this leads to changing pattern of leather business.

Lack of raw materials is cited to be one of the reasons and it forces the leather traders to import the raw materials needed for leather industry from alien nations. Import Tariff and Quotas look like threatening the leather traders and it creates a situation of leather traders giving up their leather businesses. As there is stiff competition for leather products, people in this industry had forgone many facilities and privileges which were enjoyed at the hands of the government.

6. OBJECTIVES OF THE RESEARCH STUDY

- To examine the various factors affecting the import and export of leather products at Karim International.
- To highlight the impact of Covid on Leather Business and exhibit the remedial measures taken by the Kareem International.

7. NEED OF THE STUDY

Indian Leather Industry significantly contributes sizeable income to the Indian Economy. Many products are made up of leather and they get used by the people irrespective of caste, creed, gender, religion, age and so on. Our economy also is strengthened by the export of leather products. Many overseas countries demand for leather products and raw leathers and they are exported from India thereby demand of other countries are met. Businessmen in India expand their leather businesses to every nook and corner and increase their bases all over the nations. That is why, India is best known for export of leather products. Leather industry generates employment opportunities to the people across the nation. Even women depend on leather industry as they occupy the positions of supervisor, assistant, helper and even more in the leather companies situated in Ranipet, Ambur and Vaniyambadi.

8. SCOPE OF THE STUDY

- This study is limited to only specific locations where leather companies which are run by Kareem International. This study is of great importance as it gives many opportunities to owner of Kareem International as to how to strengthen their business under debacle situation.
- Corona Pandemic shook the economy of the entire world. Leather industry is not exception to it. Even this industry also was traumatized by epidemic and

businessmen believed to get rid of this deadly situation. In subsequent point of time, people running the leather business can handle any situations.

- This study inculcated the businessmen of how to scale up the export of leather products based on the demand of the people of that countries. In the same way, people know where to approach for import tariff, quotas and subsidies.

9. REVIEW OF LITERATURE

Thangamayan et al. (2019) referenced that In the 1980's and the 1990's the significance of cowhide industry originated from the way that it was the 6th or seventh biggest unfamiliar trade worker of the country. The focal point of the public authority obviously is on producing comprehensive development and the idea of business given by the cowhide area to be sure meets this goal. Serious issue looked by the business is with respect to accessibility of created modern plots at reasonable costs. There has been discussion about creating elite cowhide modern stops however sadly during the last arrangement time frame, not much headway could be made. The XI arrangement have additionally accommodated the foundation of many calfskin parks. The cowhide business development has been supported by the country's enormous animals populace, which guarantees a one of a kind situation on the planet, "assessed at 425 million dairy cattle, bison, sheep and goat". (57% comprised of bison, 16% of steers, 20% of goat and 4 percent of sheep populace on the planet). Liberal imports of unrefined components, cowhide machines, synthetic compounds and helpers have been the significant features of the new arrangement. The cowhide business has dealt with numerous issues i.e., contribution of natural substances and climate the board rehearses, water utilization and waste water utilization. Be that as it may, calfskin industry has shown negative development rate through the assembling area has recorded the most noteworthy positive development rate after advancement. This position has asked to the review and breaks down the Indian cowhide industry.

Razzaque et al. (2020) implied that the neighborhood market for endlessly cowhide products is extending quickly. As per industry insiders, around 6 million sets of cowhide footwear are sold in the homegrown market every year (LFMEAB, 2016a). It is additionally assessed that roughly 10% of Bangladesh's all out populace, which is around 16 million, has a pay level practically identical to that of the created nations (Paul et al., 2013). As indicated by the Bangladesh Tannery Association, around 20% of the populace purchases shoes worth $ 50 consistently, and the interest is expanding step by step (Debnath, 2017). There is an expected interest for 30 million sets of cowhide footwear in the homegrown market every year (Paul et al., 2013). Numerous nearby tanneries have their own shoe plants where around 5,000 sets of shoes are being created consistently with the end goal of commodities (Netherlands Enterprise Agency, 2017).

Dhinakaran and Kesavan (2020) in their paper referenced that the current paper is introducing the products and imports stagnation in India during COVID-19. The creators have investigated the Exports and imports of India initially, patterns in the modern area, Industry and Infrastructure of India initially, Economic expansion, unfamiliar exchange and public pay present situation, Inflation conjecture, Union spending plan 2020-21 and debate of COVID-19 Circumstances, Logistics exhibitions of India during COVID19, Exports and imports stagnations. The creators have proposed to the public authority of India, for example, deals stock expense will go up, so all organizations should take a gander at more current philosophies to discard their inventories. In India, we ought to fabricate capacities of provincial strategies organizations to change with the adjustment of interest at a short timespan. India ought to reserve oil when the costs are ideal in the worldwide business sectors. The public authority ought to think about modern creations and development for empowering trade from India. All are foreordained as the purchaser value file will be drifted between from 3.5 percent to 4.2 percent. Yet, the COVID-19 will change the assurance to build the customer cost record because of the COVID-19 cataclysmic event. These will help the policymaker to proportionate the monetary circumstances to elevate the product from the stagnation.

Clear examination configuration incorporates studies and reality discoveries, enquires of various types. The significant reason for Descriptive examination is depiction of situation, as it exists as of now. In friendly business research we calm frequently utilize the term Ex post facto research for engaging examinations. The primary trait of this strategy is that the analyst has zero power over the variable; he can report what has occurred or what's going on. Most Ex post facto research projects are utilized for enlightening investigations in which the analyst tries to gauge such things, a few graphic measurements likewise have been utilized to feature the segment subtleties of the respondents. Moreover, effect of Import and Export on Leather Industry post Corona virus additionally was depicted utilizing inferential measurements.

10. METHODOLOGY

As far as this study is concerned, the researcher has started collecting the data from the employees and employer of Kareem International. There are many employees working in the branches and Head office of Karim International situated at Ambur, Ranipet, and Vaniyambadi.

In this research, researcher has taken survey from Employees and Employer working in Kareem International at three places such as Ambur, Ranipet and Vaniyambadi. The sampling technique used was probability sampling method is adopted in this study. It refers to the technique where the probability of each cases being selected from the total population is known. The sample size is **a term used in market research for defining the number of subjects included in a sample size**. By sample size, we understand

a group of subjects that are selected from the general population and are considered a representative of the real population for that specific study. A total of 105 respondents were chosen for the study. Primary data are generated by a study specifically designed to accommodate the needs of the problem at hand. The methods used were direct interview method and interview was taken from employees of Kareem International. Secondary data are those, which are not collected specifically for solving the problem currently being investigated. Here secondary data were collected from the records available in the company and through the internet.

11. DATA ANALYSIS AND RESULTS DISCUSSION

Paired Difference between Impact of Import and Export of Leather Industry Pre Covid 19 and Impact of Import and Export of Post Covid 19 at Kareem International

Two classifications are done in this research study namely Impact of Import and Export of Leather Industry Pre Covid 19 and Impact of Import and Export of Post Covid 19 at Kareem International. In order to find whether is there any significant mean differences between Impact of Import and Export on Leather Industry Pre Covid 19 and Post Covid 19 at Kareem International, paired sample t test was performed and the following null hypothesis has been spelt out:

- *There are no significant mean differences between Impact of Import and Export of Leather Industry Pre Covid 19 and Post Covid 19 at Kareem International.*

Table 4 (c): Paired Differences between Impact of Import and Export of Leather Industry Pre Covid 19 and Post Covid 19 at Kareem International

Study Variable	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Impact of Import and Export PRE Covid 19 - Impact of Import and Export POST Covid 19	1.085	.785	.076	.933	1.237	14.157**	104	.000

**Significant at 5% level

From the above table, it indicates that Paired *t* test has been performed to ascertain that there are any significant mean differences between Impact of Import and Export of Leather Industry Pre Covid 19 and Post Covid 19 at Kareem International. Based on the test result, Mean Score is 1.05 while Standard Deviation is .785 similarly test statistic of *T* is 14.157.

Since *p* value of paired samples *t* test is less than critical alpha value (0.05), the result is significant and formulated null hypothesis i.e. "*There are no significant mean differences between Impact of Import and Export of Leather Industry Pre Covid 19 and Post Covid 19 at Kareem International*" is rejected at 95% confidence level. In other words, Kareem International had excellent business of Import and Export of Leather both locally and internationally prior to corona pandemic but post corona pandemic the business was severely affected and both export and import were badly hit due to restrictions on Transportation.

Assessing linear relationship between Predictors and Dependent Variable

Multiple regression analysis is conducted for identifying the relationship of predictors and dependent variable. Government Support towards Export of Leather Products, Factors Affecting Import and Export of Leather Goods, Impact of Covid 19 on Leather Business and Remedial Measures taken by the Company are predictors and impact of Import and Export on Leather Industry PRE and POST Covid 19 at Kareem International is Dependent Variable and the following null hypothesis is framed:

- **There is no relationship between a linear combination of the variables (Government Support towards Export of Leather Products, Factors Affecting Import and Export of Leather Goods, Impact of Covid 19 on Leather Business and Remedial Measures taken by the Company) and impact of Import and Export on Leather Industry PRE and POST Covid 19 at Kareem International.**

Table shown below indicates the results of the model summary of multiple regression analysis with regard to dependent and Independent variables.

Table 2A: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.297[a]	.088	.061	.67347

a Predictors: (Constant), Government Support towards Export of Leather Products, Factors Affecting Import and Export of Leather Goods, Impact of Covid 19 on Leather Business and Remedial Measures taken by the company

Model reveals that *R* (Multiple Correlation Coefficient) value is 0.297. It describes the degree of relationship between impact of Import and Export on Leather Industry PRE and POST Covid 19 at Kareem International and the predicted variables such

as Government Support towards Export of Leather Products, Factors Affecting Import and Export of Leather Goods, Impact of Covid 19 on Leather Business and Remedial Measures taken by the Company. R square (Co-efficient of Determination) value is 0.088. It indicates that about 8.8% of the variations in impact of Import and Export on Leather Industry PRE and POST Covid 19 at Kareem International by the variation in the independent variable i.e. Government Support towards Export of Leather Products, Factors Affecting Import and Export of Leather Goods, Impact of Covid 19 on Leather Business and Remedial Measures taken by the Company.

Adjusted R-squared value is 0.584. It adjusts the statistic based on the number of independent variables in the model. That is the desired property of a goodness of fit statistic

Table 2B: ANOVA Estimates

Model 1	Sum of Squares	df	Mean Square	F	Sig.
Regression	4.438	3	1.479	3.261**	.025[b]
Residual	45.810	101	.454		
Total	50.248	104			

a *Dependent Variable: impact of Import and Export on Leather Industry PRE and POST Covid 19.*

b *Predictors: (Constant), Government Support towards Export of Leather Products, Factors Affecting Import and Export of Leather Goods, Impact of Covid 19 on Leather Business and Remedial Measures taken by the company*

c ***Significant at 5% level*

F value is 3.261 and *p* value is significant at 5% level. Hence there is significant relationship between dependent (impact of Import and Export on Leather Industry PRE and POST Covid 19) and predicted variables (Government Support towards Export of Leather Products, Factors Affecting Import and Export of Leather Goods, Impact of Covid 19 on Leather Business and Remedial Measures taken by the company).

Table 2C: Standardized and Unstandardized Coefficients

Model 1	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	5.466	.706		7.747	.000**
Impact of Covid 19 on Leather Business and Remedial Measures taken by the company	.034	.023	.143	1.479	.142

Factors Affecting Import and Export of Leather Goods	-.063	.024	-.249	-2.615	.010**
Government Support towards Export of Leather Products	-.022	.015	-.137	-1.409	.162

a Dependent Variable: impact of Import and Export on Leather Industry PRE and POST Covid 19.

*b **Significant at 5% level*

From the above table, the coefficient shows that 1 unit increase in the value of Impact of Covid 19 on Leather Business and Remedial Measures taken by the company would result in decreasing the impact of Import and Export on Leather Industry PRE and POST Covid 19 by .034 (3.4%) while other variables being held constant. This coefficient value is insignificant at 5% level and the t-statistic of Impact of Covid 19 on Leather Business and Remedial Measures taken by the company also accounted for significant positive variation in dependent variable that is impact of Import and Export on Leather Industry PRE and POST Covid 19.

From the above table, the coefficient shows that 1 unit increase in the value of Factors Affecting Import and Export of Leather Goods would result in decreasing the impact of Import and Export on Leather Industry PRE and POST Covid 19 by -.063 (-6.3%) while other variables being held constant. This coefficient value is significant at 5% level and the t-statistic of Factors Affecting Import and Export of Leather Goods also accounted for significant negative variation in dependent variable that is impact of Import and Export on Leather Industry PRE and POST Covid 19.

From the above table, the coefficient shows that 1 unit increase in the value of Government Support towards Export of Leather Products would result in decreasing the impact of Import and Export on Leather Industry PRE and POST Covid 19 by -.022 (-2.2%) while other variables being held constant. This coefficient value is insignificant at 5% level and the t-statistic of Government Support towards Export of Leather Products also accounted for significant negative variation in dependent variable that is impact of Import and Export on Leather Industry PRE and POST Covid 19.

12. FINDINGS

- In this findings, impact of import and export on leather industry between pre covid 19 and post covid 19 is spelt out using paired samples *t* test, from the test result, it is made out that p value of paired samples t test is less than critical alpha value (0.05), the result is significant and formulated null hypothesis i.e. "There are no significant mean differences between Impact of Import and Export of Leather Industry Pre Covid 19 and Post Covid 19 at Kareem International" is rejected

at 95% confidence level. In other words, Kareem International had excellent business of Import and Export of Leather both locally and internationally prior to corona pandemic but post corona pandemic the business was severely affected and both export and import were badly hit due to restrictions on Transportation.

- According to Multiple Regression Model, it reveals that R (Multiple Correlation Coefficient) value is 0.297. It describes the degree of relationship between impact of Import and Export on Leather Industry PRE and POST Covid 19 at Kareem International and the predicted variables such as Government Support towards Export of Leather Products, Factors Affecting Import and Export of Leather Goods, Impact of Covid 19 on Leather Business and Remedial Measures taken by the Company. R square (Co-efficient of Determination) value is 0.088. It indicates that about 8.8% of the variations in impact of Import and Export on Leather Industry PRE and POST Covid 19 at Kareem International by the variation in the independent variable i.e. Government Support towards Export of Leather Products, Factors Affecting Import and Export of Leather Goods, Impact of Covid 19 on Leather Business and Remedial Measures taken by the Company. Adjusted R-squared value is 0.584. It adjusts the statistic based on the number of independent variables in the model. That is the desired property of a goodness of fit statistic.
- Furthermore, F value is 3.261 and p value is significant at 5% level. Hence there is significant relationship between dependent (impact of Import and Export on Leather Industry PRE and POST Covid 19) and predicted variables (Government Support towards Export of Leather Products, Factors Affecting Import and Export of Leather Goods, Impact of Covid 19 on Leather Business and Remedial Measures taken by the company).
- Similarly it is also found that 1 unit increase in the value of Impact of Covid 19 on Leather Business and Remedial Measures taken by the company would result in decreasing the impact of Import and Export on Leather Industry PRE and POST Covid 19 by .034 (3.4%) while other variables being held constant. This coefficient value is insignificant at 5% level and the t-statistic of Impact of Covid 19 on Leather Business and Remedial Measures taken by the company also accounted for significant positive variation in dependent variable that is impact of Import and Export on Leather Industry PRE and POST Covid 19.
- However, 1 unit increase in the value of Factors Affecting Import and Export of Leather Goods would result in decreasing the impact of Import and Export on Leather Industry PRE and POST Covid 19 by -.063 (-6.3%) while other variables being held constant. This coefficient value is significant at 5% level and the t-statistic of Factors Affecting Import and Export of Leather Goods also accounted for significant negative variation in dependent variable that is impact of Import and Export on Leather Industry PRE and POST Covid 19.

- Ultimately, 1 unit increase in the value of Government Support towards Export of Leather Products would result in decreasing the impact of Import and Export on Leather Industry PRE and POST Covid 19 by -.022 (-2.2%) while other variables being held constant. This coefficient value is insignificant at 5% level and the *t*-statistic of Government Support towards Export of Leather Products also accounted for significant negative variation in dependent variable that is impact of Import and Export on Leather Industry PRE and POST Covid 19.

13. SUGGESTIONS

- In the first suggestion, Kareem International had the brisk amount of export and import earlier to corona epidemic. But, with the outbreak of Covid 19, the entire economy witnessed all time melting down situation in Tamil Nadu in general and Kareem International in particular. Total leather businesses were put upside down. Therefore, the management of the company has to enhance the sales like before by adopting to unique methods which includes embracing online sales, offering massive discount to the consumers, giving up clearance sales thereby proving that the leather products made by Kareem International are ever lasting.
- Secondly, Import Tariff and Import Quota also are not much favour to the importers of Leather Products and even this affects Kareem International when it wants to import the raw materials required for leather products from other countries. The company ends up paying more import duties to the government and it reduces the annual profit of the company. Therefore, the government has to take action plan and support the leather companies in waiving off the import tariffs or else it can reduce the import tariff for time being or the situation goes back to normalcy.
- With ever increasing fuel prices, transportation of leather products across the world has badly hit and it has led to the escalation of transportation cost. Kareem International has suffered from this limitation. Therefore, the company has to chalk out effective plan like opting for sea transport rather than opting for air transports. Domestic export also has been affected because of excessive transportation cost. The government to some extent supports the leather exporters in doing away with local taxes or imposition of less taxes.
- Kareem International has encountered the problem of shortage of manpower especially post Corona Pandemic. Due to shortage of manpower, trading operations have come to grinding halt. More than that, people resort to the activities where they are highly paid but leather companies does not pay sufficient salaries to the employees and people employed in the leather companies slowly move out of them and join the companies where they are fairly paid. Therefore, the management of leather companies should hold negotiation with other counterparts and arrive at permanent solutions to this impasse.

14. CONCLUSION

After having seen the findings of the study, there are many ups and downs at Kareem International. The company was badly hit due to Corona Pandemic prevailing across the whole world. The company has faced huge loss during the lockdown period and it continues its operations intermittently. Similarly, company paid the salaries to its staff members for a period of three months during the lockdown and this pushed the company to face huge loss within a short span of time. Now the company has started the overseas export after lockdown relaxations were announced by the government.

Presently company has undertaken its activities like pre corona period. It travels towards attaining the goals of catering to the needs of trading partner nations. It has improved operational efficiencies but the setback is lack of adequate manpower that paralyses the target of company. Therefore, the company has to fix this issue as immediately as possible. Transportations cost also threatens the company's operations therefore; company should choose the economical mode of transportations when it wants to export the products to the needy nations. It has to do away with cost ineffective mode of transportations.

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LEADERSHIP STYLES AND EMPLOYEE PERFORMANCE – A STUDY WITH SPECIAL REFERENCE TO TANNING INDUSTRY IN VANIYAMBADI, TAMIL NADU

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Abstract

The research study, entitled "Leadership Styles and Employee Performance - A study with special reference to Tanning Industry in Vaniyambadi, Tamil Nadu", examines the relationship between Leadership Styles and Employee Performance in Tanning Industry. The researchers developed various leadership styles and its relationship with employee performance after reviewing several works of literature. The data analysis was conducted using descriptive and analytical research. As observed, Organizations need to understand that not only are people the basis of the results, but the organizations or employers that employ them are equally responsible for their overall performance. Organizations perform fairly and effectively with an organized culture of regular interactions, formal meetings, appropriate tools and communication channels to provide employees with clear and measurable performance goals. Leader need to generate religion of their fans through assuming them as a crucialaid who can develop in place of simply a device for a company.

Keywords: Leadership Styles, Employee Performance, Management, Organization.

1. INTRODUCTION

Leadership is a complex phenomenon that requires many dimensions and variables to be considered in order to define it. Năstase M. And Barbu M present a new approach to leadership. This defines it through a "leadership mix". The variables used are knowledge, brain ability, and social ability. These three lead to a mixture of leadership

consisting of flexibility, follow-up, strength and firmness, mediators and emotional intelligence (Nčastase & Barbu, 2011).

Another approach to leadership is related to the impact that leaders have on people to guide them, follow them, and achieve the best possible results. According to Ciulla (after reviewing the 221 definition of leadership), the most commonly used element in defining leadership is "leadership is the person wholets others do something" (Ciulla,2002).

"The concept of performance considered a thorough assessment of overall performance and management of performance, and performance assessment was the process of classifying specific results within a specific time frame (Coens & Jenkins, 2002)". In addition, the famous maxim" Unmeasurable, Unmanageable "strengthened the foundation of an organization with a closed and widespread performance measurement system. Ahmad and Shahzad (2011) state that "compensation practices, performance evaluation practices, and employee promotion practices" set the standard for assessing employee performance.

Managing Employee Performance as an HR Strategic Perspective : It's well known People, or employees, have been a source of value creation in a variety of ways, including interacting with customers, attracting new talent to the company, and adapting quickly to dynamic situations. This all-in-return is a core competitive advantage. Over time, corporate culture becomes most difficult to imitate with people who can meet the needs of a particular organization.

2. REVIEW OF LITERATURE

Manik (2016) said : "Leadership is called development in which an individual or an individual influences the set behavior of others in order to achieve a common goal. Özaralli (2003) said, "Transformational leadership is a subordinate. The more empowerment a team member experiences, the more effective the team will be". Leadership has an important occasional link between team members who are practicing skills that drive change in their followers, explains Sosik (2005). The term "leadership" is different for every one and is difficult to formulate in individual consensus. Organizations have long sought "leadership" because their growth depends on good leaders. In the same context, several theories have been put forward in which companies attempt to classify the appropriate qualities of a perfect leader.

In Campbell's context, essentially all aspects are "written and verbal communication, demonstrating effort, maintaining personal discipline, promoting peer and team performance, monitoring and leadership, and management". The study states that "the emergence of adaptive performance by the growth of some new professions as a derivative of the modernization of techniques that require workers to engage in fresh learning and adapt to change in an efficient manner" (Griffin, Parker, & Mason, 2010; Hollenbeck, LePine & Ilgen, 1996). Therefore, employee performance as a

whole leads to innovation performance and organizational performance. Successful efforts by dedicated talent will generate innovative ideas for new products and services, improving quality performance, operational performance and customer satisfaction directly (Sadikoglu & Cemal, 2010).

Since independence, East Timor's population growth, coupled with relatively modest GDP growth, has led to lower per capita income and higher poverty rates (Lundahl & Sjöholm, 2009). Given this situation, we focused on the quality of our human resources. With the end of the UN mission in post-war East Timor in December 2012, several practical opportunities for national development have emerged. Progress can range from the establishment of state bureaucracy and government agencies to democracy and participation, building institutions including the rule of law, and managing corruption and transparency (Goldfinch & Derouen Jr., 2014). In this era of globalization, modern business is driven primarily by intellectual capital, which helps organizations build and maintain a competitive advantage (Mac Dougall & Hurst, 2005).

3. OBJECTIVES OF THE STUDY

1. To analyze the job performance of Vaniyambadi's Tanning Industries employees.
2. To determine whether manager's leadership style affects employees' performance.
3. To identify the relationship between leadership style and productivity level of employees' in tanning industries.
4. To determine which elements of leadership style have the greatest impact on an employee's individual job performance.

4. HYPOTHESIS OF THE STUDY

H01 The leadership style does not significantly affect the performance of Vaniyambadi's Tanning Industries employees.

H02 There is no correlation between the leadership styles and the work performance of employees' in Tanning Industries of Vaniyambadi.

5. RESEARCH DESIGN

Research design is a detailed overview of how research is done. Research design includes survey types such as descriptive, exploratory, semi-experimental, experimental orreview, as well as survey questions, hypotheses, experimental design, independent and dependent variables, data collection methods, statistical analysis plans, etc.

6. SAMPLING DESIGN

"Sampling is the process of drawing conclusions about the entire population using a small number of elements or parts of a larger population (Zikmund, 2003). Sampling design is from a defined population or a specific population. A specific plan for taking a sample. A sampling method is a rule and procedure for including some elements of a population in a sample.

Researchers apply the procedure to the sampling method, sampling, select the unit and sample size.

7. DATA COLLECTION METHOD

After completing the initial sample size and tool selection requirements, data collection will be performed. What is done in research work is the processing element. In the current study, the data collection method is based on the type and level of evidence required and the category of study design selected. The researcher collected the data by having Vaniyambadi's Tanning Industries staff to fill out a questionnaire.

8. LIMITATIONS OF THE STUDY

1. Based on current surveys conducted only on employees of the tanning industry in the city of Vaniyambadi, Tamil Nadu, this provides a limited but general approach to the entire private sector.
2. Many employees hesitate to give opinions because the opinions may be restricted by the organization and some of the organization's leaders are not interested in speaking and are limited to meeting with employees.
3. Because this survey is based on a cross-sectional survey, employee behavior can also change as a result of other external factors, and averaging can cause problems in psychological or behavioral surveys.
4. The lack of time and resources makes it difficult to collect and investigate further. Future studies in the same industry, or any other promising industry such as IT, hospitality, or education, may even be comparable.

9. FINDINGS AND DISCUSSIONS

Employees reported that managers showed the most transformative styles of behavior, followed by transactional styles and laissez-faire. As a result, accidental rewards are the highest sub-element of the nine elements, followed by inspirational motivation, but non-leadership is the lowest percentage. Employees are managers themselves. They believe that they will show a positive attitude when achieving their goals by trusting and best matching the exciting motivations of transformative leadership. Similar results were discovered by Barbu (2011) and employees felt motivated by the satisfaction of desires. In addition, the non-leadership sub factor receives the lowest average score that the leader remains absent when needed, which is free for the leader. It shows that it does not believe in the concept of ruin and continues to exist at the time of demand.

Employees complete tasks more often, followed by contextual performance, with adverse employee work behavior appearing as the lowest performance factor. Considering the scores, the highest score is given to the employee's ability to plan work on time, and the lowest score is given to the CWBP item. However, private employees show contextual performance behavior, such as voluntarily taking on side jobs, making

passionate decisions, and adding motivation to effectively accomplish their mission. At the same time, employees are results - oriented and effectively prioritize important work.

As a result, it was found that managers in the tanning industry mainly show "transformational leadership style behavior". This is clearly followed by a transaction management style. Identifying that "transformation styles" and their five variables are very substantial and effective, in contrast to Marcus Garvey Orji (2016), and that styles based on the observations of subordinates are wide spread. So, there was little research to support the current findings. (ClarkH 2009). It always point out that enhancing employee performance ultimately supports the company, as a talented and enthusiastic work force contributes significantly to the success of the organization. (Anitha, 2014).

"Transformational leadership styles" and all factors (IC, IB, IM, IIA, andIIB) strongly correlate with the tasks and contextual performance actions of tanning industry employees, except for unproductive behavior. Similarly, transaction styles and contingent reward factors are positively related to both aspects aside from the unproductive work behavior of employees, the task and context aspects of employee performance. A negative correlation with CWB means that managers do not encourage employees to have negative and undesirable attitudes towards their work. Yukuru (2007).

The results show that a manager's belief in an employee's ability to create and achieve goals is essential to overcoming a mission and has a positive and thought-provoking link to employee behavior. Conversion factor, IA and IB also mean having a moderate impact on tanning industry task performance. Such actions are active and are directly related to the performance of tasks restricted in the job description. In contrast to transactional style, it is more effective at persuading tasks as a result of key performance than transformational leadership (Keller, 2006).

10. CONCLUSION

This current study aims to provide a comprehensive analysis by examining the potential existence of leadership styles among bosses and employee performance levels. The transaction style focuses on acknowledging that employee efforts are relevant to the organization by providing incentives or penalties. They correlate more strongly with task completion, Mahdinezhad, Bin Suandi, Bin Silong & Binti Omar (2013). Indeed, transactional leadership can be most influential when a task or goal requires less interaction and collaboration (Podsakoff, Ahearne, and Mackenzie, 1997).

In addition, management and leaders need to increase individual viewing factors and influential motivational systems to reduce the harmful behavior of employees that can harm corporate culture inside and outside the company. Do not use the laissez-faire style as it enhances unproductive behavior. (Avolio & Bass 2004).

The results showed three main attributes, Transformation-style, idealized impact attributes and behaviors, as well as transaction - style conditional rewards, have a positive impact on employee performance levels. The attributes of transformational leadership are essential to achieving performance - driven outcomes that enable

innovative learning organizations in aknowledge - sharing attitude. It is much more common than other styles in managers' actions that emphasize the development of exciting visions and strategies rather than making difficult and influential decisions.

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ROLE OF SELF-HELP GROUPS AND NON-GOVERNMENTAL ORGANISATIONS IN UPLIFTING THE STANDARD OF LIVING OF RURAL MASSES WITH REFERENCE TO KINGSLEY COMMUNITY CENTRE IN KANDHIKUPPAM AT KRISHNAGIRI DISTRICT

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Abstract

In India around 80 percent people living in villages are below the poverty line. Therefore, the thrust of development should be on the rural poor, whose quality of life has not developed for centuries. Here comes the role of Self-Help Groups and Non-Governmental Organisations in raising the community solidarity and improving rural productivity by uplifting women and the downtrodden. Self-Help Groups empower women and train them to take active part in the socio-economic progress of the nation and make them sensitized, self-made, self-reliant and self-disciplined. This removes the social limitations on the women and gives them a dominant role in decision making. This study shows how SHGs and NGOs work to bridge the gap between women and authority. It also speaks about problems faced by village women in taking part in SHGs and it also suggests few recommendations for the betterment of SHG's through findings from the ground.

Keywords: Self-Help Groups, Empowerment, Entrepreneurship, Development, Education.

1. INTRODUCTION

NGO's have played a vital role in arbitrating the governmental Programmes to the needy in remote area. Since independence various machineries both governmental and non-governmental were involved in the integrated development of the country. Setting up the

central Social Welfare Board (SWB) in 1953 was the pioneering step taken by the central Government, The Welfare programmes of FYP (Five Year Plan) were directly monitored by the Governmental Agencies. The results of these programmes were not as expected on the contrary the non-governmental organizations have been successfully reaching out to the rural population since 1970s. Most of these NGO's were registered under societies Regulation Act, 1960 [1]. Kingsley Community Centre was established on 27th May, 1983 in memory of a small boy Jaspe R. Samuel Kingsley at Kandhikuppam village in Krishnagiri District [2]. It renders yeoman service for the development of education among the people of the nearby villages of Kandhikuppam.

Non-Governmental Organizations can be organized as three types:

1. Helping Non-Governmental Organization
2. Developmental Organization
3. Empowerment Organization

The first type was functioning with the rational helping the poor and the needy and this phase extended from 1940 to 1950. Under the second type, the developmental, Non-governmental Organizations focus until the seventies was given to the programmes of health, education, agriculture, forestry, economic activities, appropriate technology, etc. the third type empowerment NGOs are predominantly found in the current scenario [3]. In our case KCC has involved in all the three functions of NGO. It has helped the poor and needy people to uplift their lives. It promoted health, education economic activities, technology, forestry and agriculture in Rural Population. It also empowered women to act as a major player in developing their family [4].

Grassroots and community processes are also needed and the civil society's organizations women's organizations and NGOs have a role to play. The actors of civil society should contribute in organizing women, building public awareness, training and gender sensitization providing services to the unreached, public policy watching, market watching public information, monitoring violations, public information, autonomous research, innovations and experimentation, advocacy and advisory work. Non-Governmental organizations had been representing the problems of rural in international conferences too. Another notable area of activity of KCC is the development of women. It is able to get whole-hearted co-operation of the related institutions and departments like Tamil Nadu Corporation for Women Development, MYRADA etc. KCC endeavors to help the poor, neglected and deserted women of the area to stand on their own legs and earn their livelihood [5].

Self-Help group movement gained momentum in Tamil Nadu in the early 90's. However, making it reach the remote rural poor had not been an easy task. The influence of officials has an imperative function in encouraging women to join Self-Help Groups.

2. Activities of the SHG

Most of the media projected Self-Help groups major activity as on economic-oriented. In Self-Help groups savings are done either done a weekly or monthly basis. They also lend money to the members from their savings and they get bank loans for the groups.

However, conducting meeting in common places gave more flexible functioning of the women. The place was carefully chosen so that the men would not interfere in the meetings. The men were not allowed to cross the spot till the meeting end. None of the SHG's own a place for the group meeting. Other than the places mentioned above the meetings are held in a common ground of the village.

Regularity and attendance of the meetings were remarkable. It paves the way for them to discuss other social and political issues in the meeting. It was said that before attending the Grama Sabha or Panchayat meetings women come together and discuss the village concerns and prepare petitions to be given at die meetings. In most of die villages they had success stories of getting water tank, road, bridge, toilet facility, etc., Women were quite happy over their achievements which gave them self-confidence and a sense of success [6].

3. Focus on Entrepreneurship

NGOs and governmental organizations insist on entrepreneurship. Only few women in villages succeeded in starting a successful business. Even though men showed more interest but the women declined to take up entrepreneurship. Still the world of entrepreneurs remains unreachable for most of the groups. However, it was said that NGO's organized training for the Entrepreneurship Development Programmes (EDP) for members.

For Example, KCC had launched Kadhar Spinning Training Center, Tailoring training schemes. Also, Free fruit sapling programmes, gem cutting training cum production center etc., are very helpful to the womenfolk of this area to earn for their livelihood [7].

4. Forming Federations

The groups were working towards linking their SHGs with banks where they were getting loans with one percent interest. The NGOs were linked to local nationalized banks. In a few groups they had a tough time with the bankers and it reflected on the bank linkage to the group. Block level coordination committee (BLCC) meetings were held every month as the dates were given by TNCDW in which the local officials had to take part to discuss the problems of SHG women [8]. KCC arranges for IFAD loans for women beneficiaries through Indian Bank Animators training programmes are conducted periodically to impart training on various women development programmes.

The groups were asked to form Panchayat Level Federations (PLF). Hence efforts were made to bring the women together and to form PLF. Earlier a minimum of five groups were asked to form a group. However, in the absence of adequate number of groups they were asked to form with one group which would not serve the purpose of the formation of PLF.

5. SHG Women Problems

With the severe drought prevailing all over the state of Tamil Nadu, the SHG women too face the economic problems. Lack of employment led to poor income generation and there was no source to get money for savings. Most of the groups were not willing to take up EDP due to lack of cooperation of the members. The conflicts between the members' families also reflected in the group interactions. The dominating nature of the leaders often affected the group. Also, the group depended on the educated members to maintain the records.

At times husband or in-laws prevented the women from attending the SHG meetings. Criticism by the non-members and the other casted people disturbed certain group functions. Greater number of NGO's working in the same village reduced their effective functioning in SHGs. The delay in Government offices and banks which made the women members wait for many hours, often brought out the negative responses from the SHG members.

6. Impediments Faced as SHG

In becoming member of Self-Help Groups, the women face various impediments or difficulties within family as well as from the local community. Initially there had been greater opposition posed by most of the husbands of the members. In the course of time the attitudinal changes and economic benefits the women brought home changed their view. But the opposition from the caste groups and their subtle way of suppressing the women continued.

As most of the high caste men held higher posts in the village and its panchayats, they would not support the women in getting the basic amenities for the colonies were beside. Even in their ventures of starting new economic activities they had been a hindrance [9].

The Government and Non-Government machineries have their objectives in organizing women as self-help groups. It is for the purpose of increasing the rural off low level socio-economic, political empower of people.

Self-Help groups have been classified as economic empower of 29.33 percent, political empower 27.33 percent women wish to get all they are in need of especially the economic needs. Women with the purpose of women's emancipation 19.33 percent largely want to uplift the condition of women, and other with wider purpose of social empower 24 percent wanted to work for the society.

7. Findings and Suggestions

Networking of Self-Help Groups

Self-Help Group have given opportunity for the total illiterate women to come together and to get organized. Self-Help had offered from a form to speak out their problems and to seek solutions collectively. They were able to get the basic amenities and developmental schemes as a group rather than through individual efforts group involvement gives enhanced, support and confidence.

Education and Emancipation

Women attained functional literacy through self-help groups. Education of female children is given more important by the self-help group members. Health education had brought tremendous changes in their family and child care, infant and maternal mortality rates have been reduced while consciousness has become part of the education for rural women. It cannot be denied that the opportunity of formal education is essential for the empowerment of rural poor women. It cannot be denied that the opportunity of formal education is essential for the empowerment of rural poor women.

Training Programmes

Training Programmes have brought significant changes in the lives of rural women. They are eager to attend the training programmes for developing themselves in self-help proficiency. Especially the training programmes are based on cultural folklore can make them to bring out their creativity and competitive skills. Such training programmes may encourage the value of education will promote higher education of their female children and personality development may be given in a n effective manner. Role plays can be introduced to improve their communication skills and self-confidence.

Economic Development of Women

The increased span members in self-help groups their empowerment level is increased. The greater number of years. They spent as self-help group members have got a definite change in their thinking and out looking. The saving amounts grow with the years and they were able to get large amounts of Revolving fund from banks. They reach a stage where they never wait for bank loans. They are able to manage within their saving groups which has crossed more than five-year received a sum upto 12000/- from the group itself. Moreover, the loan interest also comes as income to them. In other words, it makes theme economically self-reliance [10].

Collective Efforts of NGOs

Self-Help Groups organized through in collaboration with NGOs have shown that the collective efforts of NGOs can bring out enhanced development among rural women. However, Non-Governmental organization can further broaden their outlook is reaching out the rural poor women.

Promotion of Entrepreneurs

The small savings has not brought remarkable change in their economic condition. The saving habits come to their rescue for petty and urgent needs in this context on appropriate entrepreneur. Development programme is one of the major imperatives.

Recommendation of Further

1. Coolies and rural women are more interested to join in a group to develop themselves.
2. SC/ST need to get more awareness to join in the latter.
3. It shows the responsibility of married people to develop themselves.
4. When the members of family are small, they take decision soon.
5. Middle class family shows their willingness to develop rather than others.
6. It shows that only a few earn a good income even others try to contribute what they can.
7. Members of Self-Help groups have taken initiative to spread their committee.
8. The message to the leader is to try to fulfill its members as soon as possible to make them happy.
9. 20% of members don't like their leader, so their leader must be changed, otherwise there will be no benefit, from the groups.
10. Only 4% of the community get help from their Self-Help group, it has to raise soon to develop the rural area, women, children and downtrodden.

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JEWEL – MAKING INDUSTRY DURING THE PERIOD OF KAKATIYA OF WARANAGAL IN MEDIEVAL ANDHRADESA AS REFLECTED IN INSCRIPTIOPNAL EVIDENCES

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Abstract

Jewellery making industry flourished during Kakatiya period. Numerous references in contemporary records to ornaments of gold, silver, copper etc. afford ample testimony to the flourishing condition of this industry. These Jewel-makers were also experts in the making of many articles of domestic use such as vases, cups, spittoons, toys, etc, Gold and silver ornaments were often inlaid with precious stones and thus, the art of in laying developed in close connection with Jewel making. This goldsmith is considered to be one of the important members of a village. There are quite a good number of references which mention the goldsmiths among other communities who were necessarily accommodated in every new village.

Keywords: Pancānulu, Vishvabrahma, Orugallu, Anumu, Oju, Oddānamu.

1. INTRODUCTION

The Kākatiyas of Warangal secured special place in the history of south India. After Satavahanas, Kakatiya rulers united the Telugu speaking area and ruled most of eastern part of Deccan region, consist of present Telangana and Andhra Pradesh and some parts of eastern Karnataka and southern Odisha between 12^{th} and 14^{th} Centuries. Their capital was Ōrugallu, called as Warangal. Early Kākatiyas rulers served as feudatories to Rashtrakutas and Western Chalukyas for more than two centuries.

They assumed sovereignty under Prataparudra I in 1163 CE by suppressing other Chalukyas subordinates in the Telangana region and ruled for nearly 200 years. Starting their rule from Telangana, the Kakatiya Kings extended their sway slowly all over the land of the Telugus. They were the undisputed monarchs of entire Andhradēśa between

A.D. 1158 and 1323. During this period Kākatiyas kingdom achieved political unity, and established economic prosperity.

Like Raj puts in North India Kākatiyas controlled the invasions of Turkish in south India and contributed a lot for the cause of to protect the Hindu culture and freedom from the Muslim rulers'. They maintained the integrity of their Kingdom till at last it was overwhelmed by the armies of the sultans of Delhi. Therefore this period was called as Golden period of Andhradesa. Historians generally basing on the inscriptional evidence of Andhra which ventilated the flourishing agriculture during the medieval period, to development of industries and crafts.

It may be viewed that by and a no greater emphasis was so far laid to on the growth and the role of industries and crafts in shaping the economy of Eastern part of the Deccan during the 12^{th} and 13^{th} Centuries. Basing on the research work, people may tend to hold the view that the economy of Andhra during 12^{th} & 13^{th} century continued to be primarily agrarian in nature and the industries, the crafts are the production sector equal role towards the development of economy [1]. In addition to this it is also a reality that very little information is available on industries and crafts during the Kākatiyas period in the native sources. An attempt is made in this article to highlight the Jewel making, during the Kākatiyas period.

Like the other industries, jewellery making industry flourished during Kakatiya period. Numerous references in contemporary records to ornaments of gold, silver, copper etc. afford ample testimony to the flourishing condition of this industry. These Jewel-makers were also experts in the making of many articles of domestic use such as vases, cups, spittoons, toys, etc, Gold and silver ornaments were often inlaid with precious stones and thus, the art of in laying developed in close connection with Jewel making. This goldsmith is considered to be one of the important members of a village. There are quite a good number of references which mention the goldsmiths among other communities who were necessarily accommodated in every new village [2].

The famous Malkapuram inscription of A.D. 1261 explains that goldsmith coppersmith, stone cutters, iron-smiths, potters, barbers, carpenters and sculptors the villages. Another important industry of the Kakatiya period was the jewellers were included in the group of five communities known as pancanamvāru or pancānulu in the inscriptions. The other four communities are black smiths, carpenters, stone-cutters and metal workers and the pancānulu is workmen, mechanics or handicraftsmen. Abhidānachintamani of Pulavarti Kahnvēśvara refers to the origin of the above five divisions of the artisan community from the five faces of Vishvabrahma. The word pancanana i.e. Panca = five : anama = faces, also denotes the same meaning[3].

Inscription also provides similar information regarding the origin of the pacanamvaru. Rāmāyanam Narsimha Rao made a discussion taking a meaning of 'region' or country to the word 'anumu'. But it is appropriate to take the meaning for Anumvāru as those who depended or lived on one of the five proficient crafts mentioned above [4].

Among the five-faceted community of the artisans, goldsmith can be found in a flourishing status from the inscriptions and the donations made thereof. They were popularly known as Kalsale (Karmasale) Akkasale (Arksale) or agasale (agnisale). The goldsmithery was the practice of the day, instituted a deity named after their community as "Akkasaleśvara" or after the name of Kammatsu (portabale furnace), one of their important implements of their crafts, as Kammastesvara [5].

The main feature of the crafts or industry was that it was maintained domestically and the basic training was given by the father to the son and expertise could be attained by learning at the feet of the master who was given the title 'Oju' (oju which means a teacher) perhaps by the guild of their craft, thus we can see a young goldsmith attached to his master and his place where his father/family which practised the same craft. Above all we can see the influence of the guild on their community regulating their socio-economic and cultural life [6].

The raw material which they needed in their work either gold or silver was supplied by the consumers and only making charges were paid to the smiths. As the people offered very low rates for making the ornaments, it seems, the goldsmiths used to adulterate the precious yellow metal to take a bit of it for themselves in lieu of their services. Almost all the contemporary literary works of the period blamed the goldsmiths for the dishonesty and adulteration. Mitāksara laid down a set of rules to avoid adulteration and to ensure that the same quality of raw material was given to the Smith should be returned with the finished article allowing legitimate reduction for loss of the metal by melting.

In case of gold, Mitāksara lays down that articles of the same weight should be returned to the consumer as gold is not reduced even after heating in fire in [7]. The contemporary literary works refer to the goldsmiths and their proficiency execution and design; we can find some references to the implements used by them in executing their craft. Kamatamu a portable furnace, which was considered at the most important implement of the profession, on which they named their God of worship Orugallu:

A specific stone meant for testing the quality of the metal Katteralu: scissors, Suttelu a small hammer, Patteda karul a base for hammering on, Nirukarlu and implements used to hold hot things, Sānamu: a touch-stone, Patakāru : pincers for holding, Mūsa acrucible or small vessel to get the metal dissolved, Gudulu. Goldsmiths not only made ornaments to meet the requirements of the temples and the households, but also were engaged in a variety of workmanship.

They were experts in making gold vessels used in the temples and royal palaces and were adapts gold-gilding on base metallic pan aphelia and toys furniture and in fixing the gold or gilt sheets on the walls of the harems and the palaces and temples. They were also proficient in the lay work [8]. The poor people took to gilt ornaments and imitation stones as they could not afford the precious yellow metal and precious stones. Panditārādhya caritra explains" that a lady worn silver belt (oddānamu).

The great number of ornaments which were in use during Kakatiya Kingdom, bears eloquent testimony to the skill in workmanship and creative faculty of the goldsmith in those days, many contemporary literary works like Kridabhirāmamu, Dasakumāra caritra, Kumārasambavamu etc. explains to ornaments. Both men and women used to wear ornaments.

A classification and description of these ornaments is now made from head to foot. The people of Kakatiya period in general, wore different kinds of ornaments i.e, carucukka, Bimbamu, simanta bhūsanam (head ornaments), nāsikabhūshana (nose ornaments), kanthikas (neck lets), kachabhysanamulu (bangles), muddutungaramu (ring) gajjelu (retting bells), kanchandamu (waist ornaments), oddānamu, mogalirēkulu (an ornament to be worn on the head and in the shape of flower petals)bavirela pogula (ear ornaments) haram, kundalamulu, mutyala sāralu, dandakadiyaulu, etc.

The Dharmsastras and the medical works also refers the merits in wearing ornaments made of gold, silver, copper and the strings made of pearls and coral, the works on Dharmsastras laid down that the people should bedeck themselves with ornaments at the beginning of every season. Cārucarya, a work on hygiene (A.D.13th. C) By Āndhra Bhoja mentions the use of ornaments appropriate to the season for the maintenance of good health and prevention of seasonal diseases during Kakatiya period [9].

Different types of jewels endowed to the temples for adorning the gods and goddesses prove the popularity of the gold industry during the Kakatiya period. Apart from the jewels and golden utensil, particularly such as drinking cups, vessels and dining plates and other articles used in different rituals were also endowed to the temples. An inscription from Inugurti village refers the following jewels gifted to the temple of Gopāla Krishna of Inugurti and one of the inscriptions from Warangal fort (A.D. 1185) provides ‘he gift of golden vessels endowed to the temple of Siva.

2. CONCLUSION

The above information explain that there are inscriptions belonging to the period of Kakatiya Gaṇapatidēva [10] which mentions the gifts of makaratorana, aureole, throne, palanquin and a flower necklace, all of gold and a fly-whisk with golden handle to the god Bhimesvara and the Pingali village (Guntur) inscription states that Alladi-Nāyaka son of Sabbi Nayaka put up a golden pot on the top of the temple of Sri Rāmanātha deva of Pingali.

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