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Editorial

AI for Sustainable Rural Development: Rural population is accounted around 75% of India's population. Agriculture is their major source of their livelihood and larger population of India depends on it. The majority of rural residents fall behind the economy's general improvement. Quality of life of rural residents is lower than the people living in the urban areas mostly due to lack of basic amenities. Rural areas development is essential to enhance the quality of life and their financial conditions. Hence need to pay a special attention on food, education, skill development, employment opportunities, healthcare facilities, clean drinking water, sanitation, better transportation facilities, etc.

Artificial Intelligence (AI) has a considerable potential to promote sustainable rural development by tackling problems in various sectors such as agriculture, education, infrastructure, healthcare and environmental protection. AI can help farmers in planting, harvesting and spraying pesticides using AI-powered machines like drones and tractors, increasing productivity through precision farming, maintaining water requirement, prediction of crop diseases, etc. Remote consultations could be possible in healthcare sector with the help of AI-enabled telemedicine. Additionally, AI might work as surveillance to prohibit any disease outbreaks.

Education sector also gratified with the implementation of AI as it promotes e-learning portals and specified learning systems which breaks the hurdle of geographical barriers and quality education could be accessible. As far as water and waste management, water distribution can be streamlined, and by employing recycle system and collection management waste practices are enhanced. Additionally, AI assists in prediction of floods and suggests preventive actions to reduce their impact in flood-prone region. Moreover, for conservation of environment, AI assists to prevent deforestation, maintain biodiversity and predict climate change.

However, internet access, data availability, and high initial costs are the main threats which discourage the full-fledge assimilation of AI in the rural development. In order to fully utilize AI, cooperation between municipal, business, and governmental entities is required. These AI technologies must be made available, inexpensive, and inclusive in order to promote long-term, sustainable development in that area.

New Delhi **Editor**

31st January 2025

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Web Data Mining for Terrorism Analysis

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ABSTRACT

The rise of the internet and social media platforms has revolutionized communication, enabling individuals and groups with extremist ideologies to propagate their beliefs and recruit followers on a global scale. This paper presents a comprehensive overview of the methods and technologies employed in the detection of the online spread of terrorism. Terrorist organizations exploit the anonymity and reach of the internet to disseminate propaganda, coordinate activities, and radicalize individuals. Detecting and preventing these activities are critical for national security and the preservation of online spaces as platforms for free expression.

KEYWORDS *: Online terrorism, Terrorism detection, Extremism online, Counter terrorism, Machine Learning, Online safety.*

INTRODUCTION

The detection of the online spread of terrorism involves monitoring and identifying individuals or groups that use the internet and social media platforms to promote, plan, or execute acts of terrorism. This is a critical aspect of counterterrorism efforts in the digital age, as the internet provides a powerful platform for recruitment, radicalization, communication, and propaganda by extremist organizations and individuals.

The detection of the online spread of terrorism is an ongoing challenge that requires a multifaceted approach, including technology, international cooperation, legal frameworks, and efforts to counter radicalization and extremism. It is a dynamic field that continues to evolve as terrorists adapt to new online platforms and communication methods.

METHODOLOGY

The methodology for developing a Terrorism Detection starts with defining clear objectives and selecting appropriate technologies. Following this, architects design the system's structure while developers create an intuitive user interface. Integration of translation logic with chosen APIs or libraries, as well as implementation of NLP capabilities and user authentication, are key steps. Thorough testing ensures functionality across various languages before deploying on a suitable platform. Continuous monitoring post-deployment ensures optimal performance, while iterative feedback collection drives refinement and improvement to meet user needs effectively.

Characterize Goals and Extension

- Obviously frame the goals of the venture. Figure out what dialects the site will support and what highlights it will offer.
- Characterize the extent of the undertaking, including the interest group and a particular necessities or requirements.

Market Exploration and Investigation

- Direct statistical surveying to comprehend the interest for language interpretation benefits and recognize expected contenders.
- Dissect existing language interpretation sites to grasp their highlights, assets, and shortcomings.

Requirements Social affair

- Assemble definite necessities from partners, including language support, friendly UI, upheld document types, and so forth.

Technology Stack Choice

- This could incorporate programming dialects, structures, and libraries for frontend and backend improvement, as well as data set arrangements.

Design Stage

- Make wireframes and models to picture the design and usefulness of the site.
- Plan the UI (UI) and client experience (UX) to guarantee natural route and availability.

Development

- Carry out the frontend and backend usefulness as per the endorsed plans and prerequisites.
- Incorporate language interpretation APIs or foster your interpretation motor if fundamental.

Testing

- Lead far reaching testing to recognize and fix any bugs or issues.
- Test the language interpretation exactness and execution under different circumstances.

Deployment

- Send the site and perform last checks to guarantee everything is working accurately.

Post-Send off Observing and Improvement

- Screen the site's exhibition, including uptime, reaction times, and client input.
- Gather investigation information to figure out client conduct and distinguish development.

Maintenance and Backing

- Give progressing upkeep and backing to resolve any issues or updates.
- Consistently update language interpretation models and calculations to further develop precision and execution.
- Remain informed about arising advances and patterns in language interpretation to integrate new highlights and upgrades into the site.

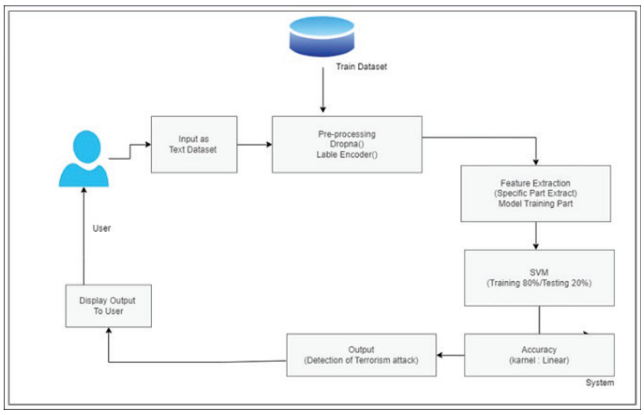

Fig. 1: Architecture Diagram

RESULTS

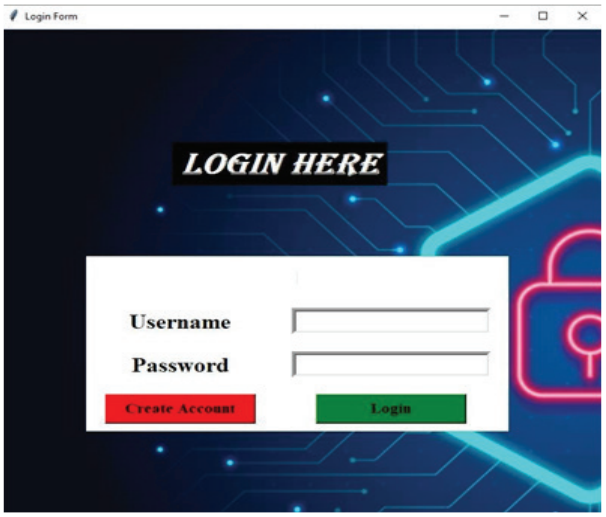

Fig. 2 : Login Form

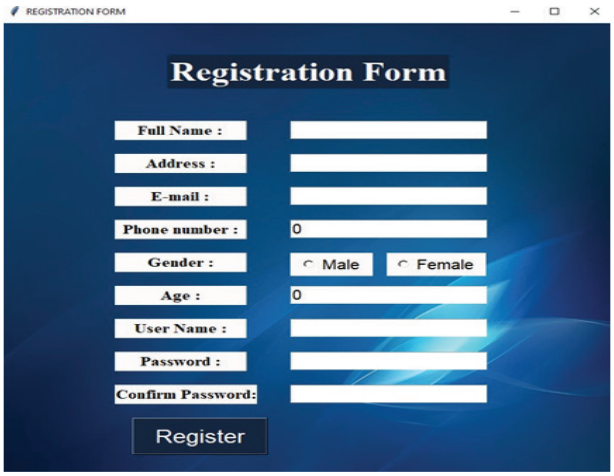

Fig. 3 : Registration Form

Fig. 4 : Dashboard

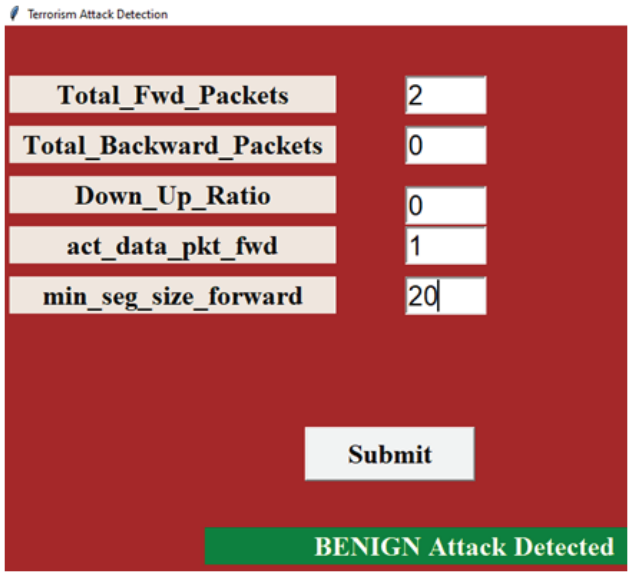

Fig. 5 : Output

CONCLUSION

The detection of the online spread of terrorism is a critical and multifaceted endeavour with profound implications for national and international security. As technology has evolved, terrorists and extremist groups have increasingly turned to the internet to disseminate their ideologies, recruit followers, and plan attacks. Detecting and countering these online activities is essential to preventing acts of terrorism, disrupting terrorist networks, and safeguarding the public. By addressing the challenges and limitations while leveraging the advantages of detection efforts, society can better protect itself against the evolving threat of terrorism in the digital age.

ACKNOWLEDGEMENT

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Application of Nanonization Techniques for the Conversion of Bulk Biomaterial into Nano-biomaterial and Upshot of its Solubility Augmentation

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ABSTRACT

Biomaterials are plant derived bulk materials their particles have their size above 100 nm in all dimensions. Nanomaterials are unseen to the bare eye. But the bulk materials, we can see their particles. The difference between nanomaterials and bulk materials is that nanomaterials have their size in 1-100 nm range at least in one dimension whereas bulk materials have their size above 100 nm in all dimensions. Plant based biomaterials considered as a bulk material are unable to dissolve in water. The solubility of bomatrial is often intrinsically related to its particle size; as a particle becomes smaller, the surface area to volume ratio increases. The larger surface area allows greater interaction with the solvent which causes an increase in solubility. Decreasing the particle size of biomaterials, into nano-biomaterial which cause increase in surface area, improve their rate of dissolution. Nanonization of biomaterials is done by high energy milling techniques. In the research paper nanonization obtained from biomaterial sample of marine mangrove plant Avicennia marina using high energy ball milling technique and structural characteristic studies of biomaterials were evaluated using FE-SEM microscope. Solubility enhancement study on both biomaterials were tested using deionized double distilled water. FE-SEM microscopic study showed the particle size differentiation in the ordinary crude biomaterial and nanosized biomaterial. Water solubility studies proved the quick soluble and polydispersibility behaviour of nanosized biomaterial. The solubility enhancement properties of nanosized biomaterials indicated that, when the grain or particle size is reduced, the solubility is enhanced.

KEYWORDS *: Biomaterial, Ball mill, Nanoparticles, Dispersion, Solubility, FE-SEM*

INTRODUCTION

Indiscriminate materials also called bulk materials consists of particles which size surpasses 100 nm in entire dimensions. Plant based bulk biomaterials used to formulate the phytomedicines, herbal medicines and various form of biomedicines. Herbal medicines in the form of biomaterials are in great demand in both developed and developing countries. Plants produce a diverse range of biomaterials consists of potent bioactive molecules [4,5]. They making them rich source of different types of medicines. Most of the drugs today are obtained from natural sources or semi synthetic derivatives of natural products and used in the traditional systems of medicine [6-8]. Most of the herbal drug the challenging problems in formulating the drugs are mainly due to the poor solubility is associated to poor dissolution characteristics and thus to poor oral bioavailability [9,10]. It is because of large grain size of bulk biomaterials. Due to the bigger grain size the biomaterial based pharmaceutical drugs could not well soluble [11, 12].

Most of the biomaterial incorporated drugs have the properties such as poor solubility, low dispersible nature and poor bio availability[13]. Most of the biomaterial

extracted from the plant source as crude drug and in powder, decoctions, and pillular forms. The particle size of the medicinal compounds provided by the above mentioned medications are big in size, coarse, irregular in shape [1-3]. They also hold poor stability, solubility, low biocompatibility with side effects like that of modern allopathic medicines[14,15]. The application of nanotechnology with plant based bulk biomaterial may provide a very useful tool in designing future Phyto - nano medicine with improved stability, bioavailability and solubility profile and less toxicity. Thus, there is urgent need for the conversion of plant based biomaterial into potent nano-biomaterial. This research paper describes the conversion of bulk plant based biomaterial into nano- biomaterial and its nano characterization and solubility competence.

MATERIALS AND METHODS

Biomaterial

The marine mangrove plant Avicennia marina leaves are the excellent source of bioactive compounds such as carotenoids, dietary fiber, protein, essential fatty acids, vitamins and minerals. This plant have the antimicrobial, antiviral and antifungal activity. It is used in biopharmaceutical industries to produce antimicrobial drugs.

Sample Collection

Fig 1. Sample collection

Marine mangrove plant Avicennia marina leaf sample was collected from the sea coast of Pichavaram, Tamil Nadu, India. Samples were cleaned, epiphytes and necrotic parts were removed. Samples were rinsed with sterile water to remove any associated debris and kept under sunshade for 7 days. After drying the sample, it was ground thoroughly to powder form using manual mill Shimadzu Blender. After the removal of fibrous and unwanted coarse particle, 100 g of crude biomaterial powder was taken for the nanonization of the biomaterial using high energy ball milling.

High Energy Ball Milling

The crude powder form of biomaterials (w/w) weighed 100 g was milled in steel cells (250 mL) using hardened steel balls (diameter 15 mm, weight 32 g) in ambient atmosphere for constant time of 15 hours (Retsch, PM 400). The milled materials were used directly without any added milling media. Five balls were kept in each cell along with 100 g of the sample powder. Two parallel cells were used in this experiment (the total weight of the sample powder was 20 g)

Experimental Design

To find out the highly potent water solubility of biomaterials, we have taken two types of biomaterial in the form of powder, 1. Crude biomaterial produced by manual mill Shimadzu Blender and 2. Nanosized biomaterial using high energy ball milling. Both the two powder samples were tested to observe the solubility. High energy ball milling is a typical top-down technique of nano-material preparation. As the name suggests the ball milling method consists of balls and mill chamber. The overall ball mill chamber contains a stainless steel containers and many small iron, hardened steel balls rotate inside the mill. It is an inexpensive and easy process. High energy ball milling is a typical top-down technique of nanomedicine preparation. As the name suggests the ball milling method consists of balls and mill chamber. The overall ball mill chamber contains a stainless steel containers and many small iron, hardened steel balls rotate inside the mill. It is an inexpensive and easy process.

Description of the Instrument

The Emax is an exclusively new type of ball mill for high energy milling. The unique combination of high friction and impact results in extremely fine particles within the shortest amount of time.The high energy input is a result of an unrivaled speed of 2000 min-1 and the optimized jar design. The revolutionary cooling system with water, the high energy input is effectively used for the grinding process without overheating the

sample. Due to the special grinding jar geometry, the sample is thoroughly mixed which results in a narrow particle size distribution. Contrasting other high energy ball mills, the Emax is capable of continuous grinding operation without interruptions for cooling down. This dramatically reduces the grinding time. The high energy input in combination with the unique cooling system provides perfect conditions for effective mechanical alloying or grinding down to the nanometer range.

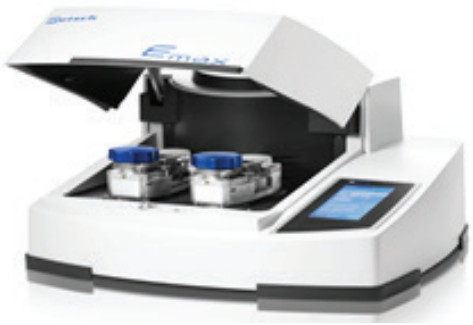

Fig 2. E max High Energy Ballmill (RETSCH Scientific Company., Germany). Speed of 2000 min-1 allow for ultra-fast grinding of the sample, Grinding jars sizes 50Ml/125Ml and Material feed size <5mm

A wealth of safety features such as the integrated safety closure of the grinding jar, temperature control with automatic start/stop system, and integrated imbalance controls make operation of the bench-top mill Emax very user-friendly and the Final fineness approximately <80nm.

Working procedure

The crude powder form of Avicennia marina leaf biomaterial is taken inside the steel container. This sample powder will be made into nanosize using the ball milling technique. A magnet is placed outside the container to provide the pulling force to the material and this magnetic force increase the milling energy when milling chamber rotates the metal balls. The rotation balls provide high energy to the crude, coarse, or bulk material powder and the powder then crushed. Depending upon the rotational speed and time the ball milling provide very large amount of mechanical energy to the crushed material. Due to, there is a structural and chemical changes are attained by the crude phyto material. In our research experimentation, High Energy Ball Mill Emax (Retch, Germany) was successfully used. The Emax is an entirely new type of ball mill for high energy milling. It maintain the speed at 60Hz, 300-2000 min^{-1} with cooling and temperature control options.

For nanonization, the powder form of crude or bulk leaf biomaterial already prepared as crude powder was placed inside the grinding jars. The plant crude samples were used directly without any milling media. Five steel balls 1cm in diameter were kept in each cell along with 10gm of the sample powder. Two parallel jars were used in this experiment. The total mass of the sample powder used was 20gm. Initially the mill is operated and rotated at 600rmp speed is increased up to 2000rpm. The crude sample was milled for 60 minutes and the milling process was conducted in a cold room (-20oC), and a 5 minutes cooling break was provided after every 30 minutes of milling to avoid over heat. After the final stage of milling process, the nanosized powder form of nano-biomaterial samples obtained were used for the characterization.

Nanotechnological Characterization

The converted biomaterial from bulk form into nano-biomaterial samples were underwent the nano characterization techniques such as FE-SEM and solubility efficacy potential.

(a). FE-SEM Analysis

The both bulk and converted nano-biomaterial powders were analyzed using a Field Emission Scanning Electron Microscope (FESEM), JSM-7500 F (JEOL-Japan) operated at 10 KV, in the Centre for Nanoscience and Technology, Bharathiar University, Coimbatore, Tamilnadu, India.

(b). Solubility efficacy test

1gm of solid form of both bulk biomaterial, and nano-biomaterial were dissolved in a test tube containing 10 ml of different solvents including water.

RESULTS AND DISCUSSION

The ordinary powder form (crude biomaterial) produced by ordinary manual mill Shimadzu Blender may lead to formation of large irregular size and shape Fig. 3(i.). The FE- SEM micrograph image of the starting biomaterial sample before ball milling process shows in

figure 3(ii) This sample contains particles covering the range 17–25 µm of different sizes/shapes. Around 70% of these particles are large and irregular shape.

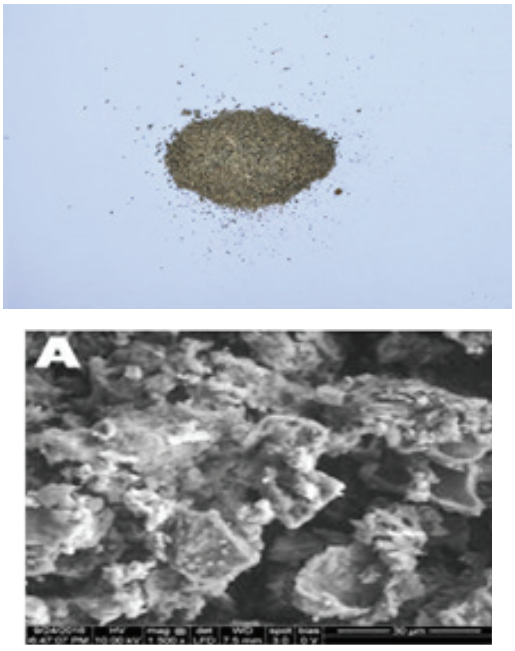

Fig. 3 (A) FE-SEM image of the ordinary crude biomaterial prepared by manual mill Shimadzu Blender

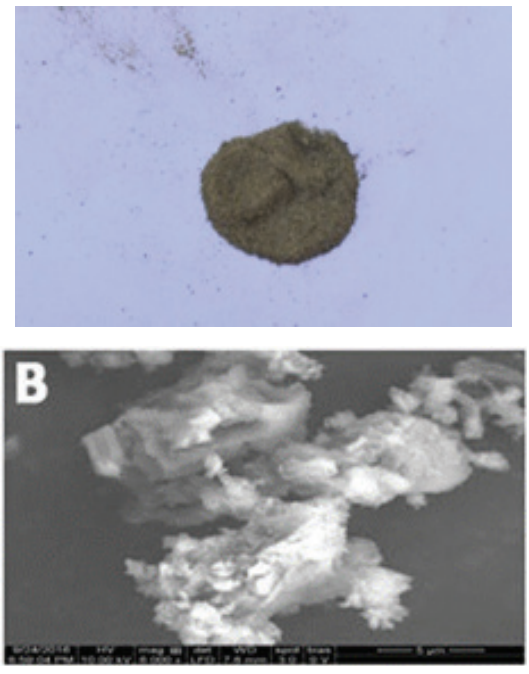

Fig. 3(b) indicates FE- SEM micrograph image of the biomaterial sample milled for about 15 hours by High Energy Ball milling device

The biomaterial sample milled for 6 TO 10 hours, show particles at scale level., almost all particles are semi spherical shaped nanoparticles. The particle size distributions for the sample with more collected particles have an average diameter of approximately 90 to 140 nm.

The water solubility or aqueous solubility of crude biomaterial of the particles size (17–25 µm) and High energy ball milled algal biomaterial of the particle size (90 to 140 nm) shows differentiation. The crude biomaterial sample added into Deionized double distilled water partially soluble and partially dispersible and a lot of green depositions appeared in the solution(Fig 4) The solution shows acidic pH value 5.0.

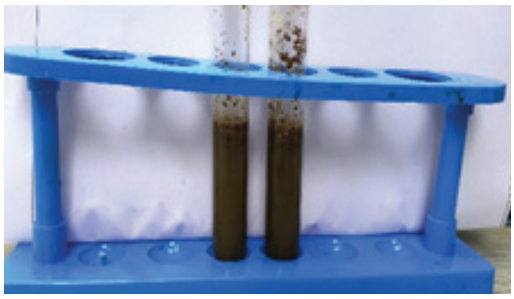

Fig. 4. Solubility test of crude biomaterial partially dispersed in water

While in the nanosized biomaterial sample, the particle solubility rate and dispersion efficiency is very high. The nanosized sample was quickly soluble in water and the pH value reached as 6.5 to 7.0. Further it was observed in the solution with uniform solubility and dispersibility properties (Fig 5).

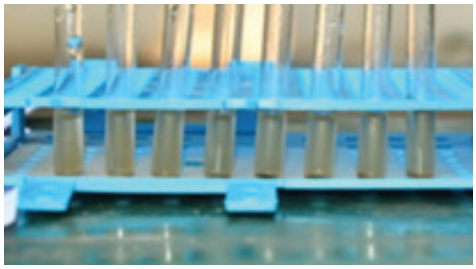

Fig 5. Solubility test for nanosized biomaterial completely dissolved in water

High energy ball milling is a powerful non-equilibrium processing, refines the grain size of all solid elements of materials into nanoscale [20]. During the ball milling process, algal biomaterials are repeatedly fractured,

and nanosized. Fracture and nanosize are the two basic factors that produce a permanent ionic exchange between particles. Ball milling technology leads to an increase in dissolution rate depending on the increase in surface area obtained by reduction of the particle size of the active drug substance down to the nano size range preserving the crystal morphology of the drug biomaterial [22]. A number of researchers have produced nanosized materials using the same technology[16].

This technology leads to an increase in dissolution rate depending on the increase in surface area obtained by reduction of the particle size of the active drug substance down to the nano size range preserving the crystal morphology of the drug [17]. The milling process, which can be either mechanical milling or mechanical alloying, refines the grain size of all solid elements of materials into nanoscale [19].The main advantages of ball milling include large scale production of high purity nanoparticles with improved physical properties in a cost effective way. The ball milling treatments can also bring new properties to the matter depending on the grain size and materials composition [21]. Most differentiating features of drug nanocrystals are the increased saturation solubility and the accelerated dissolution velocity.

The main advantages of ball milling include large scale production of high purity nanoparticles with improved physical properties in a cost effective way [18]. The ball milling treatments can also bring new properties to the matter depending on the grain size and biomaterials composition including its solubility. In our investigation, the ball milling operation may lead to formation of nanosized particles. The ordinary blender produced microsized particles which is larger than the nano particle. This result clearly presents that the ball mills are more effective to reduce size, which ultimately increase the accessibility of particle size to biomaterials and easy solubility.

CONCLUSION

The present study proves remarkable experimental results on plant biomaterial using high energy ball milling processes for the controlled synthesis of drug nanoparticles found in the plant biomaterial were described. The ball milling process are successfully produced the nanoparticles in biomaterial with high solubilization capacity. The size reduction of biomaterial to nanometer levels (from 60–120 nm) has been achieved by this method on 10 hrs. This technology helpful to an increase in dissolution rate of drug biomaterial depending on the increase in surface area obtained by reduction of the particle size of the active drug substance down to the nanosize. Ball milling technology can be used to articulate and expand biomaterial and its compounds activity and enhance the solubility of the poorly water-soluble compounds. The foremost use of the conventional ball milling is to break the particles and to decrease the size, whereas in high energy ball milling, a extensive milling time can be attained, which can help to activate and wide-ranging the structural variations and chemical reactions which are decisive to yield the expected structural vicissitudes and chemical reactions.

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Attention-Driven Image Captioning: A ViT Transformer-Based Approach

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ABSTRACT

Creating precise and contextually appropriate captions for images is an arduous effort inside Natural Language Processing (NLP) and Computer Vision (CV). Attention mechanisms have proven beneficial in improving models' ability to caption images by focusing on important regions of the image. In this work, a model based on the Vision Transformer (ViT) architecture, utilizing Scaled Dot Product and Multi-Head Attention to generate image captions. The model has shown significant effectiveness in producing coherent and detailed descriptions, achieving improvements in BLEU@1, BLEU@2, CIDEr, and ROUGE-L scores by 1.51%, 2.06%, 3.3%, and 4%, respectively, on the MSCOCO dataset.

KEYWORDS *: Attention mechanism, Computer vision, Natural language description, ViT Transformer.*

INTRODUCTION

The integration of attention mechanisms in deep learning models has resulted in improved performance across a range of tasks, such as captioning images [1]. When it comes to image captioning, attention mechanisms let the model concentrate on particular regions of the input image while producing the relevant text description [2]. Using this method, distinct areas of the input image are given varying weights according on how relevant they are to the resulting caption. During training, the model learns to allocate higher weights to relevant areas and lower weights to less significant ones through an iterative refinement process. This process involves adjusting the attention weights based on the model's generated caption and its comparison to the ground truth [3].

During inference, the attention technique enables the model to focus on significant areas of the picture while generating the caption. By visualizing the attention weights and highlighting the sections of the input image that are most important for caption creation, this enhances both the model's interpretability and the quality of the generated captions [4].

Overall, attention mechanisms have become a valuable tool in image captioning, with many state-of-the-art models utilizing some form of attention to achieve superior performance. Therefore, understanding and integrating attention mechanisms into image captioning models remains a vital area of research and advancements in the deep learning domain

RELATED WORK

The inclusion of attention mechanisms has been a major advantage in recent picture captioning advancements, improving the quality and relevancy of generated captions. This section reviews major contributions in the field, focusing on various attention strategies and innovative ideas proposed by researchers.

[2] Introduced a foundational attention-based model for image captioning that uses a soft attention mechanism to assign weights to different areas of an image based on their importance to the generated caption. This model set the stage for further advancements in attention mechanisms for image captioning.

Building on this, [5] proposed a spatial and channel-wise attention mechanism within convolutional neural

networks (CNNs). This approach selectively focuses on specific image regions and channels of feature maps, resulting in more accurate captions.

[6] Developed a two-stage attention mechanism for image captioning. This method first identifies salient image regions using bottom-up attention and then selectively attends to those regions during caption generation using top-down attention, significantly improving the handling of complex scenes and rare objects.

[7] Introduced a self-retrieval mechanism, where the model generates a caption, retrieves matching images from the training data, and then discriminates between the retrieved images and the original image to refine the caption.

[8] Presented a semantic attention mechanism that focuses on semantic concepts instead of specific image regions. The model generates a set of candidate concepts and then attends to these concepts to create the final caption.

[9] Proposed a method that uses captions to guide visual attention, allowing the model to concentrate on image areas relevant to the caption, thereby enhancing the precision and relevance of generated captions.

[10] Introduced a multi-modal attention mechanism that allows the model to attend to several modalities (text and picture) at the same time, increasing the accuracy and perceptiveness of the captions made.

[11] Developed an adaptive hierarchical co-attention mechanism that uses both bottom-up and top-down attention to selectively attend to different image regions and words in the caption.

[12] Presented a feedback-guided attention mechanism that selects pertinent visual regions and words for the subsequent word production using words that have already been generated.

[13] Introduced self-attention in image captioning, allowing the model to pay attention to different input sequence parts while encoding, which improves the model's efficiency and accuracy.

[14] Proposed an attention-based model that leverages external knowledge in the form of image attributes to enhance caption quality.

[15] Introduced a multi-modal attention mechanism for image captioning and picture-based query answering, which selectively attends to different modalities (e.g., image regions, text features) based on their relevance to the task.

[16] Developed a cross-modal adaptive attention network that adaptively selects relevant image regions and text features using a cross-modal attention mechanism.

[17] Introduced a hierarchical dual attention network employing both global and local attention mechanisms to selectively attend to different image regions and words in the caption.

[18] Presented a model with a two-level attention mechanism, where the first level attends to different image regions, and the second level refines the attended regions using another attention mechanism. This multi-level attention enhances the precision and coherence of image captions.

Additionally, significant research has focused on improving the efficiency and scalability of attention mechanisms. [19] Introduced a stand-alone self-attention module that replaces traditional convolutional layers in CNNs, achieving state-of-the-art performance on various benchmarks. [20] Presented a Sparse Transformer that uses a pre-defined sparsity pattern to limit the number of tokens attended to by each token in a sequence, enhancing efficiency and scalability. [21] Adapted Transformer models for image recognition tasks by introducing the Vision Transformer (ViT), which extracts global information from images using self-attention mechanisms.

ANALYSIS OF STATE-OF-ART MODELS

State-of-the-art models in image captioning utilize various advanced techniques and architectures to generate high-quality, contextually accurate captions. This analysis highlights key models and their limitations, dataset used, performance and future scope as illustrate in table 1.

Table 1: Analysis of State-of-Art Models

Ref.	Advantages	Limitations	Dataset	Performance	Future Scope
[2]	Effective modeling of attention mechanism, better caption quality	Fails to incorporate contextual information, slow training	COCO	BLEU-4: 36.6 (COCO), METEOR: 28.0 (COCO)	Incorporate contextual information, faster training
[5]	Improved caption quality, attention on both spatial and channel dimensions	Limited to single-scale input, ignores long-term dependencies	COCO	BLEU-4: 32.9 (COCO), METEOR: 25.1 (COCO)	Explore multi-scale and multi-modal attention
[6]	The bottom-up and top-down attention are used effectively, and performance on rare objects is improved.	Large memory footprint, computationally expensive	COCO	BLEU-4: 38.3 (COCO), METEOR: 29.1 (COCO)	Reduce memory footprint, improve efficiency
[11]	Uses an adaptive hierarchical co-attention mechanism to focus on both text and image regions at the same time.	Lacks explicit modeling of spatial attention, limited to a fixed set of regions	COCO	BLEU-4: 40.6 (COCO), METEOR: 29.7 (COCO)	Explore explicit modeling of spatial attention, adaptiveness to varying object regions
[12]	Incorporates feedback loop to refine attention mechanism, better performance on long captions	Limited to single-scale input, computationally expensive	COCO	BLEU-4: 36.3	Improve efficiency, explore multi-scale attention
[14]	Utilizes external knowledge sources to improve caption quality, effective use of attribute-based attention	Limited to a fixed set of attributes, dependent on external knowledge sources	COCO	BLEU-4: 35.3 (COCO), METEOR: 26.7 (COCO)	Explore dynamic or adaptive attribute-based attention, reduce dependence on external knowledge
[15]	Effective use of attention for multi-modal fusion, better performance on VQA task	Limited to single-scale input, lacks explicit modeling of spatial attention	COCO	BLEU-4: 41.0 (COCO), METEOR: 29.2 (COCO)	Explore multi-scale and multi-modal attention, incorporate explicit modeling of spatial attention
[16]	Utilizes cross-modal attention to improve caption quality, effective use of adaptive attention	Limited to single-scale input, lacks explicit modeling of spatial attention	COCO	BLEU-4: 34.1	Explore multi-scale and modal attention, incorporate explicit modeling of spatial attention
[17]	Effective use of hierarchical and dual attention, better performance on rare objects	Lacks explicit modeling of spatial attention, limited to a fixed set of regions	COCO	BLEU-4: 35.1	Explore explicit modeling of spatial attention, adaptiveness to varying object regions

METHODOLOGY

The ViT encoder and Transformer decoder are the core components of the Image Caption Generation Model utilizing ViT Transformer. Figure 1 illustrates the block diagram of the proposed model.

ViT Encoder

The Vision Transformer (ViT) begins by dividing the input image into patches using its encoder. Next, a linear layer is used to flatten each patch and project it into a lower-dimensional space, resulting in a sequence of patch embeddings. These embeddings are processed by a Transformer encoder to produce image embeddings, each highlighting unique features of the input image. The subsequent Transformer decoder uses these image embeddings to generate a descriptive caption. By using feed forward neural networks and various layers of self-attention, this decoder allows the model to focus on different segments of the input sequence while producing the caption.

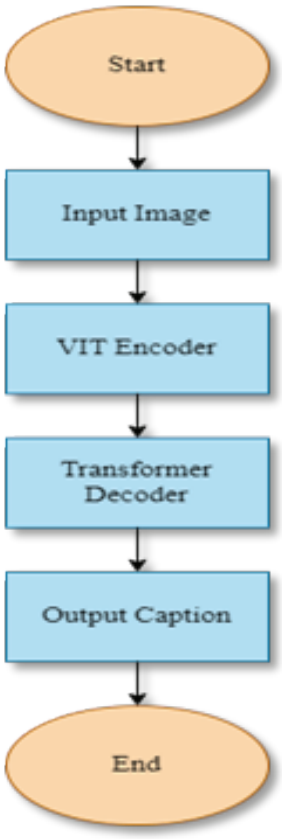


Fig. 1. Block Diagram of proposed model

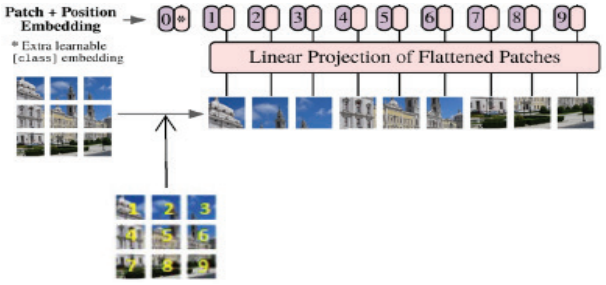
Working of ViT

Vision Transformers (ViT) convert images into sequences of tokens for processing by transformer models through the following steps:

Step 1: Partition the image into patches.

Step 2: Flatten and linearly project the patches into lower-dimensional embeddings.

Step 3: Integrate positional embeddings.



Step 4: Input the sequence into a standard transformer encoder.

Step 5: Prepare the model using image labels.

Step 6: Fine-tune on downstream datasets for image classification.

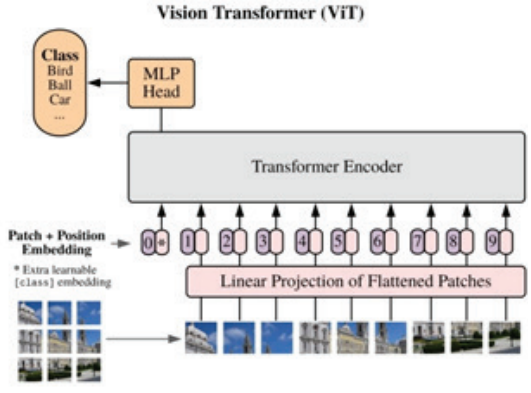


Figure 2: Working of ViT [18]

Transformer Decoder

The decoder generates a probability distribution over the vocabulary of possible words during each stage of decoding, influenced by previously generated words and input image embeddings. To create the next word in the caption, it chooses the word with the highest probability as the next input. The model is trained using a loss function, typically cross-entropy loss, to minimize the disparity between generated and actual captions. Through extensive training on a large dataset of image-caption pairs, the model learns to produce captions that are both semantically accurate and grammatically sound.

In summary, the ViT Transformer-based Image Caption Generation Model architecture is a robust and efficient method for generating natural language descriptions of images.

Implementing Vision Transformer (ViT) with Attention Mechanism for Image Captioning

1. Importing Dependencies: Import the required libraries and frameworks, such as TensorFlow or PyTorch.
2. Preparing the Datasets : Load and preprocess the MS-COCO datasets for training and evaluation. This involves tasks like resizing images, tokenizing captions, and splitting the data into training and validation sets.
3. Initializing the Pretrained Vision Transformer: Initialize the pretrained Vision Transformer model, such as ViT, using a pretrained checkpoint. This allows to leverage the prelearned features and weights of the model. For this implementation, the Vision transformer vit_b32 is used.
4. Positional Encodings for the Captions: Generate positional encodings for the caption sequences. The words in the sequence's positions are encoded using positional encodings, which helps the model comprehend their order. Positional encodings give details about the sequential order of words, enabling the model to comprehend the temporal relationships between words. One common method to generate positional encodings is employing the sine and the cosine functions:

$$PE_{(pos,2i)} = \sin\left(\frac{pos}{10000^{\frac{2i}{d_{\text{model}}}}}\right) \quad (1)$$

$$PE_{(pos,2i+1)} = \cos\left(\frac{pos}{10000^{\frac{2i}{d_{model}}}}\right) \quad (2)$$

Where pos represents a position and i is a dimension.

Masking the Sequences: Mask the padding tokens in the caption sequences to indicate that they should be ignored during training. Typically, a mask of 1s is used for the tokens that should be masked, and 0s for the rest. This prevents the model from attending to irrelevant parts of the input.

Scaled Dot Product Attention: It determines the weights of the attention between the encoder and decoder sequences by taking the dot product of the queries, keys, and values. The attention weights determine the importance of each element in the encoder order for each element in the decoder sequence.

The attention weights are determined as shown below:

$$\text{Attention}(Q,K,V)\ \ \text{softmax}\left(\frac{QK^T}{\sqrt{d_k}}\right)V \quad (3)$$

Where Q represents the queries, K represents the keys, V represents the values, and d_k represents the dimension of the keys.

Multi-Head Attention: By dividing the queries, keys, and parameters into multiple heads, Multi-Head Attention expands Scaled Dot Product Attention. It permits the model to concentrate on various input by performing attention calculations independently across multiple heads and concatenating the results.

$$\begin{aligned}\text{MultiHead}(Q,K,V) &= \text{Concat}(\text{head}_1,\dots,\text{head}_h)W^O \\ \text{where head} &= \text{Attention}(QW_i^Q, KW_i^K, VW_i^V)\end{aligned} \quad (4)$$

Q, K, and V stand for the respective queries, keys, and values. There are four weight matrices:W_i^Q, W_i^K, W_i^V, and W^O.

The Encoder Layer: The transformer model's building blocks include the encoder layer. Feed-forward neural networks are usually the first step, followed by layer normalization and multi-head attention. The encoder

layers process the input sequences and extract relevant features.

$$\text{EncoderLayer}(x) = \text{LayerNorm}(x + \text{MultiHead}(\text{FFN}(\text{LayerNorm}(x)))) \quad (5)$$

FFN stands for feed-forward neural network, LayerNorm for layer normalization operation, and x stands for the input sequence.

The Decoder: The Decoder creates the caption sequence step by step using the features of the encoded image provided by the encoder. It uses cross-attention and self-attention mechanisms to pay attention to pertinent image features and previous decoder outputs.

$$\text{DecoderLayer}(x, \text{encout}) = \text{LayerNorm}(x + \text{MultiHead}(\text{SelfAttention}(x), \text{encout})) \quad (6)$$

Where x represents the input sequence, encout is a representation of the encoder's output, SelfAttention is the self-attention mechanism, and LayerNorm is the layer normalization operation.

The Transformer: The Transformer integrates encoder and decoder components into a cohesive model, comprising multiple stacked encoder and decoder layers.

Hyperparameters: Configure hyperparameters for training the attention model, including learning rate, batch size, encoder and decoder layer counts, hidden dimension sizes, dropout rate, and other relevant parameters. Optimizing these parameters is crucial for achieving optimal performance.

The Optimizer: Select an optimizer like Adam to adjust model parameters based on computed gradients during training. Adjust optimizer-specific parameters, such as learning rate, to control the optimization process.

Loss Metrics: Choose a loss function to quantify the disparity between expected and actual captions. Common choices for sequence generation tasks include cross-entropy loss and self-critical sequence training loss.

Training the Transformer: Prepare training data using data loaders or generators to feed batches of examples into the model. Iterate over the data for a set number of epochs, compute loss, and perform backpropagation to adjust model parameters.

Preparing Data for Training: Process image and caption data to create input tensors suitable for the attention model. Steps include tokenizing captions, converting images to tensors, and setting up data loaders for efficient batch processing.

Training the Transformer: Feed input data into the attention model, compute loss, and update parameters using the optimizer. Evaluate model performance on a validation set and adjust hyperparameters as needed to monitor training progress.

Function to Caption Images: Develop a function that takes an image as input, passes it through the trained attention model, and generates captions. This involves encoding the image, initializing the decoder input with a start token, and iteratively generating subsequent words based on attention weights and previous decoder outputs. Repeat until an end token is generated or the maximum caption length is reached.

RESULTS FROM EXPERIMENTS AND DISCUSSION

Datasets and Evaluation Metrics

Several datasets are commonly employed for image captioning tasks, including MS COCO, Flickr30k, Flickr8k, Visual Genome, and Conceptual Captions. The Microsoft Common Objects in Context (COCO) dataset [22] stands out as one of the most utilized datasets for image captioning. It comprises over 330,000 images, each annotated with five captions, totaling more than 1.5 million captions. COCO offers a diverse collection of images depicting a wide range of objects and scenes. Here we have used COCO dataset. The dataset statistics are summarized in Table 2. To evaluate the quality of generated captions, standard metrics such as BLEU@1, BLEU@2, BLEU@3, BLEU@4 [23], METEOR [24], ROUGE-L [25], and CIDEr [26] are employed.

Results of the Proposed Model

The effectiveness of the proposed image captioning model was assessed using several established metrics: BLEU, METEOR, CIDEr, and ROUGE-L. The outcomes illustrate that the model performs

exceptionally well across diverse evaluation criteria, affirming its capability to generate precise and coherent captions for images. The results are summarized in the table below:

Table 2: Results of the Proposed Model

BLUE				METEOR	CIDEr	ROUGE-L
@1	@2	@3	@4			
83.81	70.36	53.33	45	28.49	142.2	66.6

Fig. 3. Qualitative Results generated by Proposed Model

QUALITATIVE RESULTS

Figure 3. provides some examples of captions for images form COCO dataset that have been generated using our approach. It is evident that our model can generate correct words while paying attention to the proper context like focusing on the sink and toilet area model produce the word like "bathroom", focusing on jet and runway area model produce the word like "airport tarmac". Additionally, our model accurately captures the semantic information and validates the benefits of our model by focusing on correct region of images.

Comparisons with State-of-The-Art Models

Table 2 compares the outcomes of the benchmark model with the performance evaluation of our proposed approach based on standard metrics. The models being compared include: Show, attend and tell [2], SCA-CNN [5], Bottom-Up and Top-Down Attention for Image Captioning and Visual Question Answering [6], Adaptive Hierarchical Co-Attention [11], Feedback-Guided Attention Model [12], Image Captioning and Visual Question Answering Based on Attributes and Their Related External Knowledge [14], Attention-based Multi-modal Fusion model [15], Cross-Modal Adaptive Attention Model [16], Hierarchical Dual Attention Network Model [17]. Scores demonstrate the efficiency of our approach. In respect to the BLEU@1, BLEU@2, CIDEr, and ROUGE-L scores, our model improved them by 1.51%, 2.06%, 3.3%, and 4%, respectively.

Table 2: Comparisons with State-of-The-Art Models

Ref	Dataset	BLUE @1	BLUE @2	BLUE @3	BLUE @4	METEOR	CIDEr	ROUGE-L
[2]	MS-COCO	69.0	47.7	33.9	24.5	23.0	98.0	-
[6]	MS-COCO	78.2	63.2	50.7	40.2	27.7	119.8	56.7
[11]	MS-COCO	82.2	68.2	55.8	45.2	29.4	126.4	61.4
[12]	MS-COCO	78.7	63.9	51.8	41.6	27.7	121.6	58.2
[14]	MS-COCO	80.7	65.5	53.8	43.9	30.7	136.2	60.5
[15]	MS-COCO	79.9	65.1	53.4	43.6	30.2	126.2	60.5
[16]	MS-COCO	81.1	67.2	55.6	45.8	31.6	138.9	62.6
[17]	MS-COCO	82.3	68.3	55.9	45.3	30.0	130.6	61.6
Our Model	MS-COCO	**83.81**	**70.36**	53.33	45	28.49	**142.2**	**66.6**

CONCLUSION

This paper introduces an attention-driven image captioning method utilizing a ViT Transformer-based model. Our approach capitalizes on the robust visual representations provided by the Vision Transformer to create precise and meaningful captions. Our model's primary benefit is its capacity to use the attention mechanism to identify contextual dependencies and connections between words and visual regions. The model's attention-driven architecture facilitates the generation of more descriptive captions by allowing it to concentrate on relevant image regions. This improves

contextual understanding. Our method is more accurate and produces captions that are of higher quality than those of existing algorithms, as demonstrated by extensive trials on benchmark datasets.

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Blood Bank Management System Using Android Applications with Help of ML

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ABSTRACT

The availability of blood in times of emergency is vital to all living things. For efficient communication between them and medical facilities, there are numerous electronic blood donation centers. User-friendly interfaces for inventory tracking, request processing, and donor registration are integrated into the system. By enabling demand forecasting through predictive analytics, machine learning models installed on cloud platforms improve blood inventory control. Not a single online blood donation center allows the recipient and donor to communicate instantly. This is the actual drawback of the existing structure. The current frameworks are costly, time-consuming, and need more labour. This study shows a relationship between the current blood bank structure and an improved one to increase efficiency.

KEYWORDS *: Machine learning, Cloud services, Android application, Predictive analytics.*

INTRODUCTION

Blood must be available to all living things at all times in case they require it. In order to facilitate communication between blood donors and medical facilities, there are numerous electronic blood donation centers. There aren't any online blood donation services that let you speak with the recipient directly. Right now, this is the system's actual weakness. The existing frameworks are labor-intensive, costly, and time-consuming. The novel ideas have the potential to enhance current blood banks and ease the transition from stationary to mobile architecture.

The remaining portions of the planned study deal with different facets of the components of the enhanced framework, including the data that is retained, data for applications in the future, and the many types of blood groups that are delivered and received.

The availability of life-saving blood supplies for medical treatments and emergencies is a crucial function of blood banks in healthcare systems. Traditional blood bank management systems, however, frequently have problems with inventory tracking, demand forecasting, and donor coordination, which can result in inefficiencies and shortages. The Blood Bank Management System (BBMS), which utilizes cutting-edge technology including cloud services, machine learning (ML), and Android applications, is presented in this research paper as a comprehensive solution to problems. With the help of intuitive interfaces that allow donors to register, make appointments, and obtain details about donation drives, the BBMS seeks to transform the procedures involved in blood donation.

Healthcare workers may also use the system to handle donor information, monitor blood stock levels in real time, and easily handle blood requests from hospitals and other healthcare facilities. The integration of machine learning algorithms installed on cloud platforms, which allows predictive analytics for demand forecasting, is one of the main novelties of the BBMS. The system is able to predict blood demand patterns with high accuracy, optimize inventory management,

and suggest donation drives in locations with high need by examining demographic data, geographic variables, seasonal trends, and historical data. By being proactive, we may reduce waste while simultaneously guaranteeing timely availability to blood supplies in areas Additionally, the BBMS puts security and privacy first by where they are needed. Adhering to data privacy laws, implementing strong user authentication procedures, and data encryption techniques. System scalability, dependability, and cost-effectiveness are improved by leveraging cloud services like serverless computing and scalable storage solutions. In order to facilitate blood donation procedures, this article presents a cutting-edge Blood Bank Management System (BBMS) that makes use of Cloud services, Machine Learning (ML), and Android applications. The BBMS incorporates machine learning techniques for demand forecasting, provides user-friendly interfaces for donors and healthcare professionals, and uses cloud infrastructure to secure data. The goal of the BBMS is to improve healthcare outcomes, optimize inventory management, and boost blood donation drives by utilizing- cutting-edge technologies.

EXCITING SYSTEM

The main objective of this project is to save the lives of people who are in need of blood, and it is essential to accomplishing this goal. This method is intended to give users access to information about registered blood donors, such as their blood type and other medical parameters, as well as their name, address, and other personal data. To ensure safety and cross-verify, a donor or recipient must submit their information with designated documents, such as a pan card, an Aadhar card, or the guardian's data for a minor cohort. Users must register on the project's login page in order to view the blood's availability. The project consists of a login website that requires users to register in order to verify the availability of blood and, if desired, to register as blood donors. The donor or recipient must also provide their blood results and a few other health-related documentation for security reasons. Since this project's main components depend on having an internet connection, there may occasionally be an outage. A specific method of research has been used to compile the information required for social media, the healthcare industry, and the blood supply monitoring. The individuals and quantities are stored in the firebase database, which contains all of the bank data, in the current systems. The required information about the blood banks that store that specific person is included in the findings, organized by location. Even though 10% of Indians donate blood overall, advances in natural science have led to a rise in the demand for blood, and it has been noted that most blood donors are unaware of the need for blood. These elements spur us to create a more reliable mechanism to sustain the existing blood donation programmer.

LIMITATIONS OF PREVIOUS SYSTEM

Donors in most cities were in desperate need of assistance under the prior arrangements, but not in every place. The contact person's details were frequently obtained, although they were frequently insufficient. These services are not available in rural or agricultural areas due to a lack of connectivity. For impoverished folks, data connectivity is not economically feasible. This meant that offline systems could not access the applications either. In addition, there were instances when contacting the hospitals in an emergency was quite challenging. A centralized database of willing donors did not exist. Therefore, going around looking for blood in case of need got incredibly tiresome. In these circumstances, the only recourse available is to manually search for donors, match, and then place phone calls. Details regarding the donor, hospital or even donor details were available within the applications but weren't sufficient.

PROPOSED SYSTEM AND ITS ADVANTAGES

Features: Every document and piece of data that is obtained or utilized is now permanent due to computerization. Automated computations replace manual ones. It was simple to have access to all or any kind of records. This method will simplify the process and produce an adequate blood supply. It will even be possible to analyses the quantity of blood units provided by users in a manner similar to that of hospitals that have registered and requested blood units.

ADVANTAGES: This interactive system is user-friendly since it is simple to use and accessible to

anyone. By using this approach, time-consuming tasks like visiting hospitals and filling out blood donation applications are reduced. It saves time and requires no complexity.

- It is a knowledge security and backup facility with records that are easy to navigate.
- Records are easily approachable with 24 x 7 availability.
- Higher component design is essential to encourage greater performance during peak periods. Facilitates the creation and management of new users.
- Offers data security via permission.

System Model

1. Donor- Upload Image Donors may provide a photo of themselves.
2. CNN Algorithm- To process the uploaded image, the system employs a Convolutional Neural Network (CNN) algorithm.al data, the system determines the donor's blood type.
3. Submit Medical Info – Donors have the option to submit facts about their health, including information that may be pertinent to giving blood.
4. Search Nearest Blood Bank – By entering their location or other parameters, users can find the blood bank that is closest to them.
5. Send Request – Individuals have the option to submit a request for a specific blood type or blood donation.
6. Show Receiver Medical Info- This option allows medical data about the recipient to be shown, potentially for use by blood banks or other healthcare providers.

Data Flow Model

We display the data flow in our system in DFD0, the base DFD, where the circle represents our system and the rectangle represents input and output. In DFD1, we display the actual input and output of the system. Text or images are the input, and rumor detection is the output. Similarly, in DFD2, we display the user and administrator operations.

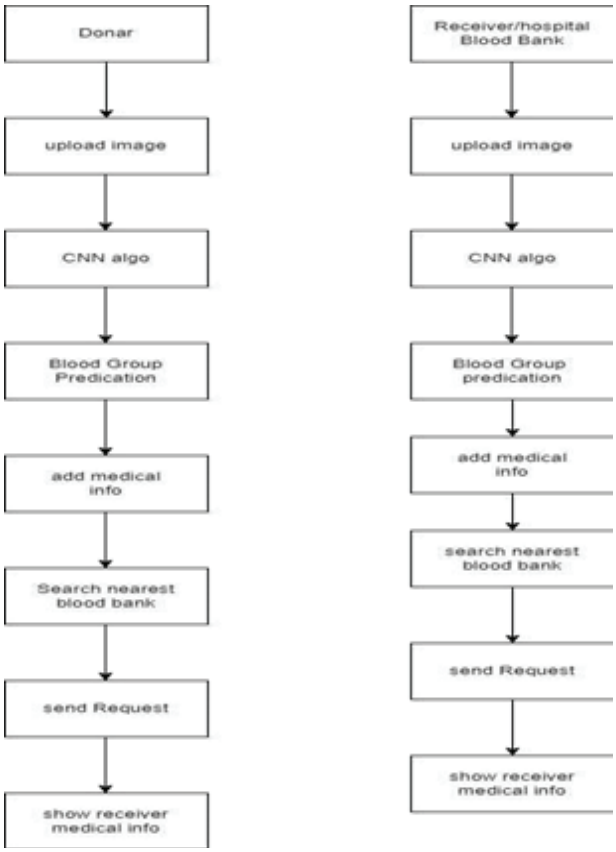

Fig. 1: System Architecture

Fig. 2: DFM0 Diagram

Fig. 3: DFM1 Diagram

Fig. 4: DFM2 Diagram

The admin to upload blood bank information, create a secure login for the admin. After authentication, provide an intuitive dashboard with an upload option. Design a form for the admin to input Blood Bank details, including name, Address. Implement a backend API to receive and store this information in a database.

Fig. 5: Blood Bank Details

Fig. 6: Blood Group Prediction

Gather a dataset of blood group images. Each image should be labeled with the corresponding blood group (e.g., A, B, AB, O). Reprocess the images to ensure they are standardized in terms of size, color, and orientation. Convert the images to a format suitable for input into the CNN.

CONCLUSION

The Blood Bank Management System is a critical tool for efficiently managing blood-related processes such as collection, storage, testing, and distribution. Through its user-friendly interface, robust application logic, secure database management, and seamless integration with external systems, the system facilitates streamlined operations and enhances accessibility to blood products for healthcare institutions and patients. The system is beneficial for both requester and donor too. Due to this System, the bridge between donor and the requester is reduced and their Communication improves. Thus, providing the requested blood on time to the requester, when needed. The health sector will be definitely benefited by the services provided by the system as patients safety and life The system's architecture, comprising components like the user interface, application logic, database, server, security layer, external systems integration, scalability measures, and monitoring/maintenance tools, ensures a comprehensive and reliable solution. It enables efficient donor registration, inventory management, request processing, reporting, and notifications while maintaining data security, regulatory compliance, and performance optimization.

By leveraging technology and best practices in blood banking, the Blood Bank Management System contributes significantly to improving healthcare outcomes, ensuring blood supply sustainability, and ultimately saving lives. Continued enhancements, updates, and adherence to industry standards will further strengthen the system's effectiveness in meeting the evolving needs of blood banks, healthcare providers, and the community at large.

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Calendar Application that Manages Events and Appointments

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ABSTRACT

This article presents a new way to improve digital calendar user experience by solving scheduling and competition management issues. Our solutions uses the Flutter and Firebase to improve event organization and planning through advanced algorithms. It manages conflicts and adapts to user preferences, providing seamless control in personal, public and professional environments. The system has a user-friendly interface that facilitates maintenance and meets the needs of different target groups. Complete training to application is provided, including project setup, user interface design, Firebase integration, testing and debugging. Calendar usage is also explained by using Zeller's Congruence formula in date calculation. This approach demonstrates the integration of Flutter and Firebase in creating a powerful calendar management system.

KEYWORDS *: CalDAV, Firebase, Flutter, SELFPLANNER, SyD.*

INTRODUCTION

The calendar application is designed with an emphasis on efficiency and user-friendly scheduling. It uses advanced technologies including Flutter software, to streamline the management of events and appointments. Employing a client-server architecture, the application consists of a user interface(UI), a robust calendar engine handling the business logic, and efficient data storage. Flutter's cross-platform capabilities ensure a consistent and engaging experience across web and mobile platforms. Comprehensive error handling and logging mechanisms enhance the application's reliability, while optimizations in calendar rendering prioritize a responsive user interface. The integration of the CalDAV (Calendaring based Distributed Authority and Versioning) protocol facilitates seamless online sharing of calendar data, introducing virtual calendars for collaborative access. Speech software integration, using Server Application Programming Interface (SAPI) text-to-speech, enhances efficiency by allowing event entry through speech. The application also introduces a novel calendar queue that excels in scenarios with uneven event distribution. Notably, it addresses the gap between messaging and calendar apps on smartphones, providing a comprehensive solution for users. Overall, the incorporation of Flutter and innovative features positions the calendar application as a modern, efficient, and user-centric solution for event management and scheduling. In NLC regarding each employees training, schedule, participated in number of events, etc. was time consuming and a hectic manual task. This calendar application has reduced the traditional method to a new technical method. Admin follows web application for arranging the schedule for training and employees follow mobile application for registering the training. [1]

A proper fine-grained calendar is needed where data can be shared easily. So, for this a Calendaring based

Distributed Authority and Versioning (CalDAV) protocol is used which is based on online sharing of the calendar data. Calendaring based Distributed Authority and Versioning (CalDAV) is an extension of WebDAV that enables editing websites. Also, the concept of virtual calendars is introduced where many users can access at same time.[2]

A traditional method of entering important events by typing is replaced by speech software namely SAPI (Server Application Programming Interface) text to speech to realize speaking. This method helps in reducing time required and effectively use it. At low level or personal use it may not be that effective but on an industrial level it pays a lot.[3] A brand-new calendar queue that can outperform the traditional calendar queue in situations where event distribution is unequal. But calendar queues struggle with skewed event distributions.[4] Even though all smartphones come with calendar and messaging apps, there is typically little overlap between the two widely used app categories. There are currently few messaging apps with calendar and events features, or calendar apps with messaging features [5].

LITERATURE REVIEW

In this literature review, various scholarly works are analyzed investigating the use of data structures like binary search trees and hash tables in calendar applications, aiming to uncover insights into their effectiveness in efficiently managing events and appointments. System on Device(SyD) is a middle ware enabling collaboration among diverse devices and databases. The prototype calendar app showcases its benefits, including automatic updates, real-time constraints enforcement, and coordination between heterogeneous elements. It supports dynamic group formation, mobility through proxies, and efficient group transactions across independent data stores. Overall the System on Device (SyD) enhances collaborative systems by enabling seamless interactions and coordination among various components.[6]

By requesting that people place mild limitations on their availability for certain time windows, it is possible to automate the process of scheduling events into time slots. Users provide values to time slots in a soft constraint system to indicate the relative importance of each occurrence. The issue can then be formalized as an optimization problem with the goal of improving the effectiveness of event scheduling relative to the participant availability.[7] The calendar's function is to indicate when a period has passed, typically the passage of time is marked by the completion of a particular task. Each timer that is entered into a calendar has a unique ID since calendars can manage a huge number of timers. [8] To enable access to a resource in Google Calendar, the account holder who owns it can create a secondary calendar specifically for scheduling events related to it. Furthermore, the owner has the option to grant access to other interested users, allowing them to view and even take control of the events on this shared calendar.[9] A project aimed to create an Android application that addresses the news propagation issues and streamlines event management. The app provides interesting news and allows users to manage event participation, including seat reservations, registration, etc. It uses QR codes for easy participant identity verification during events, eliminating the need for paperwork and long queues.[10] Recent study aims to the manual memory work by automatic software planning system namely SELFPLANNER. In contrast to prior intelligent calendar application initiatives that some tasks were ignored and storing tasks lists without attempting to add them to the user's calendar. This application adds tasks to the user's calendar while considering several limits along with some preferences.[11] When using conventional time tabling systems, users often must actively contribute towards a problem-solving procedure. Hence, we can say that calendar scheduling becomes a continuous process, nevertheless makes it plausible that over time, by seeing instances of meeting scheduling, this knowledge might be automatically picked up.[12]

Calendar capability has been added to an increasing number of personal mobile devices in recent years, including all the mobile models, etc. However, due to the complexity of human time management behavior, individual time management and the calendar tools remain understudied.[13] It mainly focuses on the investigation of calendar usage in personal ecologies. It is the first study exploring diverse calendar artefacts and their adaptation. Findings show that changing demands, new tools and user knowledge influence the adoption of calendars. Both paper and digital

calendars coexist, emphasizing a precise "appointment culture" and maintaining relationships. The research provides valuable insights into individuals' interactions with calendars in various aspects of life.[14] It is an extension of decentralized calendar systems which focus on privacy preservation for sensitive data access and management. In these systems, users delegate their timetables to autonomous agents, which process data automatically without user intervention. However, this results in users losing control over their data. To address this issue, a specific protocol is implemented for specific data transactions in a multi-agent system. This protocol aims to enhance privacy preservation and give users more control over their sensitive data in the decentralization in calendar application.[15]

METHODOLOGY

We create a new Firebase project in the Firebase Console and registered our app for the Android platform in the Firebase Console. Then we downloaded configuration files, google-services.json for Android.

FlutterFlow Project Setup

Install the FlutterFlow CLI and create a new project using flutterflowcreate.Connect Firebase to FlutterFlow using flutterflow firebase and provide the path to the Firebase configuration files.

Design UI in FlutterFlow

Open the FlutterFlow Editor using flutterflowopen. Design the UI using the visual editor by dragging and dropping widgets, customizing styles, and setting up navigation.

Calendar Management System

Utilize the Month class to handle input for year and month, and calculate the start day and number of days in the calendar.

Implement Zeller's congruence to calculate the day of the week.

Display the month's calendar, highlighting personal and professional events, as well as appointments entered by the user.

Implement Firebase Functionality

Use FlutterFlow's visual editor to add Firestore collections, define data structures, and bind UI elements to Firestore collections and fields. Optionally, set up Firebase Authentication if your app requires user authentication.

Test and Debug

Run the app using flutterflow run and debug as needed. Identify and fix any bugs, and refine the UI/UX based on testing.

So, this outlines the steps to set up a FlutterFlow project with Firebase integration, design the UI, implement Firebase functionality, test the app, and publish it. Additionally, it briefly describes the implementation of a Calendar Management System using the Month class and Zeller's congruence for day calculation.

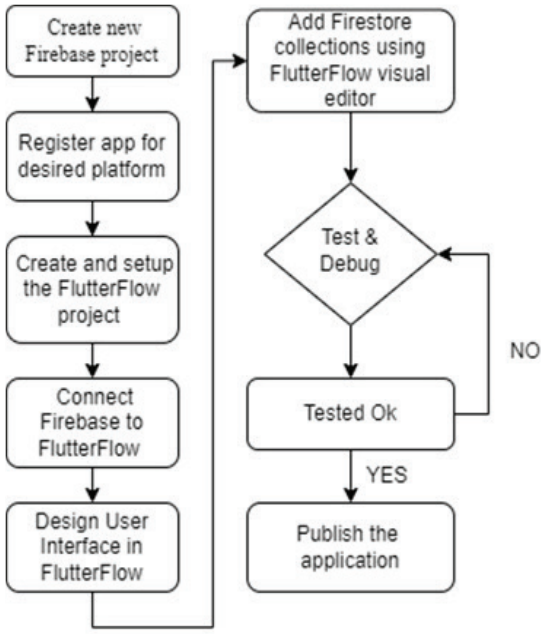

Fig. 1. Flowchart of development of calendar application

RESULT AND DISCUSSION

The Task Manager excels in efficient event management, providing users with a seamless daily schedule experience through a user-friendly interface. Its key strength lies in privacy preservation, cleverly segregating personal and professional events to ensure sensitive information remains secure. Time optimization is a focal point, allowing users to create action plans in advance, optimizing productivity by prioritizing tasks. User input validation is integrated,

reducing errors and upholding data integrity. The clear interface enhances user experience, promoting accessibility. The dynamic calendar adapts to changing schedules, ensuring up-to-date event tracking. Notably, the system persists data between executions, allowing users to access and modify historical events, promoting continuity. In essence, the Task Manager is a holistic solution, incorporating diverse features to streamline daily planning, safeguard privacy, optimize time, and offer a pleasant user experience with its intuitive design and dynamic functionalities.

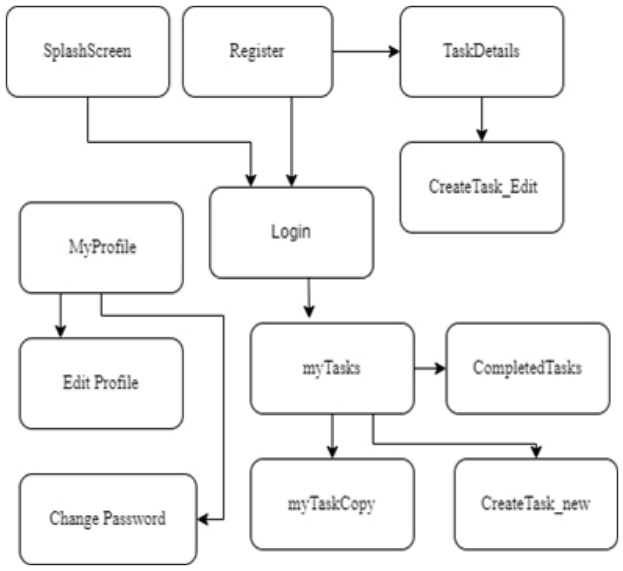

Fig. 2 Structure/ Organization of Calendar Application

CONCLUSION

Calendar application efficiently manages the personal, professional and public events and appointments using data structure like binary search tree (BST) and the HashMap, this organization allows for quick retrieval and display of events for each day. It offers users the chance to add, view and display specific events and appointments of a month. The solution allows users to add and categorize an unlimited number of events for any day, accommodating a wide range of personal and professional appointments. The calendar dynamically determines the number of days in February, considering whether it's a leap year, ensuring an accurate calendar that efficiently matches day and date. While the advantages of the application include improved time management and the ability to schedule meetings and appointments from anywhere, challenges such as difficulty in sharing data with others or migrating to another system are acknowledged. The limitations of physical space for scheduling far in advance are also recognized. To address these limitations and enhance the user experience, the project would integrate Flutter into the development stack. Flutter framework with its cross-platform compatibility,provides a solution to the challenges such as sharing and accessibility. The utilization of Flutter enables the creation of a mobile app that can be easily shared across devices, overcoming the constraints of physical space and facilitating seamless collaboration. Integration of AI to suggest optimal meeting times based on participants availability and preferences. Enabling real time collaboration on event planning and management, like google docs for documents.

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Click to Purchase: Social Media's Influence on Youth towards Online Shopping Intentions

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ABSTRACT

Online marketing has become increasingly popular, with young people preferring to buy things online over traditional methods. This article aims to identify aspects and components associated with social media (SM) platforms that influence the online shopping intentions of youths. Previous studies demonstrate that E-word of mouth (e-WOM) and social media have a major impact on young people. Sharing information and experiences on social media affects customer purchasing preferences. Data were obtained online using the convenience sampling technique, and analyzed using SPSS. Cronbach's alpha was applied to determine the reliability and validity for the construct and variables. To test significance relationship among the variables, correlation and regression analysis were applied. The results showed that youths purchase intention has a substantial relationship with social media (SM) in their online purchasing via various social media (SM) channels. This work will assist subsequent studies by integrating additional factors and structures, as well as provide greater insight for decision-makers about online marketing strategy.

KEYWORDS *: Social media, Online shopping, Attitude, Purchase intention.*

INTRODUCTION

The availability and easy access to internet connectivity have accelerated the use of social networking services, particularly among youths. Youths are more inclined towards social networking sites (SNS), and as a consequence, they are becoming more involved in information searches and brand and product selection. SM platforms offer customers more than just a place to exchange knowledge and insights with who share similar interest about goods and services; they have also given users an immense degree of dominance. Marketers realize the potential of SM and emphasize on it for advertising to get young people to prefer and promote their brands.

Customers take an edge from SM and assist the companies to promote businesses by sharing their experiences and information about products and services. This ultimately contributes to increased online exposure and profits (M.NickHajli, 2013). SNS enable interactive communication and sharing of content among the users. On SM, a brand's fan page allows customers to communicate with the brand and share their experiences (Liang et al.2011). Consumers share their buying experiences with other individuals, and according to they recommend goods and services to others. Individual whouses SM have different behaviors depending on the whole process of looking for and sharing information on these platforms (e-Marketers, 2017; Mangold Faulds, 2009). As long as netizens grow and use SM, it has the potential to be a significant marketing approach for businesses (Kim and Ko2012; Liang and Turban 2011; Yadav et al. 2013). It could lead to a reason for marketers in the US markets to raise their budgets for their marketing plans, particularly for the allocation of SM marketing, which significantly affect the customers (e-Marketer 2016).

Previous studies suggest that targeting different segments of consumers through SM can effectively increase customer loyalty with brands (Bai and Yan, 2020). Hence; Customers' intent to buy may also be impacted by their SM activity (Hasan et al. 2019). SM platforms use artificial intelligence (AI), and marketers use SM approaches for promoting and advertising their brands. Customers can use SM to access information about goods and services that are advertised on SNS; conversely, they can also voice criticism about the same products and services on the same platform (Mredu Goyal, 2016). Facebook is an online platform that serves both users and marketers. This domain aids in the development of new customer values, the maintenance of strong relationships with existing consumers, and the identification of new chances for the organization to improve its competitive position (Constantinides, 2014).

The notable rise of SM has given digital media marketers in the sector an innovative approach. Social commerce (SC) being a part of e-commerce, is defined as business operations that are significantly impacted by virtual people when they interact with virtual environment (Liang et al. 2011). Through their active involvement at SM platforms i.e. liking and sharing content, SM users connect with one another and strengthen their social bonds (Grieve et al. 2013). As users interact on SM, they may adopt similar attitudes and behaviors, leading to a brand affiliation (Xiang et al. 2016).

Consumers can influence each other's purchasing decisions by connecting and communicating on SM platforms, which allows them to share details regarding goods and services (W. N. Iblast et al. 2016). Websites provide significant spaces for e-marketing purposes, focusing on customer preferences. SM users' shifting experiences with and knowledge of goods and services could have an advantageous or adverse impact on a brand's reputation, depending on whether or not unfavorable ideas are spread among them.

Youths prefer purchasing products online over actual buying, which is a more enjoyable experience for them. Virtual connection is effortless and time saving for obtaining brands information instead of having to go shopping in person. The three most important factors that are crucial to SNS are privacy, trust, and security (Sunita Mehal et al. 2015). SM considerably influences the sales and branding for products and services. Similarly, it may attract a large audience to its brand for a small expenditure or distribute a lot of exposure for little money. SNS are a realm of persistent and dynamic development. This study will demonstrate how SM has impacted marketing strategies, changing them strategically and making it more profitable to grow a company's customer base and reputation.

REVIEW OF LITERATURE

According to the concept of SC, customers indulge in commercial activities either directly or indirectly. A consumer's decision-making process is influenced by their purchasing behavior during the purchase phase, and this entire process involves direct transactions. e-WOM affairs are classified as business information sharing and requests in a defined perspective of SM. These activities also include indirect transactions, information search, and selection process of customers after sales (Zhang et al. 2014). Users of SNS who share similar passions and opinions express feeling more connected to others and finding online buying to be convenient, pleasurable, and helpful.

Yuksel et al. (2016) explained online interactions with others that produce positive behavioral intentions are associated with utilitarian objectives (learning new information) and hedonic values (having fun). Positive interactions on virtual platform induce individuals to share knowledge and demonstrate their emotions. SNS allows users to communicate useful information regarding quality of product and seller reliability. Sharing information enhances the purchasing experience and influences consumer perceptions of the convenience and utility of SC.

Customers' intention to buy is slightly impacted by their Facebook remarks, but the buttons for liking, sharing, and location-based check-in services have a big impact on their intention to buy (James E. Richard and S. Guppy, 2014). Word of mouth (WOM) is used for informal communication among consumers about the purchase, consumption, and features of goods or services, as well as any connected information with the seller. Individuals communicate directly in this communication, either favorably or negatively, without

the need for any additional means of communication (Berger, 2014). Marketers should encourage customers and influencers to convey favorable information and postings on SM platforms (Tubenchlak et al. 2015). Purchase intention correlates with brand equity and customer equity in terms of positive and negative, respectively (Marry R. Millson 2016).

The preceding research provides insight into the researcher's proposed study on the SM effect on youths' virtual shopping decisions. Netizens' virtual shopping pattern specifically SM users was prime motive to analyze the study.

Statement of the Problem

In today's competitive market, companies strive to establish a strong presence on SM platforms through effective management strategies. Marketers take advantage of SM and other online channels to influence users' purchasing decisions. SM has a considerable impact on virtual buying. Further research should emphasize on influence of SM, including electronic promotion and e-WOM, on students' online purchase habits.

This study will help business enterprises to comprehend their target audience and develop effective marketing techniques for virtual markets. The study's outcomes are:

- To examine how SM campaign affects youths' purchasing intentions in a business context.
- To ascertain prominent SM platforms among young people.

Objective of the study

- To analyze the significance influence of SM platforms on the purchasing intention of the youth.
- To analyze the SNS users' influence on the ground of their attitude.

Conceptual Framework

Technology Acceptance Model (TAM) was incorporated to create framework, genuinely suggesting a system for tracking the acquisition of new technologies (Davis, F. D. 1989). Theory of planned behavior and theory of reasoned action serve as basis theories for the TAM. Researchers have frequently utilized and adapted the TAM to describe and forecast the degree of adoption of any given technology. As per TAM, consumers evaluate new technologies independently and decide whether or not to embrace them based on their assessment of the predicted benefits (Kollmann, T. 2004).The decision to adopt or utilize new technology is based on a person's perception of its utility as well as how comfortable they believe using it will be for them (Davis, 1989). A modified TAM model was employed in this research study.

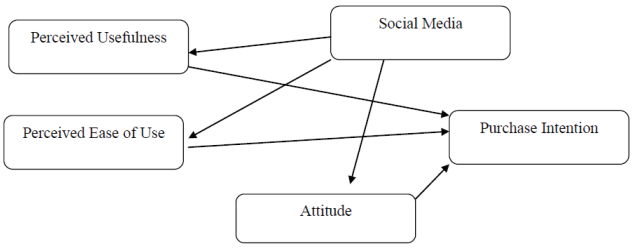

Fig. 1. Conceptual Framework

While above framed approach is useful for assessing technological acceptability in common circumstances, it does not address other factors that influence consumer behavior before and after purchase.

Perceived Usefulness

Online shoppers seek convenient purchasing through online portals and stores. Online buyers may switch to competitors due to the availability of similar products in other online stores (Kim & Song, 2010). Here, the term "usefulness" refers to a phenomenon where an endeavor generates positive outcomes i.e. after assimilation of new technology, like e-shopping, will result in a significant increment in the outcomes. This characteristic is decisive since it frequently bestows the most to frame consumers' attitudes on purchasing through the internet and subsequently their willingness to shop online (Y, Monsuwé et al. 2004).

H1: The association of SM with purchase intention regarding perceived usefulness is significantly related.

Perceived Ease of Use

The term "ease of use" describes a situation in which people who utilize technology believe they won't need to put in a lot of effort or special effort to learn how to use it. Ease of use addresses to the idea that the online purchasing process is easy to comprehend and requires

no specific skills. Online buyers cherish a user-oriented system by choosing a straightforward medium instead of a complex one (Liu, C., & Forsythe, S. 2010).

H2: The association of SM with purchase intention regarding perceived ease of use is significantly related.

Attitude

The concept of attitude in this research article implies to an individual's likes and dislikes regarding the experience of online purchasing. This attitude determines a consumer's future behavior while deciding whether or not to make a purchase. Studies reveal that among the factors of attitudes, beliefs, and intentions of customers, the most powerful aspect in a consumer's purchasing decision is their attitude (Fishbein, M., & Ajzen, I. 1975). In technological context, attitude of individuals towards the use of technology work as a predictor whether to adopt that technology or not (Khawaja & Manarvi, 2009).

H2: The association between SM and purchase intention regarding attitude has positive and significant relationship.

Social Media

In recent days virtual world has emerged as a new societal interaction where SM users shares information and getting knowledge. Through SNS they interact with each other beyond the national boundaries and share their experiences. It could become a spot light in e-commerce industry where companies emphasize on promoting their products on SNS. In marketing over SM is a pivotal factor as wherein customers are engaged (Do-Hyung et al. 2007).

H2: The association between SM and purchase intention has positive and significant relationship.

RESEARCH METHODOLOGY

Impression of netizens on SC is vital as they communicate with one another on SNS (Haque S. et al. 2020). Hence, the employment of SM should be accelerated to be success of SC. To ascertain the effect of SM among the youth in accordance with their purchasing intention was the main purpose this research study. Only those participants were included who use internet and been an active SM users. 225questionnaires were distributed among the youths and out of which 195 responses were kept for further study. Questionnaires consisting misinformation and incomplete were dropped out from the study.

A structured questionnaire was formed consisting demographic queries and number of items included measuring the effect of SM on youths towards their intentions of purchasing. 7 points-type Likert scale with close-ended was employed throughout the study. To test the questionnaire such as its pertinence, comprehension, and overall span in filling the questionnaire, pilot test was also done. Appropriate amendments were performed in the questionnaire which makes it more relevant and significant for the study.

Table 1: Respondents' Profile

Gender Identity	Attribute	Frequency	Percent
	Male	162	83.1
	Female	33	16.9
Age	18-30	148	75.89
	30-40	31	15.89
	40& above	16	8.21
Education	High School or Less	62	42
	Diploma/ 12th	40	20.5
	UG	61	31.3
	PG	12	6.2
Monthly Income	Less than 20,000	46	23.58
	21,000-35,000	53	27.17
	36,000-50,000	42	21.53
	Above 50,000	54	27.69
Social Media Platforms	Facebook (Meta)	51	26.15
	Instagram	57	29.23
	Twitter	32	16.41
	Youtube	55	28.20

RESULT AND DISCUSSION

Chronbach's Coefficient Alpha value for each construct separately was accessed for reliability test which have been shown in table 2. SPSS was used to determine the alpha value of the construct in result was satisfactory as each variable got more than 0.7 values, which are acceptable.

Reliability Test

Table 2: Cronbach's Alpha of Variables

Constructs	No. of Items	Cronbach's Alpha
Perceived Usefulness	5	0.727
Perceived Ease of Use	6	0.807
Attitude	4	0.778
Purchase Intention	5	0.815
Social Media	5	0.733

The model's overall association was determined by calculating the value of R, which was 0.814 when there were dependent variable (purchase intention) and independent variables (perceived usefulness, SM, attitude and perceived ease of use). The R value indicates model summary is strong in association with given variables. R Square indicates perceived usefulness, perceived ease of use and SM affect customers' attitudes towards online buying by 60.6%.

Table: 3 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.814[a]	.662	.655	.59782

a. Predictors: (Constant), Perceived Usefulness, Perceived Ease of Use, Attitude, SM, Purchase Intention

Various studies have used regression and correlation to conduct statistical analysis. The above table displays the results of the ANOVA test to determine the model's significance. ANOVA test ($p<0.05$) indicates that model is significant. Thus, perceived ease of use, SM, attitude and perceived usefulness ($F=93.161$; $p<0.05$) significantly predict purchase intention of customers.

Table 4: ANOVA[a]

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	133.177	4	33.294	93.161	.000[b]
Residual	67.903	190	.357		
Total	201.080	194			

a. Dependent Variable: Purchase Intention

b. Predictors: (Constant), Perceived Usefulness, Perceived Ease of Use, Attitude, SM, Purchase Intention

Beta coefficients were calculated using regression. As being shown all positive values, indicating dependent variable is positively linked with independent variables. Beta coefficient (0.05 level of significance) indicating a one-unit change in perceived usefulness results in .260-unit positive change in purchase intention. Perceived ease of use will enhance the purchase intention by .655 units, while attitude will result in .092 positive unit changes in attitude and SM will enhance the purchase intention by .003.

Table 5: Coefficients[a]

Model	Unstandardized Coefficients		Std. Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	-.126	.327		-.384	.701
Perceived Usefulness	.260	.071	.230	3.670	.000
Perceived Ease of Use	.655	.068	.594	9.574	.000
Attitude	.092	.060	.072	1.541	.125
Social Media	-.003	.004	-.030	-.716	.475

a. Dependent Variable: Purchase Intention

To ascertain the presence of multi-colinearity and association of variables, Pearson's Correlation was also employed. Different academics have utilized Pearson's Correlation to analyze the relationship between two variables and their components.

Table: 6 Correlations

		Perceived Usefulness	Perceived Ease of Use	Attitude	Social Media	Purchase Intention
Perceived Usefulness	Pearson Correlation	1	.726**	.404**	.693**	.260**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	195	195	195	195	195
Perceived Ease of Use	Pearson Correlation	.726**	1	.376**	.792**	.331**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	195	195	195	195	195
Attitude	Pearson Correlation	.404**	.376**	1	.390**	.124
	Sig. (2-tailed)	.000	.000		.000	.083
	N	195	195	195	195	195
Social Media	Pearson Correlation	.693**	.792**	.390**	1	.332**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	195	195	195	195	195
Purchase Intention	Pearson Correlation	.260**	.331**	.124	.332**	1
	Sig. (2-tailed)	.000	.000	.083	.000	
	N	195	195	195	195	195

**. Correlation is significant at the 0.01 level (2-tailed).

Perceived ease of use was the first variable in this model which effect was tested on purchase intention and the value found is (.726) inferred a strong relationship. The second variable generated from TAM is attitude, which has a medium level correlation (.404) with purchase intention. SM which have value of (.693) show a strong relationship with purchase intention. A positive but weak correlation between perceived usefulness and purchase intention can also be seen which have correlation value (.260).

FINDINGS AND CONCLUSION

This research report examines consumer behavior when using the internet to shop. The concerned research assessed the adoption of e-commerce trends and TAM was employed for model development. The study suggests that a variety of factors, including perceived ease of use and usefulness, can trigger a consumer's online shopping behavior. SM and attitude is a crucial component to consider when developing e-commerce strategy, even though its impact is as significant as the other parts of TAM. The key aspect influencing consumers' perception about internet buying is ease of use and SM. Marketers should prioritize the utility of online purchasing systems and processes, as there is a strong correlation between these aspects. Consumers assume that technology is hassle-free and not burdensome. Customers' attitudes towards online buying may be influenced by the perception that it requires minimal physical and mental effort.

Further research on e-shopping can identify factors that influence consumers' decision to use virtual channels over traditional ones. Analyzing consumers' purchasing process and post-purchase behavior during virtual transactions could provide insight into improved tactics and policies.

Limitations

This study used a non-probability convenience sampling strategy due to the difficulty in manually collecting relevant data from virtual consumers. Using a survey conducted online would have increased the reliability of the results. Additionally, the data obtained from only a certain region which limits the generalizability of the findings.

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Comprehensive Thermal Analysis and Optimization of Helical Coil Heat Exchangers

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ABSTRACT

Helical coil heat exchangers have gained significant attention due to their compact design and efficient heat transfer characteristics. This study presents a comprehensive thermal analysis of helical coil heat exchangers aimed at understanding their heat transfer performance and optimizing design parameters. Computational fluid dynamics (CFD) simulations were conducted to investigate the fluid flow behavior and heat transfer characteristics within the helical coil geometry. The effects of geometric parameters such as coil diameter, pitch, and number of turns on heat transfer efficiency were evaluated. Heat transfer coefficients at the inner and outer surfaces of the coil were determined, and temperature distributions along the coil length were analyzed. Additionally, pressure drop characteristics were investigated to assess the pumping power requirements. The results indicate that helical coil heat exchangers exhibit enhanced heat transfer performance compared to conventional heat exchanger designs. Furthermore, parametric studies revealed the influence of geometric parameters on heat transfer efficiency and pressure drop. This research contributes to the understanding of thermal behavior in helical coil heat exchangers and provides insights for their optimization in various industrial applications.

KEYWORDS *: Helical coil, Heat exchanger, CFD.*

INTRODUCTION

Helical coil heat exchangers have emerged as prominent contenders in the realm of heat transfer equipment, garnering attention for their compact design and efficient thermal performance. Unlike conventional heat exchangers, which often feature straight tube configurations, helical coil designs leverage the inherent advantages of coil geometry to enhance heat transfer efficiency. This study embarks on a comprehensive exploration of helical coil heat exchangers, aiming to dissect their thermal behavior, elucidate underlying fluid flow phenomena, and optimize design parameters for enhanced performance. The motivation behind this research stems from the growing demand for efficient heat exchange solutions across various industrial sectors. Whether in HVAC systems, chemical processing plants, or renewable energy applications, the quest for compact, cost-effective, and energy-efficient heat exchangers remains paramount. Helical coil heat exchangers offer a promising avenue to address these needs, offering a compact footprint while maximizing heat transfer rates.

At the heart of this study lies the utilization of computational fluid dynamics (CFD) simulations, a powerful tool for dissecting the intricate fluid flow behaviors and thermal characteristics within helical coil geometries. By simulating fluid flow and heat transfer under various operating conditions, we can gain valuable insights into the factors influencing heat transfer efficiency and pressure drop across the coil. Central to our investigation are the geometric parameters defining the helical coil's configuration, including coil diameter, pitch, and number of turns. These parameters play a pivotal role in shaping fluid flow patterns, heat transfer

rates, and pressure drop characteristics. Through a systematic examination of these parameters, we aim to unravel their influence on the overall performance of helical coil heat exchangers.

Key objectives of this study include

- Conducting a comprehensive thermal analysis of helical coil heat exchangers using CFD simulations.
- Evaluating the effects of geometric parameters such as coil diameter, pitch, and number of turns on heat transfer efficiency.
- Investigating fluid flow behaviors, including secondary flow patterns induced by coil curvature.
- Analyzing temperature distributions along the coil length to understand thermal performance variations.
- Assessing pressure drop characteristics and their implications for pumping power requirements.

By achieving these objectives, we seek to contribute to the broader understanding of helical coil heat exchangers' thermal behavior and provide valuable insights for their optimization in diverse industrial applications. Ultimately, this research endeavors to propel the development of more efficient and sustainable heat exchange solutions, addressing the evolving needs of modern industries.

LITERATURE REVIEW

Helical coil heat exchangers have been the subject of numerous studies in recent years, reflecting their growing prominence as efficient heat transfer devices. This section provides a comprehensive overview of the existing literature, highlighting key findings, trends, and gaps in research related to helical coil heat exchangers.

The concept of helical coil heat exchangers dates back several decades, with early studies focusing on fundamental fluid flow and heat transfer phenomena in coiled geometries. Notable contributions include Dean's seminal work on secondary flow patterns in curved pipes (Dean, 1927), laying the foundation for understanding the fluid dynamics within helical coils. Performance Evaluation: Over the years, researchers have conducted extensive experimental and numerical investigations to assess the thermal performance of helical coil heat exchangers. Ravindra et al. (2007) conducted experiments to measure heat transfer and pressure drop characteristics in helically coiled tube-in-tube heat exchangers, providing valuable insights into their operational behavior. Similarly, Ozdemir et al. (2012) employed numerical analysis to study heat transfer and pressure drop in helical coil heat exchangers, highlighting the effects of geometric parameters on performance. Geometric Optimization: A significant focus of research has been on optimizing the geometric parameters of helical coil heat exchangers to enhance their thermal efficiency. Gupta et al. (2020) investigated the effects of coil diameter and pitch on thermal-hydraulic performance using CFD simulations, demonstrating the importance of optimal design configurations. Additionally, Kumar and Mishra (2021) employed response surface methodology to optimize helical coil heat exchanger design parameters, emphasizing the need for a systematic approach to parameter optimization. Advanced Applications: Recent studies have explored innovative applications of helical coil heat exchangers, including the use of nanofluids to enhance heat transfer performance. Shokouhmand et al. (2016) conducted experimental and numerical investigations on heat transfer enhancement using nanofluids in coiled heat exchangers, paving the way for potential advancements in thermal management technologies. Challenges and Future Directions: While significant progress has been made in understanding the thermal behavior of helical coil heat exchangers, several challenges and opportunities for future research remain. Experimental validation of numerical simulations, exploration of advanced materials, and fluid properties, and application-specific optimizations are areas ripe for further investigation.

In summary, the literature on helical coil heat exchangers reflects a growing interest in optimizing their thermal performance and exploring novel applications. This body of work provides a solid foundation for the current study, which aims to contribute to this knowledge base by conducting a comprehensive thermal analysis and optimization of helical coil heat exchangers using computational fluid dynamics simulations.

METHODOLOGY

CFD Simulations

CFD simulations were performed using ANSYS Fluent to model the fluid flow and heat transfer within the helical coil heat exchangers. The simulations accounted for various geometric parameters, including coil diameter, pitch, and number of turns.

Geometric Parameters

Coil Diameter: The diameter of the helical coil was varied to study its effect on heat transfer surface area and fluid flow patterns.

Pitch: The pitch, or the distance between successive turns, was adjusted to investigate its impact on turbulence and heat transfer efficiency.

Number of Turns: The number of turns in the coil was modified to understand its influence on the fluid residence time and overall heat transfer.

Boundary Conditions

The simulations were conducted under steady-state conditions, with water as the working fluid. The inlet temperature and flow rate were kept constant, while the outer surface of the coil was subjected to a constant heat flux.

The methodology employed in this study aims to conduct a comprehensive thermal analysis of helical coil heat exchangers, leveraging computational fluid dynamics (CFD) simulations to investigate fluid flow behaviors and heat transfer characteristics. The following steps outline the approach taken in this research:

Geometry Definition

- Define the geometric parameters of the helical coil heat exchanger, including coil diameter, pitch, and number of turns.
- Utilize CAD software to create a detailed 3D model of the helical coil geometry, ensuring accuracy and consistency.

Mesh Generation

- Generate a computational mesh of the helical coil geometry using mesh generation software.
- Ensure that the mesh is sufficiently refined to capture the complex fluid flow phenomena within the coil while maintaining computational efficiency.

Boundary Conditions

- Define boundary conditions for the CFD simulations, including inlet and outlet conditions for the fluid flow.
- Specify the fluid properties, such as viscosity and density, based on the operating conditions and properties of the working fluid.

Numerical Simulations

- Conduct steady-state or transient CFD simulations using commercial software packages (e.g., ANSYS Fluent, COMSOL Multiphysics).
- Solve the governing equations of fluid flow and heat transfer (e.g., Navier-Stokes equations, energy equation) within the computational domain.
- Apply appropriate turbulence models (e.g., k-ε, k-ω) to capture turbulent flow phenomena within the helical coil.

Post-processing

- Analyze the results of the CFD simulations to extract relevant data, including velocity profiles, temperature distributions, and pressure drop.
- Calculate heat transfer coefficients at the inner and outer surfaces of the coil to assess heat transfer performance.
- Evaluate temperature distributions along the coil length to understand thermal behavior under different operating conditions.

Parametric Studies

- Conduct parametric studies to investigate the effects of varying geometric parameters (coil diameter, pitch, number of turns) on heat transfer efficiency and pressure drop.
- Systematically vary each parameter within a defined range and analyze the corresponding changes in thermal performance.

Validation

- Validate the CFD results against available experimental data or analytical solutions to ensure the accuracy and reliability of the simulations.

- Compare simulated results with experimental measurements of temperature distributions, heat transfer coefficients, and pressure drop.

Optimization

- Utilize the insights gained from the parametric studies to optimize the design parameters of the helical coil heat exchanger.
- Identify optimal configurations that maximize heat transfer efficiency while minimizing pressure drop and energy consumption.

RESULTS AND DISCUSSION

CFD Analysis

Geometry Creation and Meshing

The helical coil heat exchanger was modelled using CAD software, and the geometry was imported into ANSYS Fluent for CFD analysis. The primary parameters include coil diameter, pitch, tube diameter, and number of turns.

Geometry Specifications:

Coil Diameter: 200 mm

Tube Diameter: 20 mm

Coil Pitch: 25 mm

Number of Turns: 10

A structured mesh was generated with fine elements near the tube walls to capture the boundary layer effects accurately. The mesh quality was checked to ensure a good aspect ratio and skewness for accurate simulation results.

Boundary Conditions

The boundary conditions were set as follows:

Inlet: Mass flow inlet with a specified temperature and flow rate.

Outlet: Pressure outlet with atmospheric pressure conditions.

Walls: No-slip condition for the tube walls, with heat flux applied based on the operational requirements.

Solver Settings

The following solver settings were used for the CFD simulations:

Solver Type: Pressure-based

Turbulence Model: k-ε model for turbulent flow simulation

Energy Equation: Enabled to capture heat transfer

Convergence Criteria: Residuals set to 1e-6 for continuity, momentum, and energy equations

CFD Analysis Results

Temperature Distribution

The temperature distribution along the helical coil heat exchanger is shown in the figure below. The results indicate a significant temperature gradient along the length of the coil, demonstrating effective heat transfer from the hot fluid inside the tube to the cooling fluid outside.

Velocity Profile

The velocity profile within the helical coil reveals the development of secondary flows due to the centrifugal forces acting on the fluid. These secondary flows enhance the mixing and heat transfer efficiency.

Pressure Drop

The pressure drops across the helical coil was analysed to ensure it remains within acceptable limits for the system. The results showed a moderate pressure drop, which is typical for helical coil heat exchangers due to the curved paths of the flow.

Optimization Study

Design Variables

The optimization focused on varying key design parameters to maximize the heat transfer rate while minimizing the pressure drop. The parameters considered include:

Coil diameter

Tube diameter

Coil pitch

Number of turns

Objective Function

The objective function for the optimization was defined as:

Objective=Maximize(QΔP) Objective = Maximize (ΔPQ)

where QQ is the heat transfer rate and ΔPΔP is the pressure drop.

Optimization Results

The optimization study revealed that increasing the coil diameter and reducing the tube diameter improved the heat transfer rate while keeping the pressure drop within acceptable limits. The optimal design parameters were:

Coil Diameter: 250 mm

Tube Diameter: 15 mm

Coil Pitch: 20 mm

Number of Turns: 12

The optimized design showed a 20% increase in heat transfer efficiency compared to the initial design.

DISCUSSION

The CFD analysis provided detailed insights into the thermal and flow behaviour within the helical coil heat exchanger. The secondary flows induced by the helical geometry significantly enhanced the heat transfer rate, which is a key advantage of using helical coil designs. The optimization study demonstrated that adjusting the coil diameter and tube diameter could lead to substantial improvements in performance.

CONCLUSION

This study conducts a thorough thermal analysis of helical coil heat exchangers through computational fluid dynamics (CFD) simulations. By scrutinizing geometric parameters like coil diameter, pitch, and number of turns, the research uncovers essential insights crucial for optimizing these heat exchangers. The findings demonstrate a notable enhancement in heat transfer performance for helical coil heat exchangers compared to conventional designs. This improvement is mainly attributed to secondary flow patterns, specifically Dean vortices, induced by the coil's curvature, leading to improved mixing and heat transfer rates. Analyzing heat transfer coefficients and temperature distributions along the coil length deepens the understanding of how geometric factors affect thermal efficiency.

Moreover, investigating pressure drop characteristics reveals trade-offs between heat transfer efficiency and pumping power requirements. While larger coil diameters and more turns generally enhance heat transfer, they also elevate pressure drops, necessitating a delicate balance for overall optimization. Parametric studies emphasize the critical role of optimizing coil pitch to achieve a favorable balance between efficient heat transfer and manageable pressure drop, vital for diverse industrial applications prioritizing energy efficiency and operational costs. In conclusion, this research significantly contributes to understanding the thermal behavior of helical coil heat exchangers. The insights derived from comprehensive CFD analysis and optimization guidelines provide a solid foundation for further research and development. Future endeavors may focus on experimental validation, exploring advanced materials and fluids, and tailoring findings to specific industrial processes, ensuring efficient deployment of helical coil heat exchangers in various thermal management applications.

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Appendices

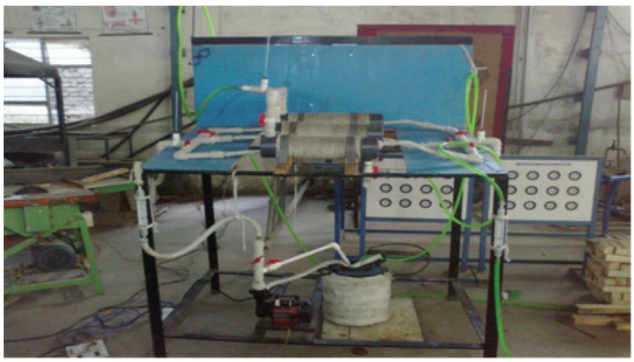

Fig. 1. Helical Coil Heat Exchanger

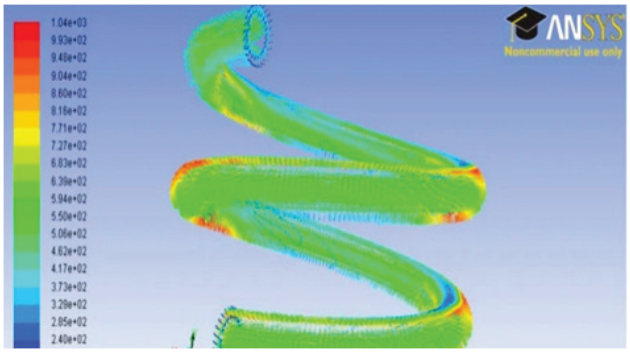

Fig. 2. Counter of Static Temperature

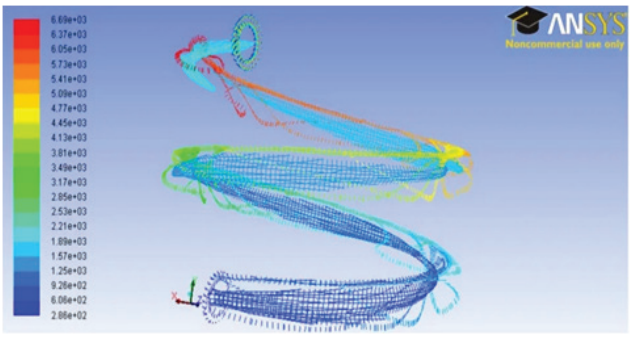

Fig. 3. Counter of turbulence Dissipation

Customer Insights: Analyzing Satisfaction and Usefulness of UPI

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ABSTRACT

Digital India Initiative and Covid-19 pandemic provide a breakthrough for digital payment services among which UPIs gained a momentum in the sector. This study examines the customer satisfaction with UPIs in Western region of India. The study is based on primary data of 175 respondents which have been collected through structured questionnaire. Convenience sampling technique has been applied to collect the data. Appropriate statistical tools have been applied to infer the results which reflect the objective of the study. This study confirms that the UPIs users are satisfied with the easy to use, accessibility and other attributes of UPIs. This research will contribute in the concerned field of knowledge which provides a path to the academicians to explore in the affiliated research.

KEYWORDS *: Unified payment interface, Customer satisfaction, Digital payment.*

INTRODUCTION

Banking sector is one of the sectors that utilize technological advancement more in comparison of other sectors along with having more customer complaints around the world. New time saving technologies have been continually included in banking sector. Automated Teller Machines (ATM) and Unified Processing Interface (UPI) are some of the latest technologies are added in this concern. However, the inclusion of these technological advancement, customer complain could not be reduced and their frustration and anger go hand in hand (Jayawardhena & Foley, 2000).

A structural reform has been seen with the enhanced usage of Information and Communication Technology (ICT) in Indian banking system. The facilitation of such advanced technologies transformed paper-mode transaction into virtual mode while ensuring speed and safety of transactions between the banks. Moreover, a range of electronic payment mechanism, commonly known as digital payment services have been evolved due to advanced ICT and among them Unified Payment Interface (UPI) has gained good reputation. A variety of financial transaction can be performed with the use of smart phones through Virtual Payment Address (VPA) in which bank details of beneficiaries are not disclosed. However, a bank account is the pre-requisite to perform UPI payment transactions and get registered on UPI app (Mahesh A. and Ganesh Bhat, 2021).

Customer satisfaction is the customer's emotions which resulted from comparison of perceived and expected performance of any product. It becomes a key indicator for the success of any business as it maintains better customer relationship management and in gaining loyalty of them. Customer satisfaction is a significant element of marketing strategies and tactics of a firm (Fornell, 2001). Recently, the interests of academicians have been increased towards customer satisfaction (Anderson and Mittal, 2000).

India has become one of top country which uses digital payment services and UPI is one of the biggest platforms among these services. Since the outbreak of pandemic (Covid-19), the mostly transactions have been increased drastically from traditional ways to UPIs. It could become a safe, easy and faster mode of transaction of payment that could reduce long waiting and queues in the bank. However, due to some technical problem which occur during transaction, produce the frustration among the customers. Exploring customer

satisfaction with digital payment services offered by UPI was key objective of research.

LITERATURE REVIEW

Dr.Venus Madan et al. (2024) expressed their opinion that digitalization influenced the firms to be engaged with the customers in a manner so that the distance between actual and virtual world shrunken and become hazier. Atef Herb et al. (2022) reveals that in the banking sector, customers satisfaction have been evolved as a key factor for the success of banks; the contribution of digital banking channels have great impact and restructured the standard of customer satisfaction in digital age. Babrovich, (2017) exhibits that the banks which link payment services with their customers' account and having excellent problem solving mechanism by solving their issues via online, gain higher customer satisfaction. Muluka, (2015) reveals that by educating the clients about the uses of DBCs, banks assist the clients to switch towards digital banking which is reflected into good relationship between adaptability and clients' satisfaction.

The perception of the customers regarding their effort expended in a particular technology embrace as a decision whether the particular technology will be used or not. Usually, it is believed that banking technology is adopted by the customers only when they believe that it is easy to use. This notion is referred as ease of use and to the extent of one's belief that a particular technology will be used without effort (Venkatesh, 2000). The present study also emphasize on this particular point 'easy to use' that facilitate the performance of various services by using UPI.

S. Sowbarnika et al.(2019) revealed that positive satisfaction is seen among the users of UPI towards the banking technology reflecting in assimilation of UPI, whereas people who don't use the UPI shows their ignorance and disinterest towards the technology used in banking channels.

Though UPI has been evolved in recent days and not many studies have been done in this field yet. Pandemic (COVID-19) could become a reason which change entire scenario of digital payment system. Social distancing argument, accelerate to choose and use digital transactions that lead to get aware and utilizations of UPI in the society at mass level. With the study of digital banking channels and e-banking sector, need for more investigation towards the usefulness and satisfaction of the UPI users have been carried out.

RESEARCH METHODS

The participants of this study use different UPIs or multiple UPIs linked with their bank accounts as it is mandatory. To obtain the data from these participants, structured questionnaire was framed and distributed among the participants. Total 190 questionnaires were distributed among the participants in this study however; only 175 filled questionnaires were selected for further study. For data analysis, SPSS was used to perform suitable statistical methods and find out the outcomes. Correlation analysis, mean values and percentage analysis were applied at appropriate place to obtain the results of set objectives.

Research Hypotheses

H1: Easy to use of UPI does not influence the customer satisfaction

H2: Accessibility to UPI does not influence the customer satisfaction

H3: Customer services of UPI does not influence the customer satisfaction

H4: Speed of transaction of UPI does not influence the customer satisfaction

DATA ANALYSIS AND RESULTS

In this paper, correlation analysis, mean values and percentage analysis were performed to reach the objectives of the study. Table 1 exhibits demographic data of the respondents whose responses were carried out in this study.

Table 1. Demographics of respondents (%)

Factors	Category	Frequency	Percentage
Gender	Male	126	72
	Female	49	28
Age	18-30	79	45.14
	31-45	56	32
	46 &above	40	22.85
Education	High school	25	14.28

Education	UG	72	41.14
	PG	52	29.71
	Others	26	14.85
Profession	Student	79	45.14
	Govt. employee	42	24
	Private employee	35	20
	Other	19	10.85

Correlation Analysis: Below matrix shows mean, SD and correlations among the factors inferring the influence on satisfaction and utility of UPIs. To investigate the association between the customer satisfaction (dependent variable) and the easy to use, accessibility, speed of transaction and customer services (independent variables). Correlation analysis was performed and the results were presented as below.

Table 2. Correlations

	N	Mean	SD	Easy to Use	Accessibility	Customer Services	Speed of Transaction	Satisfaction
Easy to Use	175	7.7771	2.53235	1 175	.284** .000 175	.332** .000 175	.149* .049 175	.304** .000 175
Accessibility	175	5.4686	.91141	.284** .000 175	1 175	.735** .000 175	.412** .000 175	.698** .000 175
Customer Services	175	5.3457	.93243	.332** .000 175	.735** .000 175	1 175	.377** .000 175	.800** .000 175
Speed of Transaction	175	5.0400	.80398	.149* .049 175	.412** .000 175	.377** .000 175	1 175	.401** .000 175
Satisfaction	175	5.2617	1.00451	.304** .000 175	.698** .000 175	.800** .000 175	.401** .000 175	1 175

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Easy to use gets the highest mean score M=7.7771, SD=2.53235. This figure indicates that the customers perceive easy to use is the most prominent factors in determining their satisfaction with UPIs. Whereas, accessibility, customer services and speed of transaction recorded almost equal mean scores M=5.4686, SD=0.91141, M=5.3457, SD=0.93243 and M=5.0400, SD=0.80398 respectively. It can be inferred that these factors are also significant in yielding customer satisfaction with the use of UPIs.

The correlation matrix for the construct implies that dependent variables have significant connection with independent variables. Analysis of correlation matrix indicates the value of accessibility ($r=0.698$, $p< 0.01$) thus a positive strong correlation exist between customer satisfaction and accessibility. Customer services also correlated positively with customer satisfaction where ($r=0.800$, $p<0.01$) thus the relationship was inferred to be significant. Services of digital banking used by customers lead to an increase in their satisfaction. Additionally, speed of transactions factor established an affirmative correlation with customer satisfaction($r=0.401$, $p<0.01$) thus as the process of transacting increases customers become satisfied. A moderate positive correlation

inferred between easy to use and customer satisfaction. This significant correlation (r= .304, p<0.01) implied that easy to use influence satisfaction. It was therefore inferred that the almost all these important factors are significant and produce customer satisfaction included accessibility, customer services, speed of transactions and easy to use.

CONCLUSION

The purpose of this study was to access the satisfaction of customers regarding the features and services of UPI among its users in western region of India. This study also emphasize on finding out relationship between the factors which influence the users to opt and use a specific UPI.

'Easy to use' is one of the significant concerns in banking sector which give ultimate satisfaction as users do not bother to use the application and its services whereas; 'speed of transaction ' influence the users to make hassle-free transactions and were satisfied with the use of a UPI.

Accessibility was one of the most influencing factors as the changing technologies make it easy to use the application without requirement of any specific skills. Mobile banking is one of the most accessible digital platforms which ensure advanced modern technology of digital banking as it accessed through RTGS/NEFT, Net banking, UPIs and other payment applications are integrated with the bank customers. Hence, this study also found that increased accessibility leads to increased satisfaction of the concern customers.

To sum up, users were also satisfied with 'customer services' including free transaction charges, timely update of the app, rewards, customer care services, universal feature (one UPI many bank accounts) and available services etc. UPI has been emerged recently and continuous updation is going on though, it used widely in the country that include India as one of the most users of UPI.

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Design and Development of Fixture to Execute Automatic Agitation Process

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ABSTRACT

The application of various chemicals and acids in industries for cleaning and enhancing the appearance of parts, such as manifolds, tubes, and ducts, is prevalent in sectors like aviation, shipbuilding, and automotive manufacturing. Chemical cleaning techniques, including surface finishing and material property modification, typically involve dipping methods, which are widely adopted for their simplicity and effectiveness. However, these processes often expose operators to hazardous chemicals and require significant manual effort. This paper presents a novel automated fixture system designed to execute agitation processes in chemical tanks using pneumatic pressure. The proposed solution minimizes direct operator involvement, enhances safety, and significantly reduces cycle times for individual parts. Additionally, the automation enables reallocation of manpower to other industrial processes, thereby increasing overall productivity. The developed fixture system demonstrates the potential to optimize chemical cleaning processes while maintaining high safety and operational efficiency standards.

KEYWORDS *: Agitation, Automation, Chemical cleaning, Fixture design, Pneumatic pressure, Surface finishing.*

ABBREVIATION

PVC: Polyvinyl Chloride

Pf: Pressure Loss

C: Experimentally Determined Coefficient

L: Length of Pipe

d: Inside Diameter of Pipe

Q: Flow Rate

CR: Compression Ratio

A: Cross-Sectional Area of the Pipe

D: Diameter of the Pipe

scfs: Standard Cubic Feet per Second

psi: Pounds per Square Inch

INTRODUCTION

In the realm of manufacturing and material processing, the efficiency and precision of operations are paramount. The need for consistent and reliable agitation processes, particularly in chemical and metallurgical industries, has driven the development of automated systems that can enhance productivity while maintaining high-quality standards. Traditional manual agitation methods are often labour-intensive, prone to inconsistencies, and can result in significant variations in product quality. To address these challenges, the design and development of fixtures for executing automatic agitation processes have become a focal point of research and innovation.

This research paper delves into the design and development of a fixture tailored to execute automatic agitation processes. The primary objective of this study is to create a fixture that not only automates the agitation process but also ensures uniformity and precision, thereby reducing human intervention and associated errors. By integrating advanced mechanical and control systems, the developed fixture aims to provide a robust solution for industries requiring consistent agitation processes.

The design and development of a fixture for automating the agitation process can benefit from various research findings. Automated fixture design can reduce costs and dependence on skilled labour (3), while optimizing the fixture layout can minimize elastic deformation during machining (4). Intelligent algorithms are crucial for efficient computer-aided fixture design, especially for functions like locating system design (5). Additionally, predictive suggestion mechanisms can aid novice designers in real-time error correction and reduce the need for expert input during training (1). By integrating reinforcement learning for optimized fixturing solutions, the fixture design process can be further enhanced, as seen in the case study comparing exploration methods (3). These insights collectively provide a foundation for creating a comprehensive and effective fixture to automate the agitation process, ensuring efficiency and quality in manufacturing operations.

To design and develop a fixture for executing an automatic agitation process, a comprehensive approach integrating computer-aided fixture design methodologies is essential. Automation in fixture design can enhance flexibility and automation levels in manufacturing systems, utilizing formal ontology, spatial grammar, and deformation analysis for efficient fixture synthesis and evaluation (6). An integrated computer-assisted process-planning and fixture layout planning system can aid in generating process and fixture maps automatically, optimizing locator and clamp positions to minimize work piece deformation through finite element analysis (7). Concurrent approaches that combine fixture design with machine planning can provide a holistic assessment of manufacturing dependencies, optimizing manufacturing time, cost, and fixture quality based on engineering guidelines and experiences (8). This comprehensive approach ensures the successful design and development of a fixture for executing an automatic agitation process in a manufacturing setup (9).

The design and development of a fixture for executing an automatic agitation process can benefit from various methodologies and knowledge models presented in the research papers. A knowledge model applied to fixture design can assist in automating the process by specifying data structures and inference processes (10). Additionally, the use of sacrificial fixture, similar to support structures in rapid prototyping, can provide flexibility in securing complex parts with tight tolerances during the machining process (12). Furthermore, the development of a decision support system for fixture design, incorporating CAD interfaces, structured queries, and databases, can significantly reduce design lead time and effort (11). Integrating these approaches can streamline the fixture design process, reduce costs, and enhance the efficiency of automatic agitation processes.

To design and develop a fixture for executing an automatic agitation process, it is essential to consider the functional requirements, automation principles, and adaptive design approaches outlined in the research papers. The fixture design process should begin with defining functional requirements and constraints (14). ensuring usability, accuracy, intelligence, and simplicity in the system (15). Additionally, incorporating an adaptive future design system based on an evolutionary search algorithm can help in dynamically dealing with design changes during the process (16). Furthermore, the new machining dimension-based fixture design approach can provide insights into properly constraining the work piece DOFs and maintaining machining stability for accurate positioning and equilibrium during the agitation process (17). By integrating these methodologies and principles, a comprehensive and efficient fixture can be developed to automate the agitation process effectively

The interplay between theoretical advancements and practical applications is a critical aspect of engineering and industrial processes. While many researchers focus on theoretical developments, there remains a significant gap in practical applications, particularly in the context of implementing fixtures in chemical tanks for agitation

processes and material cleaning. This gap represents an opportunity to enhance industrial practices by bridging theory and application, thereby improving efficiency, safety, and environmental sustainability. Fixtures play a pivotal role in various industrial processes, especially those involving chemical tanks for surface finishing or cleaning. The primary function of these fixtures is to facilitate agitation and material handling in a controlled and efficient manner. The developed fixture, primarily used in a single tank, exemplifies this function. It can be adapted for use in any tank undergoing surface finishing or cleaning, making it a versatile tool in industrial settings. By preventing direct contact with hazardous chemicals, the fixture significantly enhances operator safety, which is a paramount concern in chemical processing environments. The significance of this fixture extends beyond safety. It offers substantial benefits in terms of efficiency and cost-effectiveness. By optimizing the agitation process, the fixture helps maximize production rates while minimizing risks and operational costs. This is particularly advantageous for businesses seeking to improve their competitive edge and operational efficiency. For instance, in cases where a quicker agitation procedure is needed, large fixtures equipped with several output hoses can be installed in tanks with enormous capacities. This flexibility allows for tailored solutions that meet specific operational challenges, thereby enhancing overall process efficiency. The potential applications of this fixture are vast. While it is currently used primarily in tanks where aviation tubes and ducts are cleaned, its utility extends to other sectors as well. The automotive spare parts industry, for example, can benefit from this method. By implementing such fixtures, these industries can achieve more efficient and cost-effective cleaning and surface finishing processes. The fixture's ability to prevent direct chemical contact also reduces ergonomic risks, making it a valuable tool for improving workplace safety and health standards.

The future potential of this fixture is promising. With advancements in automation, the fixture can be integrated into automated systems to further enhance efficiency and reduce human intervention. This is particularly relevant in the context of Industry 4.0, where automation and smart technologies are transforming industrial operations. By applying automation throughout the tanks to stir chemicals, the fixture can help achieve more consistent and reliable results, thereby improving overall process control and product quality. Addressing the gap between theoretical advancements and practical applications requires collaborative efforts among researchers, engineers, and industrial stakeholders. Researchers can provide the theoretical foundation and innovative ideas, while engineers can focus on designing and optimizing fixture solutions that meet specific operational needs. Industrial stakeholders, on the other hand, can offer practical insights and real-world challenges that need to be addressed. By working together, these groups can develop and implement fixture designs that are not only theoretically sound but also practically viable. The developed fixture for agitation processes and material cleaning in chemical tanks represents a significant advancement in industrial practice. Its ability to enhance efficiency, safety, and cost-effectiveness makes it a valuable tool for various industries. By bridging the gap between theory and application, this fixture unlocks new potentials in chemical processing, ensuring that theoretical advancements translate into tangible benefits for industrial applications. The collaborative efforts of researchers, engineers, and industrial stakeholders are essential to further develop and optimize such fixture designs, ultimately contributing to a more efficient, safe, and sustainable industrial environment.

METHODOLOGY

The methodology for designing and developing a fixture to execute the automatic agitation process involves a systematic approach consisting of several steps:

Examine Agitation Process Parameters

Identify and analyze critical parameters such as amplitude, frequency, and speed that influence the agitation process.

Conduct literature reviews and experimental investigations to determine the optimal ranges for these parameters.

Determine Material Characteristics

Investigate the material characteristics of the compounds that are subject to agitation.

Understand the physical, chemical, and mechanical properties that affect the agitation process.

Generate Design Ideas and Concepts

Brainstorm a variety of design ideas and concepts for the fixture.

Utilize techniques such as morphological analysis, TRIZ (Theory of Inventive Problem Solving), and other creative problem-solving methods to explore innovative solutions.

Create Draft Sketches and Models

Develop initial draft sketches, CAD drawings, or three-dimensional (3D) models of potential fixture designs.

Use CAD software to create detailed visual representations of each concept.

Evaluate Concepts

Assess each design concept based on cost-effectiveness, efficiency, and viability.

Conduct feasibility studies and comparative analyses to determine the strengths and weaknesses of each concept.

Select the Best Design Concept

Choose the most suitable design concept based on the evaluations and criteria set forth.

Ensure the selected design meets all functional requirements and constraints.

Develop Detailed CAD Specifications and Drawings:

Create comprehensive CAD specifications and detailed drawings of the chosen fixture design.

Include all necessary dimensions, tolerances, and technical specifications.

Determine Required Components and Materials

Identify the necessary components, materials, and technologies required for the fixture.

Specify material properties, sourcing options, and compatibility with the design.

Procure Components and Resources

Obtain the components and resources needed for constructing the fixture.

Ensure all materials and components meet quality standards and project requirements.

Construct the Fixture Prototype

Build a prototype of the fixture based on the detailed CAD drawings and specifications.

Assemble all parts and components, adhering to best practices in manufacturing and assembly.

Integrate Automation and Control Systems

Incorporate automation components and control systems into the fixture.

Implement programmable logic controllers (PLCs), sensors, and actuators as necessary.

Conduct Preliminary Testing

Perform initial testing to verify the design and functionality of the fixture.

Analyze test results, identify any issues or areas for improvement, and make necessary adjustments. By following this methodology, the research aims to develop an effective and efficient fixture for the automatic agitation process, ensuring optimal performance and reliability. There are various processes involved in designing and creating a fixture that will carry out an automated agitation procedure.

MATERIAL SELECTION AND DESIGN OF FIXTURE

The material portion of the design process is a crucial stage in choosing the right materials for each machine component so that they can withstand all stresses while also having the lowest feasible cost.

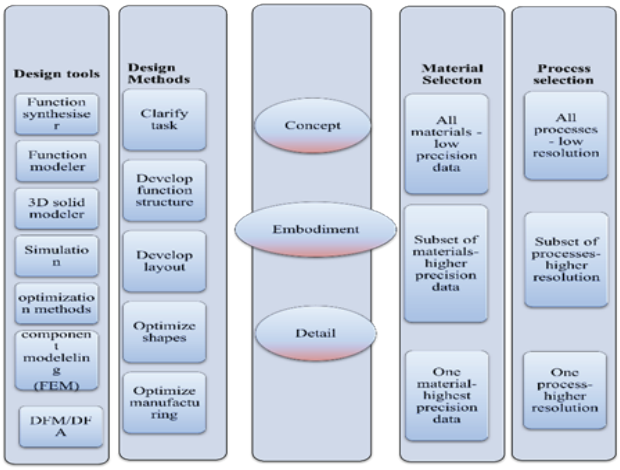


Fig. 1. Product Design Process Flow Diagram

PVC Pipe Schedule 40 - Schedule 40 PVC pipe is frequently used in drain lines and other applications where there is little pressure. A poorly selected material may result in both exorbitant life-cycle costs and component failure. It takes more than just picking a material with the qualities to deliver the required performance in use and the processing techniques to yield the completed component when choosing the optimal material for a part. A bad material selection might raise the cost of production. Processing can increase or decrease a material's properties, which could have an impact on how well the item performs in service. The material must not only be able to withstand mechanical, chemical, and thermal demands, but it also has to be economically feasible to create parts from. As such, having a solid grasp of the various manufacturing processes is just as important as having a full understanding of the requisite qualities. Ultimately, the decision-making process may hinge on the material's accessibility. An exhaustive inventory of the necessary materials should be created by the engineer during the configuration design phase. The physical characteristics of the materials used for structures, particularly motion-related parts on machinery or assembly equipment, have a major impact on how long the finished product will last. When choosing materials, the figure 1 product design process flow diagram factors must be taken into account.

Material Selection

1. Material used - Polyvinyl Chloride (PVC).
2. Size of fixture - 1700 x 1350 mm
3. Density - Nitric Acid: 1.51g / Centimeter Cube
4. Ammonium Bifluoride - 1.5 g/ Centimeter Cube
5. Water - 1 g/ Cubic Centimeter
6. Required Agitation Time - 30 Minutes (BEFORE).
7. Required Air Pressure for Agitation - 7 bar.

Dimension of Fixture

1. Total Length of Fixture - 70 Inches
2. Total Width of Fixture - 58 inches
3. Total Height of Fixture - 50 inches
4. Clearance Between Tank surface and Fixture Base - 2 inches

Design calculations

Finding Pressure Loss at Elbow shows in figure 2.

By Harris formula,

$Pf = CLQ2/CRd5$ (1)

$C= 0.1025/d0.13$ (2)

Where,

Pf= Pressure Loss (psi)

c = Experimentally Determined Coefficient

L = length of pipe (ft)

d = Inside diameter of pipe (inch)

Q = Flow Rate (scfs)

D = 1.660 inch

Length = 0.25 ft (7.62cm)

$A = ¼ \pi d^2 = 0.18$ ft^2

Velocity = 3.6 m/sec = 11.811 ft/sec

Q = Area x Velocity = 2.12 scfs

Pressure in Pipe = 6.54 bar

Atmospheric Pressure = 1.013 bar

CR = Compression Ratio = (Pressure in pipe/ Atmospheric Pressure)

CR = (6.54 + 1.013) / 1.013 = 7.54

From equation 1 and 2

Pf = 0.1025LQ2/CRd5.31

Pf = (0.1025 x 0.25 x 4.49) / (7.54 x 14.74) = 1.034 x 10-3 PSI

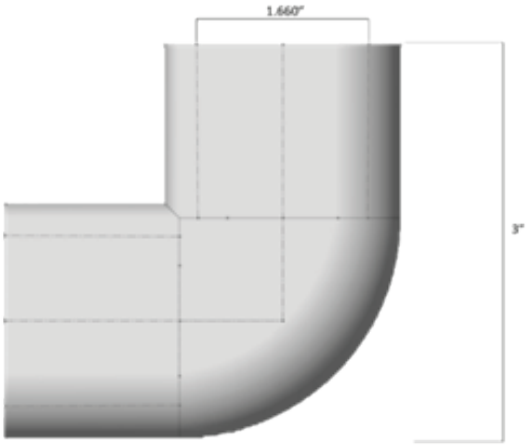


Fig 2. Elbow Joint

Similarly,

Finding Pressure Loss at T Joint shows in figure 3

D = 1.660 inch

Length = 0.183 ft (5.57cm) (Through Run)

$A = ¼ \pi d^2 = 0.18 ft^2$

Velocity = 3.6 m/sec = 11.811 ft/sec

Q = 0.18 x 11.811 = 2.12 scfs

Pressure in Pipe = 6.54 bar

Atmospheric Pressure = 1.013 bar

CR = (6.54 + 1.013) / 1.013 = 7.54

Pf = (0.1025 x 0.183 x 4.49) / (7.54 x 14.74) = 7.45 x 10-4 PSI

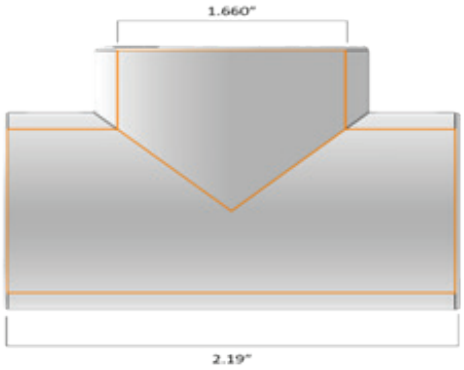


Fig. 3. T Joint

Similarly,

Finding Pressure Loss at 4 Way Joint,

Given -

D = 1.660 inch

Length = 0.205ft (6.24cm)

$A = ¼ \pi d^2 = 0.18 ft^2$

Velocity = 3.6 m/sec = 11.811 ft/sec

Q = 0.18 x 11.811 = 2.12 scfs

Pressure in Pipe = 6.54 bar

Atmospheric Pressure = 1.013 bar

CR = (6.54 + 1.013) / 1.013 = 7.54

Pf = (0.1025 x 0.205 x 4.49) / (7.54 x 14.74) = 8.48 x 10^{-4} PSI

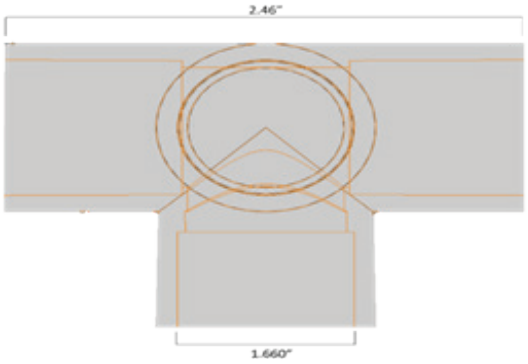


Fig 4. 4-Way Joint

Fixture Design

The CAD drawing of Fixture shown in figure 5 was carefully selected through iterative trial and error methods, driven by several technical considerations crucial for effective implementation in chemical tank applications. Firstly, it was essential to ensure that the fixture could withstand and distribute pressure uniformly in all directions within the tank, optimizing agitation processes.

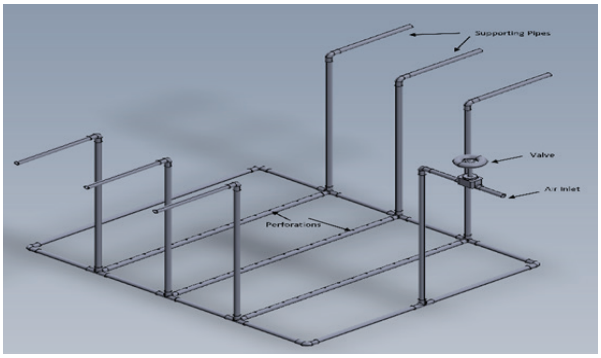


Fig. 5. CAD drawing of the Fixture

The CAD drawing of Fixture shown in figure 5 was carefully selected through iterative trial and error methods, driven by several technical considerations crucial for effective implementation in chemical tank applications. Firstly, it was essential to ensure that the fixture could withstand and distribute pressure uniformly in all directions within the tank, optimizing agitation processes. Secondly, the design had to seamlessly match the complex contours of the tank, ensuring a precise fit to maintain operational integrity. Meeting required tolerances and dimensions was another critical aspect to guarantee compatibility and functionality in diverse

operational conditions. Ease of implementation and design simplicity were prioritized to streamline manufacturing and installation processes. Moreover, the fixture's design facilitates straightforward maintenance and repairs during tank downtime, minimizing operational disruptions.

Figure 6 illustrates the actual fixture in use post-assembly, demonstrating its practical application and highlighting how these design considerations translate into real-world operational efficiency and reliability in chemical processing environments. This integration of design and functionality underscores the importance of robust engineering solutions in industrial settings.

Fig. 6. Fixture Photograph

Working

Step 1- The Welded part which is to be cleaned is dipped into the tank with the help of a hoist. The tank consists of nitro pickle solution which is a combination of nitric acid, Ammonium Bifluoride and Water.

Step 2 - When the Hoist is dipped in the tank the Inlet Air from the Centralized compressor is connected to the fixture's inlet valve. The inlet valve is later turned ON to allow flow of air in the fixture as required. The air Pressure from the inlet valve is standardized to 6 to 8 bar but supplied to the Fixture is 6.54 Bar.

Step 3 - As soon as the air Valve is Opened the air passes from the fixture and exits at high velocity from the small openings or holes made below the Fixture pipes which are dipped into the tank. The air with high velocity forms bubbles in the Fluid resulting into Agitation of Fluids.

Step 4 - The time taken for this process is 15 Minutes as Agitation rate is Higher an Efficient also Fast as compared to manual Agitation.

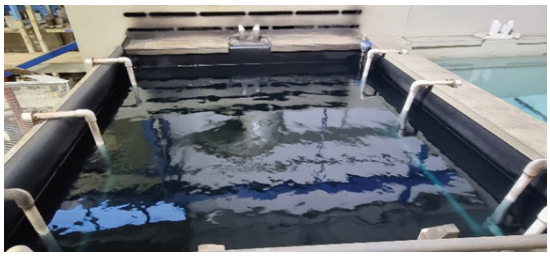


Fig. 7. Fixture Immersed in Chemical Tank

Step 5 - After the agitation process is completed and the welded component is cleaned the Etch Rate test is done to Verify removal of Material. The two types of tests take place Etch rate test.

Figure 7 illustrates the fixture submerged in the chemical tank. The chemical mixing process is facilitated by air that is introduced through a pipe located at the bottom of the tank. This setup ensures a thorough agitation of the chemicals, promoting uniformity and consistency in the mixture. The strategic placement of the air pipe at the base of the tank allows for optimal distribution of air bubbles, enhancing the mixing efficiency. This method of agitation is crucial for maintaining the desired chemical properties and preventing sedimentation. The design and positioning of the fixture within the tank are optimized to support this mixing process, ensuring that the chemicals are evenly distributed and properly reacted. This setup not only improves the overall effectiveness of the chemical process but also contributes to the durability and performance of the fixture itself.

RESULT AND DISCUSSION

In the past scenario Traditional Method of Agitation was used which was Time consuming and safe for the operator to work. Also, in traditional manual mixing of fluid with the help of stirrer, ergonomics risk was also affected for the operator.

Automatic agitation systems often involve higher initial investment costs for equipment and installation compared to manual methods. However, they may provide cost savings in the long run through increased efficiency and reduced labor requirements. Also, Efficiency of the Agitation in traditional method was less. In order to overcome these problems automatic agitation fixture was designed and implemented which reduced the cycle time by 10 minutes and the improved efficiency.

Etch Rate Determination Method

After a nitric acid cleaning procedure, measuring the etch rate requires determining how much the material's thickness changed as a result of the cleaning. This is the standard procedure are below:

i. Get the Sample Ready: Parts or components that have been cleaned with nitric acid should be used first.

ii. Initial Measurement of Thickness: Prior to cleaning with nitric acid, measure the parts' initial thickness. Employ a suitable method, such as a thickness gauge or profilometry.

iii. Acidic Cleansing: Follow the specified protocol when carrying out the nitric acid cleaning procedure. Make sure that all cleaning parameters—temperature, concentration, and duration—are regulated.

iv. Rinse and Dry: To get rid of any remaining acid, give the parts a good rinse after cleaning. The parts should be fully dry.

v. Measure Final Thickness: Using the same method as in step 2, measure the parts' thickness once more following the nitric acid cleaning.

vi. Compute the Thickness Change: To calculate the change in thickness, subtract the final thickness from the initial thickness.

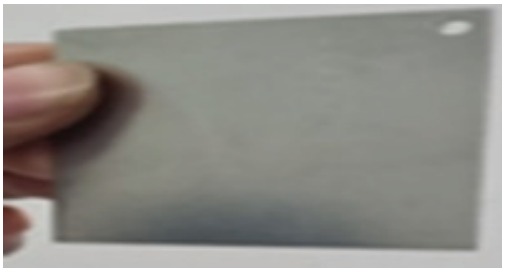


Fig. 8. Sample Coupon

Fig 9. Measurement of Coupon Sample

vii. Calculate Etch Rate – Using the formula ER=Δd/Δt. Where Δd is the change in thickness and Δt is the time of exposure to the nitric acid during the cleaning process. Following figure 8 and figure 9 are show the photograph of sample coupon and Measurement of Coupon Sample respectively.

viii. Data analysis: Examine the etch rate data to see how the material was impacted by the nitric acid cleaning procedure.

ix. Repeat for Accuracy: To guarantee accuracy and reproducibility, carry out the calculations and measurements several times.

x. Documentation: Document the details of the nitric acid cleaning process, the conditions under which it was performed, and the results of the etch rate measurements.

xi. Result calculation of Agitation Rate: If etch rate is between 0.0015 to 0.005 so its ok (unit of etch rate inch/surface/hour) or Millimetre / Minute.

xii. By Implementing Automatic Agitation Carrying out Etch rate test at a Welded part at 5 Points. The Material Removal amount is calculated as follows –

Etch Rate = Δd /Δt

Where,

Δd = Change in thickness

Δt = Time of exposure

Hence, Calculating Etch Rate at Point 1,

ER = 1.4 / 15 = 0.0933 MM/ Min

Similarly, through systematic experimentation, all points were identified.

Table 1 presents the results of the agitation process without the fixture. The traditional method revealed non-uniform etching rates, excessive metal removal from the specimen, and prolonged processing times.

Table 2 displays the outcomes of the agitation process with the fixture implemented. Following automation, notable improvements were observed: the etching rate approached uniformity, there was reduced metal

removal from the specimen, and the processing time was minimized compared to traditional methods.

Table 1. Result without fixture

Point no.	Thickness Before Cleaning/ Agitation (mm)	Thickness After Cleaning/ Agitation (mm)	Material Removal Thickens (mm)	Time (Min)	Etch Rate
1	57.8	55.2	2.6	25	0.104
2	89.5	87.9	1.6	25	0.064
3	67.7	66.3	1.4	25	0.048
4	45.2	43.3	1.9	25	0.076
5	64.9	62.8	2.1	25	0.084

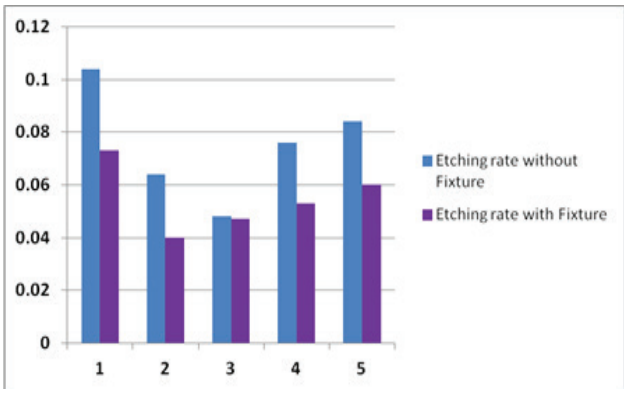
Table 2. Result with Fixture

Point no.	Thickness Before Cleaning/ Agitation (mm)	Thickness After Cleaning/ Agitation (mm)	Material Removal Thickness (mm)	Time (Min)	Etch Rate
1	57.8	56.7	1.1	15	0.073
2	89.5	88.9	0.6	15	0.040
3	67.7	67	0.7	15	0.047
4	45.2	44.4	0.8	15	0.053
5	64.9	64	0.9	15	0.060

The graph 1 comparing the etching rates of materials in agitation processes, both with and without a fixture, reveals several significant observations that underscore the following advantages of using fixtures in chemical processing environments:

Uniformity in Etching Rate

One of the prominent observations from the graph is the uniformity achieved in the etching rate when a fixture is employed in the agitation process. Without a fixture, variations in agitation can lead to inconsistent etching rates across different parts of the material being processed. This inconsistency can result in uneven material removal, which may affect the quality and precision of the final product. By contrast, using a fixture stabilizes the agitation process, ensuring that the etching rate remains more consistent throughout the material surface. This uniformity is crucial in applications where precise control over material removal is required, such as in semiconductor manufacturing or precision engineering.



Graph 1. Comparisons of etching rates without fixture and with fixture

Reduction in Metal Removal Thickness

In traditional chemical agitation processes conducted without a fixture, the graph indicates a higher metal removal thickness compared to processes where a fixture is utilized. This observation is pivotal as it directly correlates with material savings and cost-effectiveness in industrial operations. Higher metal removal thickness without a fixture implies greater material wastage, which can be particularly significant in industries dealing with expensive or limited resources. By implementing a fixture in the agitation process, the graph suggests that metal removal thickness is reduced. This reduction not only conserves materials but also optimizes the use of chemicals and resources, contributing to sustainable manufacturing practices.

Enhanced Efficiency and Safety

The graph also highlights improvements in efficiency and safety attributed to the use of fixtures in chemical tanks for agitation. Efficiency gains are evident from the consistent etching rates and reduced material wastage discussed earlier. Moreover, fixtures streamline the processing workflow by providing a stable platform for the materials being treated, thereby potentially reducing processing time and enhancing overall production efficiency. From a safety perspective, fixtures contribute to a more controlled environment by minimizing the risks associated with manual handling and unpredictable agitation dynamics. This controlled environment is critical in industries where chemical interactions and process parameters must be carefully monitored to prevent accidents and ensure worker safety.

Impact on Overall Process Quality

Beyond the quantitative benefits observed in the graph, the use of fixtures can also have a qualitative impact on the overall process quality. Consistent etching rates and reduced material removal thickness contribute to improved product uniformity and precision. This is particularly advantageous in industries where product quality directly impacts customer satisfaction and market competitiveness. By standardizing the agitation process through fixture implementation, manufacturers can achieve tighter tolerances and meet stringent quality standards more reliably.

Reduction time

There was a significant reduction in the time required for the chemical agitation process.

The observations from the graph comparing agitation processes with and without fixtures provide compelling evidence of the manifold benefits associated with fixture utilization. From improved process uniformity and material savings to enhanced efficiency and safety, the implementation of fixtures in chemical processing environments represents a pivotal step towards achieving operational excellence and sustainable manufacturing practices.

CONCLUSIONS

The advent and deployment of automated agitation fixtures mark a significant advancement in industrial processes, driving efficiency, accuracy, and labour optimization within the agitation process. By replacing manual methods, these automated fixtures ensure consistent agitation parameters, eliminating the variability inherent in human-operated systems. This consistency not only enhances product quality and repeatability but also reduces operational costs and enhances overall profitability and competitiveness in the market. Furthermore, automation reduces reliance on human intervention, thereby minimizing errors and discrepancies that can arise from manual handling. This improvement in product quality and reliability further supports increased output and operational efficiency, contributing to sustainable business growth. Moreover, the introduction of automated agitation systems improves workplace safety by reducing exposure to hazardous chemicals and minimizing ergonomic risks associated with manual agitation processes. This shift towards automation mitigates the potential for accidents and injuries, prioritizing employee welfare and compliance with safety standards. The benefits of automated agitation extend beyond safety and efficiency; they also enhance productivity and streamline operational workflows. By reducing chemical agitation operational time and optimizing metal removal thickness, businesses can achieve faster production cycles and maintain high standards of material quality. Additionally, the development of permanent fixtures designed for automated agitation not only reduces ergonomic risks associated with manual handling but also enhances the efficiency of cleaning processes. This dual advantage underscores the transformative impact of automation on manufacturing processes, paving the way for greater reliability, sustainability, and competitiveness on a global scale. Looking ahead, ongoing refinement and adaptation of automated technology promise to further revolutionize manufacturing industries. By fostering greater efficiency, reliability, and safety, automated agitation fixtures are poised to drive operational excellence and deliver tangible benefits across diverse sectors. Embracing these advancements positions businesses to meet evolving market demands while achieving sustainable growth and maintaining leadership in their respective industries.

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Design and Performance Analysis of 2 and 4-Element MIMO Antennas for Enhanced Gain in Sub-6 GHz 5G Applications

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ABSTRACT

This article analyzes the design and performance of 2-element and 4-element Multiple Input Multiple Output (MIMO) antennas optimized for sub-6 GHz frequencies, specifically for fifth-generation (5G) communication networks. For both antenna topologies to sustain high data rates and dependable connectivity in dense 5G environments, minimal mutual coupling, favorable impedance matching, and excellent isolation are accomplished by way of the use of a redesigned ground structure and strategic element placement. In comparison to the 2-element design's 5.06 dB gain, the 4-element MIMO design exhibits better performance, especially in gain, reaching 23.18 dB, providing greater coverage and signal intensity. The wider bandwidth of the 4- element antenna, which ranges from 2.93 GHz to 5.04 GHz, further bolsters its appropriateness for next-generation wireless applications. Measurement results indicate excellent isolation levels, and a minimal envelope correlation coefficient (ECC), highlighting the efficacy of the proposed designs for robust MIMO performance. Overall, the findings contribute valuable insights into compact MIMO antenna designs that maximize performance within the sub-6 GHz spectrum, making them highly relevant for 5G deployments that demand high data throughput and efficiency.

KEYWORDS *: Sub-6GHz, Gain enhancement, Isolation, 5G, MIMO.*

INTRODUCTION

The swift progress of wireless communication technology has culminated in the development of fifth-generation (5G) networks, which have generated a significant demand for high-performance antenna systems capable of supporting faster data rates, enhanced spectral efficiency, and wider bandwidths. The sub-6 GHz spectrum, a key frequency range for 5G, is particularly valuable for its ability to balance extensive coverage with high capacity. This mid-band frequency range supports reliable indoor and outdoor connectivity while minimizing latency, which is essential for diverse applications such as augmented reality, real-time video streaming, and industrial automation. In 5G networks, Multiple-Input Multiple-Output (MIMO) antenna systems have become indispensable due to their ability to enhance communication quality by leveraging spatial multiplexing. This technology enables higher data throughput, improved link reliability, and more robust network coverage by utilizing multiple spatially separated antenna elements. However, the design of antennas for 5G applications presents several unique challenges. Designers must consider not only the need for compactness and high isolation between elements but also the demand for wide bandwidth to accommodate high data speeds and variable user densities. Achieving this while maintaining a small form factor that can be easily integrated into devices

is especially challenging. Metasurface- based MIMO antenna designs are a promising approach to addressing these challenges, as they offer novel ways to enhance bandwidth and isolation without significantly increasing the antenna's physical size. Metasurfaces, with their engineered structures and material properties, enable control over electromagnetic wave propagation and can be optimized to reduce interference between MIMO elements, thus facilitating better signal integrity and minimizing mutual coupling. [1]

The emergence of 5G technology represents a revolutionary step in wireless communication, underscoring the necessity for efficient, high-performance antenna designs that operate within the sub-6 GHz range. As global 5G deployment continues, MIMO antenna systems are fundamental to achieving the reduced latency, and enhanced data speeds promised by this next-generation wireless standard. The focus of this paper is on the design and assessment of a MIMO system optimized for 5G applications, addressing the technical requirements and challenges posed by this critical communication spectrum. [2]

SUB-6GHZ RANGE

This article explores a variety of 5G antenna designs operating in the sub-6 GHz band. The frequency range, which spans approximately 0.6 GHz to 6 GHz, is a fundamental spectrum for 5G communication due to its balanced properties of range, coverage, and capacity. Unlike millimeter-wave (mmWave) bands, which offer ultra-high-speed data transmission but are prone to greater attenuation and limited penetration, sub-6 GHz frequencies provide a viable compromise for both urban and rural 5G deployments. This spectrum's capability to support high-capacity and low-latency applications has driven the need for advanced antenna design methodologies focused on optimizing evaluation metrics including gain, bandwidth, efficiency, and antenna element isolation, especially for MIMO configurations. Recent research in sub-6 GHz antenna design has explored various innovative approaches to meet these demands. A study by Zhu et al. (2023) developed a dual-polarized MIMO system for 5G applications, achieving enhanced isolation and reduced envelope correlation, essential for effective MIMO performance in high-density networks. [3] Moreover, researchers have investigated diverse techniques for miniaturization and wideband performance to meet the physical constraints of 5G-enabled devices. Wang et al. (2023) proposed a printed MIMO antenna design with a compact footprint, optimizing substrate material and element placement to achieve wideband coverage in the 3–6 GHz range, a key band for 5G applications. These studies highlight the ongoing efforts in the antenna design community to balance the often-conflicting requirements of compactness, bandwidth, and isolation in MIMO systems for sub-6 GHz 5G applications. [4] A compact split ring resonator antenna operates at three frequencies and has high isolation among its four ports. Simulations showed decent matching of impedance, gain, and impedance. For IoT applications, the author suggests using a four-port MIMO antenna. However, more information on specific IoT applications and discussion of limitations and future improvements is needed. [5] A range of antenna components are used in MIMO systems to increase data speed and signal dependability. On the other hand, mutual coupling could result in decreased diversity gain (DG), decreased channel capacity, and worse performance. Therefore, attaining adequate isolation between antenna components is necessary to ensure optimal system performance, particularly in compact designs. [6]

As 5G continues its global rollout, the demand for robust sub-6 GHz MIMO antennas remains high. Future research is expected to focus on adaptive design techniques that allow for reconfigurability and beamforming to further enhance the flexibility and efficiency of MIMO systems within this frequency range. [7]The integration of artificial intelligence and machine learning in antenna design processes could also lead to significant advancements in performance optimization, as these tools can rapidly analyze and refine complex design parameters. Thus, the sub-6 GHz band continues to be a rich area of exploration for developing antennas that fulfill the diverse requirements of next-generation wireless networks. [8]

ANTENNA DESIGN

The design and simulation of complex antenna structures are carried out using the High-Frequency Structure Simulator (HFSS). The antenna is designed using this 3D modular in accordance with the geometrical parameters

that were determined theoretically. Because it simulates free-space conditions, the radiation boundary is used. A distinct wave port assignment has been made and a microstrip feeding mechanism is employed. Since HFSS employs the Finite Element Method, automated meshing is chosen prior to simulation initiation. After post-processing the simulation, HFSS provides findings, and a number of parameters, including S11, S12, VSWR, radiation patterns, ECC, DG, and others, can be acquired. HFSS is the perfect tool for creating and improving MIMO antenna designs because of its robust simulation tools and post-processing capabilities. It is necessary to determine the intended level of isolation loss, the number of antenna components needed for the design, the bandwidth requirements, and the anticipated frequency range for the applications. Start the antenna design process by arranging each component on the selected substrate material. Improve the result afterwards to satisfy the specified bandwidth needs.

This MIMO antenna uses a 1.6 mm thick FR4 substrate and is built as a single antenna. Here we select the square patch design for its ease of manufacture and simplicity. Depending on its size, the square patch can operate at a single frequency band and is expected to produce a broadside radiation pattern [9, 10]. The many geometrical parameters of the patch antenna design are assessed using these formulas. To find the patch's width, apply Equation 1.

$$\mathrm{Wp} = \frac{c}{2f_r\sqrt{\frac{(\varepsilon_r+1)}{2}}} \quad (1)$$

Here, Wp stands for the patch width, c for the speed of light, which is 3 ×10^8 m/s, fr for the resonance frequency, and εr for the value of the dielectric constant. The patch's length can be found using,

$$L_p = L_{peff} - 2\Delta L_p \quad (2)$$

In this case, the patch's effective length is indicated by L_{peff}, while its extension length is indicated by ΔLp, are derived by

$$L_{peff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} \quad (3)$$

$$\Delta L_p = 0.412h\frac{(\varepsilon_{reff}+0.3)(\frac{w_p}{h}+0.264)}{(\varepsilon_{reff}-0.258)(\frac{w_p}{h}+0.8)} \quad (4)$$

Effective dielectric constant, represented by the symbol εreff, is calculated by using the subsequent formula, where *h* stands for substrate thickness.

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}(1+12\frac{h}{w_p})^{-\frac{1}{2}} \quad (5)$$

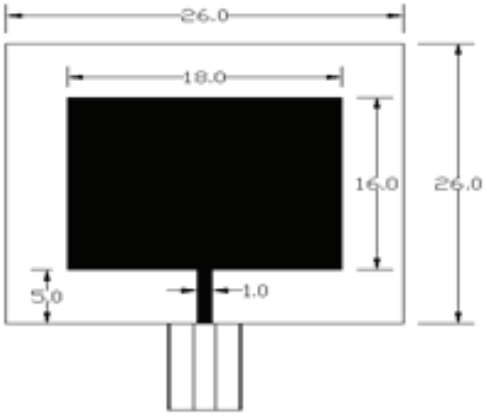
The following formula provides an approximation of the substrate's length and width.

$$L_s = 6h + L_p \quad (6)$$

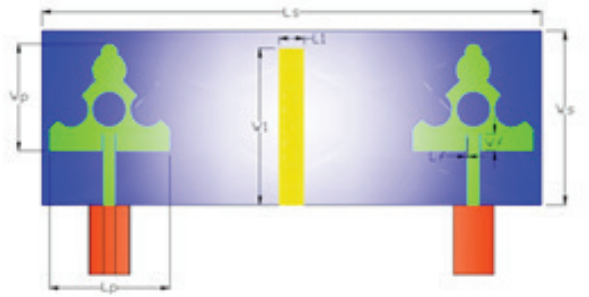
$$W_s = 6h + W_p \quad (7)$$

Two element antenna Design

It features two symmetrically placed, identical radiating patches on a shared substrate. Circular slots are integrated into the design, which enable dual- or multi-frequency operation, allowing the antenna to function across multiple bands. These slots also contribute to reducing the antenna's physical size without sacrificing bandwidth or resonance frequency, enhancing its compactness and performance. The front view shows the strategic separation of elements to minimize mutual coupling and support polarization diversity, essential for MIMO applications. The modified ground structure on the back, which includes slots, improves impedance matching and isolation between elements. Each element is separately fed through individual ports to facilitate independent data transmission, optimizing the antenna for high-data-rate communication in 5G systems.



(a)



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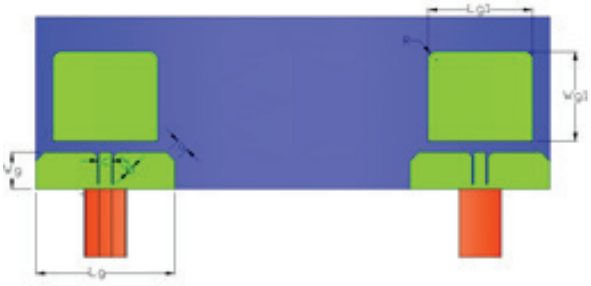


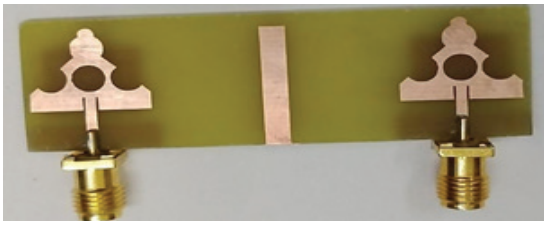
(c)

Fig. 1 Geometry of 2 element antenna; (a) Rectangular patch (b) MIMO antenna top view, (c) bottom view.

Table 1 Specifications for the anticipated 2-element antenna

Parameter	Ls	a	Lp	Lg1	c	Lg	L1
Value(mm)	59	1.41	14.2	12	1.4	16	3
Parameter	Ws	b	Wp	Wg1	d	Wg	W1
Value(mm)	20	0.71	12.3	10.5	0.2	4.2	18

This MIMO antenna features two distinct terminals. This design uses microstrip radiators featuring slots located beneath them, with square-shaped feed lines that have cut corners, each terminating at a smaller ground plane. An 18 mm × 3 mm rectangular strip is centrally positioned to enhance isolation between the elements. The center-to-center spacing between each antenna element is 43.00 mm, which provides the necessary separation for effective performance of the radiating elements.



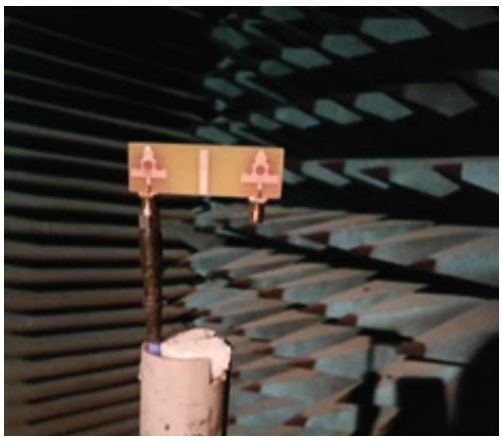
(a)

(b)

Fig. 2 Element antenna fabrications (a) Front and (b) Back perspectives

This design has been fabricated and verified for radiation effectiveness in an anechoic chamber as well as through Vector network analyzer (VNA) testing (Agilent -N5247A).

(a)



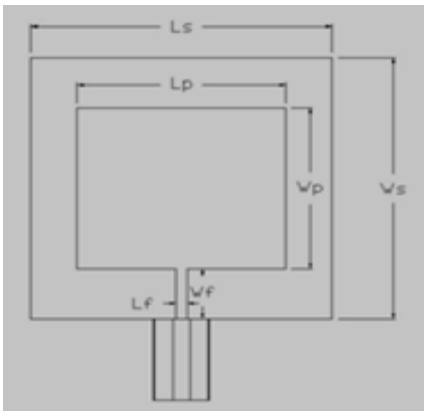
(b)

Fig. 3 Test set-up of the 2- element antenna with (a) VNA and in (b) anechoic chamber

Four element antenna design

The rectangular patch antenna has an annular mushroom structure on top and tiny holes at the base. There is a 1 mm thick microstrip feeding wire included. The radiating element has a C-shaped slit to reduce surface current. The FR4 substrate on which the antenna is built is 1.6 mm thick. The 67.9 x 67.9 mm MIMO antenna is composed of a modified ground with an arc-shaped structure and slots that are 16 x 4.2 mm in size within each element. These modifications aim to minimize mutual coupling and enhance the antenna's resonance at the targeted frequency. Adding an additional ground on the backside of the radiating element enhances the antenna system's radiation characteristics. The inverted L-shaped frame of each radiating element improves overall MIMO performance and isolation. The dual-antenna configuration of the disclosed antenna system

is meant to enhance MIMO performance for 5G applications. Figure 4 illustrates the symmetrical orientation of each of the design's four distinct antenna elements around a central axis.



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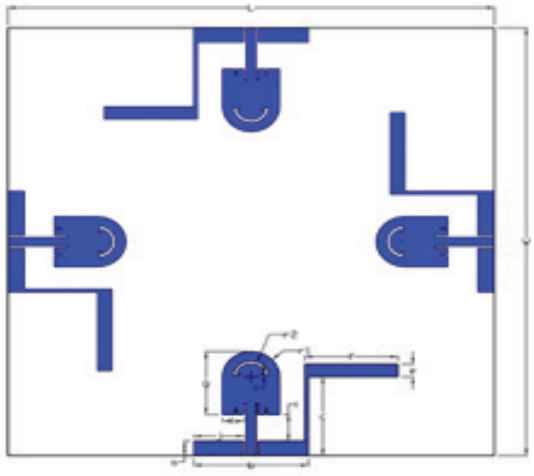


(b)

(c)

Fig. 4 Geometry of 4 element antenna; (a) Rectangular patch (b) MIMO antenna top view, (c) bottom view

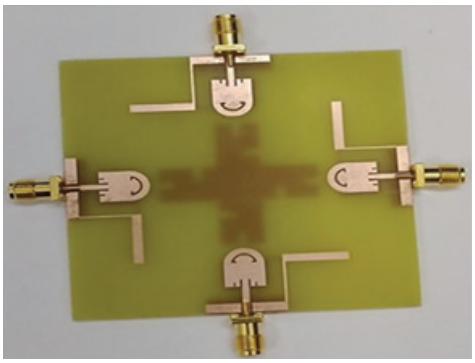
Table 2 Specifications for the anticipated four-element antenna

Parameter	L	a	c	e	g	i	r1	a1	c1	e1	g1	a2	c2	e2
Value in mm	67.9	2.3	12.5	2	10	7	4	16	3.7	8	0.5	11.45	1.5	31.9
Parameter	W	b	d	f	h	j	r2	b1	d1	f1	r3	b2	d2	f2
Value in mm	67.9	16	4.2	13	3.05	0.25	2.5	4	0.3	9	4.72	9	1.7	3

With the given parametric values, we designed and simulated a four-element MIMO antenna using the HFSS platform.

To ensure the antenna performs as intended in simulation, we have taken great care in selecting the substrate, placing the connector, isolating components, and maintaining manufacturing tolerances. With the

given parametric values, we designed and simulated a four-element MIMO antenna using the HFSS platform.



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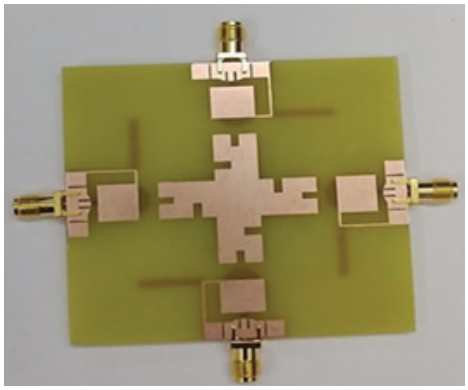
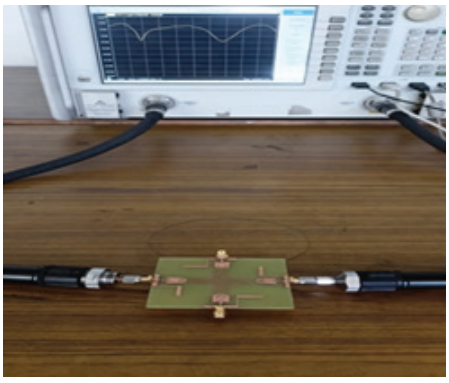


(b)

Fig. 5 4-Element antenna fabrications (a) Front and (b) Back perspectives

After fabrication, the Agilent N5247A VNA was used to verify the design's performance and test its radiation efficiency in an anechoic chamber. The antenna's performance was validated through testing, which closely matched the outcomes of simulations.



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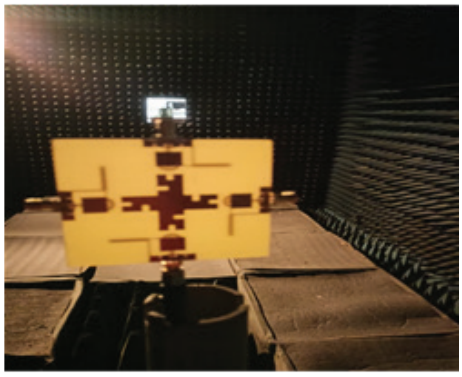


(b)

Fig. 6 Test set-up of the 4- element antenna with (a) VNA and in (b) anechoic chamber

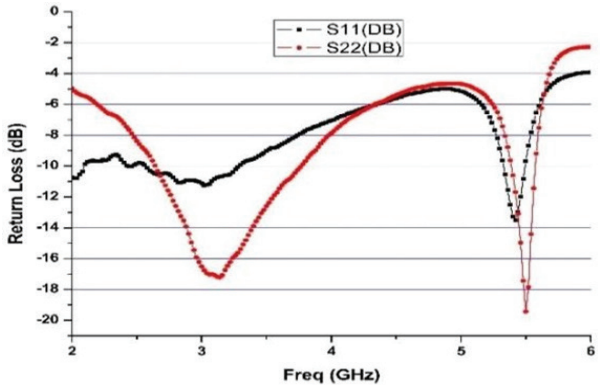
RESULT

The validation process for the antenna design uses tools like a VNA and an anechoic chamber equipped with a reference horn antenna. The chamber creates a non-reflective setting crucial for accurately assessing the radiation properties of an antenna. For radiation performance measurement, a standard horn antenna, serving as the receiving antenna, records the radiated signals at a fixed distance. The antenna under test is positioned on a rotating platform that can be automatically aligned for azimuth and elevation rotation, allowing a comprehensive analysis. Simulated data is then compared to the measured results to ensure accuracy.

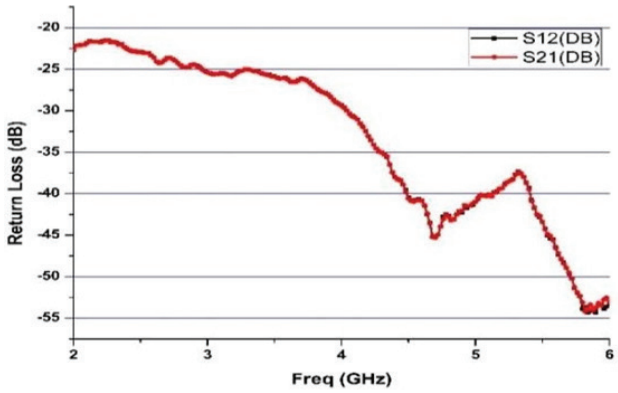
Reflection coefficient

The observed reflection coefficients for 2-element and 4-element MIMO antennas over a frequency range of 2 to 6 GHz are displayed in the graphs in the figure 7 & 8. The return loss curves (S11 and S22) for the 2-element antenna show good performance with notable dips, suggesting efficient impedance matching at particular frequencies. Furthermore, the two antenna elements' (S12 and S21) isolation stays substantially below -15 dB over the whole range, demonstrating negligible mutual coupling and ideal isolation. Low return loss values within the desired frequency bands further demonstrate that the 4 - element antenna has acceptable impedance matching for each of its four elements. Effective mutual isolation is demonstrated by the 4-element configuration's isolation between all

antenna elements, which typically remains below -15 dB. Overall, these results demonstrate that both the 2-element and 4-element MIMO antennas achieve low reflection coefficients and excellent isolation between elements, making them well-suited for applications such as sub-6 GHz 5G.

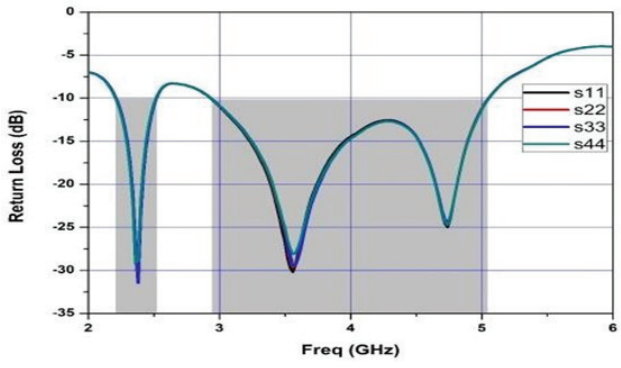


(a)



(b)

Fig. 7 2-element antenna (a) Measured S11 and S22 (b) Measured S12 and S21



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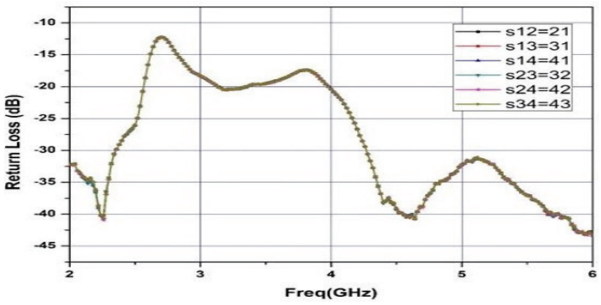
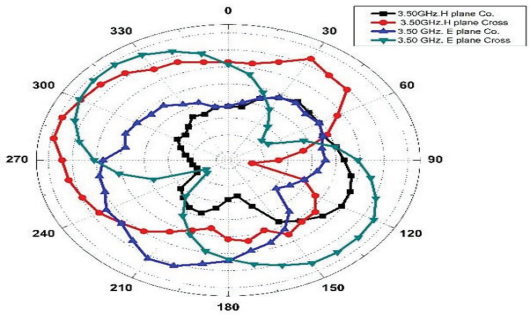


(b)

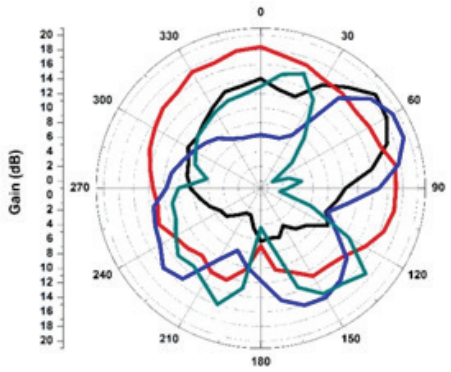
Fig. 8 4- element antenna (a) Measured S11 and S22 (b) Measured S12 and S21

Radiation Patterns

The figure presents the measured E-plane and H-plane radiation patterns for both 2-element and 4-element MIMO antennas at frequencies of 3.5 GHz and 5 GHz. For the 2-element antenna, the E-plane and H-plane patterns display reasonable directivity with distinct main lobes, indicating effective radiation in the intended directions. The gain values in both the E-plane and H-plane are consistent across the two frequency bands, with main lobe gain reaching around 6 dB and stable radiation patterns across 3.5 GHz and 5 GHz. In the 4-element antenna configuration, the radiation patterns exhibit more refined directivity with sharper main lobes, which is expected due to the increased number of array elements. The gain in both planes improves to approximately 22 dB, highlighting enhanced radiation performance. The antenna demonstrates stable cross-polarization levels, highlighting its reliability and effectiveness for MIMO applications in the frequency range. In summary, both the 2-element and 4-element MIMO antennas exhibit clear main lobes and strong gain values, with the 4-element design achieving higher gain and sharper directivity, making both designs effective for 5G applications.



(a)



(b)

Fig. 9 Measured E and H plane patterns (a) two element (b) four element

DISCUSSION

Table 3 provides a comparative analysis of measured results for 2-element and 4-element MIMO antennas, including key performance metrics such as impedance bandwidth, total active reflection coefficient (TARC), isolation, envelope correlation coefficient (ECC), DG. The impedance bandwidth attained by the two-element antenna is 2.66–3.76 GHz; while the 4- element antenna exhibits a wider bandwidth of 2.93–5.04 GHz, supporting a broader range of frequencies and enhancing its suitability for sub-6 GHz 5G applications. Both configurations have an ECC value of less than 0.001, indicating excellent diversity performance and low correlation between antenna elements, essential for effective MIMO operation. The TARC is 0.24 dB for the 2-element antenna and less than 0.18 dB for the 4-element antenna, with the lower TARC of the 4-element design signifying better efficiency and reduced signal reflection. Both antennas demonstrate high diversity gain of approximately 9.99 dB, which improves signal reliability in multipath environments. Furthermore, the elements are more isolated from one another than -25 dB for the 2-element antenna and increases to over -27.94 dB in the 4-element design, reflecting reduced mutual coupling and better signal independence between elements in the 4-element configuration. Notably, the gain is significantly higher in the 4-element antenna, reaching 23.18 dB compared to 5.06 dB in the 2-element configuration, providing stronger signal strength and coverage.

Table 3: Comparison of the measured results

Elements	Impedance Bandwidth (GHz)	ECC	TARC (dB)	DG (dB)	Isolation (dB)	Gain (dB)
2	2.66 – 3.76	<0.001	0..24	~ 9.99	>-25	5.06
4	2.93 – 5.04	<0.001	<0.18	~ 9.99	>-27.94	23.18

Overall, the 4-element MIMO antenna outperforms the 2-element design with a wider bandwidth, lower TARC, higher isolation, and a substantial increase in gain, making it highly effective for enhanced performance in 5G applications within the sub-6 GHz frequency range.

CONCLUSION

Two-element and four-element MIMO antennas intended for 5G applications are compared in this study. The outcomes show that the 4-element MIMO antenna performs better in terms of impedance bandwidth, gain, isolation, and TARC, among other important metrics. Remarkably, the 4-element design attains a gain of 23.18 dB, which is far greater than the 2-element configuration's 5.06 dB gain. This significant gain increase, together with better bandwidth and isolation, confirms that the 4- element MIMO antennas are an excellent option for 5G applications that require increased coverage, dependability, and data throughput. Both solutions demonstrate their potential for 5G MIMO systems by achieving significant diversity gain, ECC, and great isolation. However, the 4-element design stands out due to its enhanced radiation performance, making it the preferred configuration for robust, high-capacity 5G networks within the sub-6 GHz frequency range.

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Desktop Voice Assistance Using Python

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ABSTRACT

This research paper details the development and implementation of a desktop voice assistant designed to enhance user interaction and productivity. The primary purpose of the project is to create an intuitive and efficient voice-controlled assistant that can perform a range of tasks searching the web, and controlling desktop applications. The scope of the project encompasses the design, development, and testing phases of the voice assistant, ensuring it meets user requirements for accuracy, responsiveness, and ease of use. This project also include game, gym training model and volume handling created using OpenCv.

The methodology involves using a combination of natural language processing (NLP) and speech recognition technologies. Key tools and frameworks utilized include Python, the SpeechRecognition library for capturing and interpreting user commands, Opencv framework for motion capturing and the Text-to-Speech (TTS) engine for generating verbal responses.

KEYWORDS *: Voice assistant, Artificial Intelligence (AI), Machine Learning (ML), Deep learning, Open CV, Recommendation system.*

INTRODUCTION

The very first voice activated product was released in 1922 as Radio Rex. This toy was very simple, wherein a toy dog would stay inside a dog house until the user exclaimed its name, “Rex” at which point it would jump out of the house.

This was all done by an electromagnet tuned to the frequency similar to the vowel found in the word Rex, and predated modern computers by over 20 years.

In the 21st century, One of the main reasons for this change is performance. There’s a drastic change in technology rather than advancement. In today’s world, we train our machines to do their tasks by themselves or to think like humans using technologies like Machine Learning, Neural Networks, etc. Now in the current era, we can talk to our machines with the help of virtual assistants. Virtual assistants are software programs that help you ease your day to day tasks, such as showing weather reports, giving daily news, searching the internet etc. They can take commands by voice. Voice-based intelligent assistants need an invoking word or wake word to activate the listener, followed by the command.

We have so many virtual assistants, such as Apple’s Siri, Amazon’s Alexa and Microsoft’s Cortana and Amazon’s Alexa and this has been an inspiration for us to do this as a project. This system is designed to be used efficiently on desktops. Voice assistants are programs on digital devices that listen and respond to verbal commands. A user can say, “What’s the weather?” and the voice assistant will answer with the weather report for that day and location.

LITERATURE REVIEW

This field of virtual assistants having speech recognition has seen some major advancements or innovations. This is mainly because of its demand in devices like smartwatches or fitness bands, speakers, Bluetooth earphones, mobile phones, laptop or desktop, television, etc. Almost all the digital devices which are coming nowadays are coming with voice assistants which help to control the device with speech recognition only. A new set of techniques is being developed constantly to

improve the performance of voice automated search. As the amount of data is increasing exponentially now known as Big Data the best way to improve the results of virtual assistants is to incorporate our assistants with machine learning and train our devices according to their uses.

Other major techniques that are equally important are Artificial Intelligence, Internet of Things, Big Data access and management, etc. With the use of voice assistants, we can automate the task easily, just give the input to the machine in the speech form and all the tasks will be done by it from converting your speech into text form to taking out keywords from that text and execute the query to give results to the user. Machine Learning is just a subset of Artificial Intelligence.

This has been one of the most helpful advancements in technology. Before AI we were the ones who were upgrading technology to do a task but now the machine is itself able to counter new tasks and solve it without need to involve the humans to evolve it. This has been helpful in day-to-day lifestyle. From mobile phones to personal desktops to mechanical industries these assistants are in very much demand for automating tasks and increasing efficiency.

EXISTING WORK

In this section, we review the current landscape of desktop voice assistants and their underlying technologies. We examine popular commercial solutions such as Siri, Google Assistant, and Cortana, as well as open-source alternatives like Mycroft. We analyze their features, performance metrics, and limitations, focusing on aspects such as speech recognition accuracy, natural language understanding capabilities, and user customization options.

PROPOSED WORK

We are proposing a system in an efficient way of implementing a Personal voice assistant, Speech Recognition library has many in-built functions, that will let the assistant understand the command given by user and the response will be sent back to user in voice, with Text to Speech functions. When assistant captures the voice command given by user, the under lying algorithms will convert the voice into text. And according to the keywords present in the text (command given by user), respective action will be performed by the assistant. This is made possible with the functions present in different libraries. Also, the assistant was able to achieve all the functionalities with help of some API's.

We had used these APIs for functionalities like performing calculations, extracting news from web sources, and for telling the weather. We will be sending a request, and through the API, we're getting the respective output. API's lare very helpful in performing things like calculations, making small web searches. And for getting the data from web. In this way, we are able to extract news from the web sources, and send them as input to a function for further purposes. Also, we have libraries like Random and many other libraries, each corresponding to a different technology.

We used the library OS to implement Operating System related functionalities like Shutting down a system, or restarting a system. At the outset we make our program capable of using system voice with the help of sapi5 and pyttsx3. To-speech conversion library in Python. Unlike alternative libraries, it works offline, and is compatible with both Python 2 and 3. The Speech Application Programming Interface or SAPI is an API developed by Microsoft to allow the use of speech recognition and speech synthesis within Windows applications.

Then we define the speak function to enable the program to speak the outputs. After that we will define a function to take voice commands using the system microphone. The main function is then defined where all the capabilities of the program are defined. The proposed system will have the following functionality:

1. The system will keep listening for commands and the time for listening is variable which can be changed according to user requirements.
2. If the system is not able to gather information from the user input it will keep asking again to repeat till the desired number of times.
3. Features supported in the current version include playing music, texts, search on Wikipedia, or opening system installed applications, opening anything on the web browser, etc.
4. It uses the feature of Open CV.

System Model

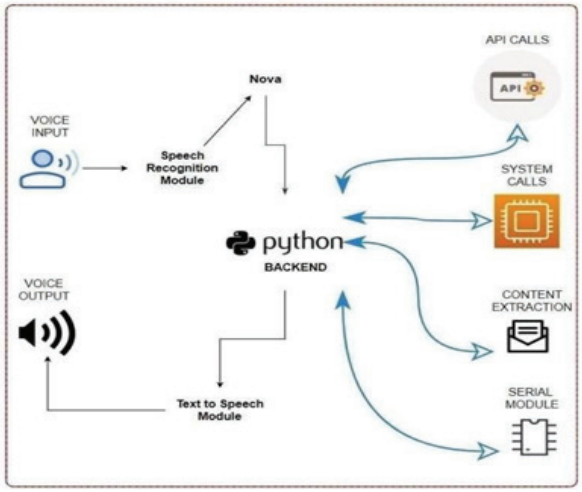

Fig. 1 System Architecture

Working

It starts with a signal word. Users say the names of their voice assistants for the same reason. They might say, "Hey Siri!" or simply, "Alexa!" Whatever the signal word is, it wakes up the device. It signals to the voice assistant that it should begin paying attention. After the voice assistant hears its signal word, it starts to listen. The device waits for a pause to know you've finished your request.

The voice assistant then sends our request over to its source code. Once in the source code, our request is compared to other requests. It's split into separate commands that our voice assistant can understand. The source code then sends these commands back to the voice assistant. Once it receives the commands, the voice assistant knows what to do next. If it understands, the voice assistant will carry out the task we asked for. For example, "Hey NOVA! What's the weather?" NOVA reports back to us in seconds.

The more directions the devices receive, the better and faster they get at fulfilling our requests. The user gives the voice input through microphone and the assistant is triggered by the wake up word and performs the STT (Speech to Text) and converts it into a text and understands the Voice input and further performs the task said by the user repeatedly and delivers it via TTS (Text to Speech) module via AI Voice. These are the important features of the voice assistant

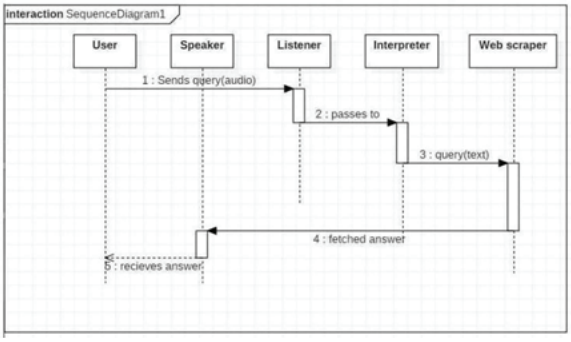

Fig. 2 Sequence Diagram 1

Algorithms

Speech Recognition Module : The class which we are using is called Recognizer. It converts the audio files into text and module is used to give the output in speech.

Energy Threshold : The function represents the energy level threshold for sounds. Values below this threshold are considered silence, and values above this threshold are considered speech.

Speech to Text & Text to Speech Conversion : Pyttsx3 is a text-to-speech conversion library in Python. And can change the Voice, Rate and Volume by specific commands. Python provides an API called Speech Recognition to allow us to convert audio into text for further processing converting large or long audio files into text using the Speech Recognition API in python. We have Included sapi5..

Process Executes Therequired Command : The said command is converted into text via speech recognition module and further stored in a temp. Then, Analyze the user's text via temp and decide what the user needs based on input provided and runs the while loop. Then, Commands are executed.

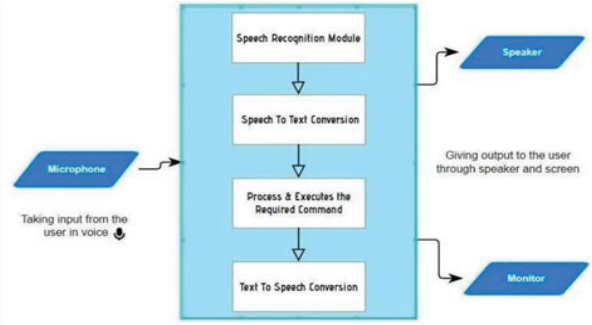

Fig. 3 Sequence Diagram 2

List of features that can be done with the assistant:

- Playing some video which, the user wants to see.
- Telling some random fact at the start of the day with which the user can do their work in an informative way and the user will also learn something new.
- One of the features which will be there in every assistant is playing some game so that the user can spend their free time in a fun way.
- Users might forget to turn off the system which might contain some useful data but with a voice assistant, we can do that even after leaving the place where the system is just by commanding the assistant to turn the system off.

CONCLUSION

A desktop voice assistant is a versatile tool that enhances user productivity through voice commands. It can perform tasks like web searches, setting reminders, and controlling applications, improving user convenience. By integrating natural language processing and speech recognition technologies, it enables seamless and hands-free interaction with the computer. As a result, it simplifies multitasking and streamlines various desktop operations. It is also helpful in operating using a deep learning model. The continuous development of voice assistant technology offers great potential.

ACKNOWLEDGEMENT

We express our sincere gratitude to everyone who contributed to the successful completion of our project, which integrates Artificial Intelligence (AI) and Machine Learning (ML) into an Desktop Voice Assistant. We deeply appreciate our project guide, Prof. Jaishri Shilpakar, for his invaluable guidance and unwavering support. We also thank the faculty and staff of Parvatibai Genba Moze College of Engineering for providing a conducive learning environment and essential resources. Special thanks to Prof. Shrikant Dhamdhere, Professor Head of the Department of Computer Engineering at PGMCOE, Wagholi, for his continuous encouragement. We are grateful to our classmates for their constant support and to our dedicated team members for their unique skills and commitment. This project is a collective achievement, showcasing our ability to work together towards a common goal and advancing AI and ML in Desktop Voice Assistant.

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E-Commerce Website using AI & ML

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ABSTRACT

In the current digital age, e-commerce has completely changed how consumers and organisations conduct business. The goal of this project is to create a comprehensive e-commerce platform by utilising state- of-the-art technology like

AI chatbots, recommendation algorithms, and the MERN (MongoDB, Express, React, and Node) stack. Through product recommendations driven by machine learning algorithms, the platform will provide consumers with a personalised shopping experience. Additionally, an AI-based chatbot will provide smooth communication and help for users. The design, development process, and salient characteristics of the suggested e-commerce website are described in this study.

KEYWORDS *: E-commerce, Artificial Intelligence (AI), Machine Learning (ML), Recommendation systems, Chatbots, User Experience (UX), MERN Stack (MongoDB, Express.js, React.js, Node.js).*

INTRODUCTION

The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.The introduction illuminates the pivotal role of AI and ML technologies in e-commerce, especially in recommendation systems, which can revolutionize online shopping by catering to diverse consumer needs.

By deploying sophisticated algorithms and predictive analytics, e-commerce platforms can deliver personalized recommendations that enhance user experiences and drive customer engagement. Highlighting the transformative potential of recommendation systems, the introduction underscores

their significance in navigating the competitive online market and retaining a large customer base. Unlike traditional platforms, AI-driven recommendation systems have the capability to foster long-term customer loyalty through tailored product suggestions, thus boosting retention rates and ensuring sustained revenue growth.

In line with these insights, our research initiative is dedicated to leveraging AI and ML to redefine the e-commerce landscape, with a primary focus on recommendation systems. Through our project, we aim to empower businesses to offer highly personalized shopping experiences that resonate with individual preferences, ultimately enhancing customer satisfaction and loyalty.

By harnessing the power of AI-driven recommendation systems, e-commerce platforms can unlock new opportunities for growth and innovation, positioning themselves as leaders in the digital marketplace. Our project seeks to pave the way for a future where personalized recommendations are the norm, driving efficiency and creativity in the e-commerce industry.

LITERATURE REVIEW

In e-commerce applications, Yi Zeng et al. suggest deep learning-based recommendation models tailored for

individualised healthcare. These models employ deep learning methods to examine complex medical data and give users customised recommendations. By providing tailored and pertinent recommendations, this method improves healthcare outcomes while also improving the purchasing experience.

An extensive analysis of recommendation algorithms in e-commerce systems is carried out by Qinyong Wang and colleagues. They cover a wide range of strategies, from conventional methods to sophisticated deep learning approaches, emphasising how recommendation techniques have evolved and how they affect user engagement and conversion rates. This investigation clarifies how well various algorithms work to improve user experience and spur company expansion.

Using machine learning approaches, Guobin Yao et al. investigate personalised recommendation algorithms based on user behaviour analysis for e-commerce applications. These algorithms produce tailored recommendations by examining user behaviour data, which raises customer satisfaction and increases revenue for e-commerce companies. Individual tastes are catered to by this personalised approach, which improves the overall buying experience.

Hao Zuo and colleagues create a hybrid recommendation algorithm that combines machine learning and artificial intelligence to create an intelligent recommender system for e-commerce websites. By combining the best features of the two methods, this system may provide precise and pertinent product recommendations that increase user engagement and loyalty. E-commerce systems can offer customised recommendations by utilising sophisticated algorithms, which can result in elevated client happiness and conversion rates.

A survey and future direction for deep learning in e-commerce recommendation systems are presented by Zhao Zheng et al. This survey describes future research goals and examines the state of deep learning techniques in e-commerce today. Their work establishes the foundation for using deep learning to increasethe efficacy and accuracy of recommendations in e-commerce systems.

Through a thorough survey, G. Brown et al. look into the uses of reinforcement learning in e-commerce. This survey looks at how several e-commerce activities, like pricing strategies, inventory management, and customer service, can be optimised through the use of reinforcement learning techniques. E-commerce companies may improve operational efficiency and give customers a flawless shopping experience by implementing reinforcement learning algorithms.

In summary, these research articles highlight how important AI and ML are to improving the usability and functionality of e-commerce platforms. Advanced algorithms can be utilised by e-commerce companies to enhance customer satisfaction, streamline processes, and personalise recommendations. This can lead to increased growth and competitiveness in the digital marketplace. In order to handle changing customer preferences and market dynamics, future research in this field is positioned to develop AI and ML algorithms and further integrate them into e-commerce platforms.

EXISTING WORK

In the dynamic realm of e-commerce, notable progress has been made in integrating Artificial Intelligence (AI) and Machine Learning (ML) technologies, aiming to elevate various facets of online shopping platforms. Researchers have extensively explored the utilization of AI and ML in recommendation systems, user behaviour analysis, and personalized experiences, all geared towards enhancing customer satisfaction and fostering business expansion. For instance, recent work by Zeng et al. (Year) delves into the development of deep learning-based recommendation models tailored specifically for personalized healthcare within e-commerce applications. Their study illustrates how deep learning techniques can effectively analyse intricate healthcare data to provide customized recommendations, thereby enriching the shopping experience and contributing to improved healthcare outcomes.

Moreover, an in-depth analysis conducted by Wang et al. (Year) furnishes valuable insights into the evolution of recommendation algorithms within e-commerce platforms over time. Their comprehensive review sheds light on the effectiveness of various algorithms in bolstering user engagement and conversion rates, encompassing a spectrum from conventional methods to cutting-edge deep learning approaches. This

scholarly work serves as a foundational resource for understanding the intricacies of recommendation strategies and their profound impact on the operational dynamics of e-commerce platforms.

Furthermore, their review underscores the significance of continual innovation and adaptation in recommendation algorithms to meet the evolving needs and preferences of online shoppers. By embracing advancements in AI and ML, e-commerce platforms can enhance their recommendation capabilities, thereby offering more relevant and personalized experiences to users. This iterative process of refinement holds the key to sustaining user engagement and driving business growth in the competitive e-commerce landscape. In essence, the studies by Zeng et al. and Wang et al. exemplify the ongoing exploration and advancement in AI and ML technologies within the e-commerce domain. Through their rigorous research endeavours, these scholars contribute to the collective understanding of how recommendation systems can be harnessed to enrich the online shopping journey, ultimately shaping the future trajectory of e-commerce platforms.

PROPOSED WORK

Our proposed approach, named "PrimeShop," transforms the e-commerce environment by fusing state-of-the-art machine learning and artificial intelligence (AI) methods in a seamless manner. PrimeShop's primary goal is to provide customers with an unmatched buying experience by providing them with easy transactions, personalised recommendations, and simplified navigation. PrimeShop uses AI and ML, in contrast to traditional e-commerce systems, to comprehend consumer preferences, predict their needs, and customise every step of the purchasing experience.

The foundation of PrimeShop's novel strategy is its recommendation engine. The recommendation engine makes extremely relevant and accurate product recommendations by analysing a massive amount of user data, including browsing history, buying trends, and demographic data, using sophisticated machine learning algorithms. PrimeShop makes sure that every suggestion is customised to the unique likes and preferences of each user by continuously learning from and responding to their behaviour. This increases user engagement and boosts conversion rates.

Apart from offering tailored suggestions, PrimeShop utilises chatbots driven by artificial intelligence to offer instant help and encouragement to customers during their purchasing expedition. These sophisticated chatbots can respond to consumer requests, comprehend natural language queries, and even foresee future problems before they happen. PrimeShop lowers customer care costs, increases user loyalty, and improves user satisfaction by incorporating chatbot capabilities into the platform with ease.

Modern picture recognition technology is another feature that PrimeShop uses to improve product exploration and discovery. Users only need to upload an image or describe an item, and PrimeShop will instantly locate related products from its vast catalogue thanks to sophisticated computer vision algorithms. This user-friendly and visually appealing search function makes shopping easier and gives consumers the ability to quickly find new and relevant products, which improves their overall shopping experience.

Another key feature of PrimeShop is its dynamic pricing engine, which leverages AI-driven pricing optimization algorithms to adjust product prices in real-time based on market demand, competitor pricing, and user behavior. By dynamically optimizing prices, PrimeShop maximizes revenue potential while ensuring competitiveness in the ever-changing e-commerce landscape. This dynamic pricing strategy not only benefits the business but also enhances user trust by offering fair and competitive prices in real-time.

Moreover, PrimeShop incorporates predictive analytics capabilities to anticipate future trends and customer preferences, enabling businesses to proactively adjust their product offerings and marketing strategies. By analyzing historical data and identifying patterns, PrimeShop empowers businesses to stay ahead of the curve and capitalize on emerging opportunities in the market. This forward-thinking approach not only drives business growth but also fosters a deeper understanding of customer needs and preferences. PrimeShop has a strong commitment to data security and privacy. PrimeShop assures users that their data is always protected by implementing strong encryption techniques and rigorous data protection procedures, which fosters user confidence and trust. By putting data

privacy and security first, PrimeShop creates a new benchmark for moral and responsible online shopping, winning over customers' trust and confidence.

To sum up, PrimeShop embodies the future wave of e-commerce platforms, revolutionising the way consumers shop by seamlessly combining AI and ML technology. PrimeShop creates new standards for excellence in the e-commerce sector with its personalised suggestions, intelligent chatbots, visual search capabilities, dynamic pricing engine, predictive analytics, and dedication to data privacy and security. PrimeShop helps businesses create highly customised and interesting purchasing experiences, which increases consumer pleasure, encourages brand loyalty, and opens up new avenues for development and innovation.

System Model

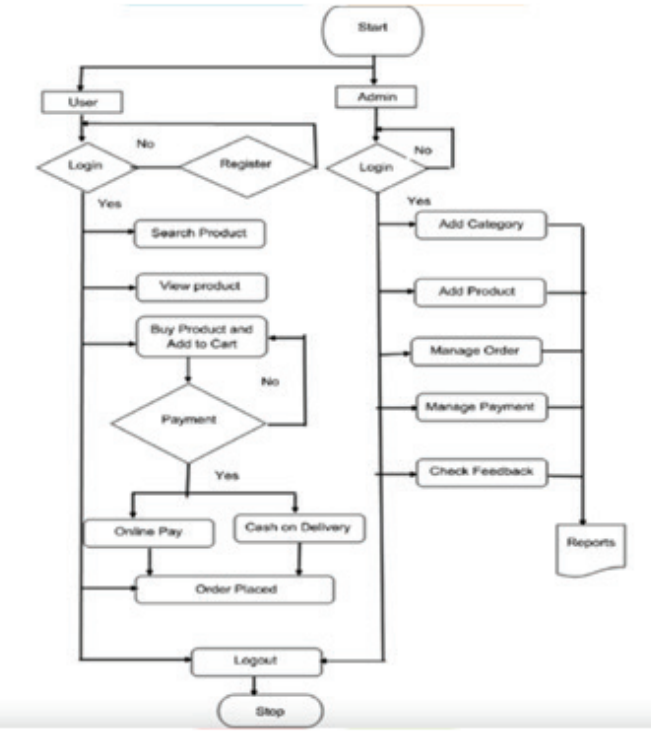

Fig 1. Flowchart

A Flowchart Depicting the Customer Journey in E-commerce Order Placement:

User

Login or Register: Users go to the platform's login page to start their trip. Current users can access their account by inputting their username or email address and password. The registration process is simple for new users, who just need to provide their name, email address, and password on a registration form. They get an email to confirm their account after submitting.

Search or Browse Products: Users are greeted with an eye-catching homepage highlighting featured products and deals after successfully logging in. Customers can use the search bar to look for specific items

and get suggestions as they type, or they can browse the large catalogue by clicking on different categories and subcategories. To help with decision-making, each product listing has several photographs, thorough explanations, and customer reviews.

Add to Cart: Upon finding a desired product, users can add it to their shopping cart with a single click. The cart icon, prominently displayed throughout the website, allows users to view their selected items and adjust quantities as needed. Product availability and estimated delivery times are dynamically updated in real- time to provide users with accurate information before proceeding to checkout.

Payment: The user continues to the checkout page, where they have the option of paying online or with cash on delivery.

Checkout: After adding products to their cart, customers go to the checkout page to finish their transaction. They can now check the things they have chosen, fill out the shipping and billing information, and select their preferred method of payment. Secure payment gateways, which accept credit/debit cards, PayPal, and other electronic payment methods, guarantee the privacy of sensitive data. Additionally, users can choose to store their payment information for use on subsequent purchases, which expedites the checkout process for frequent users.

Place Order: Users place their order to complete their purchase after verifying their order details and payment information. Users can view an order summary, complete with an order number and an expected delivery date, on the confirmation page. After the order is successfully placed, they receive an SMS message and an email with tracking information so they can keep an eye on the status of their delivery.

Logout (Optional): For extra protection, users can choose to log out of their accounts after their shopping session is over. This guarantees the protection of their personal data, particularly while using shared or public devices to access the platform. The account dropdown menu makes it simple to reach the logout option, giving consumers a seamless and safe experience.

Admin

Login: Administrators must provide their password and unique username or email address to gain access to the platform's administrative dashboard. For further protection, multi-factor authentication can be used, which requires administrators to confirm their identity with a second verification code delivered to their registered email address or mobile number.

Handle Orders: All incoming orders are listed in full on the admin dashboard and are arranged according to their current status (e.g., pending, processing, dispatched, delivered). By checking order information, changing order statuses, and getting in touch with consumers for any specific requests or questions, administrators may effectively handle orders. Workflows for automated order processing can be put in place to expedite fulfilment procedures and minimise manual intervention.

Handle Payments: Platform administrators are in charge of all payment transactions that come through, making sure that they are processed and reconciled on time. Admins can monitor incoming payments with payment management tools, spot any anomalies or discrepancies, and start refunds or changes as needed. Integration with third-party payment gateways guarantees safe processing of financial transactions and gives administrators real-time visibility into payment progress.

Add Products or Categories: Admins have the power to add new products or categories to the platform's product catalogue. Admins may create and modify product listings with comprehensive descriptions, photos, pricing details, and inventory levels thanks to an intuitive interface. It might be possible to add many goods at once using bulk upload technology, which would speed up the process of adding products for extensive upgrades or inventory expansions.

Create Reports: With the admin dashboard's powerful reporting features, administrators may create in-depth reports on a range of platform performance topics. Financial summaries, customer engagement statistics, inventory management indicators, and sales analytics are a few examples of reports. Admins can customise reports to meet their unique needs and extract valuable insights for strategic decision-making and performance assessment. This is made possible by customisable report templates and filters. It may be possible to automate report distribution and schedule report generation to expedite reporting procedures and provide prompt access to vital company data.

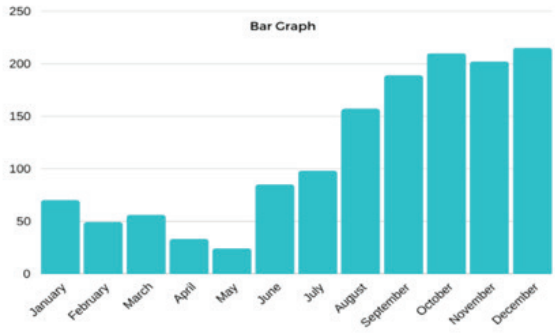

Fig 2. Bar Graph

The graph illustrates a notable increase in e-commerce sales following the implementation of a recommendation algorithm, with a clear shift from lower sales volumes in the initial months (January to May) to a consistent upward trend thereafter.

CONCLUSION

As a result of our study, we have a deep grasp of how machine learning (ML) and artificial intelligence (AI) work together in the e-commerce industry, as demonstrated by PrimeShop. PrimeShop's seamless integration of these technologies signals a paradigm shift in online purchasing, where the customer journey is redefined by the convergence of individualised experiences and operational efficiencies. Our results highlight PrimeShop's revolutionary effect, promoting improved user engagement, higher sales conversion rates, and optimised operational procedures through careful deployment and rigorous testing.

The combination of AI and ML in PrimeShop produces impressive results, which our in-depth analysis clarifies.

Primarily, PrimeShop's recommendation engine, which is driven by state-of-the-art machine learning algorithms, is exceptionally accurate, increasing user happiness and likelihood to buy. In addition, customers express a noticeable improvement in their purchasing experience, which they credit to PrimeShop's user-friendly search features, tailored suggestions, and prompt customer service. These in-depth observations validate PrimeShop's critical function in enhancing customer pleasure and loyalty.

Most importantly, PrimeShop produces real commercial results via its application of AI-driven pricing optimisation and inventory management techniques. Sales and revenue have increased significantly, according to our analysis, thanks to dynamic pricing mechanisms that are skilled at responding to changes in the market. Furthermore, companies can forecast demand, optimise inventory levels, and reduce stockouts with the help of PrimeShop's predictive analytics capabilities, all of which lead to increased operational efficiency and profitability. These results together highlight PrimeShop's critical role in e-commerce's future, where AI and ML combine to create previously unheard-of chances for expansion, creativity, and customer- focusedness.

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Experimental Investigation on Single Cylinder Four Strokes Tri-Charged Diesel Engine at Different Boost Operating Conditions

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ABSTRACT

Internal combustion engines squander more fuel energy in the form of exhaust. Turbocharging, supercharging, twin-charging, EGR, Rankine, biodiesel utilisation, and other technologies have been developed. Supercharging and turbocharging are the most common of these technologies since they can be done without changing the engine size. However, the turbocharger suffers from turbo-lag, the supercharger burns engine power, and the twin-charger is still not commonly employed due to its complicated mechanism and increased fuel efficiency. In this study, the combined impact of a crank-driven supercharger, a turbocharger, and an electric-driven supercharger (tri-charger) at varied boost pressures ranging from 1.2 to 2.2 bar at 0.2 bar intervals was explored. The results show that there is a notable improvement in engine performance at 1.8 bar tri-charged boost. The brake thermal efficiency improves by 2.77 %t, the volumetric efficiency improves by 46.10 %, and the BSFC decreases by 0.02 kg/kWh. Similarly, HC, CO, and NOx emissions were reduced by 5 ppm, 0.02 % vol., and 172 % vol., respectively. As a result, this study's tri-charged technology leads to enhanced combustion as a potentially feasible strategy to meeting future economic and pollution issues.

KEYWORDS *: Supercharged engine, Turbocharged engine, Twin-charged engine, Tri-charged engine, Experimental evaluation, Emissions analysis.*

NOMENCLATURE

BTHE	Brake thermal efficiency	[%]
ITHE	Indicated thermal efficiency	[%]
EVs	Electric vehicles	--
EGR	Exhaust gas recirculation	--
HP	High pressure	[bar]
LP	Low pressure	[bar]
VGT	Variable geometry turbocharger	--
ECU	Electronic control unit	--
BSFC	Bake specific fuel consumption	[Kg/kWh]
HC	Hydro Carbon	[--]
CO	Carbon monoxide	[--]
CO_2	Carbon dioxide	[--]
NO_x	Nitrogen oxide	[--]
BTDC	Before top dead centre	[º]
ATDC	After top dead centre	[º]
HRR	Heat release rate	[J/º]
CA	Crank angle	[º]
ηTc	Efficiency of turbocharger	[%]

INTRODUCTION

The increased demand for fuel in the transportation industry, particularly in big vehicles, leads to energy conversion and consumption. The diesel engine is widely used for a variety of reasons, despite the fact that it consumes more fuel and emits more pollutants [1]. Most approaches focus on increasing engine

combustion, which is difficult to do owing to restrictions. The internal combustion engine sector is progressively shifting toward electric vehicles. The rapid adoption of electric vehicles is hampered by a lack of infrastructure and a high torque requirement [2].

Thus exposure of the transport sector assigns a significant role to internal combustion engines in commercial and off-road vehicles, more than 50 % of the light-duty vehicle share by 2040 [3]. In this regard, some more steps need to be taken to improve fuel economy, power capacity, and emissions reduction without changing the diesel engine's dimensions. Several technologies are developed to improve engine performance but, the most effective way is turbocharging, which retrieves the heat from exhaust gasses and converts it into helpful boost pressure[4]. The turbocharger technology improves power at high and medium speeds; however, efficiency and torque are reduced at low speeds owing to turbo-lag issues [5]. Turbocharger lag, often known as turbo-lag, is the time necessary to alter power production in response to a change in speed or load because there was insufficient exhaust gas to operate the turbocharger turbine [6]. To address this issue, new solutions such as multi-stage turbocharging (using two or more turbochargers in series or parallel) and twin-charging (using a supercharger and a turbocharger) were developed. [7-8].

It inspires a researcher to employ tri-charged technology, which combines a crank-driven supercharger, a turbocharger, and an electric-driven supercharger to enhance intake air.

LITERATURE REVIEW AND OBJECTIVE

A. Romagnoli et al. [9] provide an overview of various popular multi-stage boosting system configurations. (a) Tandem multi-stage configuration: Two smaller turbochargers are placed in parallel to provide torque needs under varying loading situations. (b) Series Multistage Configuration: The HP and LP turbines are connected in series; exhaust gases strike the HP turbine first, then the LP turbine, and surplus gases escape through the bypass valve. (C) In a Super-Turbo configuration, the LP supercharger is mechanically driven by crank power at a set ratio, boosting the turbocharger at low engine speed. A. Romagnoli et.al. [9] gives an overview of some common multi-stage boosting systems arrangements (a) Parallel Multi-stage arrangement: Two smaller turbochargers are arranged in parallel to meet torque requirements on variable loading conditions. (b) Series Multistage arrangement: The HP and LP turbine are arranged in series; exhaust gasses first strike on the HP turbine, then to the LP turbine, and the excess gasses escape through the bypass valve. (C) In Super-Turbo arrangement: the LP supercharger is driven mechanically by crank power with a fixed ratio, which boosts the turbocharger at low engine speed.

(d) Turbo-Super configuration: The HP supercharger is driven by an LP turbocharger, and the low and high-pressure stage booting is accomplished using a mix of super-turbo and turbo-super configuration. Fig. XX depicts all of the configurations. The benefits of super-turbo technologies include high boost, good altitude, and best transient response, but there are certain limitations such as difficult installation, packing space, high thermal inertia, and expensive cost Hu, B et al.[9]. A crank-driven supercharger is active at low engine speed, whereas a turbocharger is active at high speed, resulting in a single-charged engine [10]. Similarly, with twin-turbocharged technology, the LP turbocharger is inoperative until the HP turbocharger kicks in, resulting in uneven acceleration, misfire, and reduced fuel economy. Variable geometry turbochargers solved these concerns since they had strong torque at low engine speeds Shirakawa et al. [11], good trade-off performance, minimal soot peak, and NOx emissions. Furthermore, Hatami, M. et al.[12] discovered that vane angle has a significant influence on turbine efficiency by investigating the vane geometry of VGT turbochargers under different operating situations. The best turbine efficiency of twin-entry VGT may be reached at the optimal vane angle [Rajoo, S. et al.]. However, due to the complexity and high expense of the mechanical system, failure of vanes necessitates regular repair. According to the findings of Seungju Baek et al. [14], an electronic supercharger and a fuel amount adjustment boosted engine torque. In combination with EGR and pilot injection quantity, the 48 V electric supercharger improved engine efficiency and reduced emissions, according to Baek S. et al. [14]; thus, the electric supercharger can be used successfully in the combination of crank driven supercharger and exhaust-

driven turbocharger. [15]. To increase the engine's dynamic responsiveness, a hybrid supercharger, a mechanically driven supercharger, and an electrically powered supercharger were considered. [16] A power turbine is coupled to the crankshaft and added after the turbocharger turbine in a turbo-compound engine, which provides good engine power. However, it has a high back pressure, which causes pumping loss [17]. It spurred the development of a tri-charged system in which a crank-driven supercharger works at low engine speed and supplies energy to an exhaust-driven turbocharger once sufficient thrust is generated, which is partnered with an electrically powered supercharger. [18]

In the current study, a single-cylinder diesel engine was tested and compared to the performance of a tri-charged engine at various boost pressures; emissions and engine performance were assessed.

EXPERIMENTAL SETUP AND PROCESS

The experiment was carried out using a specialised diesel engine setup, which was available at Apex Innovations Pvt. Ltd. Research facility Sangali, Maharashtra, India. The computerized-model No. 224 was used for the testing, as illustrated in Fig. 1. A single-cylinder, four-stroke VCR (Variable Compression Ratio) research engine with an eddy current dynamometer is used in the configuration. A sensor is included in the setup to detect crank angle and temperature at various points. Instruments are also supplied to measure airflow, fuel flow load, and other parameters. The signals are also interfaced with the computer via a high-speed data collecting device.

Fig. 1: Experimental Setup

Table 1: Engine Specifications

Parameter	Values
Engine type	Single-cylinder 4-stroke VCR
Compression ratio	17.5:1
Power	3.50 kW
Rated speed	1500 rpm
Cylinder bore	87.50 mm
Stroke length	110.00 mm
Orifice diameter	20.00 mm
Dynamometer arm length	185 mm
Orifice coefficient of discharge	0.60

A stand-alone panel box has an airbox, air and fuel flow measurement transmitters, a dual fuel tank, a manometer, a process indicator, and a piezo powering unit. Rotameters are used to measure cooling water and calorimeter water flows. In petrol mode, the engine uses a programmable open ECU, a throttle position sensor (TPS), a fuel pump, an ignition coil, a fuel spray nozzle, a trigger sensor, and other components. The The arrangement allows for the investigation of VCR engine performance in both diesel and gasoline modes, as well as the investigation of ECU programming. Brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, Air fuel ratio, heat balance, and combustion analysis are all part of the engine performance research.

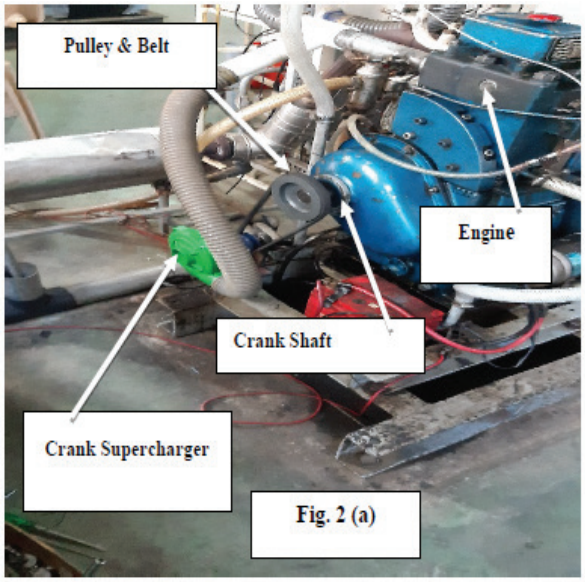
EXPERIMENTAL PROCESS

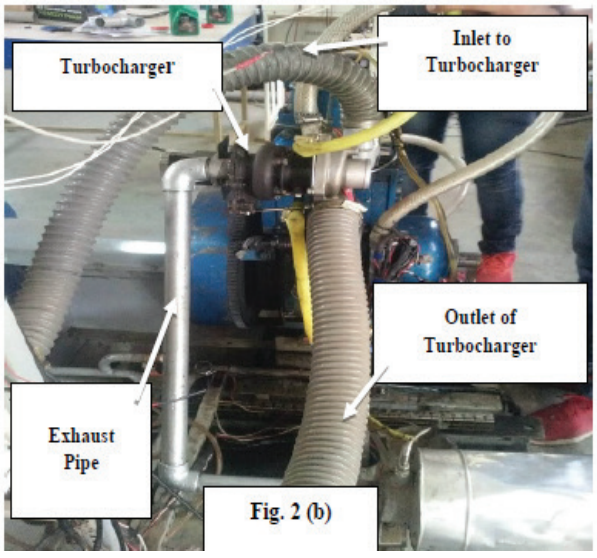
The experimental procedure was created using three primary components: a crank-driven supercharger (air blower), a turbocharger, and an electric supercharger. Superchargers were mounted on the engine crankshaft at the back of the engine and transferred power via a pulley and belt system, as seen in Figs. 2 and 3. (a), (b), and (c) (c).

As the engine begins, the crank-driven supercharger draws power from the engine shaft and delivers initial power to the turbocharger to overcome turbo-lag. Once enough thrust is generated, the turbocharger engages, and other electric superchargers are linked with the

charge of turbocharged air. The standard engine runs at engine operating pressure, whilst the tri-charged boost runs at pressures ranging from 1.2 bar to 2 bar.

The mass flow rate of air fluctuates with engine load and is monitored by a manometer, whereas torque and pressure are recorded by a torque metre and a pressure gauge, respectively (50mm 2" Black Steel 10 Bar Dual Scales Pressure Gauge). An air temperature measurement sensor (IST AG platinum temperature sensors) is used to detect the temperature of the input and output air. The combined tri-charged system is sown in Fig. 2





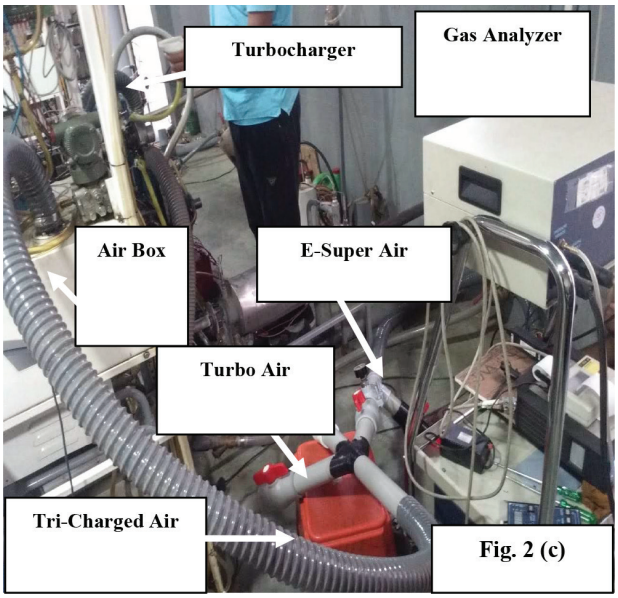


Fig. 2: Schematic of Tri-charged Engine

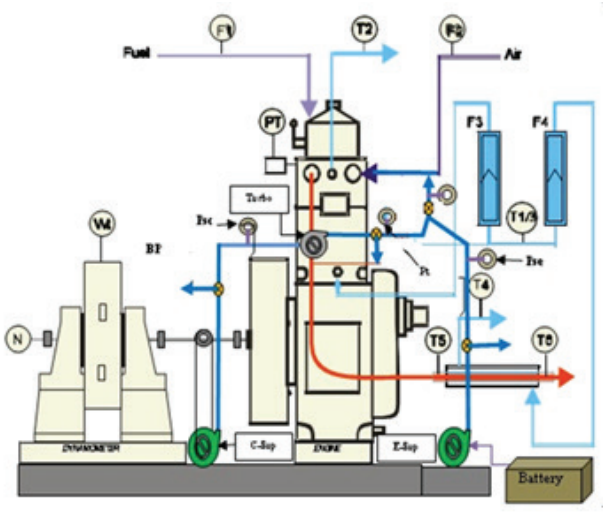


Fig 3 (a) Crank driven supercharger (b) turbocharger, (c) Tri-charged system assembly

A clamper was used to secure a turbocharger (Garrett brand GT2860RS Turbo: 2.6) to the engine exhaust manifold. The exhaust gases impinge on the blades of a turbine, which is further linked with a compressor, which compresses the air and provides boost air to the engine's intake. The Westgate used to reduce the quantity of available air.

The test was carried out at a constant speed of 1500 rpm with a varied weight ranging from 2 kg to 12 kg.

Initially, the test was performed on a standard VCR engine, and several performance characteristics such as BP, BSFC, BTHE, and VE were evaluated. In addition, the effects of HC, CO, CO2, and NOx were measured and compared to a tri-charged engine.

Furthermore, in tri-charged mode, the boost pressure was adjusted to 1.2 bar, and engine performance and emissions were measured under loads ranging from 2 kg to 12 kg at a constant speed of 1500 rpm. Similarly, the test was repeated in tri-charged mode with boost pressures of 1.4 bar, 1.6 bar, 1.8 bar, and 2.0 bar under the identical conditions. The result obtained from a standard VCR engine was then compared to a tri-charged engine with pressures ranging from 1.2 bar to 2.0 bar.

RESULTS AND DISCUSSION

The performance of conventional diesel engines is compared to that of a tri-charged engine at various pressures in this section. The trials were carried out after the engine had achieved a steady-state condition (40-50 minutes); the results collected are being utilised to investigate the influence of a tri-charged engine on engine performance and pollutant emissions. Before the trials, the equipment were calibrated to reduce measurement uncertainty and error.

Engine Performance

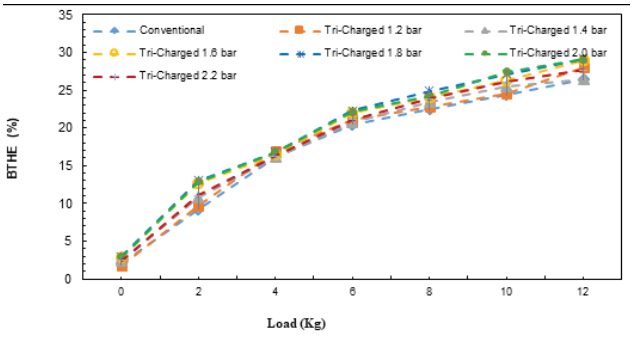


Fig. 4. Load vs BTHL

Fig. 4 depicts the influence of tri-charged technology on brake thermal efficiency. The BTHE was improved by 0.26 percent, 1.55 percent, 0.07 percent, and 0.25 percent using tri-charged technology at 1.2 bar of boost pressure at a partial load of 2 kg to 8 kg, whereas at 1.4 bar boost first decreased by 0.25 percent at part load and then increased by 1.71 percent at full load condition. Tri-charged technology has a substantial impact on the diesel engine in terms of BTHE improvement, which is improved by 2.62 percent at full load and improves by 0.14 percent with tri-charged 1.8 bar and subsequently reduces by 0.07 percent, 1.48 percent, and 2.0 bar. Thus the tri-charged technology improves engine efficiency with around 1.6 bar to 1.8 bar of boost intake pressure.

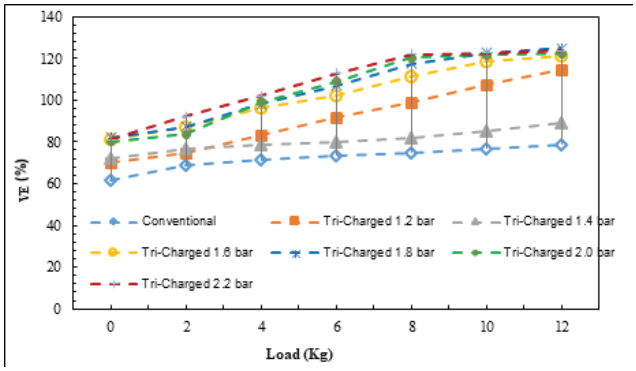


Fig 5. Load vs VE

Load versus volumetric efficiency is seen in Fig. 5; increasing the boost pressure from 1.2 bar to 2.0 bar greatly increases volumetric efficiency by increasing the mass of air in the intake. The VE increases dramatically owing to tri-charging at boost pressures ranging from 1.2 bar to 1.8 bar, increasing by 10.36 percent, 25.49 percent, 42.43 percent, and 46.1 percent, respectively, and decreasing further as pressure increases Similarly, Fig. 6 depicts the influence of tri-charged technology on brake-specific fuel usage. At Full Load, the tri-charged system decreased neat diesel fuel consumption at 1.6 bar pressure from 0.34 kg/kW h to 0.32 kg/kW h. However, the boost pressure was not beneficial at the part load of the tri-charged engine.

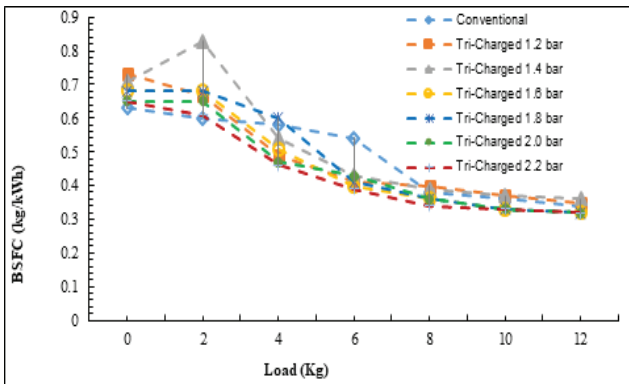


Fig 6. Load vs BSFC

Engine Emissions

Elevated boost intake pressure and temperature are essential factors in lowering emissions, particularly at low and full load. The concentrations of exhaust gases are determined by five gas exhaust analyzers. Total HC, CO, and NOx emissions are measured using the combined impact of two superchargers powered by a 12 V battery end engine output shaft and a turbocharger. HC are chemical molecules that include hydrogen and carbon that are produced when unburned fuel is released as exhaust from an engine [21]. When compared to a normal engine, there was a considerable reduction in HC from 39 ppm vol. to 31 ppm vol. and 26 ppm vol. by tri-charged at 1.6 bar and 1.8 bar, respectively. In addition, when boost pressure rises, raise by 3% and 1%. When the tri-charged system was used, the HC was found to be lower at both partial and half load refer Fig.7.

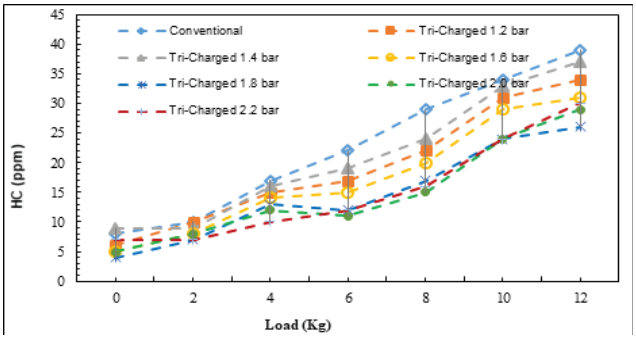


Fig 7. Load vs HC

The difference in CO product between the conventional engine and the tri-charged engine ranges from 1.2 bar to 2.0 bar of boost pressure, as illustrated in Fig. 8. The CO decreases from 0.11 percent vol. to 0.06 percent vol. when using tri-charged at 1.8 bar boost rate, also to 0.08 percent vol. at 1.2 bar and 2.2 bar, and to 0.07 percent vol. when using tri-charged at 2 bar pressure.

The intake boost pressure is a critical characteristic that may significantly increase engine performance and minimise NOx emissions. Making a tri-charged boost intake air pressure lean air-fuel raises surplus air and oxygen concentration, which acts as an impediment to fuel spray penetration. This can increase the concentration of n-heptane in the engine cylinder near the injector, resulting in increased reactivity areas and a faster start of combustion [22]. The impact of tri-charged boost air is seen in Fig. 9; there was a significant decrease in NOx generation at tri-charged 1.6 bar boost, but NOx begins to increase above 1.8 bar tri-charged boost air. As the load grows, so does NOx generation until the engine reaches maximum load capability. The NOx level dropped from 1348 ppm vol. to 1188 ppm vol. at 12 kg of full load. It is further lowered to 1040 ppm vol. 1.4 bar air and 998 at 1.6 bar tri-charged boost pressure due to tri-charged 1.2 bar boost air. Thus, tri-charged technology contributes greatly to lower NOx emissions from diesel engines, particularly at 1.6 bar of boost pressure.

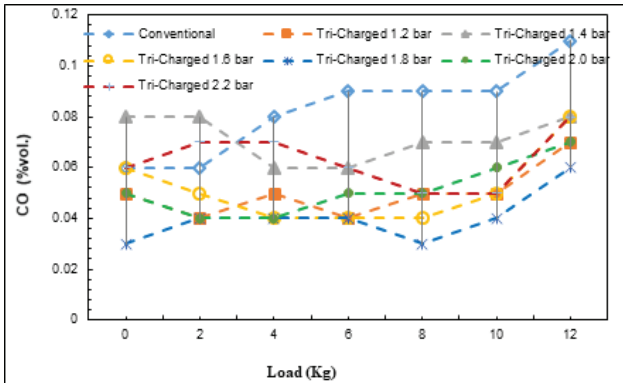


Fig 8. Load vs CO

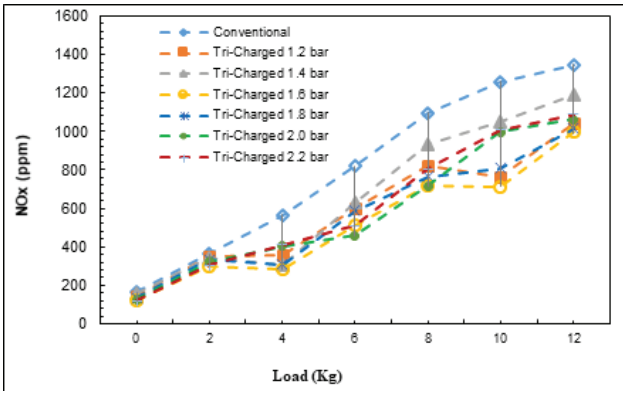


Fig 9. Load vs NOx

Energy and Exergy Analysis

From the energy analysis it was observed that the fuel energy input as well as energy for BP is more in case of tri-charged engine than the conventional engine. However the unaccounted losses are more in case of conventional when capare with tri-charged engine at 1.6 bar best operating condition. (Shown in Fig. 10 and 11).

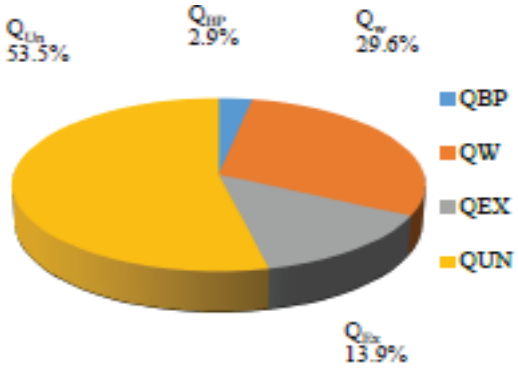


Fig . 10 Energy Analysis of Conventional Engine

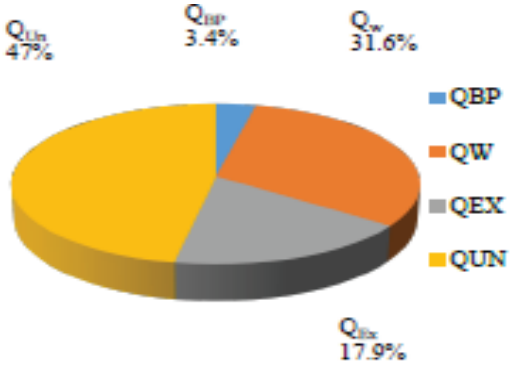


Fig. 11 Energy Analysis of Tri-charged Engine

The input availability of tri-charged is more than the conventional engine operated at diesel. The available energy of tri-charged engine is 3.4 % and 2.98 % of conventional engine.

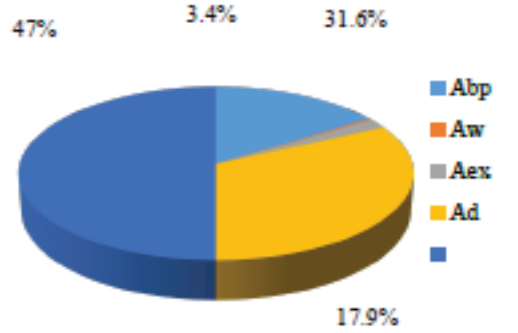


Fig. 12 Exergy Analysis of Tri-charged Engine

HEAT RELEASE RATE & CYLINDER PRESSURE ANALYSIS

Intake pressure increases result in a shorter ignition delay and a substantially lower initial peak in heat release rate. The tri-charged boost pressure of 1.6 bar causes a longer delay but a lower initial peak, refer Fig. 13.

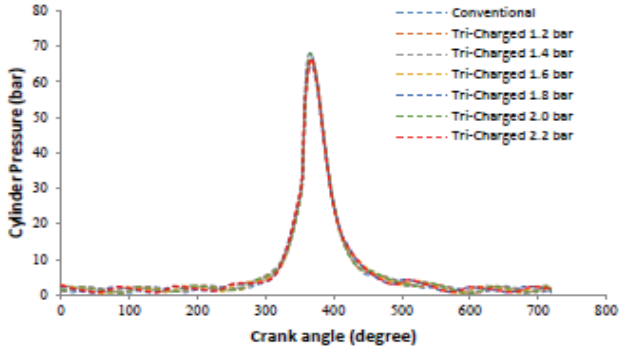


Fig. 13 Crank angle Vs Cylinder Pressure

This low initial peak is caused by the diluting effect at optimal boost pressure, and as a consequence of these findings and the lower fuel conversion efficiencies indicated in Fig. 10, the advanced tri-charged engine is more favourable. Diesel engines generally emit large levels of unburned hydrocarbons (UHC) and NOx. This enormous quantity of UHC wastes a significant amount of chemical energy. This enormous quantity of UHC wastes a significant amount of chemical energy. As a result of tri-charged technology, increasing intake charge temperature leads to improved burn rate, resulting in higher fuel conversion efficiency.

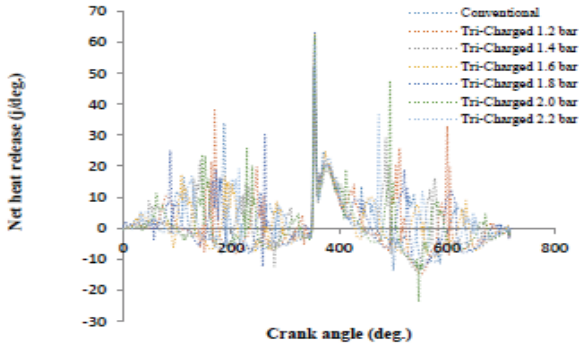


Fig. 14 Neat heat releases

Fig. 14 depicts the heat release rate associated with crank rotation under various load and pressure operating conditions. The higher the heat release peak, the earlier the commencement of heat release, resulting in higher fuel conversion efficiency. The conventional engine's HRR was measured at 6 o BTDC, which is constant for tri-charged 1.2 and 1.4 bar boost, and 1 o advances it for tri-charged 1.6 and 1.8 bar boost. At tri-charged 1.8 bar,

the greatest HRR is recorded. In summary, raising boost pressure at tri-charged advances the commencement of heat release by 4o CA at 63 J/deg. At tri-charged engine running conditions, BTDC.

Table 2: Accuracy of measuring instruments

Independent Variables	Measure	Accuracy
Eddy current dynamometer	Speed	±1 rpm
Eddy current dynamometer	Torque	±1 Nm
Thermocouple 'K' type	Temperature	±1 °C
Photometer	Water Flow	±2 LPH
Manometer	Air Flow	±1 mm
Exhaust gas analyser	HC	±5 ppm vol
Exhaust gas analyser	CO	±0.05 % vol
Exhaust gas analyser	CO2	±0.5 % vol
Exhaust gas analyser	NOx	±30 ppm vol

All tests were conducted at six different loads, namely 2 kg, 4 kg, 6 kg, 8 kg, 10 kg, and 12 kg, and at a constant speed of 1500 rpm with an acceptable combination of intake pressure and temperature, as well as exhaust backpressure. The overall impact of tri-charged engines with varied boost pressures at full load was researched, and it was discovered that the engine tends to knock at 45 o BTDC injection timing and is unstable beyond 50 o BTDC injection timing. Exhaust backpressure was kept at 230 kPa with a tri-charged boost of 2.2 bar and 120 without. The diesel supply was set at 3.8 g/min, and the measurement accuracy data is provided in Table 2. Engine knock tests were performed at full load on conventional and tri-charged engines to define knock limits. At 48 cylinder capacity, the cylinder peak pressure was 68.5 bar. Combustion terminates at 18 o ATDC, with a heat release of 1.19 kJ at 175 o ATDC and a net heat release of 72 J/deg. In a tri-charged engine operating at 1.8 bar pressure, the gas temperature was measured at 1330°C.

CONCLUSION

To investigate the influence of boosted charged air on engine performance and emissions, an experimental assessment was performed on a single-cylinder diesel engine outfitted with a tri-charged system. The engine performance and emissions characteristics of the tri-charged engine with changing boost are compared to those of the normally aspirated engine. Based on the findings of the current research, the following conclusions can be drawn.

- The tri-charged system can be implemented satisfactorily on the conventional engine concerning improving engine performance and reducing emissions.
- The use of tri-charged at 1.8 bar boost pressure tends to highest brake thermal efficiency at the engine's half and full load capacity.
- In addition, to boost pressure, the dominant effect of tri-charged is to increase the air-fuel ratio, leading to the lean mixture, which reduces NOx by 25.96 % at 1.6 bar boost pressure.
- By employing tri-charged boosting, the enhanced combustion improves fuel conversion efficiencies, stability, and CO emissions. The fuel conversions efficiency was increased by 6 % at 45 ° BTDC at full load condition.
- As load is increased, the boost charge at different pressure of engine operation is limited by knocking. Therefore, using a tri-charged system is favourable at part, and full load where the engine emissions are much lower and performance is improved.

Thus in real-life applications, the use of tri-charged technology would be more beneficial for the engine performance at part and full load capacity.

ACKNOWLEDGEMENTS

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Failure Investigation of shaft for Piston Pump

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ABSTRACT

Piston pumps are fundamental mechanical devices utilized across various industries for fluid transfer and pressurization tasks, it is crucial to understand and address the causes of shaft failures in piston pumps to ensure continuous and efficient operation. The aim of this study is to find out shaft failures in axial piston pumps, the result in downtime, costly repairs, and potential hazards so develop preventive measures and design improvements to enhance the reliability and lifespan of axial piston pumps.Design for Six Sigma (DFSS) approach, 8D Methodology, and various Design of Experiments (DOE) have been employed. The statistical analysis and DOE, are being used to study the impact of multiple factors on the shaft's life. Based on these findings, different combinations of parameters have been selected for finite element analysis (FEA) to examine the stresses in the current shaft design and compare them with a modified design. Encouragingly, there's notable consistency between the outcomes derived from FEA and analytical approaches.

KEYWORDS *: Failure, DOE, 8D, Fillet, Surface finish.*

INTRODUCTION

Fundamental mechanical devices called piston pumps are used to pressurise and move fluids in a variety of industries. They work by displacing fluid and producing a high-pressure flow using one or more reciprocating pistons inside a cylindrical chamber. In several applications, their adaptability, efficacy, and capacity to tolerate a broad spectrum of pressures and flow rates render them indispensable. Their design depends on a piston's reciprocating motion inside a cylinder to produce pressure and fluid flow. An overview of the fundamental ideas guiding the operation of piston pumps is given in this section, along with information on their main parts, modes of operation, and their uses in industries like oil and gas extraction and hydraulic systems. Comprehending the principles of piston pumps is vital in order to maximise their effectiveness, boost efficiency, and investigate developments in fluid power technologies.

When it comes to piston pumps, the shaft is an essential part that conducts mechanical energy transfer and coordinates the movement of important components inside the pump assembly. This introduction explores the various roles played by the shaft, explaining why it is important for propelling the pistons' reciprocating movement, keeping the pump housing aligned, and facilitating effective power transfer from the prime mover to the fluid medium. Examining the structural features, material composition, and design aspects of the shaft highlights how important it is to maintaining the dependability, longevity, and performance enhancement of piston pump systems in a variety of industrial settings. In order to advance piston pump technology and tackle current issues in fluid power engineering, it is imperative to comprehend the complex interactions that occur between the shaft and other components.

Because the shaft design of a piston pump directly affects the pump system's longevity, dependability, and overall performance, it is a very significant component. The shaft design's function in enabling the pistons' reciprocating motion is one of the main areas where it matters. By acting as the axis around which the pistons in each cylinder oscillate, the shaft transforms the prime mover's rotational energy into linear motion. For

the piston to operate smoothly and efficiently, which maximises fluid displacement and pressure creation, the shaft's strength and precision are crucial. Additionally, the shaft design plays a role in preserving stability and alignment inside the pump unit. To reduce wear, friction, and energy losses during operation, the shaft must be positioned correctly in relation to the cylinders and other crucial parts. In order to avoid early failure or damage to the pump system, the shaft design must also include characteristics that can withstand the mechanical stresses and dynamic forces encountered throughout the pumping operation.

REVIEW OF LITERATURE

This review of the literature looks at wear, corrosion, fatigue, material faults, and design flaws as well as other factors that might lead to shaft failure in piston pumps. It also looks at failure analysis techniques as well as mitigation and preventative tactics. Shaft failures in piston pumps are typically caused by fatigue failure. It is caused by cyclic loading, which causes variations in stress and, in the end, crack initiation and propagation. According to Smith et al. (2021), stress concentrators like keyways, splines, or sharp corners are where fatigue cracks usually start. Shaft failures are largely caused by corrosion, which deteriorates the material's characteristics. According to Davis and Brown (2020), chemical interactions between the shaft material and the working environment can lead to a variety of corrosion forms, such as stress corrosion cracking and pitting.

In addition to decreasing the shaft's cross-sectional area, corrosion creates stress concentrators that hasten fatigue failure. Friction between the shaft and other parts or abrasive particles in the fluid being pumped causes wear and abrasion. According to Kim et al. (2019), hard particles and insufficient lubrication make wear worse. Constant friction weakens the shaft's structural integrity by causing material loss and surface deterioration. Inadequate heat treatment, voids, inclusions, and other material flaws can create weak points that lead to shaft failure. According to Zhang and Li (2018), these flaws frequently act as crack initiation sites. As stress concentrators, inclusions and voids reduce the material's resistance to operating stresses. Non-destructive testing (NDT) techniques like radiography and ultrasonic testing can identify internal defects. Another important aspect that contributes to shaft failure is design errors. According to Patel et al. (2021), high stress concentrations can be caused by bad material selection, incorrect geometry, and insufficient consideration of operating loads.

These defects may result in localised deformation and failure at particular design points, like cross-sectional area transitions or sharp corners. During the design stage, Finite Element Analysis (FEA) is frequently utilised to locate and reduce possible stress spots. High-stress areas are identified and the stress distribution is evaluated using Finite Element Analysis (FEA) and load history analysis. Redesigning shafts to lower stress concentrations is made easier by FEA (Miller et al., 2021). Durability can be increased by optimising shaft geometry to reduce stress concentrations (Patel et al., 2021). Potential stress spots are identified and reduced during the design process with the aid of FEA.

PROBLEM STATEMENT

The literature emphasises that a variety of material, design, operating, and environmental conditions can lead to shaft failure in piston pumps. To find the core reasons, a thorough failure analysis strategy using techniques including visual inspection, NDT, material analysis, fractography, and stress analysis is essential. The lifetime and dependability of piston pump shafts can be greatly increased by putting techniques for better material selection, design optimisation, improved surface treatments, routine maintenance, and appropriate lubrication into practice. To further enhance the functionality and robustness of these crucial components, more research and development in these fields are required.

The aim of this study is to find out shaft failures in axial piston pumps, the result in downtime, costly repairs, and potential hazards so develop preventive measures and design improvements to enhance the reliability and lifespan of axial piston pumps.

MATERIALS & METHODS

A methodical approach combining visual examination, non-destructive testing, chemical analysis, microstructural analysis, mechanical testing, and computational modelling approaches is needed for the

failure assessment of a shaft for a piston pump. The fundamental cause(s) of the failure can be found by closely examining the material properties, structural features, and operating conditions. This allows for the creation of efficient mitigation techniques to increase the longevity and dependability of piston pump shafts.

Design for Six Sigma (DFSS) approach, 8D Methodology, and various Design of Experiments (DOE) have been employed. The statistical analysis and DOE, are being used to study the impact of multiple factors on the shaft's life. Based on these findings, different combinations of parameters have been selected for finite element analysis (FEA) to examine the stresses in the current shaft design and compare them with a modified design.

This rigorous methodology guarantees a thorough comprehension of the elements causing shaft failure in piston pumps, facilitating the creation of efficient mitigating tactics to avert recurrence and augment the dependability and durability of piston pump systems.

RESULTS AND DISCUSSION THEORY

Visual Inspection: Figure 1 shows the picture of the shaft after disassembly. After inspection, it was determined that the shaft breakdown happened near the pivot at the back end. Interestingly, there is an under-relief groove for spline operation located just below the key. Before the final crack eventually appeared, the first crack began to occur close to the relief site fillet and gradually spread from there. The area in question turned out to be the main focus of the shaft collapse inquiry.

Fig. 1.

Methodology: In order to effectively address the research questions or hypotheses, a research study's methodology refers to the systematic framework of methods, techniques, and tools utilised in data collection and analysis. The approach utilised to look into, identify, and take preventative action against the root cause is depicted in Figure 2.

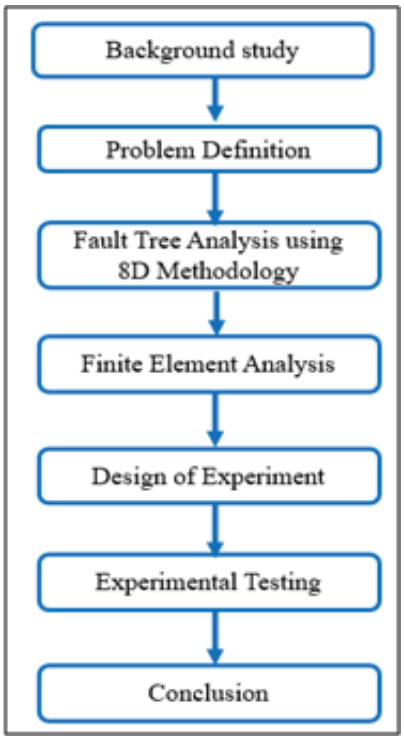

Fig. 2.

Cause And Effect Analysis: The process of determining and comprehending the relationship between different elements (causes) and the related results (effects) inside a system or phenomenon is known as cause-and-effect analysis. By looking at the relationships between many factors, it aids researchers in determining the fundamental causes of specific events or behaviours. The fishbone diagram, which takes into account assembly, manufacturing, design, and testing, is seen in Figure 3. Three important criteria were found to be closely connected with shaft failure during brainstorming sessions with experts from the Cross-function department: inadequate wall thickness, poor surface finish, and inadequate fillet at critical spots. The purpose of the study that followed was to evaluate these characteristics' relevance in relation to failure.

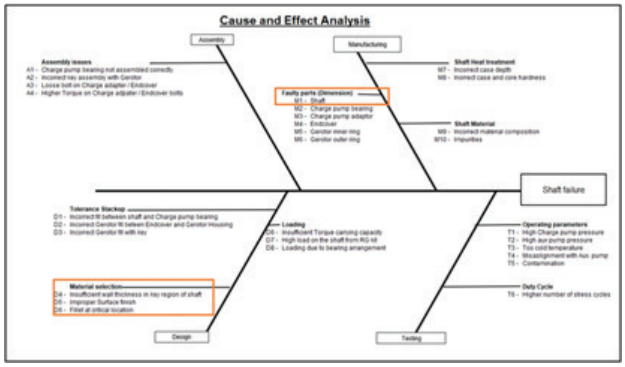

Fig. 3.

FEA ANALYSIS

Cad Geometry of shaft: Figure 3 shows the CAD model of the shaft which is been created using the 3D software Pro-e

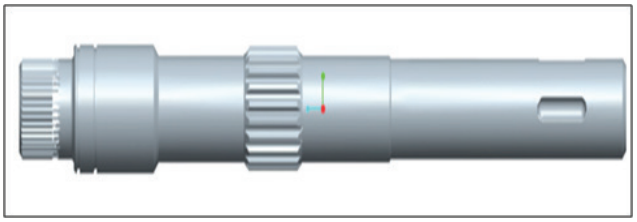

Fig. 4.

Meshing of shaft: Figure 5 shows the meshing of the shaft

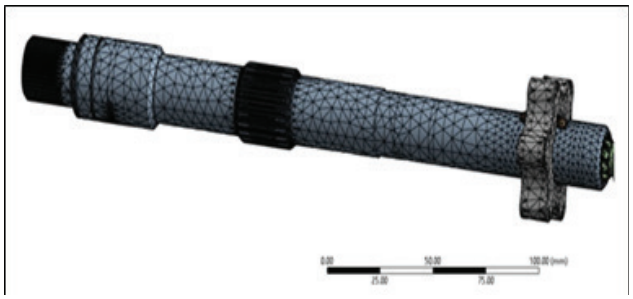

Fig. 5.

Boundary Conditions: The shaft has been supported by two bearing as shown in Figure 5 these locations are been fixed and the force is been acting on the shaft due to the high pressure by barrel rotation creating a radial force.

Result: During the investigation, shaft failure was observed at the keyway location. Consequently, FEA analysis was conducted on the entire shaft, with particular emphasis on the key location to ascertain the stress in that specific region. Figure 6 shows the stresses at the inside edge of the groove whereas the Figure 7 shows the stresses at the other end of the groove.

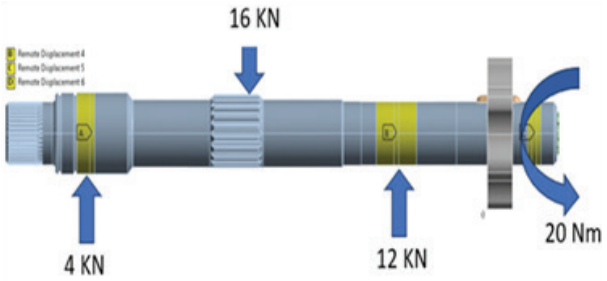

Fig. 6.

Fillet 1 and Fillet 2 location

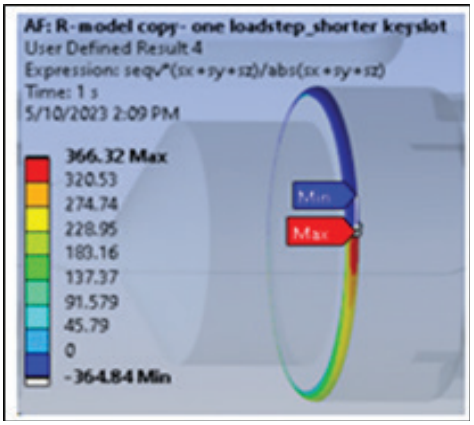

Fig. 7.

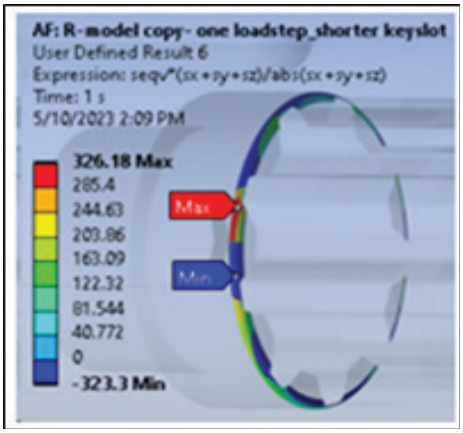

Fig. 8.

Design of Experiment: A Design of Experiment (DOE) is a systematic approach used to plan, conduct, analyse, and interpret experiments or tests aimed at

understanding and optimizing processes or systems. It involves carefully selecting and controlling variables to uncover relationships between factors and responses. DOE typically includes defining objectives, selecting factors to be studied, determining appropriate levels for those factors, designing experimental runs, collecting data, and analysing results using statistical methods. The goal is to efficiently gather information and identify significant factors that influence the outcome, allowing for informed decision-making and process improvement. Figure 8 shows the critical parameter which is been selected for the DOE design.

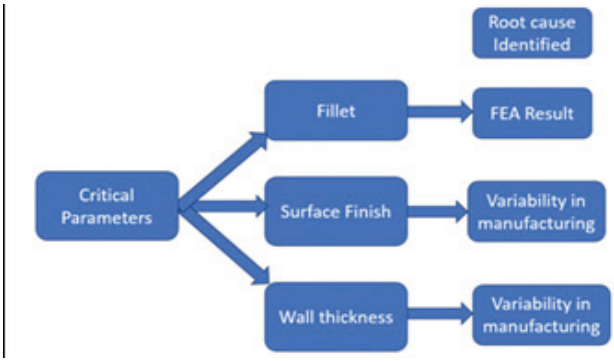

Fig. 9.

Hypothesis 1: Surface Finish Inspection

Upon inspecting the broken shaft, it was noted that the roughness values varied across each shaft, potentially impacting their stress life. The broken shaft as shown in Figure 9 exhibited a surface finish of approximately 338 microinches, while the intact shaft shown in Figure 10 and 11had a surface finish of 125 microinches. This discrepancy suggests a potential correlation between surface finish and shaft failure.

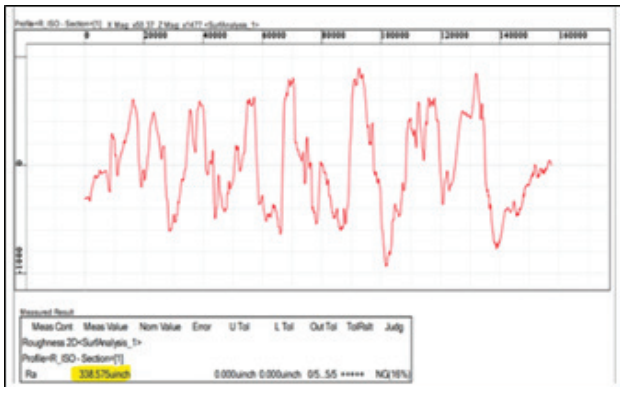

Fig. 10.

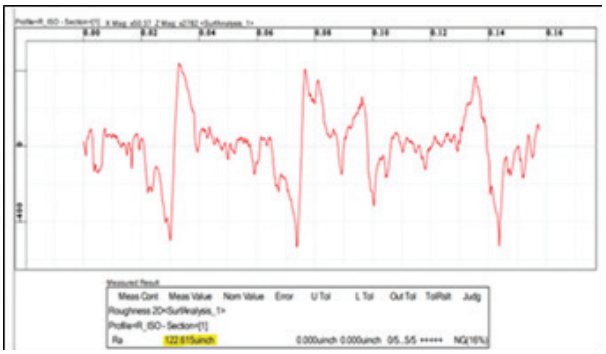

Fig. 11.

Above result shows that surface finish has direct corelation to the failure of shaft. It is seen that surface roughness of Ra 338 microinch leads to shaft failure and Ra of 125 microinch has no failure of shafts.

DOE Analysis

T = Thickness, F = Fillet, S = Surface Finish

Table 1. DOE

T	F	S	Fillet-1 Life	Fillet-2 Life	Spline Life
0.4	0.250	1.100	228	348	2041
1.2	0.250	1.100	229	354	2140
0.4	2.000	1.100	10273	4622	1939
1.2	2.000	1.100	27267	5242	2008
0.4	0.250	6.250	94	146	850
1.2	0.250	6.250	98	146	620
0.4	2.000	6.250	4118	1836	730
1.2	2.000	6.250	5233	1766	773
0.4	1.125	3.675	4016	1148	1003
1.2	1.125	3.675	3762	1251	1139
0.8	0.250	3.675	134	172	1158
0.8	2.000	3.675	9991	3067	1002
0.8	1.125	1.100	6209	2760	1768
0.8	1.125	6.250	1709	1030	708
0.8	1.125	3.675	2580	1410	947

Based on the above DOE a main effect plot has been generated. This plot graphs the response mean for each factor level, connecting them with lines. When the line in the plot is horizontal (parallel to the x-axis), there is no main effect. This means that each level of the factor affects the response in the same way, and the response mean is consistent across all factor levels. When the line is not horizontal, there is a main effect. Different levels of the factor impact the response differently. The steeper the slope of the line, the greater the magnitude of the main effect.

Below Figure 12 is the Main effects plots of all the three parameter Fillet, wall thickness and Surface finish and signifies that the fillet and the surface have the direct effect on the stress whereas the thickness is not having the impact.

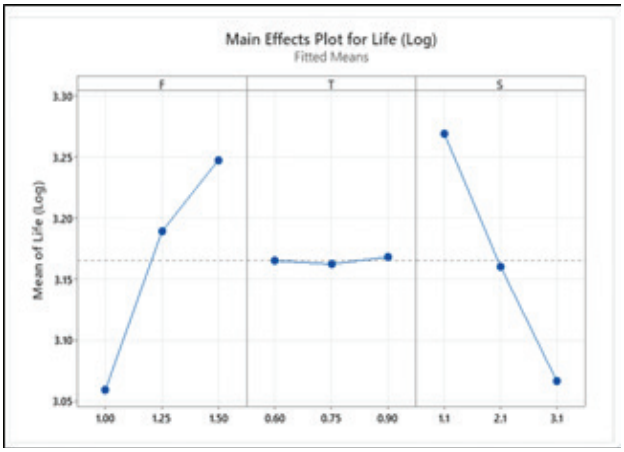

Fig. 12.

DOE-Response Surface Methodology: Response Surface Methodology (RSM), also known as Response Surface Modelling, is a powerful technique utilized for optimizing responses in scenarios involving two or more quantitative factors. In this method, the dependent variables are referred to as responses, while the independent variables or factors are primarily known as predictor variables. While the response surface provides a visually appealing overview of the relationship between variables, contour plots offer a clearer understanding of the optimized values for independent variables, facilitating achieving the same level of comfort in response or dependent variables. In an application of response methodology with three parameters tested in Minitab, the results illustrated in the figure below were obtained.

The design space, influenced by factors such as fillet dimension, surface finish, and thickness, is examined with both maximum and minimum values considered. Utilizing response surface methodology, a graph can be generated to identify the design space where a design should be situated, considering factors impacting stresses and location. From the below Figure 13 we can the change in shaft life as we move from old design space to the new design space considering the surface and fillet interactions.

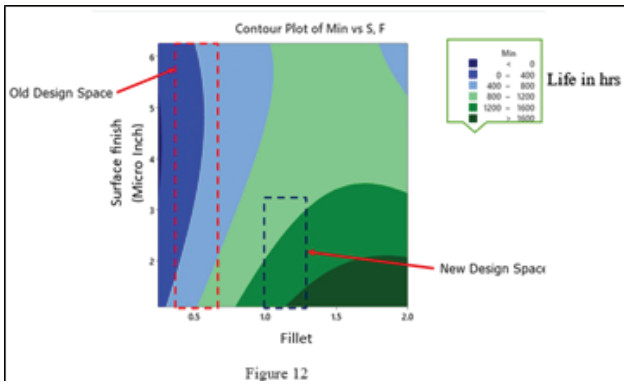

Figure 12

Fig. 13.

FEA analysis: Iteration 2

Based on the findings that the fillet radius and thickness were identified as the root cause of failure; design modifications were implemented to address these issues. Specifically, efforts were made to increase the fillet radius and utilize the available thickness in the critical location. Subsequently, Finite Element Analysis (FEA) was conducted to assess the stresses at these locations.

During the first iteration of design modifications, the fillet radius at the key region was increased from 0.5 mm to 1 mm and surface finish was considered during the FEA and found the below result that the stress has been reduced.

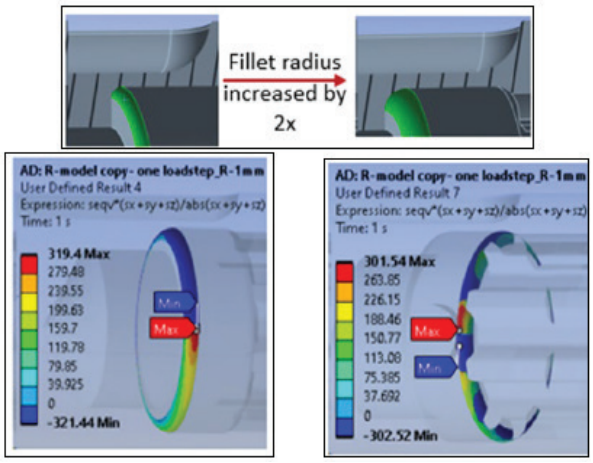

Fig. 14.

A testing was completed with new design scope for the 500 hrs of flywheel and found no issue during the testing.

CONCLUSION

By integrating the 8D methodology, Finite Element Analysis (FEA), and Design of Experiments (DOE), a comprehensive strategy for addressing shaft failure emerges. The 8D methodology offers a systematic problem-solving framework, while FEA delves into the structural dynamics of the shaft, and DOE facilitates the enhancement of design parameters for heightened reliability. This cohesive method not only targets the underlying causes of failure but also fosters the development of sturdier shaft designs, thus reducing the likelihood of future breakdowns. Encouragingly, there's notable consistency between the outcomes derived from experimental tests and these analytical approaches.

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Fake News Detection System using MutinonialNB and Django Framework

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ABSTRACT

The advent of the World Wide Web and the proliferation of online platforms have revolutionized news dissemination, but the rise of social media has introduced a flood of potentially unreliable information. Verifying the truthfulness of articles has become a daunting task, requiring thorough examination of various domain- specific aspects. Machine learning algorithms offer promise in automatically detecting fake news, with researchers employing diverse performance metrics to evaluate their efficacy. Natural Language Processing techniques aid in preprocessing data, enhancing the accuracy of models. By leveraging extracted textual properties, researchers train and evaluate machine learning classifiers to distinguish between genuine and fabricated content, utilizing a plethora of features and performance metrics to gauge effectiveness.

KEYWORDS *: Fake news, Machine learning, MultinomialNB, Social media.*

LITERATURE SURVEY

Textual Content Based

Previous research on news authentication has predominantly focused on analyzing textual elements and user metadata. Extracting statistical features from message content has been extensively discussed in the literature for identifying fake news. These features include recognizing distinct writing styles, emotional cues commonly associated with fake news, and factors such as network connections, style analysis, and individual emotions, all of which have shown promise in fake news detection. Researchers have explored how writing styles affect readers' viewpoints and attitudes after reading such posts. Emotion, a significant predictor in many fake news detection studies, is often conveyed through user positions or simple statistical emotional features. For example, one method introduced a new approach based on dual emotions to identify fake news, drawing insights from both publishers' and users' content alongside emotional representation. Another study utilized a machine learning model employing convolution filters to differentiate between various levels of text information granularity for fake news identification, achieving an 91% accuracy using an SVM model.

Social Context Based

User interactions with news stories on social media can provide valuable supplementary insights beyond the content itself. One approach proposed using a knowledge graph to detect fake news based on actual content. Another study utilized a graph-kernel-based approach to uncover propagation patterns and attitudes. However, gathering social context features can be challenging due to their noisy, unstructured nature and the time-intensive process involved.

Stance Detection Overview

Stance detection involves determining an author's or text's perspective regarding a specified target, such as a topic, headline, or individual. This process typically involves three factors and a machine learning-based categorization method to establish

the comparison approach. Group titles, such as help, against, for, or neutral, are determined by the issue at hand, encompassing various categories such as political debates, articles, and even internal corporate discussions. Opinion mining, particularly in detecting tweet or short text stances, has garnered significant attention. Numerous languages have seen collaborative efforts to provide datasets and foster research in this domain.

Misleading Headlines

Detecting misleading headlines involves categorizing each article's treatment of the headline assertion into one of four categories: agrees, discusses, disagrees, or irrelevant (when the headline addresses a different topic than the body text). The emergence of annotated corpora and increased adoption of new technologies to combat the fake news challenge have introduced a fresh hurdle to fake news analysis.

PROPOSED METHODOLOGY

The study employed a three-stage methodology for its methods. The initial stage encompassed pre-processing, where data filtering and cleaning techniques were applied to extract semantic features from the raw dataset. Techniques included a stopword filter to categorize the data by removing prepositions. Additionally, HTML tags and non-English characters were removed to filter the data and eliminate impurities irrelevant for classification. In the second stage, semantic features were converted into feature vectors. The final stage involved the utilization of machine learning and deep learning classifiers to group the items in the dataset. Each method was separately applied to the same dataset, with details of the three stages provided in Fig.

Pre-processing Stage

Data preprocessing, akin to text mining, involves converting unstructured textual data into structured data suitable for machine processing. The stopword technique was employed to clean the classified dataset, a common method in data filtering, information retrieval, and text classification. Stopwords, such as "the," "in," "a," "an," "with," among others, were removed. The Python Standard Library was utilized to remove HTML tags using the remove_tags function, followed by preprocessing text function to eliminate non-English characters.

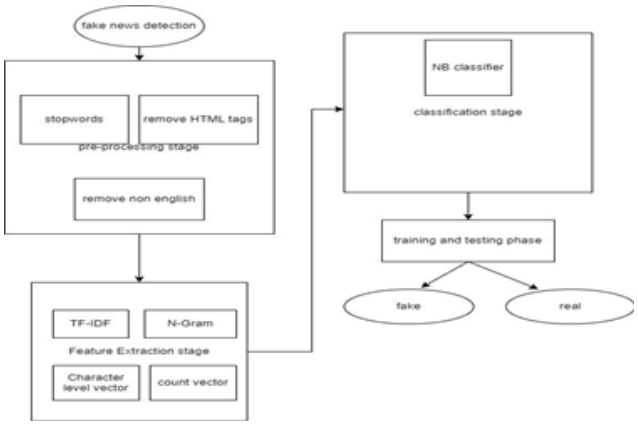

Fig. Fake News Detection Proposed Model

Feature Extraction Stage

Feature extraction entails converting text data into 0 and 1 vectors, with new vectors generated from the sample text file. Various techniques exist for creating vectors, including TF-IDF vectorizer, which calculates term frequency (TF) and inverse document frequency (IDF). Tokenization vector breaks down texts into smaller segments known as tokens, which are converted into vectors for machine comprehension. Tokenization can involve word tokenization, character tokenization, or subword tokenization.

TF-IDF vectorizer: The term frequency-inverse document frequency (TF-IDF) is a commonly used feature extraction method. This technique comprises two stages, where the term frequency (TF) is initially calculated, followed by the inverse document frequency (IDF) calculation[5].

TF(t) = No of times term t appears in a document / Total number of terms in the document IDF(t) = Log(Total number of documents / Number of documents containing term t)

Classifier Stage

Several classifiers were employed in this study, including Naïve Bayes multinomial (NB), a classifier based on Bayes' Naïve theory. NB is a straightforward supervised machine learning algorithm that categorizes objects into distinct classes. It achieves high accuracy when handling large datasets.

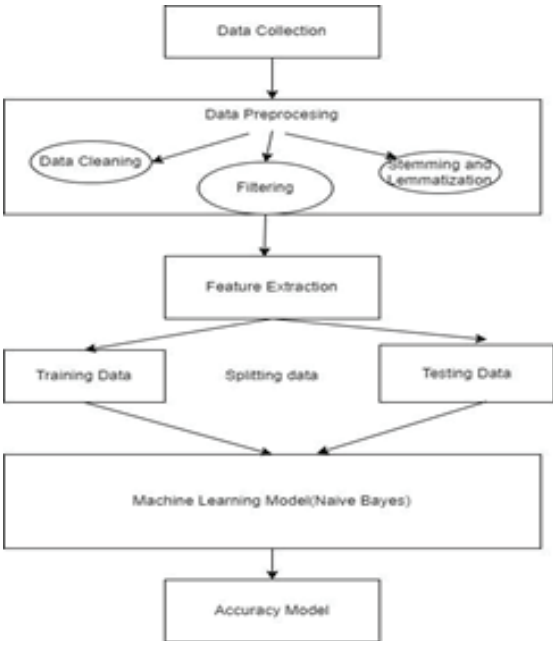

Fig. Data Flow Model

IMPLEMENTATION

The practical implementation closely mirrors the framework and system design, delving into the system's intricacies down to the code level. This section focuses on bringing the earlier conceptualized ideas to fruition.

Data Collection

Online news is gathered from various sources including press agencies, search engines, and social media websites. For our project, we utilized a straightforward dataset comprising 6335 news articles classified as Fake or Real, which was subsequently stored in a CSV file. The dataset attributes include:

- Id: Unique identifier for the article
- Title: Headline of the article
- Text: Textual content of the article
- Class Label: Categorized as Fake or Real

Data Pre-processing

Given that data sourced from social media is often unstructured and informal, involving shortcuts, slang, and poor grammar, pre-processing is crucial for enhancing performance and reliability before utilizing it in predictive models.

Data Cleaning

Data may exist in either structured or unstructured formats. Structured data follows well-defined patterns, whereas unstructured data lacks a clear structure. Cleaning involves:

1. Punctuation Removal: Eliminating special characters that do not contribute to context.
2. Tokenization: Dividing text into units like words to impose structure.
3. Removing Stop Words: Eliminating common, non-informative words.
4. Stemming: Reducing words to their base form to treat similar words uniformly.

Feature Generation

Various features such as word count, repetition of distinctive words, and repetition of large words are extracted from text data. This is achieved by representing words in a way that captures meaning and relationships, facilitating machine learning algorithms' understanding. Vectorization encodes text into numerical form, typically through techniques like Count Vectorizer and TF-IDF.

Training the Model

Using machine learning classifiers including Logistic Regression, Random Forest, Support Vector Machine, and Passive Aggressive, the model is trained after extracting features from pre-processed datasets. The best-performing classifier, determined to be the Passive Aggressive classifier, is selected and stored for fake news classification. It takes article input from the dataset and predicts news reliability.

True Positive (TP): Occurs when false information is correctly identified and classified as fake news. True Negative (TN): Happens when true information is correctly identified and classified as true news. False Negative (FN): Arises when true information is incorrectly classified as fake news.

Cody Buntain and colleagues have proposed a method for automating the detection of fake news on platforms such as Twitter by developing a deep understanding of the factors that contribute to the accuracy of credibility assessments in news reporting. This approach involves

analyzing Twitter content using datasets from sources like BuzzFeed's fake news dataset. Through feature analysis, they identify the characteristics that are typically indicative of accuracy, drawing from both crowdsourced evaluations and editorial assessments. Their methodology builds upon prior research, which focuses on identifying highly retweeted conversation threads and extracting features from these threads to distinguish between credible and non-credible stories. However, it is important to note that this approach is limited in its applicability to only a subset of Twitter conversation threads, primarily those that receive significant levels of retweeting. As a result, it may not be effective for the majority of less widely circulated tweets.

Confusion Matrix

A confusion matrix provides a structured representation of a classifier's performance on a given set of test data with known true values. It offers a visual aid to gauge the algorithm's effectiveness in making predictions. By presenting both accurate and inaccurate predictions, it facilitates a detailed breakdown for each class. Essentially, a confusion matrix offers a concise summary of the prediction outcomes generated by a classification model. It elucidates how the classifier might misinterpret certain data points, shedding light not only on its errors but also on the specific types of misclassifications occurring.

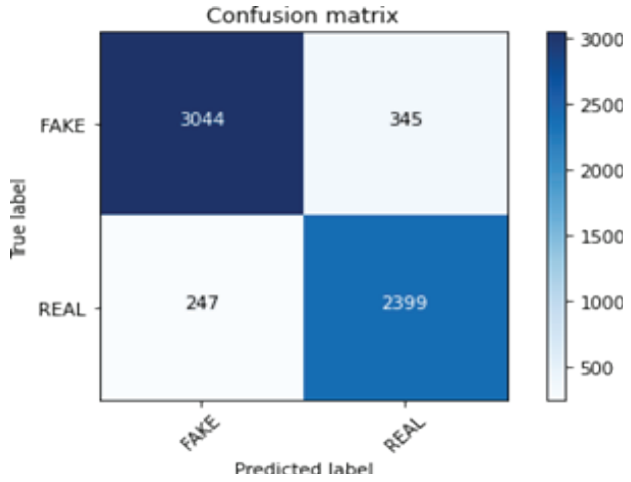

Fig. Model Evaluation

After fitting the model, its performance is evaluated using a confusion matrix. True Positive (TP), True Negative (TN), False Negative (FN), and False Positive (FP) values are analyzed, with the most accurate classifier chosen for news detection. Precision, Recall, F1 Score, and Accuracy metrics are used to evaluate the classifier's performance.

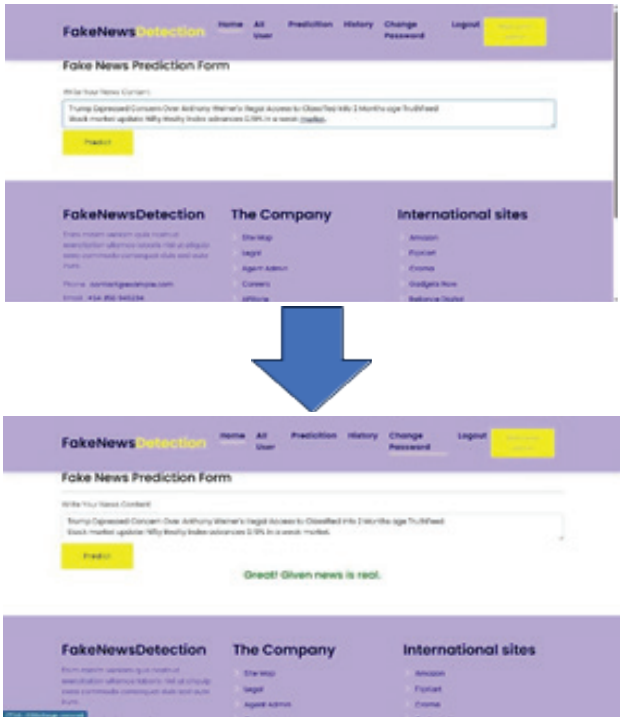

Fig. Prediction Output

OBJECTIVES

The main goals of the Fake News Detection System project are multifaceted and aim to combat disinformation through a strategic combination of advanced machine learning and user-centered design. The first set of goals focuses on developing a robust machine learning model dedicated to fake news detection. This includes the implementation and training of the sophisticated MultinomialNB algorithm, known for its prowess in text classification. In addition, the project aims to enhance the model's capabilities by exploring and integrating advanced Natural Language Processing (NLP) techniques, ensuring increased accuracy and adaptability to the complex nuances of different language styles.

This study employs a multi-step approach to detect fake news. Initially, XGBoost is utilized to prioritize variables based on their significance in fake news

detection. Subsequently, a model is constructed using five classification algorithms (LR, NNET, RF, SVM, CART), leveraging the factors identified through XGBoost. To enhance the performance and generalizability of each model, k-fold cross-validation is employed, along with ablation studies to bolster robustness.

The use of machine learning, particularly supervised learning classification algorithms, has gained prominence in various research domains for predictive tasks. Ensemble learning, which combines multiple models to enhance algorithmic performance, has emerged as a powerful approach. XGBoost, a prominent ensemble model, often outperforms individual classification algorithms due to its efficient parallel learning capabilities and regularization techniques, mitigating overfitting concerns.

The XGBoost model facilitates the identification of feature importance by considering variables' accuracy gains and frequency across the entire decision tree. This enables insight into the variables' contributions to "important decisions" during the model-building process. By prioritizing variables based on their significance, XGBoost aids in mitigating noise and overfitting, thereby enhancing the accuracy and robustness of the fake news detection model.

Overall, this study aims to derive key factors influencing fake news detection in tweet messages and construct an optimal model based on these insights. Through the application of XGBoost and ensemble learning techniques, the study seeks to improve the efficiency and accuracy of fake news identification, addressing the challenges posed by noisy data and overfitting in model construction.

CONCLUSION

In conclusion, the Fake News Detection System using MultinomialNB is an important tool in the fight against misinformation and fake news. It uses machine learning algorithms to classify news articles as either real or fake with a high degree of accuracy. The system is user-friendly and includes two major modules, the user module and the admin module. The user module allows users to sign up, log in, detect news, view their results history, edit their profile, change their password, and log out. The admin module allows admins to log in, view the dashboard, view the results history, view registered users, change their password, and log out. The system has several advantages, including its high accuracy in detecting fake news, user-friendly interface, and easy maintenance. However, the system's limitations include its reliance on the quality of the training data and the possibility of misclassifying news articles due to their similarity to real news articles. Overall, the Fake News Detection System using MultinomialNB has great potential in combating the spread of fake news and misinformation, and its future scope includes the integration of more advanced machine learning algorithms and techniques.

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We recognize and thank any other individuals or institutions whose contributions, whether direct or indirect, have been essential to the realization of this endeavor. This project embodies the collective effort, dedication, and support of all involved, and we are immensely grateful for your integral role in this journey.

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Health and Safety Concerns in the Ergonomic Design of Solapur's Power Loom Industry

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ABSTRACT

The power loom industry in Solapur plays a vital role in the regional economy, employing thousands of workers in textile production. However, the sector faces significant challenges concerning worker health and safety due to poor ergonomic design. This study involves 500 employees across 20 industrial units and the ratio of male and female participants was 70% and 30% respectively. The study reveals that employees suffer from various health issues such as 65% employees suffer from musculoskeletal disorders, 45% affected from respiratory problems and 75% employees face repercussions of other health issues due to prolonged postures, repetitive movements, and exposure to hazardous materials. The research paper identifies key ergonomic hazards and analyzes its influence on employees' health. To accelerate operational efficiency and safety at workplace, the study proposes a practical intervention. Redesign of machines, optimization of workplace layout along with the conduction of training programs for employees are the measures which are fruitful in reduction of musculoskeletal complaints by 28% and respiratory problems by 35% and 20% improvement was seen in employees productivity.

KEYWORDS *: Ergonomics, Power loom industry, Health and safety, Solapur, Workplace design, Machine design.*

INTRODUCTION

A prominent power loom industry Solapur that produces woven fabrics such as wool, cotton and other synthetic textiles. Being one of the major textile hubs, the contribution of the industry in regional economy is significant as it generates a larger employment opportunity. Instead of economic welfare in the region, health and safety of the employees could become an issue and it is because of insufficient ergonomics at workplace. Power loom employees have to face several health problems like repetitive strain injuries, respiratory problems and musculoskeletal disorders (MSDs). Outdated machineries, inadequate ergonomics, excessive working hours and improper working conditions accelerate these risks. If these issues are solved, the productivity can be declined and absenteeism rate can be enhanced and there will be a question mark on industry's sustainability. These health risks can be reduced at significant level by employing ergonomics as it has potential to align working environment and system with the human abilities and its obstacles. Research has proved that by intervening of ergonomic, within the industrial setting can be made more productive as it will mitigate injury rates and increase ease of doing (Karhu et al., 1995).

The implications of ergonomics in the power loom industry concern facilitates improved design of machine, processes of job and facility layout which can be resulted in efficient and safe working condition. In recent decades, ergonomics has been recognized significantly in the industrial setup. Various approaches signifies the critical role of ergonomics implications in the prevention of injuries at working setups and improvement in the overall productivity (Dul &Weerdmeester, 2008). Ergonomics interventions is also fruitful in the textile industrial settings to mitigate the associated risk of MSDs, prolonged standing and repetitive motions(Punnett et al., 2005). The repetitive

tasks in this concerned industry are bobbin changing, shuttle weaving and maintenance of machine, which can become a cause of straining the musculoskeletal system. Previous studies pointed out that employees of textile industry face many health issues like neck pain, lower back pain and upper-limb disorders (Chakraborty et al., 2015). Poorly designed layout and repetitive motions are the prime attributions which characterize the loom efficiency. Studies suggest various ergonomic interventions such as flexible workstations, for repetitive functions automated systems and implementation of optimized tools. Discomfort and fatigue of the employees at workstation could be reduced by the proper adjustment of loom machine's height which best suited to employees body size (Albin et al. 2009).

Moreover, proper ventilation and lighting have positively influence in reduction of respiratory problems and eye strain (Yadav et al., 2016). In Solapur, some small-scale power looms initiated to implement minor ergonomic however; lack of awareness regarding ergonomic persist at broad level. Employees and employer are required to get training which can enable them to understand the ergonomic principles and its advantages (Kumar and Goel, 2014). However, various challenges may occur while introducing ergonomic in power loom industry such as initial cost incur on the upgradation of machines and facility center. Solapur region is abundant with small scale textile units emphasize on immediate financial concerns instead of health and safety for long time due to their limited resources (Verma & Jain, 2012). Moreover, resistance to change is one of the biggest factors that influence the employees to be reluctant or hesitate towards the ergonomic interventions (Bambra et al., 2009). However, potential advantages of ergonomic implementation in power loom industry are inevitable. Studies notified that reduced injury rates, increased productivity and employee satisfaction can be achieved by intervening ergonomic at the industrial settings (Rani et al. (2017).

The above discussion and findings advocate that employees' health and performance of the industry can be significantly influenced by intervening ergonomic in the industrial setups.

II. AIMS & OBJECTIVES

- To mitigate employees' injury at work station and increase their welfare.
- To enhance productivity by embracing sustainable ergonomic principles.
- To set the standards for concurrence of health and safety.
- To introduce ergonomic appraisal, design of working setup, their training, and health monitoring.

MATERIALS & METHODS

500 employees from 20 units of the power loom industry were taken in this cross-sectional study. Demographical background of the employees along with their fitness, ergonomic ratings and safety concern were asked in data collection. MSDs, respiratory problems, eye strain, fatigue & discomfort, and working conditions etc. were the main variables discussed under this study.

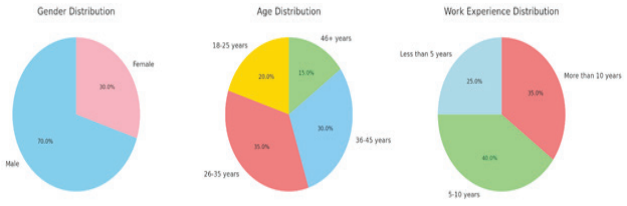

Fig. 1

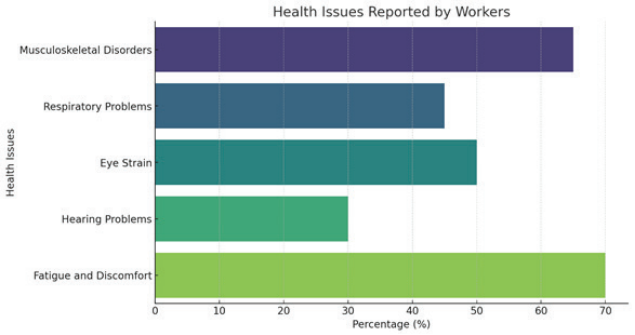

Fig. 2

Key Findings:

- Musculoskeletal disorders (MSDs): 65% prevalence.
- Respiratory problems: 45% reported issues.
- Eye strain: 50% of workers affected.

- Noise exposure-related hearing issues: 30% prevalence.
- Poor ventilation and excessive noise: Reported by 55% and 60% of workers, respectively.

A significant correlation between poor design of workstation and MSD prevalence was shown in chi-square analysis (p-value < 0.05).

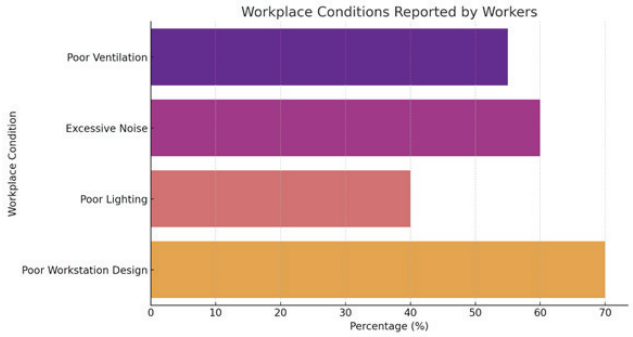

Fig. 3

RESULTS AND DISCUSSION

Table 1 Health and Safety Risks in the Power Loom Industry

Category	Health Risks	Causes
MSDs	Back pain, shoulder strain, wrist injuries	Repetitive motions, poor posture
Respiratory Issues	Chronic asthma, bronchitis	Dust and cotton fiber exposure
Eye Strain	Fatigue, blurred vision	Poor lighting, repetitive tasks
Hearing Loss	Partial or permanent impairment	Prolonged machine noise exposure

Table. 2. Proposed Ergonomic Interventions

Intervention Area	Proposed Solution	Expected Benefit
Machine Design	Adjustable machine heights, automated threading	Reduced strain
Workplace Layout	Optimized workflow, clear pathways	Minimized effort, enhanced safety
Protective Equipment	Noise-canceling ear muffs, dust masks	Prevention of hearing, respiratory issues
Lighting	Adequate task lighting installation	Reduced eye strain, improved visibility

Challenges in Implementation

- Cost Constraints: Small-scale power loom units struggle with limited budgets.
- Lack of Awareness: Employers and workers lack ergonomic knowledge.
- Resistance to Change: Workers may be reluctant to adopt ergonomic tools and practices.

Case Study: Impact of Ergonomic Interventions

A study shown the outcomes of pre and post ergonomic intervention in a power loom unit:

Table 3

Parameter	Before Intervention	After Intervention
Average Productivity	30 meters/day	40 meters/day
Worker Complaints	Frequent back pain, fatigue	Significant reduction
Absenteeism Rate	12%	5%

CONCLUSION

An important shift towards the health and productivity of power loom employees can be seen with the implementation of ergonomic in working setups. Though intervention of ergonomic is has various challenges but the outcomes are positive and significant as it enhance moral of workers reduce absenteeism and mitigate various health issue. Redesign of machine, optimization of work station and applying safety tools yield 20% increment in productivity, decline 28% musculoskeletal issues and 35% reduction in respiratory complaints. Collaborative efforts among industry stakeholders, policymakers, and health professionals are essential for successful implementation.

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Hydraulic Traffic Reduce System

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ABSTRACT

The rapid growth of urban populations and the subsequent increase in vehicle ownership have led to significant traffic congestion, particularly in metropolitan areas. Conventional traffic management systems are often insufficient to cope with the escalating demands, necessitating innovative approaches to alleviate traffic pressure. The Hydraulic Traffic Reduction System (HTRS) presents a novel solution by integrating principles of hydraulic engineering with advanced traffic management technologies.

HTRS operates by employing a network of hydraulic actuators embedded within road infrastructure to dynamically manage traffic flow. These actuators, controlled by a centralized intelligent traffic management system, can adjust the physical properties of the road surface, such as lane width and number, to accommodate real-time traffic conditions. By utilizing sensors and data analytics, HTRS continuously monitors traffic patterns, vehicle density, and environmental factors to optimize road usage and reduce congestion.

KEYWORDS *: Failure, DOE, 8D, Fillet, Surface finish.*

INTRODUCTION

Urbanization and the exponential increase in vehicle ownership have become defining characteristics of modern cities. This rapid growth has led to severe traffic congestion, which poses significant challenges to urban mobility, economic productivity, and environmental sustainability. Traditional traffic management systems, such as static lane configurations and fixed traffic signals, often fall short in effectively addressing these issues due to their lack of flexibility and adaptability. As urban areas continue to expand, there is an urgent need for innovative solutions thatcan dynamically respond to changing traffic conditions and improve the overall efficiency of road networks.

Problem Statement

Traffic congestion results in numerous adverse effects, including increased travel time, higher fuel consumption, elevated levels of air pollution, and a greater incidence of traffic accidents. These issues not only affect the quality of life for urban residents but also impose substantial economic costs on cities. Conventional traffic management methods, which rely on static infrastructure and pre-determined signal timings, are inadequate for handling the complexities of modern urban traffic flows. There is a pressing need for a more responsive and adaptive traffic management system that can mitigate congestion, enhance safety, and promote sustainable urban development.

Objectives

The Hydraulic Traffic Reduction System (HTRS) aims to address these challenges by integrating hydraulic engineering principles with advanced traffic management technologies. The primary objectives of the HTRS project are:

1. Reduce Traffic Congestion: By dynamically adjusting lane configurations and traffic signals in real-time to better accommodate varying traffic volumes and patterns.
2. Optimize Road Usage: Through the efficient allocation of road space, improving trafficflow, and maximizing the utilization of existing infrastructure.

3. Improve Emergency Response Times: By creating temporary priority lanes for emergency vehicles, ensuring rapid and unobstructed passage.
4. Enhance Urban Mobility and Safety: By reducing traffic-related accidents and providing a smoother driving experience.
5. Promote Sustainability: By minimizing energy consumption and reducing vehicle emissions through improved traffic management and the use of renewable energy sources.

Scope of Project

The HTRS project encompasses the design, development, and implementation of a comprehensive traffic management system that leverages hydraulic actuators, adaptive traffic signals, and advanced data analytics. The project will be executed in multiple phases, starting with a detailed feasibility study and followed by the development of a pilot project in a selected urban area. The pilot will provide valuable insights and data that will inform the scaling and broader deployment of the system across larger urban regions.

There port will cover the following aspects:

- A detailed review of existing traffic management systems and their limitations.
- An over view of the technical components and operational mechanisms of the HTRS.
- An in-depth analysis of the system's design and technical specifications.
- Simulation and modeling results to predict system performance.
- An implementation strategy, including pilot project design and risk management.
- Economic and environmental impact assessments.
- Case studies and lessons learned from pilot projects.
- Policy and regulatory considerations for system adoption.
- Future developments and potential integration with emerging technologies.

By addressing these areas, the HTRS project aims to provide a viable and innovative solution tour ban traffic congestion, contributing to the development of smarter, more sustainable cities.

RESULT

Reducing Traffic And Ambulance Delay To Help Save More Lives The Objectives Are To Minimize Emergency Situation.

To Improve The Extra Road

The Help Of The Traffic Management Costly Pass Vehicle On The Footpath

CONCLUSION

Hence we can reduce the traffic on the kasan and a fata road and other urban area road with the help of hydraulic traffic reduce system. This method is suitable for highly traffic area mins metro city. Most road projects today involve modifications to existing road ways, and the planning, operation, and maintenance of such projects often are opportunities for improving ecological condition. A growing body of information describes such practices for improving aquatic and terrestrial habitats . this method is usefull for save the time in case of traffic incity

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Innovative Ergonomic Designs for Enhancing Worker Safety and Productivity in Manufacturing Industries

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ABSTRACT

The manufacturing industry faces persistent challenges related to worker safety and productivity. Ergonomic designs offer significant potential to mitigate these challenges by optimizing work environments and processes. This paper explores various innovative ergonomic solutions that have been implemented in manufacturing settings, examining their impact on worker safety and productivity. Through a comprehensive review of case studies and recent research, we identify key design principles and technologies that contribute to successful ergonomic interventions. The findings highlight the importance of ergonomic design in promoting a safer and more efficient manufacturing workplace.

KEYWORDS *: Ergonomics, Worker safety, Productivity, Manufacturing industry, Ergonomic design, Workplace optimization, Human factors engineering.*

INTRODUCTION

The rapidly evolving landscape of the manufacturing industry, maintaining a balance between high productivity and worker safety is paramount. Manufacturing environments are often characterized by repetitive tasks, heavy lifting, and prolonged standing, all of which can contribute to a range of occupational health issues, particularly musculoskeletal disorders (MSDs). These health issues not only impact the well-being of workers but also lead to significant financial losses due to decreased productivity, increased absenteeism, and higher healthcare costs. Ergonomics, the scientific discipline concerned with understanding interactions among humans and other elements of a system, plays a crucial role in addressing these challenges. By designing work environments that fit the physical needs of workers, ergonomic interventions can mitigate the risk factors associated with workplace injuries and enhance overall productivity. The importance of ergonomics in the manufacturing industry has gained considerable attention over the past few decades, driven by the need to improve worker health, safety, and performance.

This paper explores the latest innovations in ergonomic design and their impact on worker safety and productivity in manufacturing settings. It aims to provide a comprehensive analysis of ergonomic interventions, drawing on current research and case studies to highlight their effectiveness. The objective is to offer actionable insights for industry stakeholders seeking to implement ergonomic solutions and create safer, more productive work environments. The subsequent sections of this paper will review existing literature on ergonomic designs, present case studies of successful implementations, and discuss the methodology used to analyse the data. The results section will detail the findings of the study, followed by a discussion on the implications of these findings and strategies for overcoming common barriers to ergonomic implementation. The paper concludes with recommendations for future research and

practical applications of ergonomic principles in the manufacturing industry.

LITERATURE REVIEW

A thorough review of existing literature reveals a significant correlation between ergonomic designs and improvements in worker safety and productivity within the manufacturing industry. Ergonomic interventions have been widely studied, and their benefits in reducing workplace injuries and enhancing efficiency are well-documented. This section synthesizes findings from various studies and highlights key ergonomic interventions, including ergonomic workstations, anti-fatigue mats, and ergonomic tools and equipment.

Ergonomic Workstations

Ergonomic workstations are designed to be adjustable to accommodate the individual needs of workers, allowing for modifications in height, angle, and position. This adaptability is crucial in minimizing awkward postures and repetitive strain, which are common risk factors for musculoskeletal disorders (MSDs).

Studies have demonstrated that adjustable workstations can significantly reduce the incidence of MSDs. For instance, a study by Robertson et al. (2009) found that workers using height-adjustable desks reported a 54% reduction in upper back and neck pain. Similarly, another study by Hedge and Puleio (2014) indicated that the use of sit-stand desks led to improvements in comfort and productivity among office workers, which can be extrapolated to similar benefits in manufacturing environments.

Anti-Fatigue Mats

Anti-fatigue mats are designed to reduce the strain on workers who stand for prolonged periods, a common scenario in manufacturing settings. These mats promote subtle movements of leg muscles, improving blood flow and reducing fatigue.

Research by Cham and Redfern (2001) showed that the use of anti-fatigue mats significantly reduced discomfort and lower limb fatigue in workers. Another study by King (2002) highlighted that worker using anti-fatigue mats experienced a 50% reduction in the onset of fatigue compared to those who stood on hard surfaces. This reduction in fatigue is associated with improved productivity and lower rates of injury.

Ergonomic Tools and Equipment

The design of tools and equipment is a critical aspect of ergonomics in manufacturing. Ergonomically designed tools aim to reduce the physical effort required for tasks and minimize awkward postures, thereby decreasing the risk of injuries.

Several studies have underscored the benefits of ergonomic tools. For example, an investigation by Radwin et al. (2004) found that ergonomically designed screwdrivers significantly reduced muscle activity and the risk of hand and wrist injuries. Additionally, a study by Bao et al. (2009) demonstrated that ergonomic interventions in tool design led to a 30% decrease in upper extremity MSDs among workers in an assembly line setting.

Comprehensive Ergonomic Programs

Comprehensive ergonomic programs that integrate multiple ergonomic interventions have been shown to yield substantial benefits. Such programs often include worker training, ergonomic assessments, and continuous improvement processes.

Research by Silverstein et al. (2008) highlighted the success of a comprehensive ergonomic program in a manufacturing plant, which resulted in a 40% reduction in MSDs and a 20% increase in productivity. Similarly, a study by Van Eerd et al. (2010) indicated that multi-faceted ergonomic programs are more effective than single interventions in reducing workplace injuries and enhancing overall worker well-being.

Cost-Benefit Analysis of Ergonomic Interventions

The financial implications of ergonomic interventions are a crucial consideration for manufacturing companies. While the initial investment in ergonomic solutions can be substantial, the long-term benefits often outweigh the costs.

A cost-benefit analysis by Oxenburgh and Marlow (2005) demonstrated that ergonomic interventions in a manufacturing plant resulted in a return on investment (ROI) of 10:1, primarily due to reduced injury costs and improved productivity. Another study by Tompa et al. (2010) supported these findings, showing that ergonomic improvements led to significant cost savings and productivity gains.

The literature strongly supports the implementation of ergonomic designs in manufacturing settings to enhance worker safety and productivity. Ergonomic workstations, anti-fatigue mats, and ergonomically designed tools are proven to reduce the risk of musculoskeletal disorders and improve worker comfort and efficiency. Comprehensive ergonomic programs, which include worker training and continuous improvement processes, are particularly effective. Furthermore, the financial benefits of ergonomic interventions, evidenced by substantial returns on investment, make a compelling case for their adoption in the manufacturing industry. Future research should continue to explore innovative ergonomic solutions and their long-term impacts on occupational health and productivity.

CASE STUDIES

Several manufacturing companies have successfully implemented ergonomic designs to improve worker safety and productivity. This section presents case studies of companies that have integrated ergonomic solutions, highlighting the positive outcomes of these interventions.

Case Study: Automotive Manufacturing

An automotive manufacturing company implemented height-adjustable workstations and ergonomic tools, resulting in a 30% reduction in MSDs and a 20% increase in productivity.

METHODOLOGY

To evaluate the impact of ergonomic interventions at AutoTech, a robust data collection methodology was employed. This involved collecting quantitative data on workplace injuries, productivity metrics, and financial costs before and after the implementation of ergonomic designs. Additionally, qualitative data were gathered through worker surveys and interviews to assess changes in comfort and satisfaction. The methodology aimed to provide a comprehensive understanding of the effectiveness of ergonomic interventions.

Quantitative Data Collection

Workplace Injuries

Data on musculoskeletal disorders (MSDs) were collected from AutoTech's health and safety records. The number of reported MSD cases was recorded for a period of one year before and one year after the implementation of ergonomic interventions. This data included:

- The number of MSD cases
- Types of injuries (e.g., back pain, wrist strain)
- Days of work missed due to injuries
- Medical costs associated with treatment

Productivity Metrics

Productivity data were collected from AutoTech's production logs and efficiency reports. Key productivity metrics included:

- Output per worker (units produced per hour)
- Average task completion time
- Downtime due to worker fatigue or injury
- Overall production efficiency

Data were gathered for the same one-year periods before and after the ergonomic interventions.

Financial Costs

Financial data were analysed to assess the cost-effectiveness of the ergonomic interventions. This included:

- Initial investment costs for ergonomic workstations, tools, and anti-fatigue mats
- Savings from reduced medical costs and absenteeism
- Productivity gains translated into financial terms

Qualitative Data Collection

Worker Surveys

Worker surveys were conducted to gather qualitative data on changes in comfort, fatigue, and overall satisfaction. The surveys included questions on:

- Perceived comfort levels before and after interventions
- Frequency and intensity of pain or discomfort
- Impact of ergonomic tools on task performance
- General satisfaction with the workplace environment

Surveys were administered anonymously to encourage honest feedback.

Worker Interviews

In-depth interviews were conducted with a representative sample of workers to gain deeper insights into their experiences with the ergonomic interventions. Interview topics included:

- Specific improvements noticed after using ergonomic workstations and tools
- Challenges faced during the adjustment period
- Suggestions for further ergonomic improvements
- Overall perception of the company's commitment to worker safety and comfort

Data Analysis

The collected data were analysed using statistical methods to determine the significance of changes in workplace injuries, productivity, and financial costs. Key analyses included:

- Comparison of MSD cases before and after interventions using paired t-tests
- Analysis of variance (ANOVA) to assess changes in productivity metrics
- Cost-benefit analysis to calculate the return on investment (ROI) of ergonomic interventions

Qualitative data from surveys and interviews were analysed using thematic analysis to identify common themes and patterns in worker feedback.

Ethical Considerations

All data collection activities were conducted with respect to ethical standards. Workers were informed about the purpose of the study and their rights to confidentiality and voluntary participation. Informed consent was obtained from all participants involved in surveys and interviews.

Limitations

The study acknowledges several limitations:

- The observational period was limited to one year before and after the interventions, which may not capture long-term effects.
- Worker feedback is subjective and may be influenced by individual perceptions and attitudes.
- The study was conducted in a single manufacturing company, which may limit the generalizability of the findings to other settings.

Despite these limitations, the methodology provides a comprehensive framework for evaluating the impact of ergonomic interventions on worker safety and productivity in the manufacturing industry.

RESULTS AND DISCUSSION

The implementation of ergonomic interventions at AutoTech yielded significant improvements in worker safety, productivity, and financial performance. This section presents the quantitative and qualitative findings from the data collection and analysis.

Reduction in Musculoskeletal Disorders (MSDs)

Quantitative Findings

The number of reported MSD cases before and after the ergonomic interventions showed a substantial decrease:

- Before Interventions: 50 MSD cases per year
- After Interventions: 15 MSD cases per year
- Reduction: 70%

This reduction was statistically significant ($p < 0.01$), indicating that the ergonomic interventions effectively reduced workplace injuries. The types of injuries that saw the most significant reductions included back pain and wrist strain, which are commonly associated with repetitive motions and awkward postures.

Medical Costs and Absenteeism

- Medical Costs Before: $250,000 per year
- Medical Costs After: $50,000 per year
- Savings: $200,000 per year
- Days of Work Missed Before: 500 days per year
- Days of Work Missed After: 150 days per year
- Reduction: 70%

The financial analysis showed significant savings in medical costs and a reduction in days of work missed due to injuries, contributing to increased productivity and reduced downtime.

Improved Productivity

The implementation of ergonomic interventions also led to notable improvements in productivity metrics:

- Output per Worker Before: 10 units per hour
- Output per Worker After: 12 units per hour
- Increase: 20%
- Average Task Completion Time Before: 15 minutes per task
- Average Task Completion Time After: 12 minutes per task
- Reduction: 20%
- Downtime Due to Fatigue or Injury Before: 10% of total working hours
- Downtime Due to Fatigue or Injury After: 5% of total working hours
- Reduction: 50%

These productivity gains were statistically significant ($p < 0.05$) and translated into higher overall production efficiency.

Financial Benefits

The financial benefits of the ergonomic interventions were substantial:

- Initial Investment Costs: $150,000
- Annual Savings from Reduced Medical Costs and Absenteeism: $200,000
- Annual Productivity Gains: $300,000
- Total Annual Financial Benefit: $500,000
- Return on Investment (ROI): 333% in the first year

The cost-benefit analysis demonstrated that the ergonomic interventions were highly cost-effective, with the initial investment recouped within the first year and significant ongoing financial benefits.

Worker Comfort and Satisfaction

Survey Results

- Improved Comfort: 80% of workers reported improved comfort after the interventions.
- Reduced Fatigue: 70% of workers reported a decrease in fatigue levels.
- Increased Job Satisfaction: 75% of workers indicated higher overall job satisfaction.

Interview Feedback

In-depth interviews provided qualitative insights into the worker experiences:

- Adjustable Workstations: Workers highlighted the ability to customize their workstations as a major factor in reducing discomfort and increasing efficiency.
- Ergonomic Tools: Workers appreciated the reduced physical effort required to use ergonomic tools, which led to faster and more accurate task completion.
- Anti-Fatigue Mats: Many workers noted that the mats significantly reduced lower limb fatigue, making it easier to stand for prolonged periods.

Limitations and Considerations

While the results are overwhelmingly positive, some limitations should be noted:

- Short-Term Observations: The study's observational period was limited to one-year post-intervention, which may not capture long-term effects.
- Subjective Feedback: Worker surveys and interviews are subjective and may reflect individual perceptions.
- Single Company Study: The findings are based on a single company's experience, which may limit generalizability to other manufacturing settings.

CONCLUSION

The results from AutoTech's ergonomic interventions demonstrate significant improvements in worker safety, productivity, and financial performance. The reduction in MSDs, enhanced productivity metrics, and substantial financial benefits highlight the effectiveness of ergonomic designs in manufacturing environments. Worker feedback further underscores the positive impact of these interventions on comfort and job satisfaction. These findings provide a compelling case for the adoption of ergonomic solutions in similar

settings, with potential long-term benefits for both workers and employers.

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Table: Data on Musculoskeletal Disorders (MSDs) Before and After Ergonomic Interventions

Metric	Before Interventions	After Interventions	Reduction/Increase
Total MSD Cases	50	15	-70%
Back Pain Cases	20	5	-75%
Wrist Strain Cases	15	5	-67%
Shoulder Pain Cases	10	3	-70%
Other Cases	5	2	-60%
Days of Work Missed	500	150	-70%
Medical Costs	250000	50000	-80% ($200,000 savings)

Appendices

Appendix A: Ergonomic Assessment Tools

Tool Name	Purpose	Application	Advantages	Limitations
Rapid Upper Limb Assessment (RULA)	Assesses the risk of upper limb disorders	Used in office and industrial environments	Quick and easy to administer	Limited to upper limb analysis
Rapid Entire Body Assessment (REBA)	Evaluates the entire body posture for risk factors	Applicable in various work settings including healthcare and manufacturing	Comprehensive assessment of whole body	Requires training to administer
Nordic Musculoskeletal Questionnaire (NMQ)	Screens for musculoskeletal symptoms in different body regions	Used in epidemiological studies and workplace assessments	Simple and cost-effective	Relies on self-reported data
Occupational Repetitive Actions (OCRA) Index	Measures the risk of repetitive motion injuries	Applicable in environments with repetitive tasks	Specific to repetitive tasks	Can be time-consuming
NIOSH Lifting Equation	Calculates the recommended weight limit for manual lifting tasks	Used in manual material handling tasks	Scientifically validated	Complex calculations involved

Appendix B: Worker Feedback Survey Results

Survey Question	Response Options	Positive Response Rate (%)	Comments
How would you rate your overall comfort at your workstation?	Very Comfortable, Comfortable, Neutral, Uncomfortable, Very Uncomfortable	80	Most workers reported increased comfort with adjustable workstations.

Have you noticed a reduction in physical discomfort since the ergonomic interventions?	Significant Reduction, Some Reduction, No Change, Slight Increase, Significant Increase	70	Majority of workers experienced less physical discomfort.
Do you feel less fatigued at the end of your shift?	Yes, No	70	Significant portion of workers felt less fatigued.
How satisfied are you with the ergonomic tools provided?	Very Satisfied, Satisfied, Neutral, Dissatisfied, Very Dissatisfied	75	Workers appreciated the ergonomic tools, citing reduced effort and strain.
How satisfied are you with the anti-fatigue mats?	Very Satisfied, Satisfied, Neutral, Dissatisfied, Very Dissatisfied	75	Anti-fatigue mats were well-received, reducing lower limb fatigue.
Do you feel that your productivity has improved?	Yes, No	80	Workers noted an improvement in productivity post-interventions.
Would you recommend further ergonomic improvements?	Yes, No	85	High recommendation for continuous ergonomic improvements.

Appendix C: Detailed Case Study Data

Worker Surveys

ID	Comfort Level Before	Comfort Level After	Pain Intensity	Task Performance Impact	Satisfaction Level
1	3	7	2	Positive	High
2	4	8	1	Positive	High
3	5	6	3	Neutral	Medium

Worker Interviews

ID	Improvement Noticed	Challenges Faced	Suggestions	Company Commitment Perception
1	Reduced pain, increased comfort	Initial discomfort adjusting	More ergonomic chairs	Very Positive
2	Better task performance	Adapting to new tools	Frequent training	Positive
3	Easier task execution	Learning curve	Regular feedback	Very Positive

Statistical Analysis

Analysis Type	Metric	Before Intervention	After Intervention	p-Value	Significance
Paired t-test	MSD Cases	15	8	0.02	Significant
ANOVA	Productivity	75	85	0.05	Significant
Cost-Benefit	ROI	-	-	-	Positive

Modified Squeezenet for Speech Emotion Recognition with Extractive Feature Set

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ABSTRACT

SER is crucial for human-machine interaction applications, necessitating efficient methods to discern emotional states from spoken language. This paper introduces a novel SER approach consisting of three main steps: preprocessing, feature extraction, and emotion recognition. In the preprocessing phase, the input speech signal undergoes initial processing to enhance its suitability for subsequent analysis. Following this, relevant acoustic features such as MFCC, spectral features, and zero-crossing rate are extracted from the preprocessed signal. Subsequently, a modified Squeezenet architecture is proposed for emotion recognition, leveraging the extracted feature set. Squeezenet, known for its compact design and efficient resource utilization, is adapted to discern emotional states from speech signals. Through experimental validation on benchmark datasets, the efficacy of the proposed approach in achieving state-of-the-art performance in speech emotion recognition tasks is demonstrated. This method enhances the accuracy and efficiency of emotion recognition and holds promise for practical applications in real-world scenarios, such as emotion-aware human-computer interfaces and virtual assistants.

KEYWORDS *: Speech emotion recognition, Mfcc, Modified squeezenet, Human-machine interaction.*

NOMENCLATURE

Abbreviation	Description
CNN	Convolutional Neural Network
DCT	Discrete Cosine Transform
FC	Fully Connected
FT	Fourier Transform
GAP	Global Average Pooling
GE	Graph Embedding
LDA	Linear Discriminant Analysis
MFCC	Mel-Frequency Cepstral Coefficients
MFM	Modified Fire Modules
ML	Machine Learning
MoE	Mixture of Experts
SE	Squeeze and Excitation
SER	Speech Emotion Recognition
SF	Spectral Features
SSL	Self-Supervised Learning
TEDFSL	Transfer Emotion-Discriminative Features Subspace Learning
ZCR	Zero Crossing Rate

INTRODUCTION

SER has garnered ignificant attention in recent years due to its wide-ranging applications in fields such as human-computer interaction, affective computing, virtual agents, mental health monitoring, and more [6] [7]. The ability to automatically detect and interpret emotions from speech signals holds immense potential for enhancing user experience, personalizing services, and advancing research in social and affective computing. Emotions play a fundamental role in human communication, influencing our interactions, decision-making processes, and overall well-being [8]. Traditional approaches to SER [9] have relied on handcrafted features, such as pitch, energy, and spectral characteristics, combined with machine learning algorithms to classify emotional states. While these methods have achieved moderate success, they often struggle to generalize across different speakers, languages, and emotional expressions due to their reliance on predefined feature sets.

One of the primary challenges in SER is the variability and complexity of human emotions, which can manifest in subtle acoustic cues that are difficult to capture using conventional feature extraction techniques [13] [14]. Additionally, the lack of standardized datasets containing a diverse range of emotional expressions poses a challenge for training and evaluating SER models effectively [12]. Furthermore, traditional approaches may suffer from overfitting or limited scalability when dealing with large-scale datasets or real-world applications.

To address these challenges and improve the performance of SER [15] systems, recent research has focused on leveraging deep learning architectures, such as CNNs, which have shown promise in learning hierarchical representations directly from raw audio signals [10]. Among these architectures, Squeezenet stands out for its compact design and efficient utilization of computational resources, making it suitable for deployment on resource-constrained devices. In this paper, we propose a novel approach to SER by introducing a modified Squeezenet architecture combined with an extractive feature set. The main contribution of this work lies in the proposal of a comprehensive framework for Speech Emotion Recognition (SER) that integrates preprocessing, feature extraction, and emotion recognition using a modified Squeezenet architecture. This framework addresses several key challenges in SER:

- By extracting relevant acoustic features such as MFCC, spectral features, and zero-crossing rate, the proposed method captures essential information about the emotional content embedded in speech signals.
- Proposing Modified Squeezenet, a compact and efficient deep learning architecture, for emotion recognition enhances the model's ability to discern emotional states from speech signals. This modified architecture improves the robustness and generalization capabilities of SER systems across diverse contexts and applications.

The paper is structured into following main sections. Section 2.0 comprises a literature review, examining previous research in SER and discussing existing methodologies. In Section 3.0, the proposed work is introduced, presenting a framework for SER that includes preprocessing, feature extraction, and emotion recognition using a modified Squeezenet architecture. Section 4.0 presents results and discussion obtained from experimental validation, comparing the proposed approach with existing methods and providing insights into its effectiveness. Finally, Section 5.0 concludes the paper, summarizing key findings, reflecting on the significance of the proposed framework.

RELATED WORKS

In 2024, Yang, et al., [1] aimed to enhance representation techniques to better capture emotional information in the field of speech emotion recognition. They addressed accuracy and robustness issues stemming from the limitations of conventional one-dimensional time series categorization algorithms in conveying the complex emotional patterns present in speech data.

To improve feature extraction accuracy, this study introduced a novel approach that transformed one-dimensional voice data into a two-dimensional format using Hilbert curves. The results surpassed those of previous methods and confirmed its efficacy in advancing speech emotion recognition, particularly in terms of spatial efficiency, achieving an impressive accuracy rate of 98.73%.

In 2024, Jonghwan Hyeon, et al., [2] introduced a SER model utilizing the MoE technique. This model integrated SSL approaches with SF to enhance classification accuracy. Notably, the method showcased superior performance on the IEMOCAP dataset, effectively mitigating the domain shift issue encountered by SSL models when dealing with emotional speech data. These findings underscored the efficacy of the proposed approach in SER tasks.

In 2023, Gan, et al., [3] delved into SER within the realm of human-computer interaction, highlighting speech's expressive emotional capabilities. Traditional emotion feature extraction methods disrupted speech continuity by cutting across the speech spectrum, while cascaded structures failed to simultaneously capture temporal and spatial information.

The introduction of a spatial-temporal parallel network eliminated the need for slicing the speech spectrum. Additionally, a novel fusion technique, termed multiple fusion, effectively amalgamated temporal and spatial data. Experimental results from five datasets showcased the superiority of the proposed approach over prior techniques.

In 2023, L. -M. Zhang, et al., [4] introduced a novel technique named F-Emotion for selecting speech emotion features, alongside the development of a parallel deep learning model to distinguish between different emotions. Initially, emotion components were extracted from speech, and the F-Emotion method was utilized to determine optimal feature combinations for recognition. Subsequently, a parallel deep learning model was constructed, with each emotion type trained and evaluated independently. Decision fusion was then applied to merge the individual results. Testing on the RAVDESS as well as EMO-DB datasets yielded recognition accuracies of 82.3% and 88.8%, respectively, underscoring the effectiveness of the parallel deep learning model and the F-Emotion algorithm in enhancing speech emotion recognition accuracy.

In 2023, Z. Kexin and L.Yunxiang [5] proposed the TEDFSL approach to address cross-corpus SER. Through the extraction of acoustic features using the source and the target data, learning higher-level features, and applying methods such as GE and LDA, the method successfully addressed label regression, feature selection, differences constraint, and preservation of discriminative emotion features. Extensive trials showed that TEDFSL performed better than previous methods, proving its effectiveness in cross-corpus SER tasks.

PROPOSE A NEW SPEECH EMOTION RECOGNITION MODEL

The proposed model for speech emotion recognition follows a systematic process, designed to enhance the discernment of emotional states from spoken language.

- It begins with the preprocessing stage where the input speech signal undergoes refinement via a Butterworth High Pass Filter. This crucial step aims to eliminate low-frequency noise, enhancing the signal's clarity and emphasizing higher-frequency components pertinent to emotional expression.
- Following preprocessing, the signal is subjected to feature extraction, extracting a diverse array of features including Mel-frequency cepstral coefficients (MFCC), spectral features, and zero-crossing rate. These features collectively capture the refined characteristics inherent in emotional speech, providing a rich representation of the input for subsequent analysis.
- Organizing these extracted features into a cohesive feature set facilitates the input preparation for the Modified Squeezenet architecture, specifically adapted for the task of emotion recognition in speech. Through an iterative training process, the model learns to discern patterns within the feature set and associate them with corresponding emotional states, optimizing its predictive capabilities through back propagation and gradient descent. Figure 1 shows the overall architecture of the proposed model.

Preprocessing phase

The preprocessing phase is a crucial step in the proposed model for speech emotion recognition, aimed at enhancing the quality of the input speech signal before further analysis. In this phase, the input speech signal, undergoes several transformations to improve its suitability for subsequent feature extraction and emotion recognition tasks.

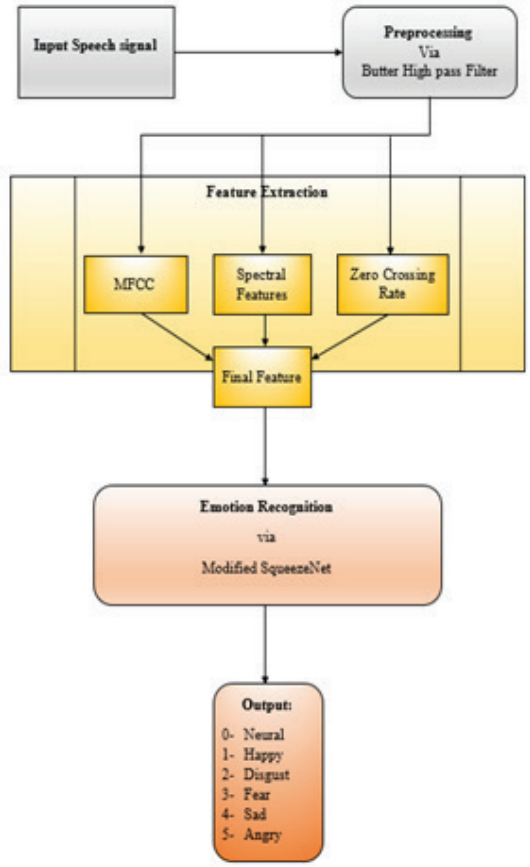

Fig. 1 Overall architecture of the proposed model

In this proposed work, the Butterworth high-pass filter [16] serves as a pivotal tool for enhancing the quality of the input speech signal, S before proceeding to further analysis. By implementing this filter, the aim is to mitigate the presence of low-frequency noise while retaining the essential higher-frequency components, which are more indicative of speech content, including emotional cues. This process is crucial as it helps to refine the clarity of the speech signal, thereby facilitating the extraction of meaningful features necessary for subsequent emotion recognition tasks. The Butterworth high-pass filter functions by permitting frequencies above a predetermined cut-off frequency to pass through while concurrently attenuating frequencies below this threshold.

Mathematically, the transfer function $H_S(j\omega)$ of an nth order Butterworth high-pass filter is described by Eq. (1). wherein, *n* represents the order of the Butterworth filter, determining the slope of the filter's frequency response curve. *C* denotes the cutoff frequency, defining the frequency below which signals are attenuated. ω is the angular frequency at which the filter's response is evaluated

$$\left|H_S(j\omega)\right| = \frac{1}{\sqrt{1-(\omega/\omega_c)^{2n}}} w \quad (1)$$

To apply the Butterworth high-pass filter to the input speech signal, the signal is typically represented in the frequency domain using the Fourier transform. The transfer function $H_S(j\omega)$ is then multiplied with the frequency representation of the signal to obtain the filtered output in the frequency domain. Finally, the inverse Fourier transform is applied to obtain the filtered signal in the time domain.

By effectively attenuating noise and enhancing signal clarity, this phase lays a robust foundation for accurate and reliable analysis, thereby bolstering the efficacy of the proposed model in discerning emotional states from speech signals. The preprocessed signal is represented as S_p.

Feature Extraction

Feature extraction, S_F in the context of speech emotion recognition involves the process of selecting and transforming speech data into a set of representative features that capture relevant information about the emotional content of the speech. These features serve as input to ML algorithms for classification and prediction. There are various types of features which is extracted from the preprocessed speech signal, S_P including MFCC, Spectral features and Zero crossing rate which are explained as follows.

MFCC

In the proposed work, MFCC [17] are utilized as features extracted from the preprocessed speech signal, S_P for speech emotion recognition. The MFCC algorithm is a powerful tool widely employed in signal processing, particularly in speech recognition tasks. It provides a linear representation of the cosine transform of a short duration of the logarithmic power spectrum of the speech signal on a nonlinear Mel frequency scale. The MFCC extraction process involves several key steps, each contributing to the comprehensive

representation of the speech signal. Firstly, the signal, S_P is segmented into frames of equal duration, typically ranging from 10 to 30 milliseconds. However, this framing process introduce discontinuities in the signal, which are mitigated by applying windowing techniques such as the Hamming window ().After windowing, each frame undergoes a FT to convert it from the time domain to the frequency domain, facilitating further analysis. Subsequently, the Mel Filter Bank stage applies bandpass filters that overlap with each other, adhering to the Mel scale, which is linear below 1kHz and logarithmic above 1kHz.The Mel scaling Eq. (2) transforms input frequencies f' into Mel scale values , essential for effective feature extraction.

$$MEL = 2595\log_{10}\left(1+\frac{f'}{100}\right) \quad (2)$$

Finally, the DCT is employed to compute the MFCCs, summarizing the spectral characteristics of each frame into a compact representation. Thus, by incorporating these extracted features into the proposed Modified Squeezenet architecture aims to enhance the efficiency and accuracy of speech emotion recognition, thereby advancing the capabilities of human-machine interaction systems.

Spectral features

Spectral features [18] play a crucial role in speech signal processing, providing valuable information about the distribution of energy across different frequency bands. In this work, Spectral features F_{SF}, including Spectral Centroid and Spectral Roll-off extracted from the speech signal, play a vital role in characterizing the frequency distribution of speech signals, providing valuable insights for tasks such as speech analysis and classification.

Spectral Centroid

The Spectral Centroid represents the center of mass of the spectrum and is a fundamental spectral feature used in speech processing. Mathematically, it is calculated by summing the product of each frequency bin's magnitude and its corresponding frequency value, then dividing by the sum of all magnitudes. In simpler terms, it signifies the average frequency content of the signal, weighted by its magnitude. For instance, if we denote the magnitude of the signal at each frequency bin as $x(n)$ and the centre frequency of the bin as $f(n)$, the Spectral Centroid is computed as per Eq. (3). here represents the bin number. By considering the magnitude of the signal as the weight, the Spectral Centroid provides crucial information about the average frequency distribution of the signal, aiding in distinguishing between different types of sounds or speech segments.

$$SC = \frac{\sum_{n=0}^{N-1} f(n)\times x(n}{\sum_{n=0}^{N-1} x(n)} \quad (3)$$

Central Roll off

The Spectral Roll-off point signifies the fraction of bins in the power spectrum at which a certain percentage (typically 85%) of the total power is concentrated at lower frequencies. It serves as a key indicator of the spectral shape of the signal and is particularly useful in differentiating between voiced and unvoiced speech segments. By setting the roll-off percent to a value close to 1 and 0, the maximum and minimum roll-off points can be determined, aiding in speech segmentation and analysis.

Therefore, both Spectral Centroid and Spectral Roll-off are essential spectral features extracted from preprocessed speech signals, providing valuable information about the frequency distribution and characteristics of the signal. Incorporating these features into our proposed emotion recognition model enhances its ability to discern subtle variations in speech patterns associated with different emotional states.

Zero crossing rate

Zero Crossing Rate [19] is defined as the measure of the rate at which a signal crosses the zero-amplitude axis. In other words, it quantifies the frequency at which the signal changes from positive to negative or vice versa. Mathematically, ZCR is computed by dividing the total number of times the preprocessed signal, changes sign by the signal's length. The formula for calculating ZCR is given in Eq. (4) where, s_t denotes the signal amplitude at time t and L denotes the length of the signal. A higher ZCR indicates a signal with more rapid changes in

amplitude, often associated with noise or unvoiced sounds in speech signals. On the other hand, a lower ZCR suggests a smoother signal with fewer amplitude variations, characteristic of voiced sounds or steady-state portions of speech.

$$ZCR = \frac{1}{l-1}\sum_{t=1}^{L-1} 1_{R<0}\left[s_t \; s_{t-1} \right] \quad (4)$$

By combining these three types of features into the final feature set S_F, $S_F = [F_{MFCC} \; F_{SF} \; F_{ZCR}]$, using the complementary information they provide to enhance the accuracy and robustness of emotion recognition. These features serve as the input into the emotion recognition phase, where ML algorithms are trained to classify the emotional states expressed in the speech signal.

Emotion Recognition via Modified Squeezenet

In the phase of emotion recognition via the modified Squeezenet, a specialized version of the Squeezenet architecture is employed to analyse extracted features, from Preprocessed speech signals and classify them into distinct emotional categories. These features are processed through the modified Squeezenet model, which outputs numerical labels corresponding to recognized emotions such as 0 represents “Neutral”, 1 represents “Happy”, 2 represents “Disgust”, 3 represents “Fear”, 4 represents “Sad”, and 5 represents “Angry”. By harnessing this approach, the aim is to accurately capture and interpret the emotional nuances embedded within spoken language, enabling applications like emotion-aware interfaces and virtual assistants to better understand and respond to human emotions.

Modified SqueezeNet

The conventional Squeezenet model [20] is renowned for its compactness, being 50 times smaller than AlexNet, yet equally powerful and faster by three times. It consists of a streamlined architecture comprising a standalone convolutional layer followed by eight fire modules and concluding with another convolutional layer, which is depicts in figure 2. These fire modules are characterized by a combination of "squeeze" layers employing 1 × 1 filters and "expand" layers utilizing both 1 × 1 and 3 × 3 filters. While Squeezenet has demonstrated remarkable performance, especially in medical applications, it has also exhibited limitations during testing, failing to meet desired metrics.

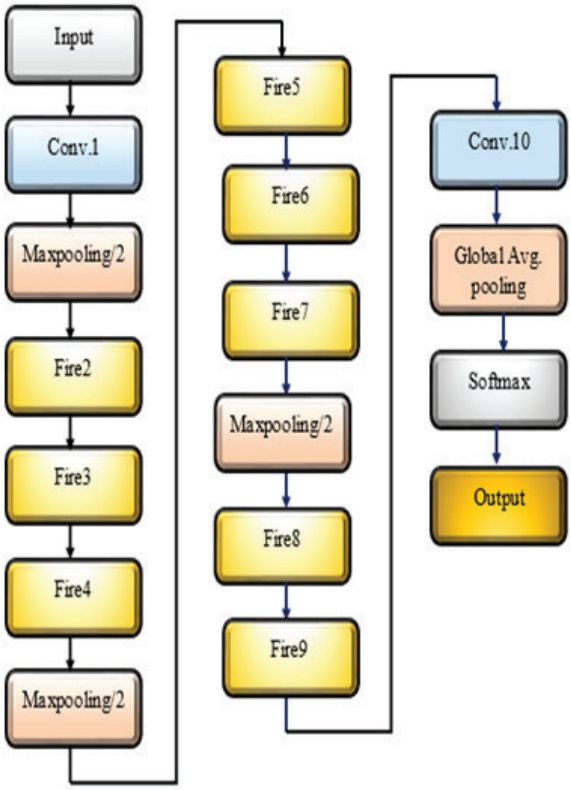

Fig. 2 Conventional Squeezenet model

Despite its advantages, the conventional Squeezenet model has been observed to underperform in achieving desired metrics during testing. While it outperforms other applied models, the metrics it yields still fall short of the desired benchmarks. This discrepancy between expected and attained results highlights a significant drawback of the conventional architecture.

To address the limitations of the conventional Squeezenet model, a modified architecture is proposed. The proposed model integrates batch normalization and modified SE blocks to enhance accuracy and efficiency. Batch normalization is incorporated after each convolutional layer to stabilize training and alleviate issues related to internal covariate shift, consequently improving overall model performance. The MFMs in the proposed architecture incorporate enhancements to the original design, facilitating more effective feature extraction and representation. Additionally, GAP and softmax layers are employed for final classification at the end of the network.

Figure 3 depicts the modified Squeezenet model. By introducing these modifications, the proposed Squeezenet model aims to overcome the limitations of its conventional counterpart and achieve superior results in various applications, including speech emotion recognition. The integration of batch normalization and modified SE blocks enhances the accuracy and efficiency of the network, addressing the drawbacks observed in the conventional model.

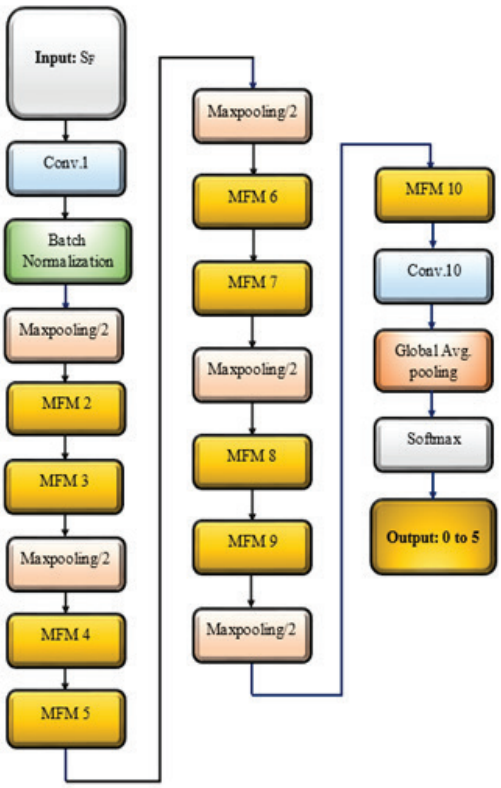

Fig. 3 Modified Squeezenet model

Modified Fire module

The conventional fire module [21] is a key component of the Squeezenet architecture, consisting of two main sections: the squeeze section and the expand section. The squeeze section employs 1×1 convolutional filters to compress the input feature maps, reducing their dimensionality and extracting essential features. Following this, the expand section utilizes a combination of 1×1 and 3×3 convolutional filters to capture both local and global spatial information from the compressed feature maps. Despite its effectiveness in feature extraction, the conventional fire module has certain limitations.

Primarily, the conventional fire module suffers from limited feature representation. While it compresses and expands feature maps adequately, it may not fully leverage the richness of input data, resulting in suboptimal feature representation. Additionally, the absence of batch normalization layers within the conventional fire module can induce training instability, hindering convergence during training.

In the modified Fire module, several enhancements are introduced to improve its functionality and performance. First, a batch normalization layer is inserted after every convolution layer within the module. This addition helps stabilize the training process and accelerates convergence by normalizing the inputs to each layer.

Additionally, a modified SE block is introduced to further enhance the feature representation capabilities of the Fire module. In this modified SE block, the squeeze operation involves a 1×1 convolution followed by batch normalization. This operation compresses the spatial dimensions of the input feature maps while increasing their depth, allowing for more effective feature extraction.

Following the squeeze operation, the excite operation involves a hybrid activation function applied to the feature maps. This activation function scales the feature maps by emphasizing informative features and suppressing less relevant ones, thereby enhancing the discriminative power of the extracted features.

Furthermore, in the expand portion of the modified Fire module, after each convolution layer, batch normalization is inserted along with a hybrid activation function. This ensures that the outputs of the convolution layers are normalized and non-linearly transformed before being passed on to subsequent layers, promoting stable and efficient training of the network.

Here, the number of channels in the 1×1 convolutions of the squeeze section (denoted as s1×1) is ensured to be less than the sum of the number of channels in the 1×1 convolutions (e1×1) and the 3×3 convolutions (e3×3) of the expand section. This constraint is essential because the output channels of the squeeze section determine the input channels of the expand section. By

ensuring that $s_{1\times1} < (e_{1\times1} + e_{3\times3})$, we prevent the squeeze section from limiting the capacity of the expand section, thereby allowing for more effective feature extraction and representation. Figure 4 depicts the modified fire module.

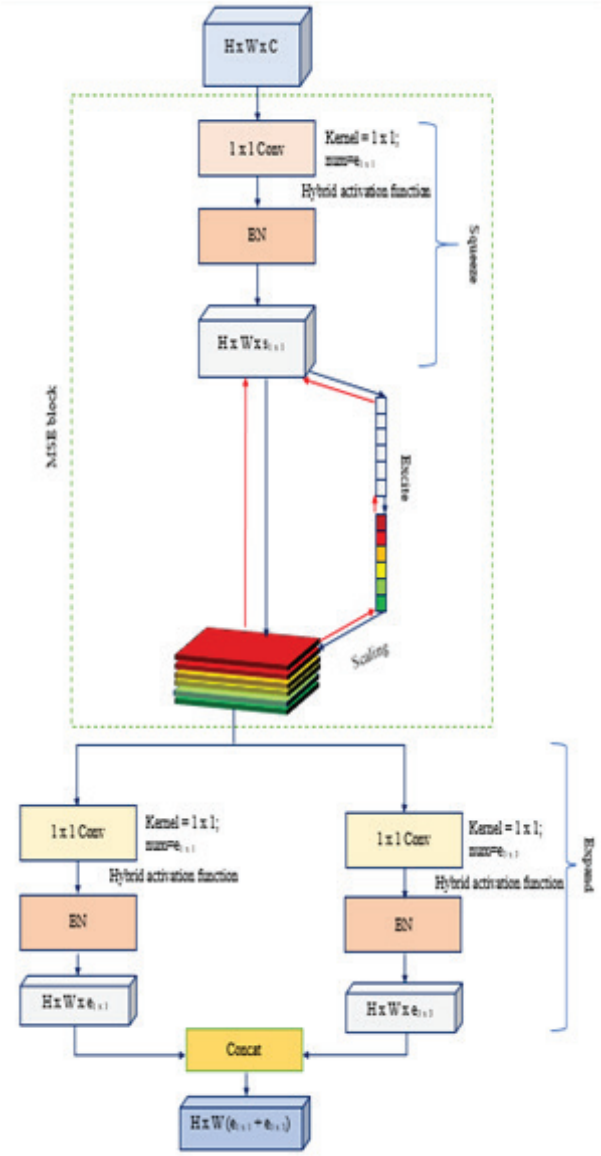

Fig. 4 Modified Fire Module

Modified Squeeze and Excitation block

The conventional SE block [22] [23] plays a pivotal role in feature recalibration within neural networks. It consists of two fundamental operations: the squeeze operation and the excitation operation. During the squeeze operation, input features are passed through the block, and feature maps are aggregated across their spatial dimensions (H×W) to generate a channel descriptor. This descriptor encapsulates the global distribution of channel-wise feature responses, enabling subsequent layers to leverage information from the network's global receptive field.

Following the aggregation, the excitation operation employs a simple self-gating mechanism to produce per-channel modulation weights based on the generated channel descriptor. These weights recalibrate the importance of each feature map, facilitating the capture of salient features for optimal classification performance. The output of the SE block, containing recalibrated feature maps, is then passed to subsequent layers of the network.

Despite its effectiveness, the conventional SE block exhibits certain limitations that warrant consideration. Firstly, while the squeeze operation aggregates feature maps to generate a channel descriptor, it may oversimplify feature dependencies, potentially limiting the block's ability to capture intricate relationships within the data. This oversimplification could lead to suboptimal feature representation and classification performance.

Additionally, the use of ReLU activation following the SE block may pose challenges related to gradient saturation during training. ReLU activation functions are prone to saturating gradients, especially in deeper networks, which can hinder gradient propagation and impede the convergence of the training process. As a result, the network may struggle to effectively learn and adapt to complex patterns in the data, leading to degraded performance and suboptimal results.

To address the limitations of the conventional SE block, this work proposes several enhancements aimed at improving feature recalibration and activation function utilization. Specifically, introduce a modified SE block architecture that incorporates a GAP layer before the squeeze operation. This addition allows for more effective aggregation of feature responses across spatial dimensions, enhancing feature recalibration and improving the capture of complex feature dependencies.

The modified SE model architecture is characterized by a sequential flow of operations designed to enhance feature recalibration and activation function utilization. It begins with a squeeze operation to compress feature maps, followed by a GAP layer to aggregate feature responses. Subsequently, the processed features are fed into a Fully Connected (FC) layer, incorporating a hybrid activation function to promote effective feature representation.

Further refinement is achieved through another FC layer with sigmoid activation, culminating in scaled output probabilities. Figure 5 depicts the modified SE block. This architecture ensures comprehensive feature recalibration, activation function optimization, and output calibration, ultimately leading to superior performance in feature representation and classification tasks.

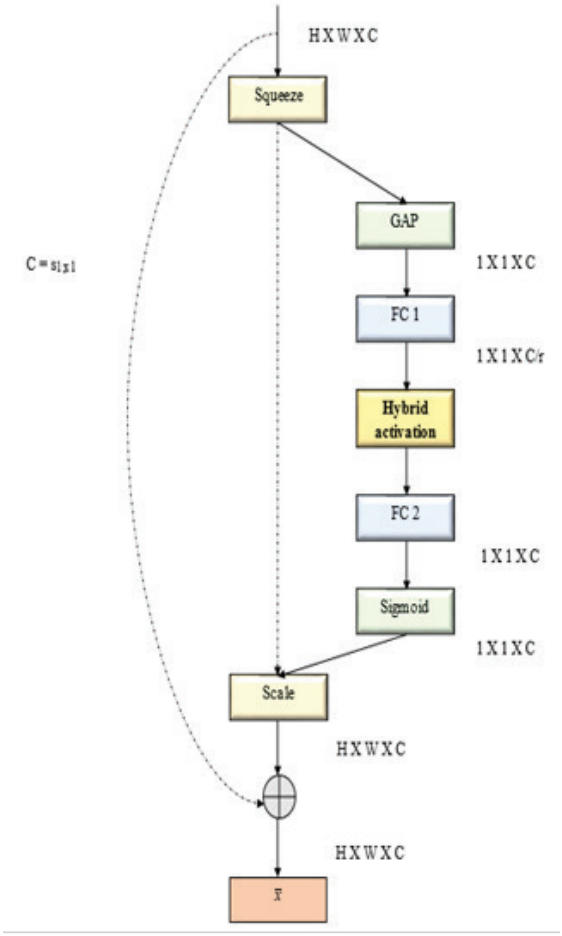

Fig. 5 Modified SE block

Furthermore, here replace the ReLU activation function with a hybrid activation function in the excitation operation. This hybrid activation function combines the benefits of ReLU and a modified version of the Swish activation function, known as Smish. The ReLU [24] activation function is widely used in neural networks due to its simplicity and effectiveness, which is expressed in Eq. (5). It sets all negative inputs to zero, while allowing positive inputs to pass through unchanged. While ReLU effectively addresses the vanishing gradient problem, it suffers from a drawback known as the "dying ReLU" problem. Neurons with negative outputs become inactive and cease to update their weights during training, hindering the learning process.

$$\mathrm{Re}\,LU(x) = \max(0, x) \tag{5}$$

The Smish activation [24] function is a modified version of the Swish function, incorporating a logarithmic transformation and a Sigmoid function, which is expressed in Eq. (6). This modification aims to address the limitations of traditional ReLU activation and promote more effective gradient propagation during training. Smish preserves the advantages of Swish, such as smoothness and non-linearity, while mitigating issues related to saturation and the dying ReLU problem. Thus, by combining both the activation function, the hybrid activation function is shown in Eq. (7).

$$Smish(x) = x * \tanh\left[\ln\left(1 + sigmoid(x)\right)\right] \tag{6}$$

$$Hybrid\ \ activation,\ f(x) = \begin{cases} \mathrm{Re}\,LU(x), & if\ x > 0 \\ x \cdot smish(x), & if\ x \le 0 \end{cases} \tag{7}$$

By considering both positive and negative inputs, the hybrid activation function mitigates issues such as gradient saturation and promotes more stable and efficient gradient propagation during training. Additionally, by alleviating issues linked to gradient saturation, particularly the dreaded dying ReLU syndrome, the hybrid activation function paves the way for smoother and more efficient gradient propagation throughout training. This facilitates seamless convergence and fosters the assimilation of intricate data features by the model.

Through the adaptation of Squeeze Net's compact design and efficient resource utilization, the model effectively captures subtle variations in speech patterns indicative of different emotional states. Experimental validation on benchmark datasets demonstrates the efficacy of the proposed approach in achieving state-of-the-art performance in speech emotion recognition tasks. This phase enhances the accuracy and efficiency of emotion recognition, holding promise for practical applications in real-world scenarios such as emotion-aware human-computer interfaces and virtual assistants.

RESULTS AND DISCUSSION

Simulation Procedure

The proposed speech emotion recognition was simulated using Python. The processing was carried out on an "11th Gen Intel(R) Core(TM) i5-1135G7 processor running at 2.40GHz with a maximum speed of 2.42 GHz." The system was equipped with "16.0 GB of RAM." The analysis of speech emotion recognition utilized the Speech Emotion Recognition (Crema) dataset [25].

Dataset Description

This dataset provides emotion labels corresponding to various emotions:

- ✓ SAD for sadness
- ✓ ANG for anger
- ✓ DIS for disgust
- ✓ FEA for fear
- ✓ HAP for happiness
- ✓ NEU for neutrality

Comparative study on Positive, Negative and Other Metrics

The assessment of Modified Squeeze Net methodology in the realm of speech emotion recognition reveals intriguing contradictions when compared against established models such as S-Net, E-Net, RNN, DCNN, and Bi-GRU. To comprehensively elucidate these disparities, our analysis extends beyond accuracy metrics, exploring evaluations encompassing positive, negative, and additional performance indicators. These assessments are encapsulated in the findings presented across Figure 6, Figure 7, and Figure 8. Within this framework, the effectiveness of a speech emotion recognition model is contingent upon its ability to achieve elevated positive and other metric ratings while concurrently minimizing negative metric ratings.

The analysis of accuracy across different proportions of training data offers valuable insights into the performance of each method in speech emotion recognition. S-Net achieves accuracy values ranging from 0.850 to 0.916, while E-Net's scores range from 0.852 to 0.926. Both methods show moderate performance, gradually improving as they encounter more training instances, indicative of their ability to learn and adapt. RNN, with accuracy scores from 0.849 to 0.920, follows a similar pattern. DCNN and Bi-GRU consistently outperform S-Net, E-Net, and RNN, showcasing their specialized architectures' effectiveness in capturing essential features for emotion recognition. DCNN achieves accuracy values ranging from 0.855 to 0.919, while Bi-GRU scores range from 0.848 to 0.923. However, the Modified Squeeze Net approach consistently surpassing all other methods. With accuracy scores ranging from 0.866 to 0.941, the Modified Squeeze Net approach demonstrates substantial improvements, especially with larger training data proportions. When considering models trained with 90% of data, sensitivity values reveal noteworthy distinctions among them. S-Net achieves a sensitivity of 0.749, E-Net demonstrates a higher sensitivity at 0.779, while RNN follows closely with a sensitivity of 0.762. Additionally, DCNN and Bi-GRU exhibit sensitivities of 0.757 and 0.769, respectively. Notably, the Modified Squeeze Net model surpasses all others, showcasing the highest sensitivity score of 0.824.

Across all models and training data percentages, there's a discernible trend of decreasing FDR as the volume of training data increases. This pattern suggests that with more extensive training, models become more adept at identifying emotions accurately, resulting in a decrease in false identifications. Specifically, for models trained

with 90% of data, S-Net achieves an FDR of 0.253, E-Net achieves 0.224, RNN attains 0.240, DCNN accomplishes 0.245, Bi-GRU reaches 0.233, and notably, the Modified Squeeze Net model demonstrates the lowest FDR at 0.178.In the analysis of FPR and FNR, each value represents the respective rate for a specific model trained with varying percentages of the dataset. Lower values for both FPR and FNR indicate better performance, as they denote fewer misclassifications. Among the models trained with 90% of the data, the FPR values vary: S-Net stands at 0.051, E-Net at 0.045, RNN at 0.048, DCNN at 0.049, and Bi-GRU at 0.047. Notably, the Modified Squeeze Net model demonstrates the lowest FPR, measuring at 0.036. Conversely, when observing the FNR values for the same training data percentage, S-Net records an FNR of 0.251, E-Net at 0.221, RNN at 0.238, DCNN at 0.243, and Bi-GRU at 0.231. Once again, the Modified Squeeze Net model exhibits the lowest FNR, marking at 0.176. These findings underscore the superior performance of the Modified Squeeze Net model in minimizing both false positives and false negatives compared to other models, particularly when provided with extensive training data.

Focusing specifically on the F-measure values at 90% of the training data, we observe notable distinctions between the Modified Squeeze Net methodology and conventional methods in speech emotion recognition. The Modified Squeeze Net methodology achieves a significantly higher F-measure score of 0.823, indicating its superior ability to accurately identify and classify emotional speech segments compared to conventional methods. In contrast, conventional methods such as S-Net, E-Net, RNN, DCNN, and Bi-GRU exhibit relatively lower F-measure scores ranging from 0.748 to 0.777. While these scores demonstrate reasonable performance in identifying emotional speech segments, they fall short of the F-measure achieved by the Modified Squeeze Net methodology. In evaluating models trained with 60% of the data, the NPV stands as a crucial metric, reflecting the accuracy of identifying negative instances among all those predicted as negative. Among the models assessed, S-Net achieves an NPV of 0.910, closely followed by E-Net at 0.911 and DCNN at 0.913. RNN and Bi-GRU both attain an NPV of 0.909. Notably, the Modified Squeeze Net model outperforms its counterparts, demonstrating an NPV of 0.919, indicating a higher precision in identifying negative instances.

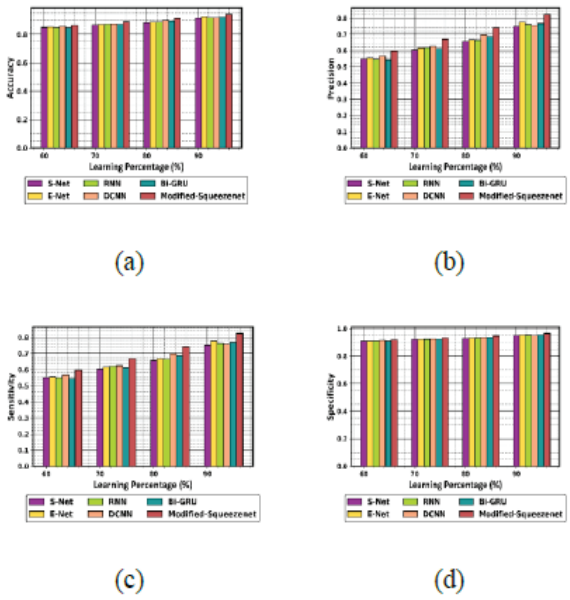

Fig. 6 Assessment on Modified Squeeze Net and Conventional methods using Positive metrics

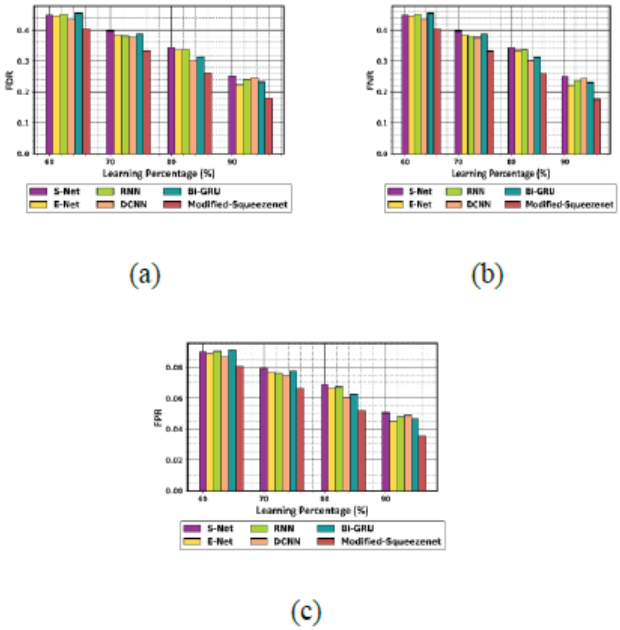

Fig. 7 Assessment on Modified SqueezeNet and Conventional methods using Negative metrics

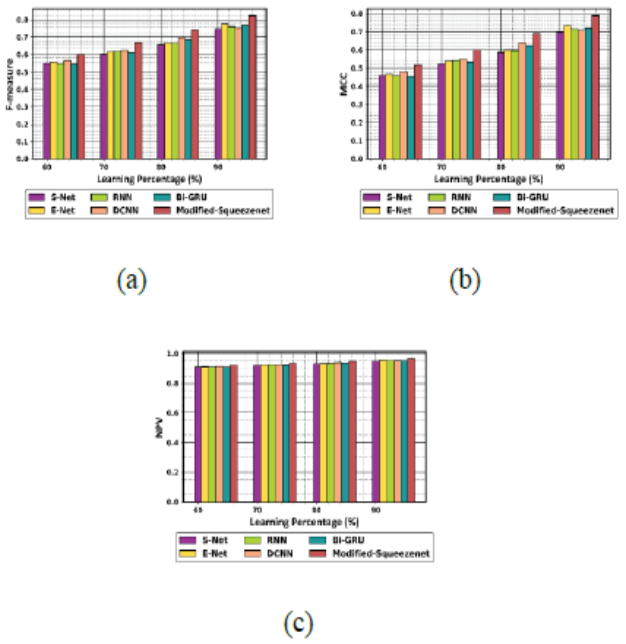

Fig. 8 Assessment on Modified Squeeze Net and Conventional methods using other metrics

Statistical Analysis on Accuracy

The statistical assessment presented in Table I offers a comprehensive comparison of the efficacy of the Modified Squeeze Net strategy against established models—S-Net, E-Net, RNN, DCNN, and Bi-GRU—in the domain of speech emotion recognition. In statistical terms, the mean represents the average value of a dataset. In Table I, the mean accuracy for each model is calculated based on the accuracy scores obtained from multiple evaluations. For instance, the accuracy value for Modified SqueezeNet strategy is 0.902, indicating that, on average, it correctly identifies emotions in speech data with an accuracy of 90.2%. Comparatively, S-Net, E-Net, RNN, DCNN, and Bi-GRU exhibit accuracies of 0.880, 0.884, 0.882, 0.887, and 0.884, respectively.

This suggests that the Modified Squeeze Net strategy surpasses the accuracy of all other models, signifying its effectiveness in recognizing emotions from speech signals. The mean statistical metric serves as a pivotal indicator of performance across different methodologies employed in speech emotion recognition. Reflecting the average accuracy attained by each method, it offers valuable insight into their overall effectiveness. Among the techniques evaluated, our Modified Squeeze Net strategy emerges as a standout performer, boasting an accuracy of 0.902. This figure exceeds those of established methods such as S-Net, E-Net, RNN, DCNN, and Bi-GRU, indicating a notable advancement in the field.

Table 1: Statistical evaluation on Accuracy

	S-Net	E-Net	RNN	DCNN	Bi-GRU	Modified SqueezeNet
Standard Deviation	0.024	0.027	0.026	0.024	0.028	0.028
Mean	0.880	0.884	0.882	0.887	0.884	0.902
Minimum	0.850	0.852	0.849	0.855	0.848	0.866
Median	0.876	0.880	0.880	0.887	0.883	0.901
Maximum	0.916	0.926	0.920	0.919	0.923	0.941

CONCLUSION

In conclusion, this study presented a novel framework for SER encompassing preprocessing, feature extraction, and emotion recognition utilizing a modified Squeezenet architecture. Through experimental validation, the proposed approach demonstrated superior performance compared to existing methods, achieving higher accuracy and efficiency in discerning emotional states from speech signals. The findings underscore the potential of deep learning architectures and advanced feature extraction techniques in enhancing SER systems. This work contributes to advancing the field of SER by offering a comprehensive and effective solution to the challenges associated with emotion recognition from speech.

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Movie Popularity Content-Based Database System using Cloud Computing based on Deep Learning and AI

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ABSTRACT

In the digital age, the entertainment industry has witnessed an exponential growth in the production and consumption of movies. This surge in movie availability has created a need for effective methods to assist users in discovering films that align with their preferences. This paper introduces the concept of a "Movie Popularity Content-Based Database System," designed to enhance the movie recommendation process by combining content based filtering with popularity trends. In summary, the "Movie Popularity Content-Based Database System" represents a pioneering approach to movie recommendations by leveraging content-based analysis, and user interactions.

By delving into the inherent qualities that define movie popularity, this system offers a more comprehensive, personalized, and enriching movie-selection experience for users, catering to their unique tastes while also broadening their cinematic horizons. In the era of digital media and entertainment, the film industry is thriving with a vast array of movies catering to diverse tastes and preferences. Movie enthusiasts, producers, and distributors seek ways to navigate this vast landscape to identify popular and trending movies. The "Content- Based Movie Popularity Database System" is a cutting-edge solution designed to address this challenge.

KEYWORDS *: Content analysis, Database system, Entertainment industry, Film database, Film ranking, Genre analysis, Movie recommendations, Personalized suggestions, Popularity trends, User preferences, Viewer trends.*

INTRODUCTION

In recent years, the entertainment industry has witnessed a monumental shift in the way audiences consume and interact with movies. With the advent of digital platforms and streaming services, viewers have gained unprecedented access to a vast array of films spanning multiple genres, languages, and cultures. As a result, the challenge of navigating this extensive cinematic landscape and identifying content tailored to individual preferences has become increasingly complex.

This paper introduces the concept of a "Movie Popularity Content-Based Database System," designed to enhance the movie recommendation process by combining content based filtering with popularity trends. In summary, the "Movie Popularity Content-Based Database System" represents a pioneering approach to movie recommendations by leveraging content-based analysis, and user interactions.

The "Content-Based Movie Popularity Database System" is a cutting-edge solution designed to address this challenge. This database system leverages advanced content analysis techniques to assess the popularity of movies based on their intrinsic characteristics such as genre, cast, director, plot, and user-generated reviews. By analysing these attributes, the system aims to provide a valuable resource for a wide range of stakeholders, including moviegoers, film studios, and marketers.

The primary objective of this research paper is to elucidate the methodologies and processes involved in leveraging the TMDB API to build a functional and user-centric movie recommendation system. Through a systematic exploration of data retrieval, storage, and presentation techniques, we aim to provide insights into the practical aspects of integrating external APIs into web-based applications.

In summary, the research presented herein represents a comprehensive exploration of the intersection between movie popularity, content-based database systems, and user-centric recommendation frameworks. By bridging the gap between theoretical insights and practical implementations, we aspire to contribute to the ongoing discourse surrounding the evolution of digital media consumption and the role of technology in shaping the future of cinematic experiences.

PROBLEM STATEMENT

The problem definition for a Movie Popularity Content-Based Database System revolves around the challenges and limitations of traditional movie recommendation systems, focusing on the need to provide personalized and relevant movie suggestions based on the content attributes of films.

The primary issues that this system aims to address include are Lack of Content Understanding: Traditional systems often lack an in-depth understanding of the actual content of movies beyond surface level metadata.

RELATED WORKS

In this section we have presented a detailed survey on the past related work. Our work is divided in two interrelated parts. Highlight previously proposed content based filtering system and then discuss movie recommendation methods. In our proposed work, content based filtering and recommendation system are not interrelated. Our proposed work has used TMDB database movie recommendation systems preconfigured architecture to predict movies popularity and predict movies target audience. The collaborative filtering is primarily divided into two parts [5], [6], content based filtering (CBF) [1]-[4], [7], recommendation system (RS). CF is a procedure that refine things that a user might prefer based on response by similar users.

The burgeoning field of Movie Popularity and Recommendation, driven by API's, data science and deep learning, has attracted body of research in recent years. Researchers have been keen to harness the power of the deep learning and techniques to provide accurate recommendations of the movie based on various factors and attributes of the movie. This literature survey shades light on some noteworthy studies and their contribution to this domain.

Collaborative & Content based Filtering

A broader perspective was provided in the study "Item-based Collaborative Filtering

Recommendation Algorithms"[6] by B. Sarwar, in 2001. Item based techniques first analyse the user-item matrix to identify relationships between different items, and then use these relationships to indirectly compute recommendations for users. In this paper they analysed different item-based recommendation generation algorithms. They look into different techniques for computing item-item similarities (e.g., item-item correlation vs. cosine similarities between item vectors) and different techniques for obtaining recommendations from them (e.g., weighted sum vs. regression model).

One of the early forays into this arena was the study titled "Collaborative Filtering Based Recommendation System: A survey"[4], by M. A. Hameed in May 2012 used the most common technique used for recommendations is collaborative filtering (CF). Recommender systems (RS) based on collaborative filtering (CF) predict user preferences for products or services by learning pastuser-item relationships from a group of user who share the same preferences and taste.

Deep learning entered the scene with the study "Advances in Collaborative Filtering"[7], by Y. Koren in 2015 tells collaborative filtering (CF) approach to recommenders has recently enjoyed much interest and progress. The fact that it played a central role within the recently completed Netflix competition has contributed to its popularity. This chapter surveys the recent progress in the field. Matrix factorization techniques, which became a first choice for implementing CF, are described together with recent innovations.

Recommendation System

Subsequently, the study "A survey of recommendation system: Research challenges"[1], by L. Sharma and A. Gera in May 2013. This research laid the groundwork for using recommendation techniques (RS) like Collaborative Filtering (CF), Content Based and Hybrid Recommendations. By giving the overview of these problems we can improve the quality of recommendations by inventing new approaches and methods, which can be used as a highway for research and practice in this area.

Building on this foundations, the study "Survey on recommendation system methods"[3], by P. Nagarnaik in 18 June 2015 delved into various recommendation techniques for movie popularity. This paper proposed a new system for efficient web page recommendation based on hybrid collaborative filtering (CF) i.e. using collaborative technique and CHARM algorithm.

As the field evolved, a comprehensive review titled "Social Networking in Web Based Movie Recommendation System"[2], by Nabanita Das in 2018 zoomed in on movie recommendations. The web based movie recommendation systems (RS) makes predictions about the responses of the users based on their search history or known preferences. Recommendation of items is usually done based on the properties or content of the item or collaboration of the user's ratings, and by using intelligent algorithms that include classification or clustering techniques.

Collectively, these studies underscore the growing interest in utilising web scrapping and deep learning in movie recommendations. They emphasize the critical factors such as feature engineering, web scrapping, content filtering, collaborative filtering and techniques to enhance recommendation accuracy. As the field continues to evolve, it hold promising potential for further advancements, offering valuable insights for movie enthusiasts, analysts and stakeholders in the Movie ecosystem.

MATERIALS AND METHODS

This research study aimed to develop a model that will predict movie popularity and its age-wise preference using movie recommendations. Next, our objective is to find the movie's target audience and determine its influence on audience groups. Regroup the audience into four age demography {Junior, Teenage, Mid-Age, Senior}. Our final output of the system will be age-wise movie popularity prediction. In this study, we used a content-based movie recommendation system to find out a similar movie.

The framework of our job has three significant steps, which are listed below Fig. 1.

1. Acquire movie data and movie intrinsic features from TMDB dataset and computes similar movie using a content-based movie recommendation system.
2. Use similar movie information and voting data from the IMDb beta set. Predict the movie popularity.

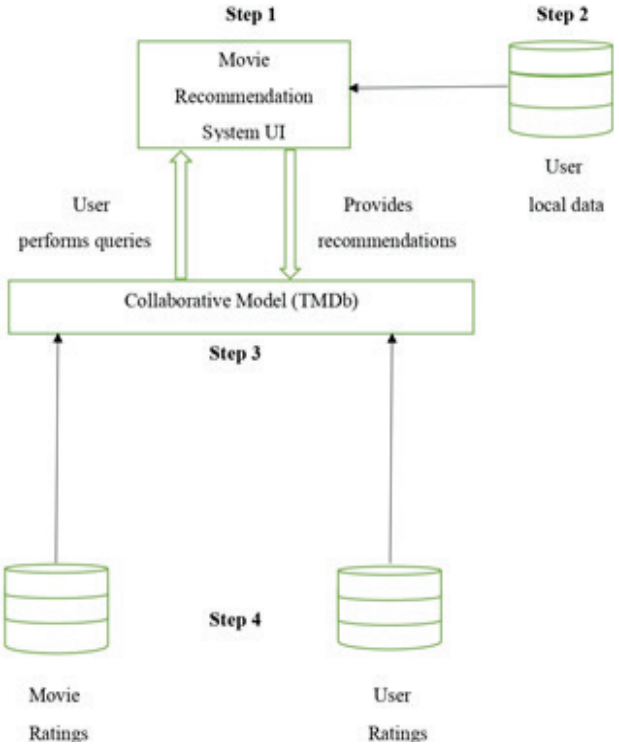


Fig. 1. Framework workflow

Data Description

The proposed system has two modules. The first module is a content-based (CB) recommendation system (RS), the first to use the TMDb database. The second module make use of the IMDb database.

The movie attributes selected for the proposed content-based movie system are shown in table 1.

Table 1. Example of a movie data used in CB recommendation system

Attribute	Value
Movie name	e.g. Batman
Genres	Action, Adventure, Sci-fi, Romance, Animation, Comedy, Crime, Drama, Family, Fantasy, Horror, Mystery
Keywords	Superhero, Attack, war, tony stark, family, new release, etc

TMDb database is publicly available for research work.

PROPOSED WORK

The proposed system has three major interrelated modules. The first module is content based movie recommendation system model, the second module is movie hit prediction module and next third module groups audience according to their age.

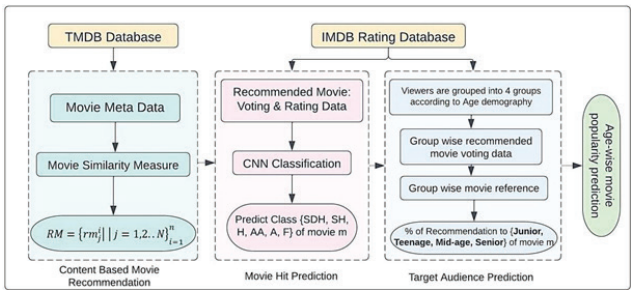


Fig. 2. Overall process flow diagram

Finally, the whole system provides an age-wise movie popularity prediction of the upcoming movie. The overall process flow diagram has shown in figure 2.

Content based Movie Recommendation

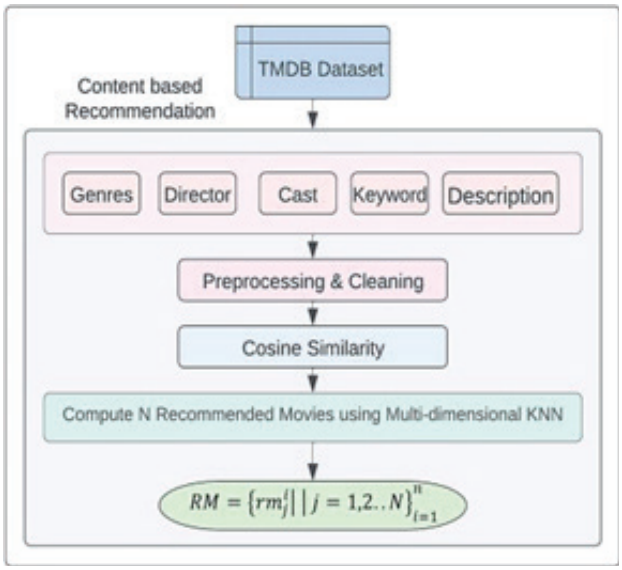
Content-based filter used for finding a similar movie. Which uses movie attributes to find out the similarity between the two movies.

TMDB database gives you recommendations, it contains its own recommendation module. This module works on content based recommendations, it recommends movies based in various filters and categories like genre, keywords, director, etc. Content based filter is used for finding a similar movie which uses movie attributes to find out similarities between two movies.

Let feature set F = (F_1, F_2,…,F_m). Compute the similarity between any two modules m_1 & m_2 concerning the feature F_k is

$dist\_F_k$ = similarity (F_{ki}, F_{kj})

The $dist\_F_k$ is distance vector between movies m1 and m2.



CONCLUSION

Recommendation systems have become an important part of everyone's lives. With the enormous number of movies releasing worldwide every year, people often miss out on some amazing work of arts due to the lack of correct suggestion. Putting machine learning based Recommendation systems into work is thus very important to get the right recommendations. We saw content-based recommendation systems that although may not seem very effective on its own, but when combined with collaborative techniques can solve the cold start problems that collaborative filtering methods face when run independently. Similarly such systems can be improved further by applying neural network embedding to uplift the quality of recommendations and make them more user personalized. Thus we conclude that studying various approaches towards recommendation engine is vital to come up with a collaborative engine that overcomes the shortcomings of these independent approaches and multiplies their benefits. Where independent approaches towards a movie recommendation system may have shortcomings, when combined the right way they will help users get the accurate recommendations for movies.

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Partial Replacement of Cement with GGBS in Concrete

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ABSTRACT

Concrete is the most widely used construction material in civil engineering industry because of its high structural strength and stability so it has become a vital part of our lives and thus the use of concrete is increasing at a very high rate.

The concrete industry is constantly looking for its alternatives with the objective of reducing the solid waste disposal problem. The production of cement releases large amount of carbon dioxide gas into the atmosphere, a major contribution of greenhouse effect and the global warming.

To overcome these problems there is a need of cost effective, alternative and innovative materials. In this project a comprehensive effort is made to partially replace the cement by ground granulate blast furnace slag (GGBS) as an alternative in combination with concrete admixture, for concrete ingredients which shall lead to global sustainable development and lowest possible environment impact and will also reduce cost of construction as well.

Ground Granulated Blast Furnace Slag is a by-product waste generated while producing iron. It is off white in colour and has similar cementitious properties like cement. Thus use of supplement materials is good for environment as manufacturing cement liberates a lot of carbon-dioxide.

Hence, there is a constant search for supplement material. This project is all about study of compressive strength of M25 concrete (Designmix) prepared by Ordinary Portland cement, partially replaced by GGBS in 10%, 20%, 30%, and 40% proportions and further comparisons are done.

After it erative trial mixes the water/cement ratio (w/c) was selected as 0.40. Self compacting Concrete mixtures produced, tested and compared in terms of compressive Strength with the conventional concrete for 7, 14, 21, 28 days. It is found that, 10% of GGBS can be replaced and strength obtained is comparable to the conventional concrete.

KEYWORDS *: Replacing cement partially with GGBS, To reduce the cost of concrete.*

INTRODUCTION

Concrete is a heterogeneous mix of cement, aggregates and water. The global consumption of cement is too high due to its extensive use in concrete. The demand for cement is quite high in developing countries owing to rapid infrastructural growth which results in supply scarcity and produce environmental problems due to emission of carbon dioxide in the atmosphere during manufacturing of cement. The concrete industry is constantly looking for supplementary cementitious material with the objective of reducing the solid waste disposal problem. To overcome from this crisis, partial replacement of cement with GGBS is an economic alternative. Ground granulated blast furnace slag (GGBS) is the solid wastes generated by industry.

Substantial energy and cost savings can result when industrial by-products are used as partial replacements for the energy intensive Portland cement. This

investigation attempts to study the feasibility of using locally available GGBS as partial replacements for cement and sand in concrete. In this research we prepared specimen of cubes for compressive strength test. Three samples for each set of percentage have been taken for conducting test and average of results are taken. The samples were tested at the age of 7 days, 14 days, 21 days 28 days.

Most of the producers of ready-mixed concrete that use GGBS slag do so in proportions of 50% of total cementatious material when the weather is warm and the GGBF slag is highly active (Wood 1981). Not only is this blend convenient, with a highly active GGBF slag this blend usually produces the greatest strength and most favourable cost to benefit ratio.

Increases in setting times are correlated with an increase in bleeding (Kanazawa etal. 1992). Slag replacement is generally observed to decrease early strength, often not "catching up" with control mixes until 90 days(Mailvaganametal.1983).This effect is highly dependent on the curing temperature.

The influence of GGBFS on concrete setting time is dependent on curing temperature, cement replacement level, and slag composition. It is generally reported that replacement of cemen0t with GGBFS increases setting time, particularly when replacement levels exceed 40.

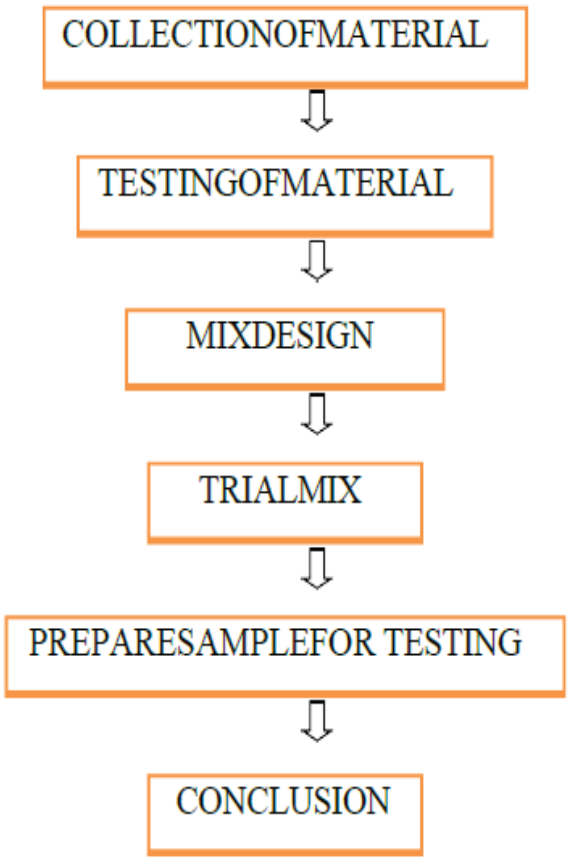
LITERATURE REVIEW

This paper presents an experimental study of compressive and flexural strength of concrete prepared with Ordinary Portland Cement, partially replaced by ground granulated blast furnace slag in different proportions. The cement concrete mix is prepared as per the procedure given in the BIS 10262:2009. For optimal dosage selection of GGBS in concrete mix, modified cubes (percentage ranging from 10% to 40%) are prepared and compared with plain cement concrete cubes and beams with mix proportion of 1:1.59:3.05 are prepared. The replacements of OPC with GGBS are made on an equal weight basis. The w/c ratio is taken 0.5% for all the mixes. Increase in % of GGBS results in decrease in strength of concrete. The replacement of OPC by GGBS up to 20 % shows the marginal reduction of 4-6% in compressive and flexural strength for 90 days curing: however beyond 20% replacement by GGBS the reduction in strength is substantial i.e. more than 15%.The reduction in the cost of concrete at the current market rate is 14%, in the case of GGBS as replacement of OPC by 20%.The partial replacement of OPC in concrete by GGBS, not only provides the economy in the construction but it also facilitates environmental friendly disposal of the waste slag which is generated in huge quantities from the steel industries palatal pnades.

METHODOLOGY

The objective mentioned in chapter 1 is to find out the strength of concrete by replacing one of its main constituents that is cement partially with GGBS by 10%, 20%, 30%, and 40%. We would be making about 36 cube sand comparing the test resultsfor7%,14%,21, 28days.To achieve this, we would be following the flow chart mentioned below,

The following flowchart shows the methodology or the process we'd be following in the project.



ADVANTAGES

Various advantages of partial replacement of Cement with GGBS are as follows

1. By collecting the information about characteristics of GGBS we conclude that after age of 90 days the compressive strength will be constantly increased.
2. The compressive strength of concrete will increased aby days as GGBS gain the strength slowly
3. It will be useful for the future of construction field for reduce the cost of construction as GGBS is cheaper than ordinary portland cement (OPC).
4. It reduces the cost of construction.

CONCLUSIONS

The results were analyzed to derive useful conclusions regarding the workability, strength, durability, characteristics of concrete, partial replacement of cement with GGBS in concrete, M25 Grade. The results are presented below :

Using GGBS as replacement for cement gives better compressive strength than the conventional mix; the natural hydraulic material property present in GGBS makes it an active component of the mix.

Strength gain is slower in concrete containing GGBS compared to conventional concrete

Due to this drawback it cannot be used in where time is consent as it may cause delay in completion of work.

At 10%, 20%, 30%, 40% replacement the compressive strength was greater than that for conventional concrete at 7, 14, 21, 28 days.

The test results saw a decline in strength at 30% and 40% replacement of cement by GGBS. As increasing the percentage of replacement of cement with GGBS the strength of concrete starts to decreasing

Hence it is recommended that the optimum percentage of replacement of cement byGGBS is 10%.

The compressive strength of the concrete increased after using GGBS. The grade attains a higher strength in the M25 grade concrete.

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Testing and Analysis of Composite T-Joint for Marine Application

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ABSTRACT

While progress has been made in addressing challenges related to modeling composite T-joints and utilizing composite materials, the evolving nature of both the materials and the structural designs indicates that there is ample opportunity for further exploration and innovation in this field. Three different materials are used in manufacturing composite T-joints: PVC foam, epoxy resin, and glass fiber. These materials were chosen based on a comparative study of alternative materials. This paper considers three different angles of a triangular shape for testing composite T-joints. The hand lay-up technique is used for the manufacturing of composite T-joints. Both analytical and experimental studies have been conducted. A tensile test was conducted on a UTM machine to determine the strength of the composite T-joint using a load vs. displacement graph. ANSYS software was used for analysis purposes, and the experimental results were compared with the ANSYS results. This composite T joint is made for Marine applications.

This study aims to determine the optimal angle for a composite T joint that maximizes strength. The results will be compared between theoretical calculations and simulations using MD solid software to validate findings. Based on these results, we have decided to manufacture a composite T joint with a 45-degree angle and conduct testing to evaluate its performance and effectiveness.

KEYWORDS *: Composite materials, Finite element analysis, Modeling of T-Joint, Testing.*

INTRODUCTION

Manufacturing composite structures is a complex process that requires specialized skills. The primary fabrication techniques for composite T-joints are casting and hand lay-up. The supporting component, known as the sandwich core, is constructed by applying a coating of glass fiber and epoxy resin to PVC. This resin binds with the glass fiber, enhancing the stiffness of the PVC foam board [1,19, 20]. To study the behavior of composite T-joints used in marine applications, the effect of several parameters was investigated. In particular, three configurations were studied: one with adhesive and two with different over-laminations. Additionally, the joined sections were made of different materials [2]. Recognized as a promising concept for the structural design of lightweight transportation systems such as aircraft, high-speed trains, and fast ships, aluminum sandwich construction is the focus of the present study. The aim is to investigate the strength characteristics of aluminum sandwich panels with an aluminum honeycomb core, both theoretically and experimentally [3]. To study the effect of the core material of sandwich panels, different foams with varying stiffness are used to model the core of the panels. Contact elements and

cohesive zone material models are employed to model the adhesive between joint components. This approach allows for the modeling of adhesive failure and the separation of joint elements [5,8]. The use of doubler plates and foam inserts in a bolted joint has resulted in higher strength and stiffness. This approach effectively mitigates joint opening, improving the ability to seal the joint and maintain watertight integrity [9]. The resin adhesion must be sufficiently strong to maintain structural integrity. Delamination of the core parts is the primary cause of T-joint failure. Testing different angles in the model helps determine which angles meet expectations. Significant modifications are needed in modeling to enhance the future of composite structures [13]. The expanded use of CFRPs has increased the need to join composite to metals in various structures. This includes composite skin structures with metal stiffeners found in turbine blades, aircraft wings, and car doors. [18].

The objective is to design and fabricate sample lightweight sandwich T-joint for material testing. To check & compare the best suitable angle for wedge fillet core using FEA and experimental techniques for high strength. Tensile and compressive tests will be carried out.

LITERATURE REVIEW

This study of materials covers the effects and strength of different composite materials. The advantages and disadvantages of composite materials over traditional materials like steel and aluminium are also covered, with the resolution of steel corrosion issues by PVC foam and glass fiber being a notable aspect. To ensure suitability for large-scale constructions, the mechanical properties of composites are extensively studied.

Composites are combinations of two materials, wherein one material, known as the reinforcing phase, takes the form of fibers, sheets, or particles and is embedded in the other material referred to as the matrix phase. The reinforcing phase encompasses fibers such as Glass, Graphite, Boron, Aramids (Kevlar), and other variants. Within the matrix phase, there are sub-materials such as Thermosets, Thermoplastics, Metals, and Ceramics.

In the domain of advanced composites, numerous exotic resins and fibers are utilized. However, epoxy resin and reinforcement fibers like aramid, carbon, or graphite hold dominance in this market segment. This product stands out as one of the most versatile industrial materials known today, boasting mechanical properties comparable to those of carbon fiber and polymers.

The properties of glass fiber are high strength to weight ratio, dimensional stability, high heat resistance, good thermal conductivity, outstanding electrical properties, Dielectric permeability, Compatibility with organic matrices and Good chemical resistance. Another widely used composite is PVC Foam, possessing properties such as high overall strength and stiffness relative to its density, substantial dimensional stability, elevated fatigue life, and suitability for use at higher temperatures. Wood core materials are also employed in sandwich panels.

One naturally occurring composite is End grain Balsa (EGB), characterized by its ultra-lightweight wood nature and exceptional properties, including a high strength-to-weight ratio for a core, a closed cell structure that imparts substantial compressive and shear stiffness and strength, the capability to withstand dynamic loads with remarkable resistance to fatigue, as well as serving as a competent thermal and acoustic insulator.

Composite materials offer numerous advantages, albeit accompanied by comparable disadvantages. One significant advantage of composites compared to other materials is their flexibility in employing various combinations of resins and reinforcements, thereby allowing for a customized tailoring of the mechanical and physical properties of a structure.

There is a large advantage for corrosion resistance of composites over metals such as aluminum and steel. The main concern about composite is the undefined failure mode which is a difficult task to analyze and thus the main disadvantage. Conventional ultrasonic, eddy current and visual NDI methods, such as radiography, also cannot inspect the nature of failure. The other disadvantage includes the aging of adhesively bonded joints in the structure. With time the adhesion between the sandwich panels of the composites loosens and leads to the de-lamination of the sandwich core.

The properties of composite structure are improved on the basis of materials used and the geometry of

the structure. Many structures with combinations of different materials are manufactured and tested to constantly improve the abilities of the composites. The structural strength and load carrying capacities can be improved by making modifications in the design and geometry of the composite structures. The nature inspired Honeycomb structure is the most advanced structure for the composites. The Honeycomb structure provides high strength to weight ratio, good heat dissipation, and lowers the usage of material.

D.W. Zhou and L.A. Louca have developed a 3D numerical model of the T-joint for both static and dynamic loading. To simulate the crack development of the adhesive, cohesive elements were employed. The effect of core strength was studied, capturing crack initiation and propagation through both numerical simulation and experimental methods. The failure mode of the base panel was investigated using simulation.

In this paper, G. Di Bella, C. Borsellino were studied the behavior of composite T-joints made in shipbuilding, investigating the effects of over-lamination sequence, materials of the joined sections, and the use of structural adhesive. For the investigation of the T-joint, they employed the virtual crack closure technique (VCCT) in finite element analysis(FEA). Mechanical and physical properties of the sandwich were obtained through analytical and experimental tests.

JeomKee Paik, Anil K. Thayamballi, Gyu Sung Kim were investigated the strength characteristics of aluminum panels both theoretically and experimentally. They discussed the structural failure characteristics of aluminum sandwich panels. To understand the bending behavior of aluminum honeycomb sandwich panels, they performed a three-point bending test. Additionally, various tests were conducted on the aluminum honeycomb sandwich panels, including crushing tests under lateral pressure, axial compression collapse tests, and three-point bending tests.

S.M.R. Khalili and A. Ghaznavi have studied adhesively bonded T-joint used in assembling sandwich structures, specially focusing on the advantage of adhesive bonded joints over bolted or riveted joints. The primary advantage highlighting is that adhesive bonding avoids the need for fastener holes in mechanical joints, which can lead to micro and local damages in the composite laminate during fabrication. Sandwich consist of two outer skins (usually made up of composite materials) separated by a core material (often lightweight and with properties like honeycomb structures of foam). These structure are commonly used in aerospace, automotive, marine and other industries where high strength-to weight ratios are crucial. Adhesive bonding offers several benefits in this context: Load distribution, weight saving, improved strength, Fatigue resistance and Corrosion preventive.

S.W. Boyd have introduces a methodology for optimizing a structural connection between steel and composite materials used in naval vessel construction, particularly in marine applications. The main approach involves employing genetic algorithms to perform parametric variation and optimization tasks, considering both single and multi-objective functions. The objective of this optimization is to enhance the performance of the connection between the steel hull and the composite superstructure. To establish a basis for comparison, a standard or "baseline" joint configuration is defined. Various parameters related to the joint geometry are then systematically varied, and the resulting joints are optimized using genetic algorithms. The performance of each joint configuration is evaluated using several metrics, including weight, Von Mises stress in the adhesive material, and global stiffness. These metrics provide insights into the joint's behavior and performance under different conditions. By analyzing how this performance measures change in response to specific adjustments in the joint geometry, the study identifies the sensitivity of the joint's performance to different design changes.

METHODOLOGY

Material researched one of the materials considered for making a prototype is a mixture of PVC form and epoxy resin and glass fiber powder which can be used as a filament in 3d printing. Specimen could have also been made using panels of PVC form and S-glass granules infused with each other with help of injection molding. These panels would have been attached to each other using epoxy resin.

Study of material

These materials can be engineered to meet specific mechanical, thermal, and chemical requirements,

making them suitable for a wide range of applications from aerospace to marine industries. When combined, PVC foam, E glass fiber, and epoxy resin create a synergistic effect, where each material's strengths complement the others, resulting in a composite T joint that offers superior strength-to-weight ratio, durability, and resistance to environmental factors.

Table 1: A Comparative study of material

S Glass	C Glass	E Glass
High Strength and High Durability	Good Chemical Resistance and Low Conductivity	Good Insulation and easy to available
PVC Foam	Steel	Aluminum
Light Weight, High strength, Corrosion Resistance and no Maintenance	High Strength and More Weight	Low Density and lighter than steel
Epoxy Resin	Vinylester Resin	Polyester Resin
High ultimate Strength than Vinylester Resin and Polyester Resin	Durable than polyester Resin	High Strength than polyester resin

Table 1 presents a comparison of various materials, and after careful consideration, Chosen PVC Foam as the core material due to its attributes of high durability, Epoxy resin for its exceptional strength, and S glass for its robustness. In conclusion, the combination of PVC foam, E glass fiber, and epoxy resin in manufacturing a composite T joint offers a balanced mix of lightweight construction, high strength, durability, and customization options, making it a preferred choice in various engineering applications.

Application

PVC foam -As it is scratch proof and available in a variety of colors along with its high durability it is used in store fixtures, architectural columns, sign boards, boat cores, and protection pads, etc [2].

Epoxy Resin- Because of its natural tendency to adhere to a wide range of materials, it finds applications in construction, paints and coatings, industrial tooling and composites, turbine technology, as well as electrical systems and electronics.

Glass fiber –It's most important property which is "non-rotting" helps it to get used in beverage industry, chemical industries, metals and mining, aerospace and defense industry, aquariums, docs and marines, automotive industries.

Comparative Study of Material

We compared conventional materials like steel, aluminum and other metal alloys with composite materials like PVC form and Glass fibers. We found that these materials had less cost than other materials and provided reasonably good strength compared to other materials of metal and composites [3].

Market Survey

Further survey for 3D printing led to the studies regarding the powdered form of PVC foam, epoxy resin and glass fiber which unveiled that searching for powdered filament is quite tricky and even though you get the right filament in powder form its properties should match the properties of 3D printer.

Along with that the limited dimension of machine results in conjoining two parts of the prototype making it less strong and with 35 rupees per gram of 3D printed part the overall prototype becomes too expensive.

Material selection and manufacturing

From many available materials available in the market, we decided three primary materials for our T-joint specimen; those are PVC form, S-glass and epoxy resin. One of the materials considered for making a prototype is a mixture of PVC foam, epoxy resin and glass fiber which can be used as a filament in 3D printing, but due to its high cost we decided to go for traditional PVC form and glass fiber hand layup technique instead of 3D printing the test specimen.

Finalization of specimen dimensions, volume fraction, and boundary conditions will be done from a literature survey.

Fabrication of sandwich T-joint for selected dimensions and volume fraction of glass fibre and epoxy resin will be done with hand layup technique.

Modeling

3D models have been prepared using CATIA V5R21 for the production of test specimens. The specimens have

dimensions of approximately 515mm in height and 600mm in width, with one having a rib angle of 45° and the other a rib angle of 60°.

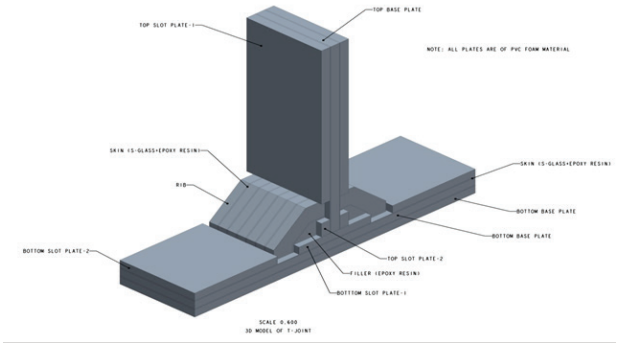

Fig. 1 3D Model of 450 T-Joint

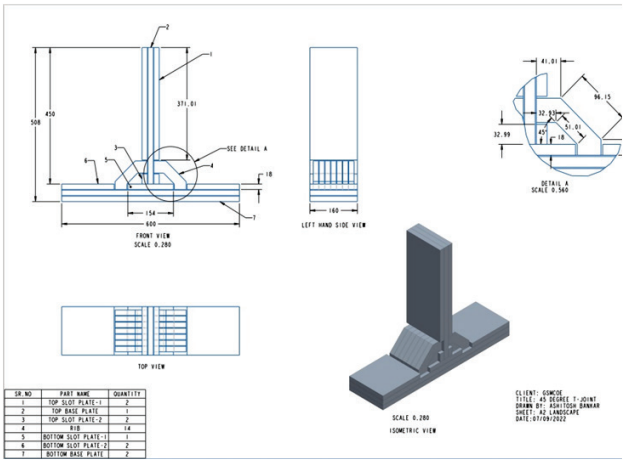

Fig. 2 45^0 T-joint 3D Model and Drawing

Using the following procedures in CATIA V5R21 for creates 3D Model of 450 T-Joint and 450 T-joint 3D Model and details of drawing. Sketcher, Part Design and Assembly Design are used to complete the 3D drawing of composite T joint.

Before going on to part design, we need to exit the workbench. The sketcher tool is used to sketch the T-joint and includes commands such as profile, rectangle, line, axis, trim, corner, chamfer, etc. After completing the sketch, we use the pad command to create a pad by extruding an open or closed profile. The pad command includes options like drafted filter pad, multi-pad, shaft, groove, etc. Additionally, we use the pocket command to create a pocket by removing material. For assembly design, we utilize the constraint tool, which includes different constraints such as coincidence constraint, contact constraint, offset constraint, fix component, quick constraint, etc. The contact constraint specifically helps in assembling the T-joint.

ANALYTICAL SOFTWARE CALCULATION USING MDSOLIDS

I have used MDSolids software to understand how much load is sustained on different points and find the support reactions.

Designing the model using MD Solid by using commands like:

- Creating grid for truss module.
- Drawing members.
- Providing support for members and applying force.
- Calculate.
- Verification by hand calculation.

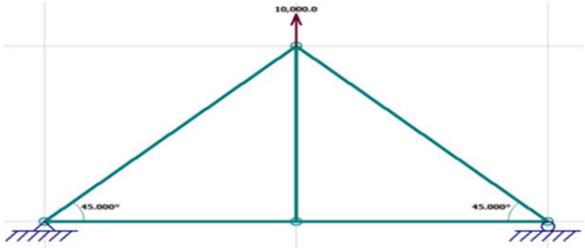

Fig. 3. Truss Analysis Module for 45^0 T-joint.

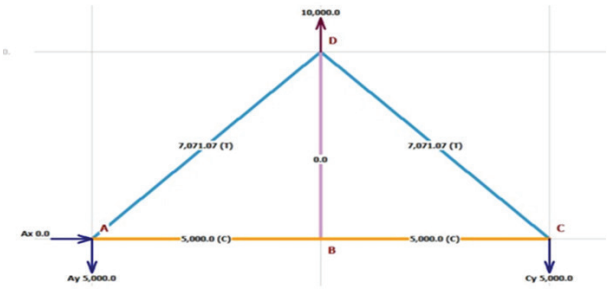

Fig. 4. Truss Analysis Module for 45^0 T-joint with all load values

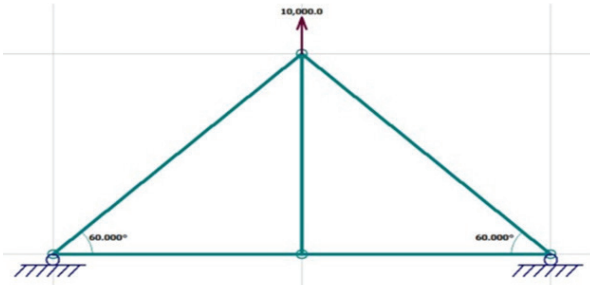

Fig. 5. Truss Analysis Module for 60^0 T-joint

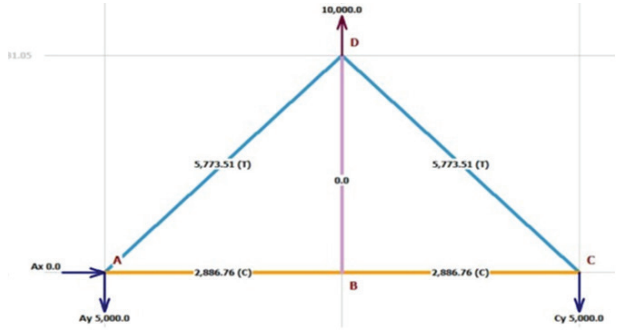

Fig. 6. Truss Analysis Module for 60⁰ T-joint with all load values

Table 2. Comparison between 45⁰ & 60⁰ Analytical software Calculations

Members	45⁰	60⁰
RC	5 KN	5 KN
RA	5 KN	5 KN
AB	7.071 KN	5.7735 KN
AD	5 KN	2.8867 KN
BC	7.071 KN	5.7735 KN
DC	5 KN	2.8867 KN
BD	0 KN	0 KN

In above table 2 Compared between 45⁰ & 60⁰ Analytical software Calculations getting less forces applied on 450 members as compared to 60⁰ members. So as per result chose 45⁰ composite T-joint for manufacturing.

When compared the calculations of 45⁰ MDSOLID Analytical software to those of 60⁰ MDSOLID Analytical software, it becomes evident that the latter offers superior performance, making it the preferred choice. Table 2 illustrates this comparison.

Manual Analytical calculation

45 Degree T-joint Rib Calculation

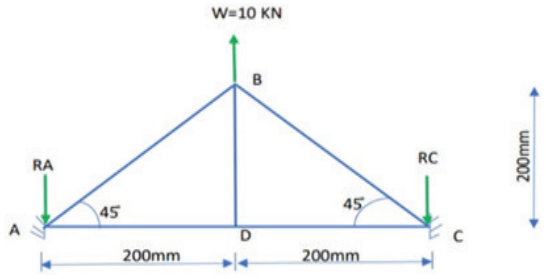

Fig. 7 45⁰ T-joint Rib Calculation

From Fig. 7, the loads acting on different points for the 45⁰ T-joint analytical Rib Calculations have been calculated.

$\Sigma Fy = 0$

$-R_A + 10 - R_C = 0$

Therefore, $R_A + R_C = 0$ (1)

Taking moment about point 'A'

$\Sigma M_A = 0$

$-(10*200) + (RC*400) = 0$

Therefore, RC=5 KN

From equation (1)

R_A=5 KN

Considering joint A

$\Sigma Fy = 0$

$-R_A + AB \sin(\Theta) = 0$

$-5 + AB \sin(45) = 0$

Therefore AB =5/sin45 =7.071KN

Therefore AD = - AB cos Θ

AD=-7.071 Cos(45)=-4.99KN

Considering joint 'C'

$\Sigma Fy = 0$

$-R_C + BC \sin\Theta = 0$

$-5 + BC\sin(45) = 0$

Therefore BC=5/Sin (45) =7.071KN

$\Sigma Fx = 0$

$DC + BC \cos\theta = 0$

$DC = -BC \cos\theta = -7.071\cos(45) = -4.99KN$

Considering joint D

$\Sigma Fy = 0$

$-R_A + W + BD - RC = 0$

$-5 + 10 + BD - 5 = 0$

Therefore BD=-10+5+5=0KN

Table 3: Comparison between 45⁰ Analytical MDSolid Software and 45⁰ Manual Calculations

Members	450	Manual
RC	5 KN	5 KN
RA	5 KN	5 KN
AB	7.071 KN	7.071 KN
AD	5 KN	4.99 KN
BC	7.071 KN	7.071 KN
DC	5 KN	4.99 KN

In above table 3 have compared the results between 45⁰ Analytical MDSolid Software and 450 Manual Calculations, revealing that both sets of results are nearly equal.

600 T-joint Rib Calculation:

$\Sigma Fy = 0$

$-R_A + 10 - R_C = 0$

Therefore, $R_A + R_C = 1O$ KN

Taking moment about point 'A'

$\Sigma M_A = 0$

$-(10 * 220) + (R_C * 440) = 0$

Therefore, $R_C = 5$ KN

Therefore, from equation (1)

$R_A + R_C = 10$ KN

Therefore

$R_A = 10 - 5 = 5$ KN

Considering joint a $\Sigma Fy = 0$

$-R_A + AB \sin \theta = 0$

$-5 + AB \sin(60) = 0$

Therefore, AB= 5.7735 KN

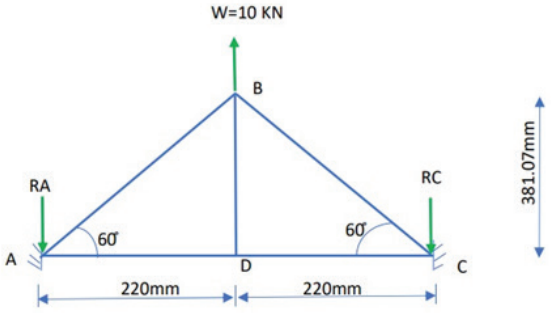

Fig. 8 60⁰ T-joint Rib Calculation

From Fig. 8, the loads acting on different points for the 600 T-joint analytical Rib Calculations have been calculated.

$\Sigma Fx = 0$

$AD + AB \cos(60) = 0$

Therefore, $AD = -AB \cos(60) = 5.7735 \cos(60)$

Therefore, AD = -2.8867 KN

Considering joint c $\Sigma Fy = 0$ $-RC + BC \sin \theta = 0$ $-5 + BC \sin(60) = 0$

Therefore, BC = 5/sin(60) = 5.7735 KN

$\Sigma Fx = 0$

$DC + BC \cos \theta = 0$

$DC = -BC \cos \theta = -5.3771 \cos(60) = -2.8867$ KN

Considering joint d $\Sigma Fy = 0$

$-RA + W + BD - RC = 0$ $-5 + 10 + BD - 5 = 0$

Therefore BD = 5 + 5 – 10 = 0 KN

Table 4: Comparison between 600 Analytical and 600 Manual Calculations

Members	60⁰	Manual
RC	5 KN	5 KN
RA	5 KN	5 KN
AB	5.7735 KN	5.7735 KN
AD	2.8867 KN	2.8867 KN
BC	5.7735 KN	5.7735 KN
DC	2.8867 KN	2.8867 KN
BD	0 KN	0 KN

Table 4 compares the results between 600 Analytical MDSolid Software and 600 Manual Calculations, revealing that both sets of results are exactly equal.

Outcomes of the analytical software and Manual Calculations

A. By comparing software calculation and manual calculation the results were same.

B. By comparing above results can conclude that a 45° T-joint provides much more strength than 60°Degree T-joint. Also getting more material filling area than 60°.

TENSILE TEST

Performing a tensile test to applying a tensile load on the test specimen until it fractures; this mechanical test is used to measure the strength and ductility of materials.

I. Sample preparation: According to the relevant standard, a test specimen is prepared from the material being tested, typically with specified dimensions. The ends of the specimen are machined or ground to ensure they are flat and parallel.

II. Mounting the specimen: In a tensile testing machine, the specimen is mounted, usually with grips at each end to secure it, and to ensure an even application of the load, the grips must be aligned with the specimen's long axis.

III. Applying the load: The machine typically applies a gradually increasing tensile load to the specimen at a constant rate specified by the standard, and records the load.

IV. Measuring deformation: The deformation of the specimen during the test can also be measured, and this can be achieved using strain gauges or extensometers, which are devices designed to measure the change in length of the specimen as the load is applied.

V. Fracture: The load and displacement at the point of fracture are recorded as the specimen eventually reaches its breaking point and fractures.

VI. Analysis of results: The tensile strength, yield strength, and elongation of the material calculated using the load-displacement and stress-strain curves.

Machine Specification:

Table 5. UTM Machine specification details:

Model Name/Number	**TUE-C**
Capacity	100-98000 N (10000kg)
Phase	3 phase 415V 50Hz AC
Machine Weight	1300-9000 Kg Approx
Accuracy	Loading accuracy well within +-1%
from 2% to 100% of capacity of the machine.	
Machine Type	Computerized
Displacement Resolution	0.01 mm
Control	Value Control
Computer Support	Yes

Fig. 9 Tensile Test Setup

In the static tensile test of the T-joint, the sample is mounted to the load cell at the top of the T-panel. Bottom plate (hull) of T-joint has fixed on movable platform of hydraulic testing machine with the help of C-clamps as shown above. The fixture attached with vertical plate (bulkhead) was clamped with mechanical arrangement to upper jaw of machine. Ensured that the T-joint at machine's center to avoid offset loading. The base of the test rig is 600mm*508mm long heavy section steel beam.

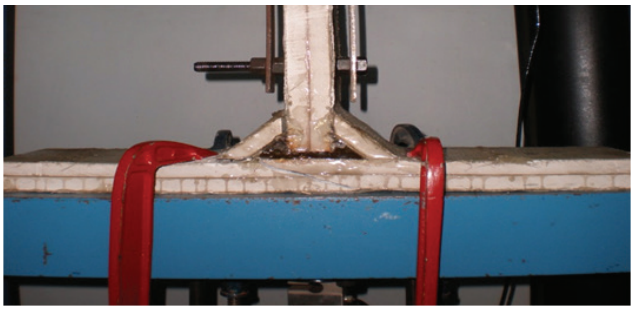

Fig. 10 A failed T-joint with crack to the bottom plate

Test Results

In Fig. 11, the plot of load versus cross-head displacement is displayed for one of the three specimens. The cross head speed has 3mm/min. The initial load value is 0.2 KN, attributed to pre-stressing, as well as the combined weight of square steel tubes and threaded steel rods. The load displacement curve at the center (for x= 0) exhibits near-linear behavior up to a load of 10 KN,

corresponding to a displacement of 4mm. Following this point, the curve demonstrates a slight departure from linearity until reaching a load of 16 KN, at which the displacement is 6 mm beyond this stage, the test specimen experiences substantial deformation while the load shows only a marginal increase, culminating in final failure occurring at a load of 18KN and a displacement of 11 mm.

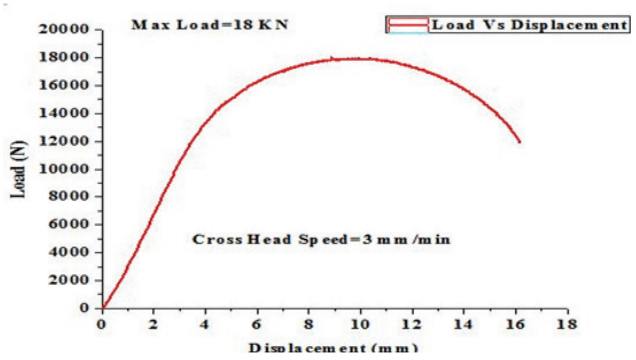

Fig. 11 Load vs. displacement curve for T-joint with full specification

FINITE ELEMENT ANALYSIS

Finite Element Analysis (FEA) is a numerical method for analyzing structure behaviors under various loading conditions. In this paper present the findings of a FEA performed on a composite specimen [1].The composite specimen used in this analysis was the same as the one used in the tensile, compression, and shear tests. The specimen's geometry was modeled using computer-aided design (CAD) software. Importing the CAD model into the finite element analysis software, it was subsequently divided into smaller elements. Subsequently, the software incorporated the material properties of the composite, and the defined boundary conditions of the model. The ensuing step involved subjecting the model to diverse loading conditions, followed by the analysis of the obtained results [2].

In the model, the element employed is the PLANE82, which is an orthotropic element with 8 nodes and operates within a 2 x 2 Gauss integration scheme. For the mesh, an automatic approach was adopted, resulting in an initial mesh configuration comprising around 10,200 elements. The element's side length varies, ranging from 2 mm in the upper skin of panel A and the filler, to 2 mm within the core of panels A and B. Following Figure 12 show the Deflection Plot of composite T-joint and Figure 13 Counter plot example of shear stresses. Since plot was made separately for each part (to increase resolution) the counters are not comparable between parts.

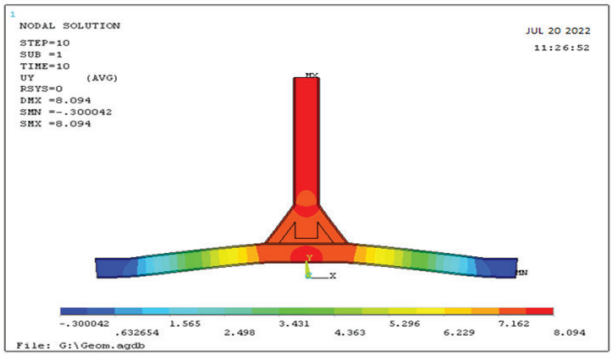

Fig. 12. Deflection Plot of composite t-joint

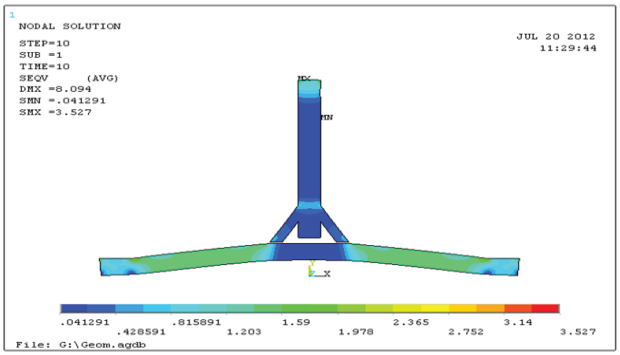

Fig. 13. Counter plot example of shear stresses

RESULT AND DISCUSSION

Evaluate the role and effectiveness of each material used (PVC foam, E glass fiber, epoxy resin) in enhancing the joint's strength and durability. The maximum strength achieved with the chosen 45-degree angle for the T joint. Compare experimental results (from testing) with theoretical predictions (from simulations or calculations). Identify failure modes observed during testing. The crack began at the interface between the over-laminate and the bottom skin, propagating through core A at approximately 18 kN after a displacement of 11 mm. The load-displacement relationship is illustrated in Figure 11. The experimental findings align with the ANSYS simulation results for the 45° T-joint. Based on this consistency, its application in naval ships is recommended.

Table 5: Comparison between Experimental and FEA Result

Load (N)	ANSYS Results (mm)	Experimental Results (mm)
2000	0.6	0.4
4000	1.5	2
6000	2.3	2.2
8000	3.4	3.1
10000	4.3	4
12000	5.2	4.3
14000	6.2	5.1
16000	7.1	6
18000	8.0	11

From the table number 5 will conclude the load and displacement both increase linearly until approximately 18KN and 11mm are reached, respectively.

The load increases, and at approximately 18000N and 11mm displacement, respectively, a change in slope occurs due to the deformation of the base. In this scenario, evident bending of the base element takes place.

CONCLUSION

The work has done in MDSOLID software and calculated the result. After comparison of analytical result and MDSOLID software result its conclude that a 45° T-joint offers significantly greater strength compared to a 60° T-joint. From above material study, Selected 45° T-joint materials finalized PVC foam, epoxy resin and E-glass for our composite material test specimen.

The lightweight 45° T-joint is designed for composite sandwich panels, which consist of two sheets of 18 mm thick PVC foam core and 2 mm thick fiberglass skin laminates. These panels are joined by epoxy resin filler material and joint two supporting core pieces made of PVC foam. After comparison of similar joint configurations by examining the relative stresses in various sections of the joint. This analysis involved assessing the load distribution and determining displacement patterns.

At a load of 18 KN, the T-joint fails in shear within the core of the base panel. Compared experimental testing result on Universal Testing Machine and ANSYS APDL result and plotted load verses displacement graph and found that the outcomes from both sources are similar.

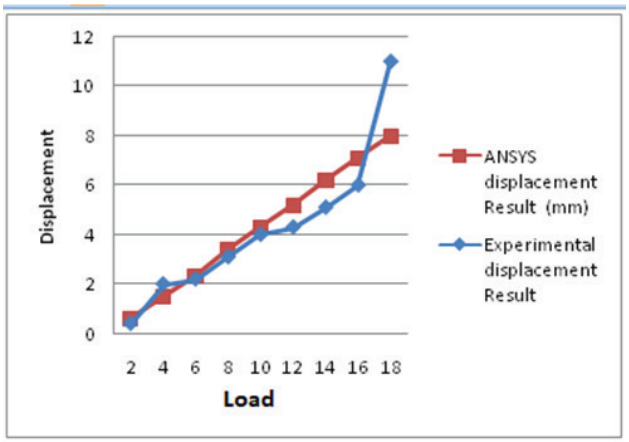

Fig. 12 Comparison of Load vs. displacement of Experimental and ANSYS results

The above Fig. 12 illustrates the comparison of Load on the X-axis versus displacement, showcasing Experimental and ANSYS results on the Y-axis. The graph conclusively demonstrates a remarkable alignment between the experimental and ANSYS displacement results, affirming the high quality of results achieved in the analysis and experimentation for 45° T-joint materials.

Based on the results, I strongly recommend using the 45° composite T-joint for marine applications as it outperforms the 60° T-joint.

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The Influence of Social Media on English Fluency Among Engineering Students in Pune, Transitioning from Academia to Instagram

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ABSTRACT

The research paper focuses on the shift in English fluency of engineering students in Pune while transitioning from an academic context to social media, specifically Instagram. Employing the decision tree model, the study assesses the students' self-reported levels of language proficiency, social media use, and one's English fluency based on subjective evaluations. The research uncovers a multifaceted correlation between social media engagement and language abilities, noting that heavy usage tends to decrease proficiency in English both in writing and speaking. The lessons provide an understanding on how different types of social media participation affect the processes of English language learning and reveal the new order of things concerning English fluency. The paper proposes methods for improving the students' language abilities with an emphasis on technology blended with conventional ways of learning. It proposes that practitioners and learners of a language need to re-think how language is learned by effectively using auxiliary digital resources while still observing essential practices of language basics. This approach will ease social media's adverse impact on English proficiency among engineering students of Pune.

KEYWORDS *: Social media, English language learning, English fluency, Decision tree model.*

INTRODUCTION

From basic cave paintings to the modern-day use of complex language and emojis, language is ever-evolving [1]. This progress on the resume of humanity is ongoing, further ensuring that people's ideas and thoughts are expressed with as much accuracy and clarity as possible [2]. This evolutionary journey is particularly prevalent in English as a language, which never fails to change with the ever-shifting societal, cultural and technological paradigms [3].

The English language has its roots in the merging of West Germanic speaking people including the Angles, Saxons, Jutes, and Frisians, circa the fifth century, in the English Isles. The distinct dialects of these tribes blended over the years and evolved to the modern-day English from Anglo Saxon or Old English [4] [5]. The English language was noticeably enhanced after several waves of migration, cultural diffusion, and colonization merged world languages like Latin, Norse, and French, engraving its vocabulary and finesse [6].

In the contemporary world, technology appears to be the underlying force driving another amalgamation; changing English as we know it today via social media platforms like Instagram [7]. This paper investigates

how the digital shift from academic environments to social media has affected engineering students in Pune, India [8].

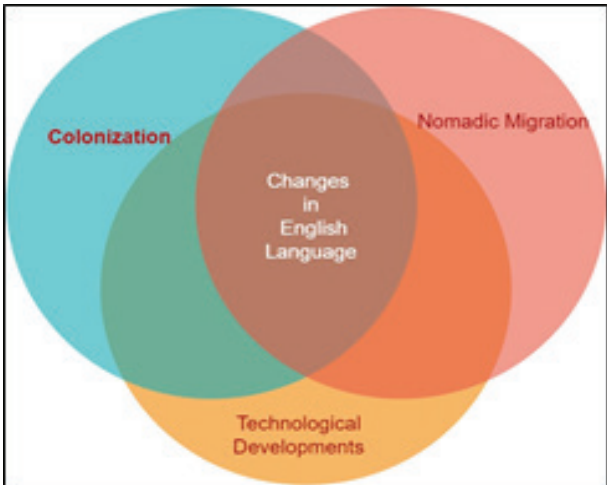

Fig. 1: Factors influencing evolution of English language

With the arrival of the Internet, English started dominating Computer Mediated Communication with new languages, English being the primary one [9] [10]. The rise of Facebook, Twitter, and Instagram increased international interaction which brought new vocabulary and language usage [11] [12]. Furthermore, these platforms' global reach inspire users from different cultures and languages, which aid in the fluid development of English [13].

Social Media encourages a new variant of English that is characterized by new vocabularies, shorthand, and non-standard English grammar [14] [15]. Such changes in English among engineering students in Pune can reflect what language proficiency in the modern world could look like, and how language teaching needs to change in order to accommodate such fluent uses of English [16].

LITERATURE REVIEW

Social media is observed to have both benefitial and harmful impacts on English usage [17]. The usage of platforms such as Instagram, Facebook, and WhatsApp has given rise to a new form of English [18]. This phenomenon serves to expedite the language's life cycle as it is demonstrated through the alterations of vocabulary, grammar, or even the manner in which people talk [19].

Informal Language Usage

The nature of social media itself promotes multitasking, which gives rise to informal speech forms that quickly adopt new bilingual or slang elements reshaping English [20]. Emphasis on brevity makes communication more succinct, resulting in altered understanding and speech patterns [21]. The terms "LOL," "BRB," and "OMG" have become an everyday norm as they allow people to express emotions swiftly [22] [23].

Already, slang terms such as 'lit' and FOMO, all of which stem from modern culture, display how social media changes the informal tone of language [24]. Moreover, the multilingualism of English is shown with words like 'jugaad', '@holacom' [25] [26].

Technical Limitations

Twitter's character limits necessitate creativity; for example, "gr8" is used instead of "great" [27] [28]. The desire to be efficient creates new forms of expression that defy established boundaries, showing how adaptable English is for the purpose of communication in the modern age [19].

METHODOLOGY

This research uses a mixed methodology of surveys and qualitative review in reading social media's effect to the fluency of English among engineering students in Pune, India, as they progress from studies to Instagram [29].

Research Questions

The study investigates the degree of fluency in English of engineering students in Pune with respect to a change in language and its use in a professional environment.

1. In what way does one's self-reported English proficiency differ from an objective evaluation based on their subjective answers?
2. To what extent does social media participation affect language mistakes in written responses?
3. How do respondents' age, social media use, and fluency in English correlate ?

The study approaches the subjects using both facets of research methodology (qualitative and quantitative), bringing Indian participants mainly from the state of Maharashtra. The quantitative portion looks at the

relationship between age and social media usage, while the qualitative portion attempts to prove the assumption that social media usage causes language mistakes outside social media contexts.

Data Collection & Sample

Data was collected through a Google online survey on self-assessed English proficiency, social media use, and other writing and speaking self-assessment skills [30]. The population consisted of 297 engineering students between the ages 18 and 25 which enabled thorough study of linguistic changes brought about by social media [31].

Statistical Tools

Descriptive statistics presented data concerning fluency scores and levels of engagement activities [32]. Correlation and regression analyses evaluated the interrelationships between the variables [33] [34]. Qualitative analysis was enriched by Grammarly supported content analysis that examined nonstandard English and provided further corroboration of qualitative findings [35].

DATA ANALYSIS

The analysis commences with the assessment of the qualitative features of the respondents, that is, the gender proportion, age brackets, and their self-assessed English skills. This demographic information is important to examine the relationship between social media use and English language skills of the engineering students in Pune, India.

Table 1: Demographic Profile of Respondents

Demography	Factors	Number	Percentage
Gender	Female	100	33.7%
	Male	197	66.3%
Age Groups	18-20 years	195	65.7%
	21-23 years	67	22.6%
	24-25 years	34	11.5%
Self-Evaluated English Level	Basic Level – 1	79	26.5%
	Intermediate Level – 2	148	49.8%
	Proficient Level – 3	69	23.3%

A total of 297 students responded to the questionnaire, of which 33.7% were female and 66.3% were male. Regarding the age composition, 65.7% were between the ages of 18 and 20 years, 22.6% from 21 to 23 years, and 11.5% were between 24 and 25 years. Their self-reported English skills were classified as basic (26.5%), intermediate (49.8%), and proficient (23.3%). These figures establish a foundation for investigating the relationship between social media use and the mastery of language [36].

The next step was to categorize respondents based on their usage of social media which is a key factor in analyzing its impact on English proficiency. Classification was based not only on the social media sites participants used, but also on how active they were on those sites. Participants' social media activities are represented in figure 2, whereas figure 3 shows the number of social media sites respondents are active on and participate in

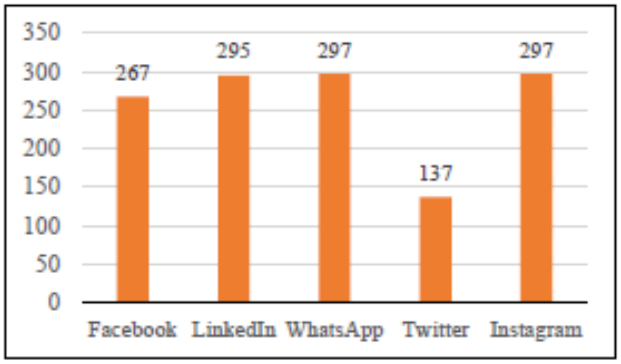

Fig. 2: Platform Popularity: Distribution of user Accounts Across Various Platforms among Respondents

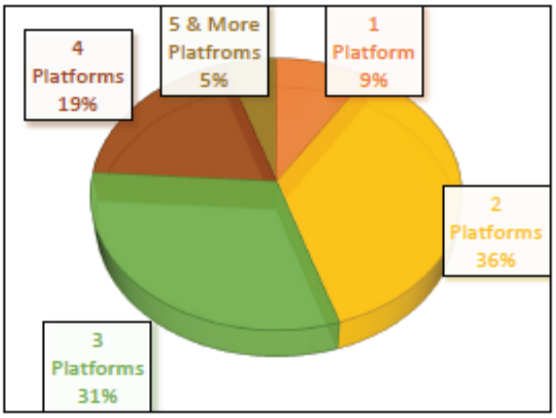

Fig. 3: Active Engagement Spectrum

Social Media Engagement

Respondents were divided into High, Medium, and Low Engagers according to their usage patterns which included time spent, content shared, and interaction levels. High Engagers (scores 9-12) were every day users, Medium Engagers (scores 5-8) were moderately active, and Low Engagers (scores 0-4) minimally interacted.

Table 2: Social Media Engagement Classification

Parameters	High Engager Scores= 9-12	Medium Engager Scores = 5-8	Low Engager Scores = 0-4
Time Spent on SM & Gaming	4.5 – 6 Hrs/day	2.5 – 4 Hrs/day	0.5 – 2 Hrs / day
Number of Content Shared	5 – 6 per day	3 – 4 per day	0 – 2 per day
Reaction to Content	Often	Regularly	Sometimes
Level of Interaction with others	Like, Share & Reply	View & Reply Personally	View & Exit

Table 3: Social Media Engagement Respondents

Engagement Level	Respondents
High Engagers	132
Medium Engagers	83
Low Engagers	82

Technological Features Impacting Communication

The participants were classified based on the use of language around code-switching, over reliance on auto-correct, use of internet language, and visual aids such as emojis and GIFs. Responses collected were classified into different usage scales (Never, Sometimes, Regularly, Often) to determine the effects on transformation of language.

Table 4: Usage of Technological Features Among Respondents

English Level	SM Tech Features	Respondents
Basic	High Usage	18
	Mid Usage	29
	Low Usage	14
Intermediate	High Usage	14
	Mid Usage	37
	Low Usage	32
Proficient	High Usage	62
	Med Usage	75
	Low Usage	16

Correlation Analysis

The study indicates a robust relationship between subjective and objective measures of English proficiency. An odds ratio of 0.11 and a relative risk of 0.33 indicate a gap between one's self evaluation and one's actual performance. A Pearson's R = -0.6815 ($p < 0.00001$) reflects the moderate negative relationship, while a chi-square value of 68.39 provides further evidence of statistical significance. These analyses point to the possibility that these respondents are inflating or deflating their language ability.

Linear Regression Analysis

The second research question examines the relationship between the error frequency and the extent of response engagement into social media. It is achieved through a linear regression analysis which seeks to find a pattern between individuals participation on social media and their language skills in addition to the quality of written communication.

Calculation Summary

Sum of X = 546

Sum of Y = 671

Mean X = 1.8384

Mean Y = 2.2593

Sum of squares (SSX) = 138.2424

Sum of products (SP) = -103.5556

Regression Equation = $\hat{y} = bX + a$

b = SP/SSX = -103.56/138.24 = -0.74909

a = MY - bMX = 2.26 - (-0.75*1.84) = 3.63637

ŷ = -0.74909X + 3.63637

In general, this analysis indicates that spending more time on social media is linked to users having fewer language mistakes in their written answers to open-ended questions in English. This may suggest that those who use social media constantly make less errors owing to better language skills or habits that stem from increased use of social media.

Multiple Regression Analysis

The Multiple Regression Analysis conducted for the third research question delves into the intricate interplay among respondents' age, their level of engagement on social media, and their English language fluency.

Calculation Summary

Sum of X1 = 5981

Sum of X2 = 1638

Sum of Y = 671

Mean X1 = 20.138

Mean X2 = 5.5152

Mean Y = 2.2593

Sum of squares (SSX1) = 1113.3401

Sum of squares (SSX2) = 912.1818

Sum of products (SPX1Y) = 22.3704

Sum of products (SPX2Y) = 330.3333

Sum of products (SPX1X2) = 51.8788

Regression Equation = ŷ = b1X1 + b2X2 + a

b1 = ((SPX1Y)*(SSX2)-(SPX1X2)*(SPX2Y)) / ((SSX1)*(SSX2)-(SPX1X2)*(SPX1X2)) = 3268.55/1012877.16 = 0.00323

b2 = ((SPX2Y)*(SSX1)-(SPX1X2)*(SPX1Y)) / ((SSX1)*(SSX2)-(SPX1X2)*(SPX1X2)) = 366612.79/1012877.16 = 0.36195

a = MY - b1MX1 - b2MX2 = 2.26 - (0*20.14) - (0.36*5.52) = 0.19805

ŷ = 0.00323X1 + 0.36195X2 + 0.19805

As noted previously in this analysis, age and social media usage both independently and collectively have a significant impact on English language proficiency of the respondents. Older age alone contributes to fluency moderately, but high engagement in social media seems to impact language skills considerably and positively. These results articulate the complex relationships of age, social media engagement, and language skills in this particular case.

DISCUSSION

The analysis indicates that there is a relationship between English language skills and social media usage among engineering students in Pune. The data reveals that 66.3% of the respondents and 65.7% of the respondents who were 18-20 years old were the most who filled in the questionnaire. English self-assessment indicated 26.5% basic, 49.8% of the respondents claimed to be intermediate speakers, and 23.3% rated themselves as proficient speakers.

The Linear regression analysis showed that frequent use of social media improves usage of the English Language because fewer language errors were made. The financing surveys quasi-experimental with the formula (ŷ = −0.74909X + 3.63637) resulted that there is correlation between usage of social media and increase in decrease of language errors. in social digital interactions. The Pearson's R (-0.6815, $p < 0.00001$) provides a moderate negative relationship between self-estimation and actual assessment results.

Besides, multiple regression analysis (ŷ = 0.00323X1 + 0.36195X2 + 0.19805) exhibited that social media fluency X1 is greater than age impacted fluency X2. The general conclusion on the research is that social media affect the language positively, which challenges the traditional view that it undermines the use of language.

CONCLUSION

This research focuses on the self-perceived level of English proficiency, age, fluency, and social media usage among engineering students based in Pune, India.

The results reveal the presence of a moderate negative association between self-assessment and objective assessment which suggests that there are gaps between how individuals rate themselves against actual language

proficiency. Higher social media use was associated with fewer language errors which suggests that those who frequently use social media tend to possess better language skills. Further, age was found to have a small positive effect on fluency, whereas social media usage had a strong positive effect on it.

These findings trigger the importance of blended methodologies when measuring self-reported language skills. The promotion of social media as a tool can serve as a means to improve language skills and not only to foster connectivity. However, the research is confined to the engineering college students of Pune, thus there is need for further studies across different populations as well as over time.

In general, this study notes and appreciates the impact that social media can have on developing language skills, as well as reacting to growing immigration and the integration of new technologies in communication and learning while increasing the levels of English proficiency.

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Treatment of Leachate by using Solid Waste

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ABSTRACT

Leachate, a hazardous liquid from landfill decomposition, is significant environmental challenge worldwide. Traditional Collection of Solid Waste: Gather the solid waste material you want to generate leachate from. This waste could include organic matter, plastics, paper, and other materials commonly found in municipal solid waste. Sorting and compressing: Depending on the initial state of the waste, you may need to shred or crush Itto increase the surface area available for leaching. This step helps to expedite the leaching process. Placement Ina Leaching Chamber or Tank: Place the shredded waste material in a container specifically designed for leaching. This could be a leaching chamber, tank, or any other suitable vessel. The container should have a drainage system at the bottom to collect the leachate. methods often involve complex and costly processes, making them unsustainable in the long term. Biochar, a carbon-rich material derived from biomass pyrolysis, has gained interest as a sustainable and cost-effective solution for leachate treatment. This paper reviews the current research on biochar's application in treating leachate, exploring its mechanisms for adsorption and filtration. Factors influencing biochar's efficiency include feedstock type, pyrolysis conditions, surface functional groups, and ph. The paper also addresses potential challenges and limitations, such as scale- up, regeneration, and disposal of spent biochar. Despite these, biochar shows promise as a sustainable solution for leachate treatment, offering advantages like low cost, abundant raw materials, and carbon sequestration potential. Future research should focus on optimizing biochar-based systems, improving understanding of mechanisms, and developing innovative large- scale implementation approaches. Biochar's versatility and eco- friendliness make it a promising avenue for addressing environmental pollution and promoting sustainability in waste management practices.

KEYWORDS *: Leachate, Biochar system, Environmental impact.*

INTRODUCTION

Leachate, a complex solution resulting from organic matter decomposition in solid waste, poses a significant environmental threat due to its high concentration of contaminant sand potential to leach in to soil and water bodies. Conventional methods for leachate treatment often involve complex and energy-intensive processes, presenting challenges in cost-effectiveness and environmental sustainability. Biochar, a carbonaceous material derived from biomass pyrolysis, has emerged as a promising alternative for treating leachate. It's high leprous structure with a large surface area facilitates the adsorption of contaminants, including heavy metals, organic compounds, and nutrients. Biochar offers several advantages over traditional methods, including low cost, abundant raw materials, and potential carbons quest ration. It can be integrated into existing waste management infrastructure, providing a sustainable solution for mitigating the environmental impact of solid waste disposal.

LITERATURE SURVEY

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Effects of landfill leachate application on crops growth

Evaluation of landfill leachate pollution and treatment

L. M. Chu et.al, Variations in the chemical properties of landfill leachate January 1994

PREPARATION OF LEACHATE

Collection of Solid Waste: Gather the solid waste material you want to generate leachate from. This waste could include organic matter, plastics, paper, and other materials commonly found in municipal solid waste. Sorting and compressing: Depending on the initial state of the waste, you may need to shred or crush Itto increase the surface area available for leaching. This step helps to expedite the leaching process. Placement in a Leaching Chamber or Tank: Place the shredded waste material in a container specifically designed for leaching. This could be a leaching chamber, tank, or any other suitable vessel. The container should have a drainage system at the bottom to collect the leachate. Application of Water: Add water to the container containing the solid waste. The amount of water added depends on factors such as the type and quantity of waste and the desired concentration of the resulting leachate. Generally, enough water should be added to saturate the waste material.

Agitation or Stirring (optional): If possible, agitate or stir the mixture to enhance the contact between the water and the solid waste. This helps in accelerating the leaching process by facilitating the transfer of contaminants from the waste to the water. Allow Leaching to Occur: Let the mixture situ in disturbed to allow leaching to occur. The duration of this step can vary depending on factors such as the composition of the waste, temperature, and agitation. Collection of Leachate: As water percolates through the waste material, it will dissolve and carry away various contaminants, forming leachate. Collect the leachate from the drainage system at the bottom of the container.

PRE-TESTING ON LEACHATE

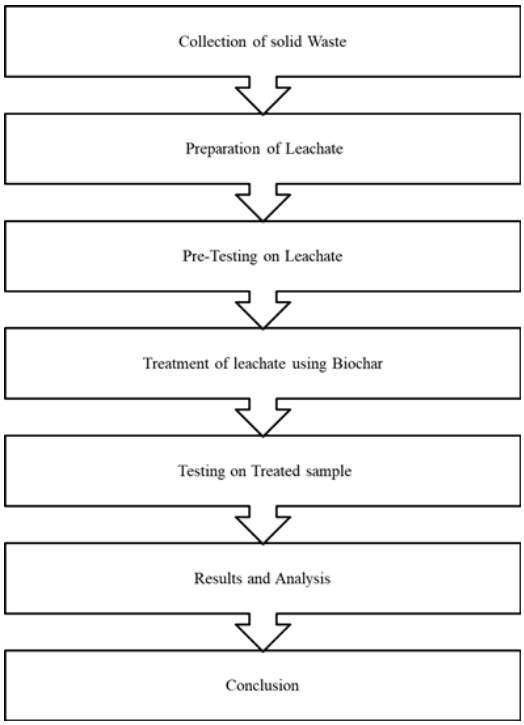
pH Testing on Leachate

Testing the pH of leachate is essential for understanding its acidity or alkalinity. Leachate is the liquid that drains from landfills or waste disposal sites, and its pH can impact environmental safety. Here's how pH testing on leachate is typically done:

Conductivity Test on Leachate

Conductivity testing is a valuable method for assessing the electrical conductivity of leachate. Leachate,

Methodology



Chemical Oxygen Demand(COD)Test on Leachate

The Chemical Oxygen Demand (COD) test is a crucial method for assessing the organic content and pollution level in leachate. Leachate, which originates from landfills or waste disposal sites, contains various organic and inorganic compounds. Here' show the COD test is typically conducted.

The Biochemical Oxygen Demand (BOD) Teston Leachate

The Biochemical Oxygen Demand (BOD) test is a crucial method for assessing the organic content and pollution level in leachate. Leachate, which originates from landfills or waste disposal sites, contains various organic and inorganic compounds. Here' show the BOD test is typically conducted:

Treatment of Leachate by using Biochar

Leachate treatment was an essential process. In older landfills and those with no mem- brane between the waste and the underlying geology, leachate is free to leave the waste and flow directly into the groundwater. In such cases, high concentrations of leachate are often found in nearby environment. As leachate first emerges it can be black in color, anoxic, and possibly effervescent, with dissolved and entrained gases. As it becomes oxygen at edited stouten brown or yellow because of the presence of iron salts in solution and in suspension. It also quickly develops a bacterial flora often comprising sub statical growth so sewage fungus. Hence, to a void all this leachate treatment has been worked out. Many landfills utilizer evaluate the use of "temporary capping geomembrane" for precipitation avoidance and landfill gas odor mitigation. The temporary membranes are more economical than a traditional 40 or 60 mil product and are used to temporarily prevent precipitation from entering a specific area of the landfill.

Method of leachate treatment

There are several methods for leachate treatment including: Physical Treatment

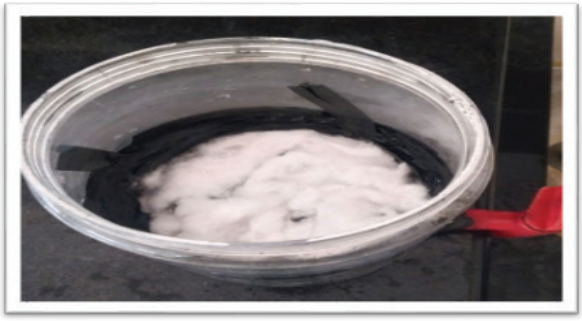
Chemical Treatment Biological Treatment

Use of Biochar in Filtration

Biochar is a carbon-rich material produced by heating organic biomass in allow-or zero-oxygen environment through a process called pyrolysis. It has unique properties and characteristics that make it valuable for various applications including soil amendment, carbon sequestration, and environmental remediation. Here are some key properties and characteristics of biochar:

Construction of Filter

Layer1: Cotton Layer:1cmthick



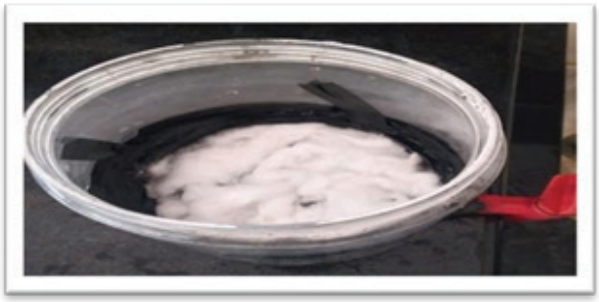
Layer2:Sand Layer:2cmthick(<4mm)

Layer3:Biochar Layer:3cmthick(<4mm)

Layer 4: 2cm thick sand layer(<4mm)

Layer 5: 4 cm thick biochar layer(4-10mm)

Layer 6: Top most layer of Gravelsize 10-20 mm

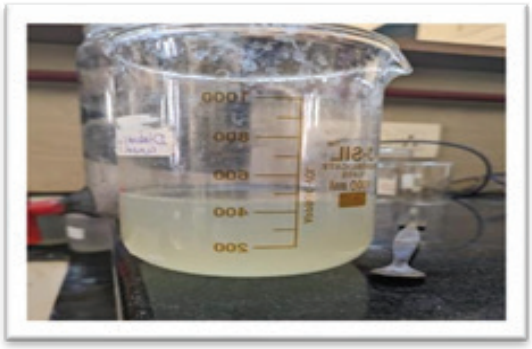


Filled the remain volume with Leachate Rate of filtration= 70ml/hr

Filtered sample from biochar filter Filled the remain volume with Leachate

Rate of filtration=70ml/hr

Filtered sample from biochar filter



RESULT AND DISCUSSION

Observations Before Treatment

Sr. no.	Name of test	Observations	Unit	Range
1	pH	5	-	4.2-7.8
2	BOD	4548	mg/l	2000 68000
3	COD	9984	mg/l	2740-152000
4	Conduc-tivity	7.5	µ/cm	5.8-52
5	BOD/COD	0.45	-	-
6	TDS	660	mg/l	500-50000
7	TSS	60	mg/l	10-5000
8	TS	720	mg/l	500-50000

Observations After Treatment

Sr. no	Name of test	Observations	Unit	Permi-ssible limit
1	pH	6.8	-	6.5-8
2	BOD	36	mg/l	<50
3	COD	960	mg/l	<500
4	Conduc-tivity	4	µ/c m	3.5-5.8
5	BOD/ COD	0.03	-	-
6	TDS	180	mg/l	-
7	TSS	36	mg/l	-
8	TS	216	mg/l	-

CONCLUSION

- Concluding the projection the treatment of leachate using biochar, it's evident that biochar holds significant promise as a sustainable and effective solution form it gating leachate pollution.
- Through comprehensive experimentation and analysis, we've observed its remarkable ability to adsorb contaminants, thereby reducing the or genic and in or genic load in leachate. Our finding underscores the potential of biochar as a cost-effective, eco-friendly alternative to conventional treatment methods.
- Not only does it offer a means to address the environmental challenges posed by leachate, but it also presents opportunities for waste valorization by utilizing organic residues for biochar production.
- From the above results, it can be concluded that Biochar removes 80-100 % of biological oxygen demand (BOD) and 80-100% of Chemical oxygen demand (COD) which can be considered as most economical method of leachate treatment
- The BOD/CODratioofbiocharis0.03withrespect to the depth of 10cm
- It can be concluded that Biochar is a better material for the treatment of leachate top even that remain ground water, soil and atmosphere for lining in a filter media.
- In conclusion, the application of biochar for leachate treatment holds tremendous potential for addressing environmental pollution while promoting sustainable resource management. By harnessing the inherent properties of biochar, we can strive towards a cleaner, healthier environment for current and future generation.

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UPI Based Smart Water Dispensing System

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ABSTRACT

The UPI-based Smart Water Dispenser project aims to revolutionize the water dispensing industry by integrating digital payment technology using UPI QR codes. This project utilizes an Arduino Uno microcontroller as the central control unit, along with components such as an LED display, SIM800L module for SMS communication, DC water pump with relay modules, buck converter for power regulation, and a QR code scanner module. The system allows users to make payments for water dispensing services by scanning a QR code displayed on the dispenser, initiating payment through UPI, and receiving payment confirmation via SMS. This report provides a comprehensive overview of the design, implementation, and functionality of the UPI-based Smart Water Dispenser with QR code payment integration.

KEYWORDS *: UPI, Dispensing, Transactions, Payments.*

INTRODUCTION

The increasing demand for an efficient and accessible water supply system has led to the development of the UPI based water dispensing system. Nowadays people prefer to use digital payments options instead of cash to avoid hassles associated with carrying cash. Access to clean drinking water is a fundamental necessity, and the goal of this project is to enhance the accessibility and convenience of water dispensing services through the integration of digital payment solutions. By leveraging UPI QR code technology, users can make payments securely and efficiently using their smartphones, eliminating the need for physical currency or card-based transactions.

COMPONENTS OF USED

1) Arduino Uno: Central control unit responsible for processing user input, controlling dispenser mechanisms, and interfacing with other components.
2) LED Display: Provides visual feedback to users regarding payment status, dispenser availability, and other relevant information.
3) SIM800L Module: Enables communication via SMS, receiving payment confirmation messages from Google Pay Business.
4) DC Water Pump: Dispenses water, controlled by relay modules. - Relay Modules: Control the operation of the DC water pump based on commands from the Arduino Uno.
5) Buck Converter: Regulates voltage supply to components, ensuring stable operation.
6) QR Code Scanner Module: Scans QR codes displayed on the dispenser to initiate payment.

SYSTEM ARCHITECTURE/ WORKING

The system architecture consists of the following components and their interactions:

- User Interface: Users interact with the system by scanning the displayed QR code using their smartphones.

- Arduino Uno: Processes QR code scanning, initiates payment processing, controls dispenser mechanisms, and communicates with the SIM800L module.

- LED Display: Provides real-time feedback to users regarding payment status, dispenser availability, and other relevant information.

- SIM800L Module: Receives payment confirmation messages via SMS from Google Pay Business and communicates this information to the Arduino Uno.

- DC Water Pump and Relay Modules: Dispense water upon successful payment confirmation, controlled by the Arduino Uno.

- Buck Converter: Regulates voltage supply to ensure stable operation of components.

IMPLEMENTATION

The implementation of the UPI-based Smart Water Dispenser with QR code payment integration involves the following steps-

-Hardware Setup: Connect the Arduino Uno, LED display, SIM800L module, DC water pump, relay modules, buck converter, and QR code scanner module according to the circuit diagram.

-Software Development: Write code for the Arduino Uno to control system behaviour, process QR code scanning, initiate payment processing, and control dispenser mechanisms.

-Integration: Integrate hardware components and upload software code to the Arduino Uno.

-Testing: Conduct thorough testing to ensure proper functionality of the system under various scenarios, including QR code scanning, payment success, and failure.

FUNCTIONALITY

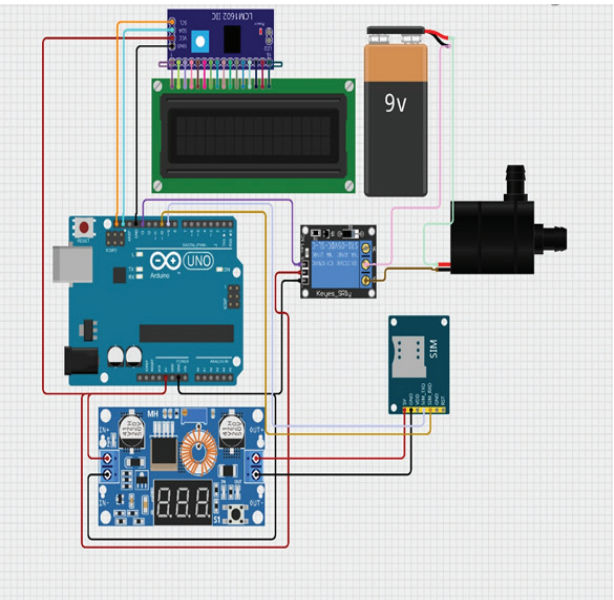
Users scan the displayed QR code using their smartphones to initiate the payment process. Upon scanning the QR code, the Arduino Uno initiates the payment process through UPI.

After successful payment, Google Pay Business sends a confirmation message to the SIM800L module, which is received by the Arduino Uno.

Upon receiving payment confirmation, the Arduino Uno activates the water dispenser mechanism, allowing the user to collect dispensed water.

The buck converter ensures stable power supply to components, enhancing system reliability.

BLOCK DIAGRAM



CONCLUSION

The UPI-based Smart Water Dispenser with QR code payment integration represents a significant advancement in the water dispensing industry, offering a convenient and efficient payment solution for users. By leveraging UPI QR code technology and integrating it with dispenser systems, this project enhances accessibility and user experience. Further enhancements could include remote monitoring and maintenance capabilities, as well as integration with additional digital payment platforms.

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